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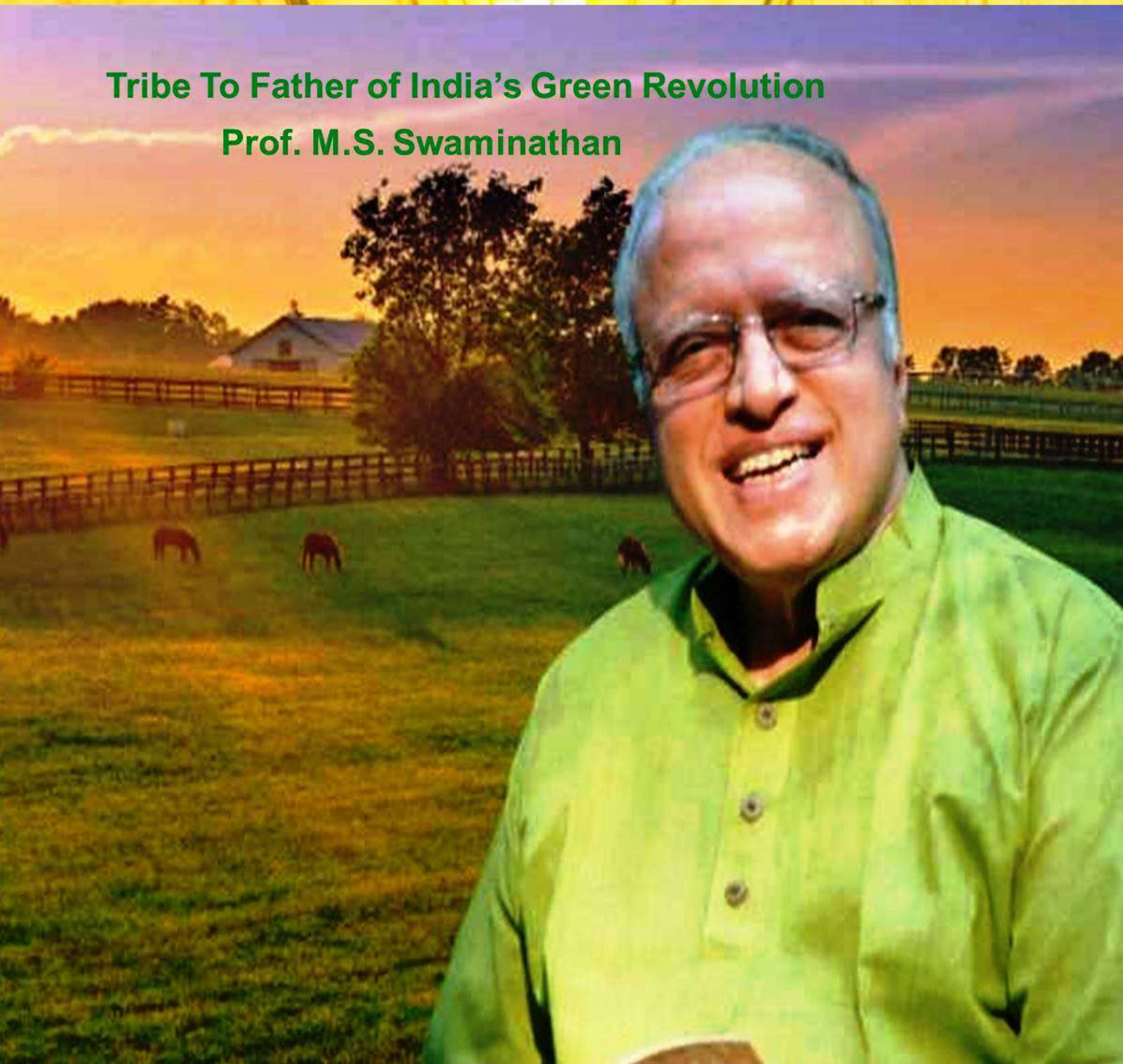
AgriGate

GROW WITH EVERY PAGE!

An International Multidisciplinary Monthly e-Magazine

Tribe To Father of India's Green Revolution
Prof. M.S. Swaminathan



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DOUBLING FARMERS INCOME BY 2022
KRISHI VIGYAN KENDRA
West Kameng, Dirang, Arunachal Pradesh
FARM SCIENCE CENTRE
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From the Desk of Editor-in-chief

October 2023 | Vol. 03 |Issue No. 10

I would like to introduce the launch of **“AgriGate - An International Multidisciplinary Monthly e-Magazine Volume 03 Issue No. 10 – October 2023”** with immense pleasure. Ourteam is privileged to dedicate this issue to **Prof. M.S. Swaminathan**. He is known as the “Father of the Green Revolution in India” for his leadership and success in introducing and further developing high-yielding varieties of wheat and rice in the country**.** He received the first World Food Prize in 1987, recognized as one of the highest honours in the field of agriculture.

The main objective of the magazine is to provide a publishing platform to young researchers and scientists as well as an information hub for the enthusiast, progressive farmer and also common readers. We envisage providing an online platform that appreciates illuminating articles on various topics related to agriculture and allied sciences monthly that will appraise and update the students, farming community and the whole society at large on the updates in agriculture.

Last but not the least, I wholeheartedly thank the editorial team, authors as well as anonymous reviewers for contributing to the release of this issue.

Our team welcomes your constructive feedback and suggestions to improve delivering fruitful content to hungry minds.

Dr R Shiv Ramakrishnan
Editor-in-chief
AgriGate Magazine

Volume: 03 Issue No: 10

THE POWER OF BIOPESTICIDES: GREEN SOLUTIONS FOR A SAFER FUTURE

Article ID: AG-VO3-I10-01

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Abstract

Undoubtedly huge amount of research on biopesticides is going on but its production and commercialization part still needs improvement although government has tried to incentivise all the biopesticides manufacturing companies to increase its production and its dissemination. Now the farmers have to decide between the acute but harmful outcomes generated by uses of insecticides and eco-friendly and long-lasting effects formulated by the use of biopesticides. The use of biopesticides, which combine efficient pest control with environmental responsibility, offers prospects for long-term pest management. They provide an arsenal of tools derived from nature to combat pests while minimizing risks to human health and the environment. However, addressing the limitations and challenges associated with biopesticide development, regulation, and accessibility is crucial to their wider adoption. Continued research, investment, and supportive policies can contribute to harnessing the full potential of biopesticides paving a way for more sustainable and resilient agricultural future.

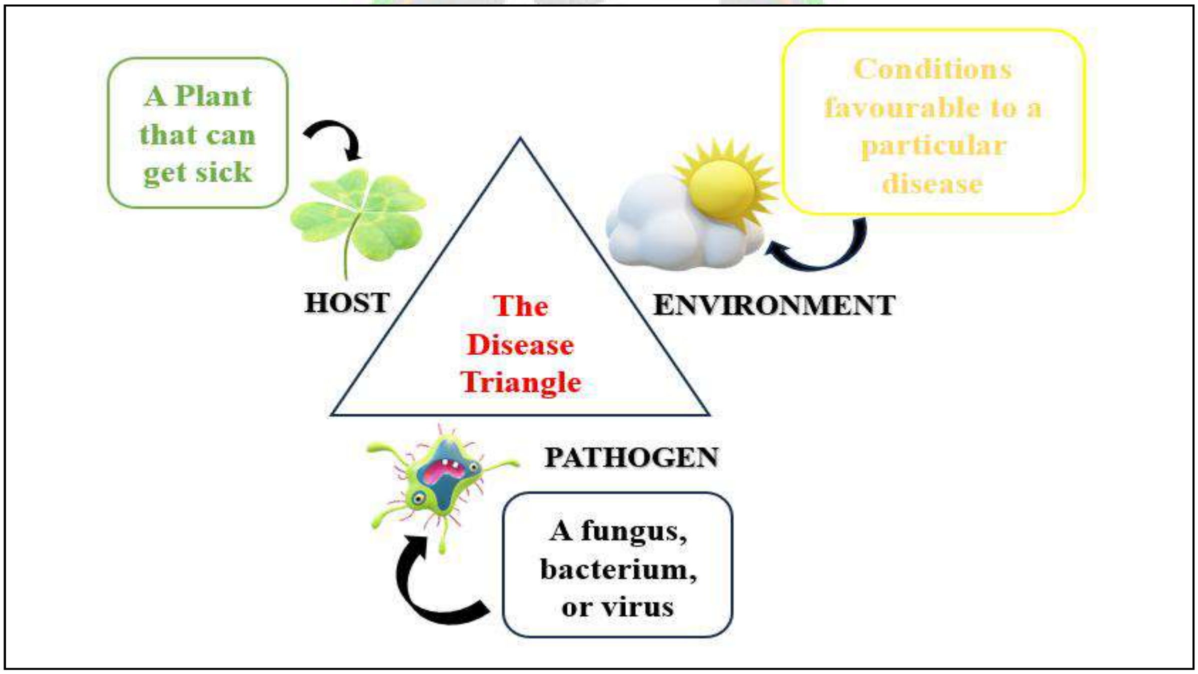
Keywords: Biopesticide, indiscriminate, agrochemicals, government schemes and sustainable agriculture.

Introduction

The demographic load of the world is increasing day by day and to cater the need of this growing population, the production & productivity of agricultural crops should be increased. We are well aware with a fact that the productivity of staple crops has become stagnant for the last couple of years due to several factors. Apart from that there are certain biotic and abiotic stresses *viz.*, natural calamities, manmade nuisance and particularly insect pest which hamper the production of agricultural crops. In particular, there are several diseases (fungal, bacterial, viral etc.) that pose a serious threat to agricultural crops. To counter the detrimental effects of these biotic stresses a wide range of agrochemicals are being used nowadays. Undoubtedly there are unwanted harmful effects on human beings and their belongings.

In order to comprehend the entire phenomenon, first we need to understand what is disease and its mechanism. The disease is an outcome of interaction of host, pathogen and environment and can be depicted through a disease triangle. The disease triangle refers to three critical elements that must coincide for an infection to occur though excluding any one of them can avoid the infection.

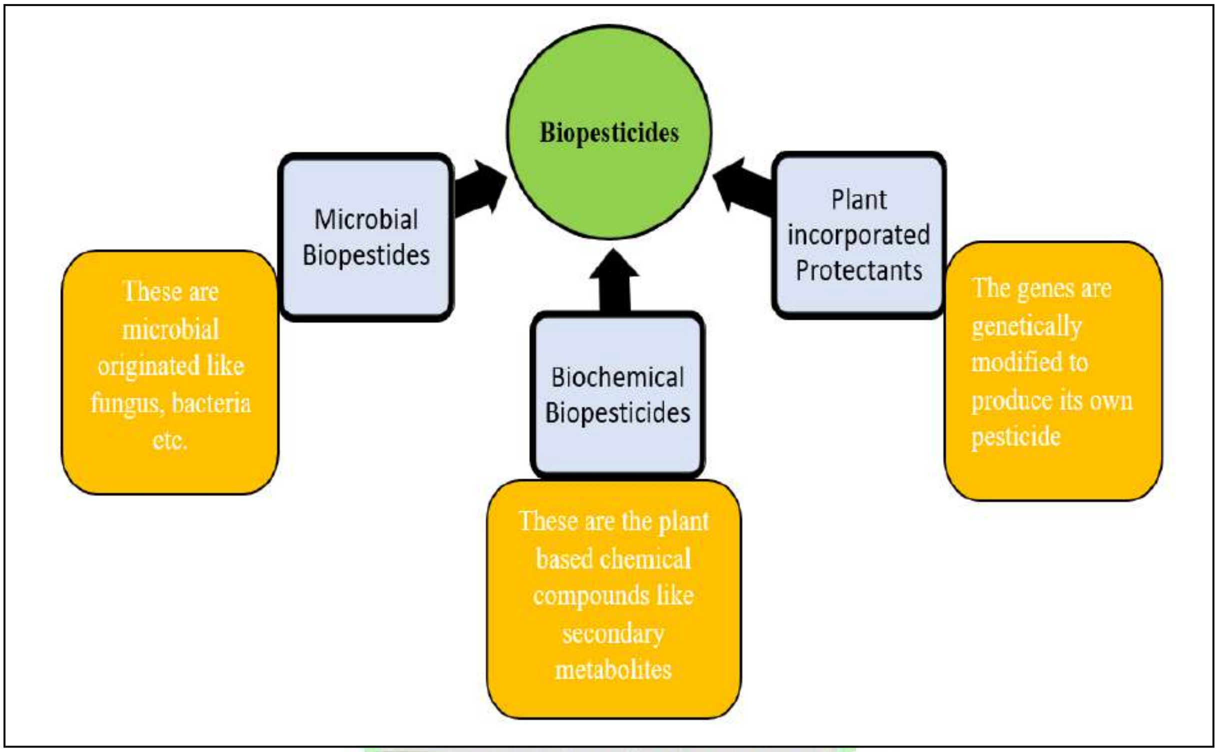
Therefore in order to counter these diseases huge amount of agrochemicals (fungicides) are being used to fulfil the requirement of food for survival. Over the last 60 years, the increased use



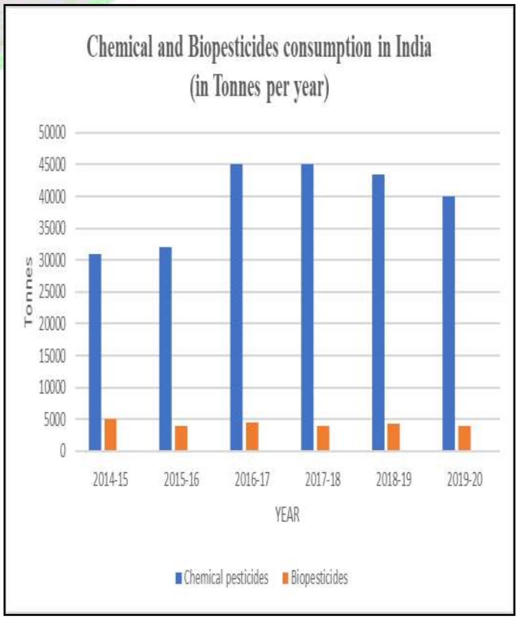
of chemical pesticides has led in an endless number of concerns, including pesticide resistance, pesticide-induced epidemics of various pests, revival, and harmful effects on human health and the environment.Given the environmental impact of chemical pesticides, the Government of India is supporting the use of biopesticides for the management of the ecosystem, since they are cost effective and environmentally benign.

Biopesticides

Biopesticides are certain types of natural compounds that have been derived from living organisms to protect the agricultural vegetations from the phytopathogens (Kumar and USEPA). Further, biopesticides can be classified into three major categories:



Every year, around 25 million individuals in underdeveloped nations suffer from acute occupational pesticide exposure, and nearly 20,000 people die globally. The harmful impact of the chemical insecticides could be either direct or indirect, for instacnce, The Bhopal Gas Tragedy in 1984, where leakage of Methyl isocyanate gas from pesticide plant caused death of thousands of people and it still affecting the people today (Broughton, E, 2005& Hanley, 2021). According to Nayak (2021) the consumption of biopesticide is quite low as compared to chemical pesticide due to chronic result



or limited awareness. Although chemical pesticides provide quick action against the target pathogen but it may also cause hazardous effect on human beings and environment if not used rationally. India is the 12th largest chemical manufacturer with a 4.2% share of the global biopesticide industry (Sharma et al., 2018).

How chemical pesticides are different from the biopesticides?

Biopesticides	Chemical pesticides
Friendly to non-target species	Harmful to non-target species
Do not cause serious pollution to ecosystem	Serious pollution to the ecosystem
Relatively cheaper	Relatively expensive
Lower risk of resistance	Pest eventually develop resistance
Minor residue issue on crops	Residues can cause serious threats

In order to create awareness among farmers and encourage the production (companies), Government of India has launched several programmes aimed at encouraging organic inputs and chemical free agriculture produce in order to improve people's health. (PIB Delhi, 2020).

Sr. No.	Schemes initiated by Govt. of India	Purpose of scheme
1.	Paramparagat Krishi Vikas Yojana (PKVY)	A grant of Rs. 50,000 per hectare is provided for three years, with Rs. 31,000 (62%) going directly to farmers through DBT for inputs (bio-fertilizers, bio-pesticides, vermicompost, botanical extracts, etc.) procurement and post-harvest management.
2.	Mission Organic Value Chain Development for North Eastern Region (MOVCDNER)	Farmers receive Rs. 25000 per hectare for three years for both on-farm and off-farm organic inputs, as well as seeds/planting material.
3.	Capital Investment Subsidy Scheme	It encourages bio-fertilizer production by providing 100% assistance to state governments and government agencies up to a maximum of Rs.160.00 lakh per unit for the establishment of

		state-of-the-art liquid/carrier-based bio-fertilizer units with a capacity of 200 tonnes per year. Similarly, the National Bank for Agriculture and Rural Development provides support up to 25% of the cost of a unit, up to Rs.40 lakh/unit, as capital investment.

References

Broughton, E. (2005). The Bhopal disaster and its aftermath: a review. *Environ Health* 4, 6 https://doi.org/10.1186/1476-069X-4-6.

Hanley, B. (2021). What Caused the Bhopal Gas Tragedy? The Philosophical Importance of Causal and Pragmatic Details. *Philosophy of Science*, *88*(4), 616-637. Doi:10.1086/713902.

Kumar, J., Ramlal, A., Mallick, D., & Mishra, V. (2021). An Overview of Some Biopesticides and Their Importance in Plant Protection for Commercial Acceptance. *Plants (Basel, Switzerland)*, *10*(6), 1185. https://doi.org/10.3390/plants10061185

Nayak, P. &. (2021). Pesticides and Indian agriculture-a review. International journal of research granthaalayah, 9(5), 250-263. Retrieved from https://doi.org/10.29121/granthaalayah.v9.i5.2021.3930

PIB Delhi (2020). Promoting use of bio pesticides and fertilizers. Ministry of Agriculture & Farmers Welfare.

Sharma, Kamal & Raju, Svs & Jaiswal, Deepak & Thakur, Sudeshna. (2018). Biopesticides: an effective tool for insect pest management and current scenario in India. *Indian Journal of Agriculture and Allied Science*, 4(2).

USEPA. (2008). What are biopesticides? http://www.epa.gov/pesticide/biopesticides//what arebiopesti cides.htm

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REVOLUTIONIZING AGRICULTURE: THE RISE OF VERTICAL FARMING

Article ID: AG-VO3-I10-02

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Introduction

In a world grappling with population growth, urbanization, and climate change, traditional agriculture faces unprecedented challenges. The demand for fresh, nutritious, and sustainably grown produce has never been higher. Enter vertical farming, an innovative agricultural technique that is poised to change the way we grow and consume our food. In this article, we'll explore the concept of vertical farming, its benefits, and its potential to reshape the future of agriculture.

Fig.1 . Vertical Farming

The Vertical Farming Concept

Vertical farming is a revolutionary farming method that takes agriculture to new heights—literally. Instead of sprawling fields and large, land-intensive operations, vertical farming leverages technology to cultivate crops in stacked layers or vertically inclined surfaces. These indoor farms can be found in repurposed warehouses, shipping containers, or purpose-built structures in urban areas.

Key Components of Vertical Farms:

1. Vertical Structures: Vertical farms are equipped with multiple levels or shelves that maximize space utilization. Each level is equipped with specialized lighting, climate control, and irrigation systems to optimize plant growth.

2. LED Lighting: Advanced LED lighting systems provide plants with the precise spectrum of light they need for photosynthesis. This means that crops can grow efficiently year-round, regardless of external weather conditions.

3. Hydroponics or Aeroponics: Soil is often replaced with hydroponic or aeroponic systems, where plants receive nutrients directly through water or a nutrient-rich mist, eliminating the need for soil. This method also reduces water usage.

4. Climate Control: Temperature, humidity, and CO_2 levels are carefully controlled to create the ideal conditions for plant growth, resulting in faster growth and higher yields.

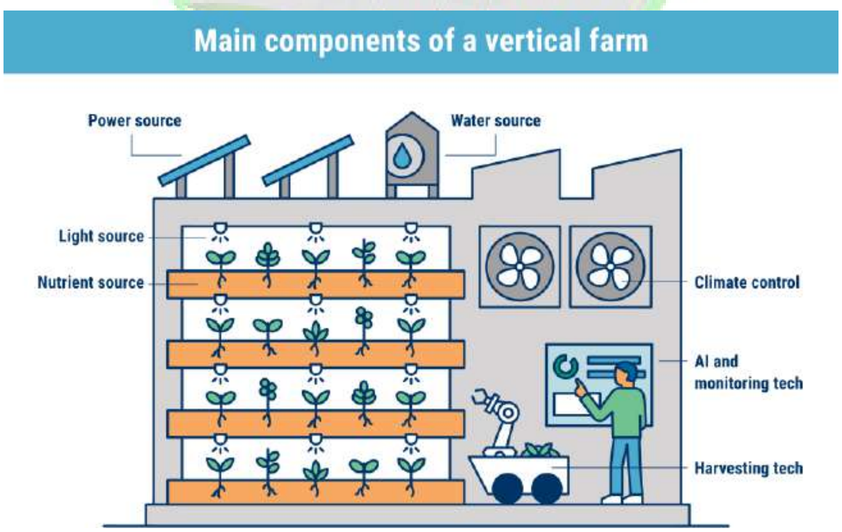

Figure 2. Key Component of Vertical Farming

Benefits of Vertical Farming

1. **Year-round Production:** Vertical farms are not dependent on seasons or weather

conditions, allowing for continuous, year-round crop production. This reduces the vulnerability of agriculture to climate change and weather-related disasters.

2. **Reduced Land Footprint**: Vertical farms occupy significantly less land compared to traditional agriculture, making them ideal for urban environments where space is limited. This land efficiency can help preserve natural habitats and reduce deforestation.
3. **Water Efficiency:** Hydroponic and aeroponic systems used in vertical farming use significantly less water compared to traditional soil-based farming. Water recycling systems further minimize waste.
4. **No Pesticides:** The controlled indoor environment of vertical farms reduces the need for pesticides and herbicides, resulting in cleaner, healthier produce.
5. **Shorter Supply Chains:** Vertical farms can be located closer to urban centers, reducing the distance food travels from farm to table. This shortens supply chains, reducing transportation emissions and ensuring fresher produce.
6. **Higher Crop Yields:** With optimized growing conditions and precise control over environmental factors, vertical farms often achieve higher crop yields per square foot than traditional farms.

Crops Suitable for Vertical Farming in India

As a farmer, you have to decide which crop should be produced. So, you have to choose the crop after study of market demand and production cost.

Some Small Size Vertical Crops are;

- Lettuce
- Broccoli
- Amaranthus
- Tuber crops, etc.

Some Medium Size Vertical Crops are;

- Cabbage
- Cauliflower
- Tomato
- Brinjal, etc.

Some Big Size Vertical Crops are;

- Maize

- Sorghum, etc.

Challenges and Future Prospects

Energy Consumption

- One of the challenges of vertical farming is its energy consumption, primarily due to the need for artificial lighting and climate control.
- Advances in energy-efficient technologies are expected to address this issue.

Economic Viability

- The cost of setting up and operating vertical farms can be high.
- Continued research, innovation, and economies of scale are essential for making vertical farming economically sustainable.

Scaling Up

- As the demand for vertical farming grows, there is a need to scale up operations to make a significant impact on food production.
- Investment and policy support can play a vital role in this expansion.

The Future of Food

Vertical farming is not just a novelty; it's a sustainable solution to some of the most pressing challenges facing our agricultural system. As the global population continues to grow, and as urbanization increases, the demand for fresh, locally sourced, and environmentally friendly food will only rise.

In cities around the world, vertical farms are already producing a wide range of crops, from leafy greens to strawberries and even fish. With ongoing advancements in technology and increased investment in vertical farming, we can expect to see even more diverse and sustainable food options become available.

Conclusion

Vertical farming represents a promising step towards a more sustainable and resilient food system. By maximizing space, minimizing environmental impact, and producing fresh, pesticide-free crops year-round, it offers a glimpse into the future of agriculture. As we continue to confront the challenges of a changing climate and a growing population, vertical farming is set to play a crucial role in feeding our world while preserving the planet for generations to come. It's time to embrace this innovative approach to farming and reap the benefits it offers for both people and the planet.

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KADAKNATH FARMING: A PROFITABLE VENTURE FOR INDIAN FARMERS

Article ID: AG-VO3-I10-03

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Abstract

Kadaknath, a black chicken indigenous to India, is one of the only three black meat chicken breeds in the world, along with Ayam Cemani from Indonesia and Silkie from China. This breed of poultry inhabits vast areas of the western region of Madhya Pradesh, mainly Jhabua and Dhar districts. Its meat is used in tribal medicine for its invigorating and health-promoting properties. Expectations of immune-boosting and therapeutic properties in its meat are creating a buzz these days. It is the only animal breed to get GI tag for protein rich and black coloured meat, which is native to Jhabua. In India, Kadaknath poultry farming is mostly carried out by rural communities that are impoverished and marginalized. It offers opportunity for women's self-help organizations, tribal farmers, jobless youth, etc. to live sustainably. In 20 Indian states, Kadaknath has already touched 117 districts.

Keywords: Kadaknath, Farming, Black Meat, Sustainable Livelihood, Therapeutic Properties.

Introduction

The original name of Kadaknath, Kala Masi, means chicken having black flesh. It is an indigenous breed of poultry inhabiting the western region of Madhya Pradesh, mainly Jhabua and Dhar districts, and adjoining areas of Gujrat and Rajasthan. Kadaknath is also called Chhattisgarh's 'Black Gold' as it is famous for its black meat, and its eggs also have a high amount of protein. It is usually reared by poor and marginalized rural households and tribal farmers in the backyard method, but now farmers are attracted to rearing this breed because it is disease-resistant and far more tolerant to changing environmental conditions like summer heat and cold winter stress compared to exotic varieties of poultry. These birds also grow well in challenging situations like poor housing, bad management, and subpar nutrition. For a long time, this breed has been reared by tribals in Madhya Pradesh (Bheels, Bhillalas, and others). Therefore, through many generations of selection and fixation of genes, some of the important breed characteristics have been established.

Breed characteristics

Kadaknath is one of the native chickens as per the ICAR National Bureau of Animal Genetic Resources (Accession No. INDIA_CHICKEN_1000_KADAKNATH_12009).

The specialty of the breed is black coloured flesh and internal organs, so it is also called black meat chicken and Kala Masi. It should be noted that it is the only black meat chicken breed in India. Though the meat is black in colour, Kadaknath comes in three different coloured feathers viz. jet black, pencilled, and golden Kadaknath.

Jet black adults are black in colour, the golden adults are basically black in colour but with golden feathers on the head and neck; whereas in pencilled variety adults are black with white feathers on the neck. Males and females of all three varieties have black to dark gray-colored skin, beak, shank, comb, wattles, toes, and soles.

The GraminVikas trust of Krishak Bharati Cooperative (KRIBHCO) had sought Geographical Indication (GI) tag for the protein rich and black coloured meat of the Kadaknath variety of chicken, which is native to Jhabua. Geographical Indication Registry and Intellectual Property India has awarded GI tag to Madhya Pradesh's Kadaknath chicken on July 30, 2018, which makes it the only animal in India to attain the same status[1].

A. 

B. 

Distinctive differences between chicks of a. Jet black and b. Pencilled variety

Source: Poultry Farm, College of Veterinary Science and Animal Husbandry, Mhow

Parameter	Details
Meat	Black colour
Plumage	Blue-black
Internal organs	Black-hued
Body weight at 20weeks	920g
Body weight of adult cockerel	1.5-2 kg
Body weight of adult hen	1-1.5 kg
Sexual maturity	At 180 days
Average annual egg production	105 eggs
Weight of egg at 40 weeks	49g
Fertility (%)	55%
Hatchability FES(%)	52%

(Source: GI Journal No. 104 March 2018)

Production potential

Kadaknath hens start laying eggs from six months onward. Eggs are laid in 2-3 clutches in a year, with 25 to 30 eggs per clutch. Thus, 80 to 90 eggs are produced annually. Egg laying capacity of this breed is extremely low during the summer season, particularly in May and June; hatchability is very poor if eggs are laid[2].

House Management

Kadaknath chickens thrive in temperatures between 20 to 26 degrees Celsius (68 to 79 degrees Fahrenheit). Humidity levels should be maintained between 50 to 70 percent. Both litter systems and cages can be used for rearing Kadaknath chickens. The shed's dimensions should have a width of 30 feet, with the length being variable. The height of the shed's middle portion should be between 10 to 15 feet, and the sides should be 8 to 10 feet high. The shed and surrounding areas must be kept clean and free from animals like cats, snakes, and dogs, as well as flies and mosquitoes. Proper lighting and ventilation are essential in all seasons to maintain the health and well-being of the chickens. The flooring should be made of concrete to minimize the risk of disease, infection, and maintenance issues. Spread sawdust, chopped straw, paddy husk, or similar materials on the floor to provide comfort for the chickens. The roof of the shed can be made from materials such as coconut leaves, asbestos, plastic, or fiberglass. by adhering to these guidelines, you can create an environment that is conducive to the health and growth of Kadaknath chickens.

Meat characteristics

As mentioned earlier, Kadaknath chicken meat offers abundantly rich levels of nutrition and has therapeutic properties. The black meat has an intense and distinct taste. In all three varieties of Kadaknath viz., jet black, pencilled, and golden, the black colour of the meat is due to hyperpigmentation associated with the Fibromelanosis character[3]. There is deposition of melanin pigment in the connective tissue of organs and dermis, resulting in intense black colour[4]. The colour of the chicken meat is influenced by various factors such as muscle type, genotype, age, sex, diet, amount of myoglobin and heme pigments in muscles, processing, etc.[5] Melanin pigment present in meat is found to be beneficial for heart patients.

The meat of this bird contains a high amount of protein and has aphrodisiac properties[4]. The meat contains approximately 25-27% protein, which is much higher than that of white chicken meat (18% protein). In a study, out of 19 amino acids investigated, the Kadaknath had a significantly higher content of 11 amino acids, while the commercial broiler had a significantly higher content of 3 amino acids [6]. In one study, the Kadaknath breed was compared with commercial Cobb 400 broiler and was found to be an enriched source of functional biomolecules, i.e. carnosine, anserine, and creatine[7]. It is also believed to have higher levels of antioxidants as well as immune-boosting properties. These attributes make this meat highly desirable to the consumer because of the increase in health consciousness.

The dressing percentage of Kadaknath is similar to that of other native breeds such as Aseel Peela (70.8 %) and Ghaghus (70.2%)[8]. The weight of dressed weight and cut up parts is higher in male birds but there is no significant differtence in most of the carcass traits including dressing percentage in male and female Kadaknath birds[9].

Drum part of Kadaknath has significantly more meat and hence higher MBR as compared to that of commercial broiler. This finding is desirable and economically significant as Indian consumers prefer drum part of chicken leg as compared to breast meat[7].

Kadaknath: The source of subsistence for Indian farmers:

The age-old practice of Kadaknath rearing began in the tribal community of Madhya Pradesh, and from there it has now reached a very wide range of consumers due to its high quality and benefits. Being unique in meat colour and hardiness, it has greater market demand

and price than other indigenous poultry breeds. So, modern farmers are inclined towards rearing Kadaknath. In 20 Indian states, Kadaknath has already touched 117 districts.

To recognize the importance of this breed, KVK Jhabua, under the National Agricultural Innovation Project, started a pilot project and named it "Kadaknath Murgi Palan Samooh, Jhayda" of Jhabua district. The training and awareness programme resulted in an assured income of Rs. 90,000 to 105,000 per beneficiary per year and additional employment of 95 man days per year per family. In India, rural people have crop production as their major occupation, but due to changing scenarios, they need diversification in agriculture to sustain themselves. Kadaknath chicken rearing has the potential to alleviate poverty and increase food production.


Kadaknath rearing in college of Veterinary Science and Animal Husbandry, Mhow

<u>Benefits of Kadaknath farming</u>:

- Kadaknath chicken black meat has good medicinal values, good textured and flavored.
- Kadaknath chicken breeds are adaptable to any kind of environment either cool or hot
- Kadaknath chicken meat and their eggs are sold for high price in the market.
- Meat of kadaknath is good for health as it contains many amino acids, vitamins and mineral and also helps in curing many diseases.
- This meat helps to increase blood cells count and hemoglobin.
- The high levels of Vitamin and Phosphorous content present in Kadaknath Chicken boosts body metabolism to a great extent providing sustained energy levels at all points of time
- The Kadaknath birds convert feed quickly into the meat (feed conversion ratio is high).
- Kadaknath chicken is said to be good for women health as well.

- The tribal community in MP uses Kadaknath chicken blood in the treatment of chronic disease.
- The Kadaknath breed is hardy and highly resistant for diseases and mortality is very low
- Unlike broiler chicken kadaknath can survive even on kitchen waste.
- The best advantage is, these birds meat has more protein, less fat and low cholesterol when compared to similar kind of poultry breeds.
- Commercial large scale farming of Kadaknath chicken defiantly give good profits if proper marketing channel is established.

Some state governments like Madhya Pradesh and Tamil Nadu have incentive scheme for people who were interested in breeding the Kadaknath chicken

Points to consider for start and running a successful Kadaknath chicken farming venture:

1. Learn about Kadaknath chicken breed, its characteristics, benefits, and requirements.
2. Create a comprehensive business plan that includes budgeting, target market, and production goals.
3. Purchase day-old chicks from reputable government-approved or private poultry farms. Ensure chicks are properly vaccinated before bringing them to your farm.
4. Build a suitable housing structure that provides adequate ventilation, lighting, and protection from predators and adverse weather conditions. Maintain proper hygiene and sanitation in the housing area to prevent disease outbreaks.
5. Provide a balanced and nutritionally complete diet to promote healthy growth and production. Consult with poultry experts or veterinarians to formulate the right feed for Kadaknath chickens.
6. Follow a vaccination schedule recommended by poultry experts to prevent common bacterial and viral diseases.
7. Begin with a small number of birds, such as 30 to 50, to gain experience and understand the requirements of Kadaknath farming. Increase the bird count as you become more confident and knowledgeable.
8. Inquire about any incentives or subsidies offered by state governments or agricultural universities for Kadaknath chicken farming. Take advantage of such benefits to reduce initial costs.

9. Establish a marketing strategy to sell your Kadaknath chicken products. This could involve local markets, restaurants, online platforms, and direct sales. Highlight the unique qualities of Kadaknath meat to attract customers.
10. Adopt animal welfare practices to maintain healthy and stress-free birds.
11. Maintain accurate records of bird health, vaccinations, feed, and production data.
12. Kadaknath chickens are best suited for back yard farming rather growing on commercial scales. The meat quality and disease resistance nature of kadaknath chicken can create great revolution poultry industries

Conclusion

In the past three decades, Kadaknath poultry development in India has made significant strides from a small backyard business to a fully-fledged commercial agro-industrial enterprise. A powerful weapon for assisting the poorest of the poor is backyard poultry, which requires little in the way of industrial development. Given that it is high in bioactive dipeptide carnosine and a nutritionally significant source of the nutrients anserine and creatine, Indian Kadaknath chicken flesh may be considered as a functional food for enhancing human growth, development, and health. It has strong anti-oxidant properties. In rural India, value addition can encourage Kadaknath backyard poultry farming, which will empower women and improve socioeconomic situation.

References

GI Journal.2018. Geographical Indications Journal No. 104 GOI, March 2018.

Mishra A., Singh S.R.K., and Raut A.A. 2020. Kadaknath Farming for Farmer's Livelihood and Empowerment. https://atarijabalpur.icar.gov.in. 20 August, 2023

Saxena D.P. 2019. Molecular Characterization of Indian Breed Kadaknath Chicken. Msc thesis (Published). Vinayka Mission University Salem, Tamilnadu, India.

Rao G.V. and Thomas P.C. 1984. The breed of indigenous (Desi) chicken. Avian research 68(1-2):55-57.

Widemann N., O'Bryan C.A., Crandell P.G. 2016. Factors affecting poultry meat colour and consumer preferences- A review. World Poult. Sci. J.2016;72;353-366.

Haunshi S., Dewatkal S., Prince L.L.L., Ullengala R., Ramasamy K., and Chatterjee R. 2022. Carcass Characteristics, Meat Quality and Nutritional Composition of Kadaknath, a native Chicken Breed of India. 11(22):3603

Sharma R, Sehrawat R, Ahlawat S, Sharma V, Parmar A, Thakur MS, Mishra AK, Tantia MS. et.al. 2022. An attempt to valorize the only black meat chicken breed of India by delineating superior functional attributes of its meat. Sci Rep. 3;12(1):3555.

Haunshi S., Ullengala R., Prince L.L.L., Ramasamy K., Gurvnathan K., Devatkal S. et al. 2022. Trend of production and reproduction traits, meat quality status of Ghagus, and indigenous chicken of India. Trop. Anim. Health Prod. 2022;54:170.

Haunshi S., Rajkumar V., Paswan C., Prince L.L.L., Chattarjee R.N. 2021. Inheritance of growth traits and impact of selection on carcass and egg quality traits in Vanashree, an improved indigenous chicken. Trop. Anim. Health Prod.2021;53:128.

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THE SPLENDIT SPEAR GRASS

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Introduction

Spear grass is botanically called as *Heteropogon contortus* (2n = 60), and commonly called as Black spear grass or Tangle head grass (in English) Thumma Jana or Thumma Jantu (in Telugu), Vellai Karuvaali (in tamil), Guntu-beru or Gontu-beru (in Kannada), Bhaloo Ghaas (in hindi). Spear grass a species belonging to the grass family Poaceae. The other related genera include *Stenotaphrum secundatum* (Agusutine grass or buffalo turf), *Piptochaetium avenaceum* (Black Oat grass), and comprising grass species commonly known as needle grasses. *Heteropogon contortus* is a tropical, perennial tussock grass with a native distribution encompassing Southern Africa, Southern Asia, Northern Australia, Oceania, and South western North America. In India, Spear grass is primarily found in the Northern and North western parts of the country. These grasses are typically found in the Himalayan region, including states such as Jammu, Kashmir, Himachal Pradesh, Uttarakhand and parts of Arunachal Pradesh. Spear grass may also have cultural or historical significance in certain regions. They might be mentioned in local folklore, used in traditional crafts or weaving, or have other practical or symbolic uses in indigenous cultures. Spear grass is a cross-pollinated forage grass having its origin from the tropical or subtropical Africa (Clark, 1980).

Fig. 1. Spear grass in its natural habitat

Botanical Description

Spear grass is a tufted perennial grass 0.5 – 1.5 m tall, rather variable in habit. Root system is generally fibrous root. Erect to geniculate at the base, often branched above, particularly at flowering, flattened towards the base, glabrous, smooth and glabrous. Leaves basal and on the culm, green, or bluish; leaf sheath smooth, compressed, keeled, striate, sometimes with a few hairs near the ligule, ligule a short, membranous rim, blade linear, folded in the lower part, becoming flat, slightly rough to the touch with a few long hairs particularly towards the base, apex blunt, almost canoe- shaped. Inflorescence a simple raceme of pairs of spikelets arranged in 2 rows, 3-8 cm long (excluding the awns), the outermost ones pedicellate and overlapping and enclosing the innermost sessile spikelets; at the raceme the spikelets are similar (Homogamous) and awnless, male or sterile at the top the spikelets are dissimilar (Heterogamous), comprising sessile, awned spikelets and pedicelate, male or sterile, awnless spikelets. Homogamous sessile spikelets 5-8mm long, linear to lanceolate; ceolate ; upper glume 5-7 mm long, elliptic – lan-ceolate; lower floret male; upper floret male; first lemma 4-8 x 1- 1.5 mm , lanceolate; second lemma 4-6 x 1mm, linear to lanceolate ; stamens three. Heterogamous sessile spikelets 5- 8 mm long, linear, awned; lower glume 5-8 * 1-1.5 mm, oblong, apex rounded; upper glume linear, keeled; lower floret empty; upper floret bisexual; first lemma 2-

3*0.5-1 mm, oblong, ciliate towards apex; second lemma 2-3 mm long, one nerved, awn 3- 8 cm, long, densely hairy , tip contorted; ovary 1mm long, linear; glumes not broadly winged; florets similar to those of homogamous pedicelled spikelets. Fruit is a caryopsis (grain), cylindrical, 3.5-4.5 mm long, grooved and whitish in colour.

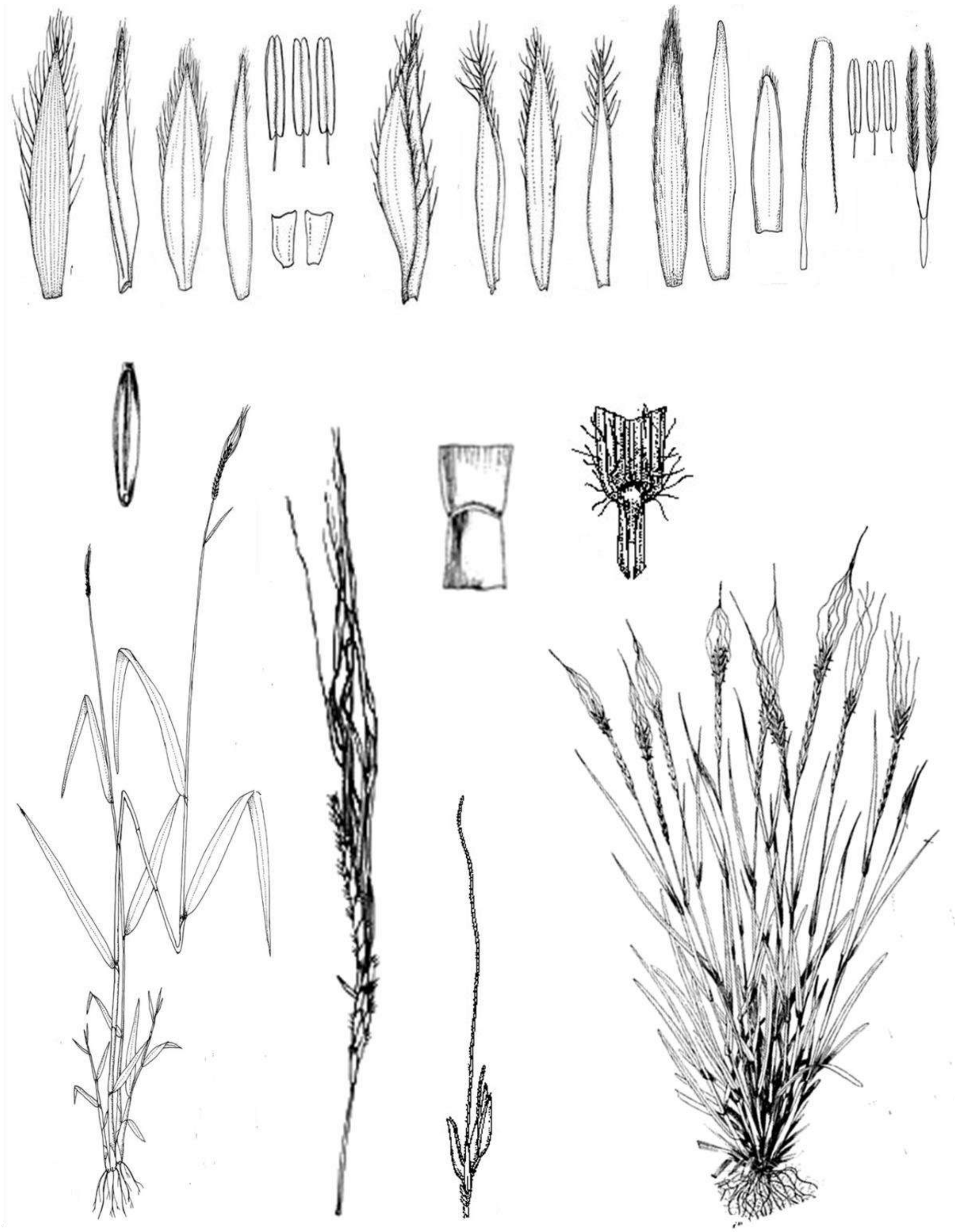

Fig. 2. Botanical description of Spear grass- *Heteropogon contortus*

Growing condition

Spear grasses can be found in various climate types, including temperate, subtropical, and tropical regions. They may have adaptations to specific climate conditions, such as drought tolerance or cold hardiness. Most spear grass species prefer full sun exposure, meaning they require at least 6 to 8 hours of direct sunlight per day for optimal growth and development. Spear grasses generally prefer well-drained soils. They can tolerate a range of soil types, including sandy soils and loamy soils. Once established, spear grasses are often adapted to tolerate drought conditions. However, during the establishment phase, they may require regular watering until their root systems are well-established. Afterwards, they typically rely on natural rainfall and can withstand dry periods. Depending on the species, spear grasses may benefit from occasional pruning or mowing to promote healthy growth and prevent the accumulation of thatch.

Cultivation methods

Spear grass can be propagated through seeds or vegetative methods, such as rhizome division or stem cuttings. If seed propagated, they are sown at 1/4 to 1/2 inch deepth and 12 to 18 inches apart. Regular watering is done gently after planting. Once established, spear grass is known for its drought tolerance and can survive with minimal irrigation. However, if we want to maintain optimal growth and productivity, periodic watering during dry periods may be necessary. Regular monitoring of cultivation area and manual weeding are needed. Nitrogen-based fertilizers are generally recommended for Spear grass, Harvesting of Spear grass for forage production, is done before it becomes too mature and loses its nutritional value. The grass is cut at a height of about 4 to 6 inches above the ground. Regular mowing or grazing can help to maintain the growth and prevent it from becoming too invasive.

Fig. 3. Harvested green fodder of Spear grass

Fodder quality of Spear grass

Green fodder: Young plants before flowering can be used as green fodder. The yield of dry matter production of spear grass ranges from 0.5 to 8.7 t/ha. This is highly variable of varied performance in different growing conditions. Once established, and if defiolation is not too heavy, spear grass may survive several years.

Pasture

It is moderately tolerant of grazing. It is recommended thet a minimum stubble height of 15 cm is maintained under continuous grazing . Proportion of spear grass in the pasture can be increased by a strategy of deferring grazing for 4 or 6 months or significantly reducing the stocking rate after burning in spring. Native spear grass pastures can be over sown with legumes to increase the nitrogen content of the sward. Spear grasses tend to have high fiber content, including both crude fiber and lignin. The fiber content contributes to the coarse texture of the grass and can make it less digestible for animals. High fiber content may lead to reduced nutrient availability and lower overall energy value. Spear grasses provide moderate energy content. The energy value is influenced by factors such as maturity stage and growing conditions.

Fodder value

Generally, spear grasses have low to moderate nutritional value compared to other grass species commonly used for fodder. They are often characterized by their tough, wiry stems and long, narrow leaves. Spear grasses are typically not highly palatable to livestock due to their coarse texture and potential for sharp awns or bristles, which can cause injury or irritation to animals' mouths, throats, and digestive systems. However, during certain stages of growth, when the grass is young and tender, livestock may graze on spear grass to some extent. Grazing management practices, such as rotational grazing, can help control the impact of spear grasses on livestock and ensure a more balanced diet for animals.

Nutritional value

Heteropogon contortus has a low nutritional value: it has a high cell wall content (about 75% NDF in the DM), it is low in protein (3-9% DM) and deficient in minerals (P, Ca, Mg, S, Cu, Zn). The crude protein and nutrient levels level will be moderate in young leaves *viz*., crude protein 7%, fiber 34%, Mineral ash 9.2% and total digestible nitrogen 57%, P 0.15%, Ca 0.30% compared to their levels in matured plant as crude protein 4.4% , crude fibre 42%, P 0.09% and Ca 0.23% (Krishnamoorthy *et al*., 1995).

Palatability

Palatable in the early vegetative stages, but becoming less attractive as it matures.

By the end of the growing season when there is a preponderance of stem, it is only eaten if supplemented with urea and molasses.

Toxicity: No toxicity problem reported. The main problem arises by virtue of the sharp, barbed seeds that contaminate wool and can penetrate skin causing infections.

Uses of Spear grass

1. It is used as thatch for huts and is commonly woven into mats.
2. Spear grass is a good forage and fodder grass when young .
3. The grass is mainly used as part of the natural savanna pasture.
4. Young plant can be conserved as hay or silage.
5. It can be planted for erosion control and revegetation of degraded habitats.
6. In South Africa, young leaves are used in the tratement of burns, wounds and rheumatism.

Advantages of Spear grass

1. Spear grass acts as carbon reservoir in arid and semi-arid wastelands.
2. It is useful in controlling desertification of drought affected soils.
3. It is used to soil cover in drought affected soils and reduced soil temperature.
4. It serve as a collateral host for downy on sorghum and maize.
5. It is useful to stabilize critical areas , rangeland of drought zones .
6. It is used to control soil erosion in dry areas.

Limitations of spear grass

1. Grazing at or after flowering is injurious to animals due to the presence of awns in florets.
2. There is a wide yield variation between wet and dry growing conditions.
3. It affects the wool quality of sheep if allowed to graze after flowering.
4. The seeds of mature plants can induce corneal opacity syndrome in grazing animals (Prasad *et al*., 1980). Sheep and goats appear more sensitive than cattle and buffaloes to mouth ulceration from hard seeds contained in milled forages, even though grazing animals are able to avoid them by selection.
5. Bristles from spear grass seeds were observed at the upper lateral neck region of lambs, near the larynx. The sharp base of the bristle penetrates the skin against body movement, and the susceptibility in lambs can be explained by the lack of a thick wool coat (Narayanan *et al*., 2003).

References

Clark, L., 1980. Pasture improvement in spear grass country. Rural Res., 109: 16-20.

Krishnamoorthy, U., Soller, H., Steingass, H., Menke, K. H., 1995. Energy and protein evaluation of tropical feedstuffs for whole tract and ruminal digestion by chemical analyses and rumen inoculum studies *in vitro*. Anim. Feed Sci. Technol., 52 (3-4): 177-188.

Narayanan, K.; Balachandran, C.; Rajapandi, S.; Manohar, B. M.; Rajendiran, A. S., 2003. Spear grass awns as a cause of physical injury in Bharat Merino lambs. Ind. Vet. J., (80 (8): 821-822.

Prasad, R. D.; Mathur, P. B.; Bohra, S. D. J., 1973. Evaluation of some pastures on growth-rate of Corriedale and cross-bred lambs. Ind. Vet. J., 50 (9): 928-931

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SOIL AND WATER CONSERVATION MEASURES FOR SPICE CROPS

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Introduction

Land, which is the most precious heritage and the physical base of biomass production of life supporting systems, is finite. In this natural non-renewable endowment, the share of our country is fixed at about 329 million ha. About 173 million ha covering slightly half of the country are threatened by various types of degradation like salinity, alkalinity, water logging, ravenous and gullied lands, areas under ravages of shifting cultivation, desertification, etc. About 800 ha of arable land are being lost annually due to ingress of ravines. There are specific problems of land degradation due to open-cast mining operations, using good productive land for brick kilns, coastal erosion and seawater ingress, excessive erosion and landslides in the crumbling hill areas. Our forests and grass lands have been over exploited. Frequent occurrences of floods and droughts in different parts of the country are evidence of improper land use in the catchments and inadequate conservation and use of rain water. The problem of land degradation has brought us face to face with the ever increasing depletion of the productivity and the basic land stock through nutrient deficiencies on the one hand and the ever growing demand for food, fodder, fibre, fuel, land based industrial raw materials.

It takes nature 600-1000 years to build 2.5 cm of top soil but get displaced in a year only due to misuse. It has been reported that 6000 million tonnes of productive soil are lost every year from about 80 million hectare of cultivated land alone in India. It has also been proved that soil lost from unprotected land is about 120 tonnes /ha/year and may go as high as 300 tonnes /ha/year. Thus, a part from depletion of fertile soil erosion results in the loss of run- off water, plant nutrients and micro flora, siltation of reservoirs and riverbeds thereby adversely affecting irrigation and power potential, causing floods in plain and valley which damage crops, animals, habitation, communication, etc.

Soil and water conservation measures

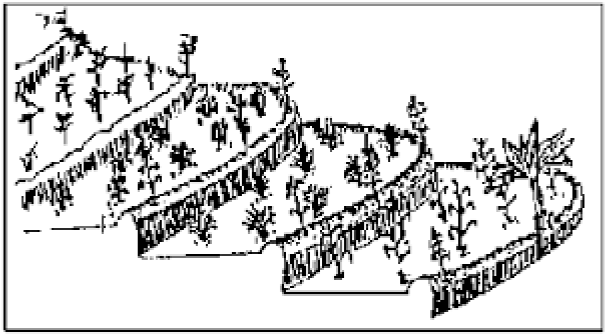
Contour cultivation, contour trip cropping, mixed Cropping, tillage, mulching, zero tillage, are some of the agronomical measures for the *in-situ* soil moisture conservation. Mechanical measures like contour bunding, graded bunding, bench terracing, vertical mulching etc. also need to be followed for effective soil and moisture conservation measures in dry lands. Another technology for efficient utilization of runoff is water harvesting recycling. Rainwater harvesting includes collecting runoff water into dug out ponds or tanks in small depressions, gullies and into storage dams of earth or masonry structures. Rain water harvesting is possible in areas having rainfall as little as 500 to 800 mm. Depending on the rainfall and soil characteristics, 10-50% of the runoff can be collected in farm pond. Surface run off thus collected in a farm pond can be used to provide protective irrigation in the period of prolonged dry spell or through micro-irrigation techniques.

(1) Contour bunds

Bunds are either mechanical or vegetative barrier created across the slope. The purpose is to divert the excess run-off during rain to the waterways and to retain eroded soil. These bunds on steep slopes are created by way of excavating parabolic channels (0.3 m top and 0.2 m deep) on contours and keeping the dugout soil in form of a bund at the lower edge of the channel. These bunds require care in maintenance during first 2 years. The vegetative barrier alone will not serve the purpose on steep slopes. The vertical interval of these bunds may vary from 0.5 to 5 m depending on the land use, soil depth and slope of the land.

(2) Bench terrace

Bench terraces are flat beds constructed across the hill slope; spaces between two contours are leveled by cut and fill method. In micro-watershed involving steep slopes, experiences showed that only at foot hills few benches may be constructed to produce food crops through intensive cropping. The vertical interval of such terraces should not increase more than one meter. Such measures can be adopted where the soil depth is more than 1.0 m. In case the entire hill slope is to be converted into benches, the construction should start from foot hill.



(3) Half-moon terrace

These are level circular beds having 1 to 1.5 m diameter cut into half-moon shape on the hill slopes. These beds are used for planting and maintaining sapling of fruits and fodder trees in horticulture/agro-forestry land uses.

(4) Grassed waterways

These are channels laid out preferably on natural drainage lines in the watershed. As far as possible, natural courses should be used without much disturbances for draining out the excess water. At appropriate locations, stilling basin (water pools) should be created with land use of earthen and boulder pitched bunds for temporary detention of run-off water. This structure will also serve the purpose of energy dissipation of flowing run-off water.

(4) Water harvesting ponds

Dug out cum embankment type of water harvesting structure can be used for creating seasonal and perennial ponds at the foot of the micro-watershed for irrigation and fish farming purposes. The above soil and water conservation measures can be created with the use of local resources. On hill slopes, soil and water conservation measures may be followed with horticulture land use system.

Soil conservation measures in spice crops

(i) Cardamom

Minimum runoff and soil loss were found in contour staggered trenches (CST) with pineapple planting. Continuous half-moon and half-moon terracing and pit system of planting recorded higher yield compared to trench and scooping and planting. Besides, mulching is also practised to conserve moisture, reduce weed growth and to overcome dry situations.

(ii) Black pepper

Before planting, if the terrain of the land is sloppy or uneven, carry out contour bunding or terracing to prevent soil erosion. Mulching is very essential where pepper is grown with minimum shade, to conserve moisture, using banana trash, dried grass and other substances. Sawdust, areca husk and straw can also be used for mulching. Growing cover crops like *Calapogonium mucanoides*, *Mimosa invisa* are provided effective soil cover to control soil erosion during rainy season. Further they dry up during summer, leaving a thick organic mulch.

(iii) Ginger

Mulching the beds with green leaves or organic waste is an important operation for ginger. Besides a source of organic manure, mulching prevents washing of soil, conserves soil moisture, smothers weed growth and improves the physical properties of the soil. The first mulching is done at the time of planting with 12.5 tonnes of green leaves and the second mulching is given after 45th day and 90th day with 5 tonnes of green leaves per hectare immediately after weeding and application of fertilizers. Daincha can be raised in the interspaces of beds immediately after planting ginger and they can be uprooted before second mulching and may be used for second mulching after earthing up.

(iv) Turmeric

Immediately after planting, the field is mulched with green leaves at 15 t/ha. This is repeated after 50 days of planting when the rhizomes have fully sprouted.

Water Management options for spice crops at stress situation

Situation	Black Pepper
Late onset of monsoon by 15 – 30 days	**Established plantations** • Mulch the basins & interspaces with green leaves. • Spray lime 1% or kaolinite on foliage to reduce transpiration as well as heat load. • Postponed new planting/gap filling • Irrigate the crop @ 8–10 litres/day/vine (drip irrigation) or 50 litres / week / vine (hose irrigation) **Very young plantations** • Mulch the basins & interspaces with green leaves/coir pith compost. • Protect young vines by providing sufficient shade.
Drought during vegetative / reproductive stage	• Provide hose irrigation @ 35-40 litres/vine/week or 8–10 litres / vine / day (drip irrigation) till monsoon is resumed. • Apply organic manures like FYM @ 10 kg/vine and mulch the basin with green leaves (10 kg/vine) / coir pith compost (2 kg/vine) • Postponed new planting / gap filling • To prevent termite attack on live supports, drench the soil with chlorpyriphos 0.075% and spray on support up to 1 m height & repeat the spray after 21 days if necessary
Terminal drought	• Mulch the basins & interspaces with green leaves / coir pith compost. • Protect young vines by providing sufficient shade. • Irrigate the crop @ 5–8 litres/day/vine • To prevent termite attack on live supports, drench the soil with chlorpyriphos 0.075% and spray on support up to 1 m height; repeat the spray after 21 days if necessary

Situation	Cardamom
Late onset of monsoon by 15 – 30 days	• Slash the weeds and apply as mulch • Avoid new planting till monsoon sets in • Provide drip @ 8 litres/clump/day (once in 10-12 days) or sprinkler irrigation (4 hours per day equivalent to 25 mm of rain) • Provide adequate shade for young plants
Drought during vegetative / reproductive stage*	• Provide drip irrigation @ 8 litres/clump/day (once in 10-12 days) or sprinkler irrigation (4 hours per day equivalent to 25 mm of rain) • Apply green mulch • Provide adequate shade for young plants • Remove old and unproductive suckers
Terminal drought	• Provide drip irrigation @ 8 litres/clump/day (once in 10-12 days) or sprinkler irrigation (4 hours per day equivalent to 25 mm of rain) • Apply green mulch • Provide adequate shade for young plants • Remove old and unproductive suckers
Situation	**Ginger & Turmeric**
Late onset of monsoon by 15 days	• Cultivate short duration varieties • Provide thick mulch cover with green leaves/coir pith compost. • Growing suitable intercrops for shade
Drought during vegetative stage	• Irrigate the crop weekly once equivalent to 5 – 10 mm of rain • Apply green leaf/coir pith compost mulch
Drought during rhizome formation	• Irrigate the crop weekly once equivalent to 5 – 10 mm of rain • Apply green leaf/coir pith compost mulch • Ginger can be harvested and used for vegetable purpose
Terminal drought	• Harvest the crop

Situation	Nutmeg
Late onset of monsoon by 15 days	• Provide thick mulch cover with green leaves/coir pith compost around basin. • Provide adequate shade for young plants
Late onset of monsoon by 30 days	• Irrigate plants @ 50 to 100 litres/plant/week and apply green mulch • Provide adequate shade for young plants
Drought at reproductive stage*	• Irrigate plants @ 50 to 100 litres/plant/week and apply green mulch • Provide adequate shade for young plants
Terminal drought	• Irrigate plants @ 50 to 100 litres/plant/week and apply green mulch • Provide adequate shade for young plants
*Cardamom and Nutmeg are perennial crop, vegetative and reproductive phases occur simultaneously	

Drip irrigation in turmeric

Drip irrigation in ginger

Seed spices

There are several opportunities for improving the water productivity of seed spices in India.

Irrigation

They are providing full irrigation to meet the full crop evapo-transpiration demand or providing supplemental irrigation in critical periods of crop growth for the rain-fed crops for increasing the crop yield. Replacing old and less effective means of irrigation with more efficient and durable methods such as drip irrigation and sprinkler irrigation system where ever necessary to increase the water use efficiency.

Combining irrigation water, fertilizer and pesticide application to increase the efficiency of irrigation system and also input use efficiency in long duration and high nutrient demanding seed spices such as fennel, Ajwain, Nigella and celery.

Transplanting methods

Adopting transplanting techniques in seed spices such as fennel, dill, Ajwain, celery and Anise crop leads to water saving by nursery period and advancement of crop by maturity.

Mulching

Use of mulch materials like plastic mulching sheet, crop waste as anti-evaporates to save the irrigated water from the soil surface so that irrigation frequency can be reduced thereby saving water, energy and cost of production.

Varieties

Breeding of water efficient varieties such as short duration varieties which require little irrigation as compared to long duration ones, varieties which are tolerant to moisture stress, high yielding varieties without increasing the crop consumptive use are need to be prioritize in seed spices.

Organic manuring

Improving the water holding capacity by adding more organic matter to soil so that applied water by any means may be preserved in the soil.

Salinity / alkalinity tolerance

Exploring the possibility of cultivation of tolerant seed spices such as cumin, dill, fennel and celery in saline and alkaline soils. Since these crops are fairly tolerant to salinity and alkalinity. In these conditions use of drip irrigation can yield better without increase in the salinity/alkalinity level of the soil.

Future thrust in water conservation of seed spices

Based on all the research work carried on irrigation management in seed spices to improve productivity, it is found that still more work is required to understand the crop water requirement particularly critical stages of water requirement, use of sensors in irrigation quantification. It is proved that increased irrigation level will increases the biomass content but reduces the water use efficiency in producing economic yield. This is the area where research is required to improve use efficiency of inputs such as moisture, nutrients, energy etc by various moisture retention techniques to increase the economic yield rather biological yield or it can also say that higher harvest index. Hence, each and every drop of applied water is to be utilized by the crop so that higher water use efficiency can be achieved. In seed spices quality is most important along with optimum productivity hence focus on improving quality with seed yield is most necessary. In most of the studies either by drip irrigation or surface irrigation methods irrigating seed spices at 0.5-1.0 IW: CPE ratio is found optimum. But, instead of irrigating crops by visual assessment without quantifying the water leads to huge loss. It is also found that flowering and seed setting stage is most critical in coriander, fennel and nigella for its quality improvement. Hence irrigating the crop according to soil moisture status, crop need and climatic condition by following suitable moisture conservation techniques is most important in seed spices.

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SOILLESS AGRICULTURE: CULTIVATING INNOVATION AND SUSTAINABILITY

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Introduction

In the realm of agriculture, traditional practices have revolved around the use of soil as the primary growth medium for plants. However, as the world battles to balance population growth, environmental degradation, and resource limitations, alternative methods of cultivation have gained prominence. Soilless agriculture emerges as a cutting-edge solution that redefines the way we grow crops. This article investigates the intricacies of soilless agriculture, exploring its techniques, benefits, and challenges to illustrate its transformative potential.

Decoding Soilless Agriculture

Soilless agriculture is a revolutionary approach that involves cultivating plants without traditional soil as a growth medium. Instead, plants receive essential nutrients through a nutrient-rich water solution, or an aerated nutritious medium often in the form of various systems. This bypasses the limitations and variability of soil, enabling precise control over plant nutrition, growth conditions, and resource utilization.

Novel soilless farming methods continue to emerge as innovative solutions to address the challenges of traditional agriculture. These methods leverage advanced technologies and creative approaches to optimize resource utilization, crop growth, and environmental sustainability. Here are some interesting examples of novel soilless farming methods:

1. ***Aeroponics*:** Aeroponics takes soilless farming to the next level by suspending plant roots in the air and delivering nutrients through a fine mist. This method maximizes oxygen

exposure to the roots, promoting rapid growth and efficient nutrient absorption. It also reduces water consumption compared to hydroponics, making it an ideal choice for water-scarce regions.

2. ***Aquaponics*:** Aquaponics is a symbiotic system that combines aquaculture (fish farming) with hydroponics. Fish waste serves as a nutrient source for plants, while the plants purify the water for the fish. This closed-loop system minimizes waste, conserves water, and produces both fish and vegetables in a sustainable manner.
3. ***Vertical Farming***: Vertical farming involves cultivating crops in stacked layers, often within controlled indoor environments. Utilizing LED lighting and precise climate control, this method enables year-round cultivation, independent of external weather conditions. Vertical farms maximize space utilization, making them suitable for urban areas with limited land availability.
4. ***Floating Raft Systems***: These systems, a variation of hydroponics, involve placing plants on horizontal floating rafts on the surface of nutrient-rich water. The roots dangle below, absorbing nutrients from the water. Floating raft systems are commonly used for growing lettuce, herbs, and other leafy greens.
5. ***Substrate Culture***: Involves growing plants in inert materials like coconut coir, perlite, or vermiculite instead of traditional soil. These substrates provide mechanical support while nutrient-rich water is delivered directly to the root zone. Substrate culture offers a balance between soil-based and soilless methods, combining benefits from both approaches.
6. ***Fogponics*:** It is an advanced form of aeroponics where nutrient-rich water is transformed into a fine mist using ultrasonic vibrations. This mist envelops plant roots, delivering nutrients and moisture in a highly efficient manner. The fine droplets also promote increased nutrient absorption.
7. ***Bioponics*:** Combines hydroponics with organic practices by utilizing organic nutrient solutions derived from compost teas, worm castings, and other natural sources. This approach merges the benefits of soilless agriculture with the principles of organic farming.
8. ***Wick System*:** The wick system is a simple and passive form of hydroponics. It involves a wick (often made of fabric) that draws nutrient-rich water from a reservoir to the plant's

root zone. This method is low-cost and easy to set up, making it suitable for beginners and educational purposes.

9. ***Algae Cultivation***: Algae-based soilless systems involve growing microalgae in nutrient-rich water solutions. These algae can serve as nutrient sources for plants or even as a food source for humans and animals. Algae cultivation contributes to nutrient recycling and offers a sustainable protein source. (e.g., Azolla)
10. ***Sponge Culture***: Sponge culture employs sponges or foam blocks as growth mediums. Plant roots are inserted into the sponge, and a nutrient solution is delivered to the sponge to nourish the plants. This method provides excellent aeration to the roots while ensuring efficient nutrient uptake.
11. ***Photoselection*****:** It is a plant breeding method using controlled light to speed up desired trait development. It involves adjusting light conditions to prompt traits like early flowering, stress resistance, and improved growth. This technique is especially useful in controlled environments for faster and more targeted crop improvement.

These novel soilless farming methods showcase the remarkable diversity of approaches that modern agriculture is embracing. As technology advances and our understanding of plant physiology deepens, these methods hold the potential to revolutionize food production, mitigate environmental impacts, and provide sustainable solutions to global food challenges.

Benefits of Soilless Agriculture: Cultivating a Greener Future

Soilless agriculture, with its innovative approach, brings forth a plethora of benefits that resonate across various dimensions of modern agriculture and sustainability.

1. ***Enhanced Resource Efficiency***: One of the most compelling advantages of soilless agriculture is its remarkable water efficiency. Traditional soil-based agriculture often leads to water wastage through evaporation, runoff, and inefficient absorption. In soilless systems, water is precisely delivered to plant roots, drastically reducing overall consumption. This efficiency is of paramount importance in regions facing water scarcity and drought conditions. Furthermore, nutrient solutions in soilless systems can be recirculated, ensuring minimal nutrient wastage.

2**. *Optimized Growth Conditions***: In conventional farming, plants must contend with the variability of natural soil conditions, which can impact nutrient availability and plant health. Soilless agriculture eliminates this uncertainty. By providing a consistent and controlled environment, soilless systems empower farmers to fine-tune nutrient delivery, pH levels, and oxygenation. As a result, plants experience accelerated growth, higher yields, and shorter cultivation cycles. This optimization also extends to temperature and light, enabling year-round cultivation even in regions with extreme climates.

3. ***Space Utilization and Vertical Farming***: The spatial efficiency of soilless agriculture is a game-changer, particularly in urban environments where land is scarce. Vertical farming is a prime example of this advantage. By stacking growing layers vertically, urban spaces can be transformed into thriving farms. This technique allows for the cultivation of a larger volume of crops in a smaller footprint. The integration of agriculture into urban landscapes not only enhances local food production but also improves the visual and environmental aspects of cities.

4. ***Reduced Environmental Impact***: Soil erosion, nutrient runoff, and pollution from agricultural practices have contributed to ecological degradation. Soilless agriculture minimizes these negative impacts. With no soil to erode and controlled nutrient delivery, the risk of runoff and pollution is substantially diminished. Additionally, the reduced reliance on pesticides, which can leach into soil and water, is a notable environmental benefit. By adopting soilless techniques, farmers contribute to ecosystem health and promote sustainable agricultural practices.

5. ***Year-Round Cultivation and Food Security***: Traditional agriculture often faces challenges associated with seasonal changes and adverse weather conditions. Soilless systems offer a solution by enabling year-round cultivation. This consistent production helps address issues of food scarcity and fluctuating market prices. In regions with harsh winters or limited arable land, soilless agriculture offers a reliable source of fresh produce, reducing the dependence on imported goods and enhancing local food security.

Challenges in Soilless Agriculture

While the benefits of soilless agriculture are compelling, it is essential to acknowledge the challenges that this innovative approach presents. However, these challenges are often met with ingenious solutions and ongoing research.

1. ***Technical Expertise***: Transitioning from traditional soil-based agriculture to soilless systems requires a shift in knowledge and skillsets. Farmers need to learn about hydroponic or aeroponic systems, nutrient management, pH monitoring, and environmental controls. Training programs,

workshops, and educational resources play a crucial role in equipping farmers with the necessary expertise.

2. ***Initial Investment***: The setup of soilless systems involves an upfront investment in infrastructure, equipment, and nutrient solutions. This initial cost can be a deterrent for small-scale farmers with limited resources. However, as the technology matures and gains wider adoption, economies of scale and advancements in equipment can lead to cost reductions.

3. ***Disease Management*****:** The absence of natural soil barriers can expose plants to certain diseases that thrive in soilless environments. However, innovative solutions like using disease-resistant varieties, implementing strict sanitation protocols, and adopting advanced monitoring technologies are being developed to counter these challenges.

4. ***Regulatory Frameworks***: The agricultural sector is often regulated based on traditional practices. The introduction of soilless agriculture requires adjustments and adaptations to existing regulations to accommodate this emerging approach. Collaboration between policymakers, researchers, and farmers is essential to create a supportive regulatory environment.

5. ***Energy Consumption***: Some soilless systems, especially those in controlled environments, require energy for lighting, heating, cooling, and maintaining optimal conditions. While advancements in renewable energy and energy-efficient technologies are helping mitigate this challenge, finding a balance between energy consumption and sustainable practices remains an ongoing concern.

Conclusion

Soilless agriculture marks a pivotal paradigm shift in our food production strategy, responding to the alarming reduction of arable land. Its advantages go beyond amplified yields and optimized resource use, reaching into the realms of sustainable urbanization, prudent water management, and fortified food security. As urbanization escalates and traditional farming faces limitations, soilless agriculture emerges as a feasible solution. By sidestepping soil dependence, it introduces the possibility of cultivating crops in urban environments and other unconventional settings.

Moreover, the implications for water conservation are profound. Amid increasing water scarcity, soilless systems exhibit precision in water distribution and recycling, mitigating wastage and alleviating the strain on finite water resources. Despite the challenges that inevitably arise, the relentless innovation in soilless technologies creates hope in overcoming these obstacles. The evolution of these methods holds the potential to yield solutions that surmount present limitations. Gazing ahead, soilless methods exemplify the consolidation of human intellect and environmental conservation. In an age of unprecedented global challenges, they can be a system of resourceful adaptation, contributing to sustainable food production in the adverse future.

References:

El-Kazzaz, K. A., & El-Kazzaz, A. A. (2017). Soilless agriculture a new and advanced method for agriculture development: an introduction. *Agric. Res. Technol. Open Access J*, *3*, 63-72.

Mahesh, P. J., Naheem, M., Mubafar, R., Shyba, S., & Beevi, S. (2016, October). New aspect for organic farming practices: Controlled crop nutrition and soilless agriculture. In *2016 IEEE global humanitarian technology conference (GHTC)* (pp. 819-824). IEEE.

Byrd, G., Maharjan, S., Jha, B., & Gurung, S. (2021). A Review of Soilless Agriculture in Nepal. *World Appl. Sci. J*, *39*, 69-83.

Christie, C. B., & Nichols, M. A. (2003, February). Aeroponics-a production system and research tool. In *South Pacific Soilless Culture Conference-SPSCC 648* (pp. 185-190).

Sharma, N., Acharya, S., Kumar, K., Singh, N., & Chaurasia, O. P. (2018). Hydroponics as an advanced technique for vegetable production: An overview. *Journal of Soil and Water Conservation*, *17*(4), 364-371.

https://www.agritecture.com/blog/2019/3/7/soilless-agriculture-an-in-depth-overview

Fussy A, Papenbrock J. An Overview of Soil and Soilless Cultivation Techniques-Chances, Challenges and the Neglected Question of Sustainability. Plants (Basel). 2022 Apr 24;11(9):1153. doi: 10.3390/plants11091153. PMID: 35567154; PMCID: PMC9102199.

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FASCINATING FOXTAIL MILLET

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Introduction

Foxtail Millet is botanically called as *Setaria italica (L.)* and is one of the oldest of the cultivated millets in the world, is cultivated in more than 20 countries in Asia, Africa and America. It is commonly called as magical millet or miracle grain. It is a self-pollinating, short duration, C4 minor millet, good as food for human consumption, feed for poultry and cage birds and fodder for cattle. Foxtail millet ranks second among the millets production in the world and continues to have an important place in the world agriculture providing food to millions of people dependant on poor or marginal soils in the temperate regions of Southern Europe and tropical and subtropical regions of Asia. In India, it is grown mainly in Andhra Pradesh, Karnataka, Telangana, Rajasthan, Maharashtra, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, and in a small extent in the North eastern states of India. It is used as an energy source for pregnant and lactating women, and for sick people and children. Of late, the importance of foxtail millet is recognized as diabetic food. It is rich in dietary fibre, minerals, micronutrients, protein, and has low glycaemic index (GI). Unlike rice, foxtail millet releases glucose steadily without affecting the metabolism of the body. The incidence of diabetes is found to be rare among the population consuming foxtail millet diet.

Botanical description

Foxtail millet is an erect annual, leafy and tufted grass, fast-growing up to 90-220 cm height. It has a dense root system of thin adventitious roots. Its stems are erect, slender and tiller from the base. The leaves are alternate with lanceolate and serrated blades, 15-50 cm long and 0.5-4 cm broad. The inflorescence is an erect or pendulous spike-like bristly panicle, 5-30 cm long x 1-5 cm wide, bearing between 6 and 12 spikelets. Each spikelet consists of a pair of glumes that embraces two minute flowers. The lower one is sterile whereas, the upper one is fertile or bisexual with three stamens and a long oval smooth ovary with two long styles ends feathery. The anthers are yellow or white, ovary surmounted by two long styles and feathery stigmas. The lodicules are two in number. The grain is oval in shape, shiny, 2 mm in length, tightly enclosed within the thickened lemma and palea; varying in colour from cream to orange, yellow brown to black. The fruit is a caryopsis.

Fig. 1. Foxtail millet –*Setaria italica*

Cultivated types of foxtail millet

There are many wild and cultivated types of *Setaria italica*, which are interfertile. Wild types are annual weeds (green foxtail millet) that are very common in temperate areas. There are three cultivated types of foxtail millet that differ in height, habit, inflorescence structure, number and colour of grain.

i. *Moharia* cultivars: These are high-tillering (up to 50 culms) with more or less erect inflorescences. They are grown in Europe, USA and in south western Asia, mainly for fodder.

ii. *Maxima* cultivars: These have between 1 and 8 unbranched culms with large inflorescences. They are cultivated in Russia and Asia.

iii. *Nana* cultivars: These have very short stature with small inflorescence.

iv. *Indica* cultivars: These are intermediate in terms of number of tillers and in inflorescence size. They are grown in Southern Asia

Cultivation method

Foxtail millet needs moderately fertile well drained soil for good yields, although it can grow on soils ranging from sandy to heavy clay soils. It grows better in place with annual rainfall of 500-700 mm. It cannot tolerant water logged condition or extreme drought. In Tamil Nadu it is sown during August or September (Rabi crop), while in Karnataka during July or August and in Maharashtra it is sown during second and third week of July (Kharif crop). The seed rate is 8-10 kg/ha for line sowing and 15 kg / ha for broadcasting. Before sowing, seed treatment with Ridomil @ 2g or Carbendazin @ 2 g/kg. The row to row spacing is 25-30 cm and plant to plant spacing is 8-10 cm. The seeds should be sown at 2-3 cm in depth. Application of compost or farmyard manure @ 5-10 tonnes/ha about a month before sowing. Generally fertilizers recommended to get a good crop are 40 kg Nitrogen, 20 kg P_2O_5 and 20 kg K_2O per ha. Apply entire quantity of P_2O_5 and half of Nitrogen at the time of sowing and remaining half of Nitrogen at 30 days after sowing. Two inter cultivations and one hand weeding in line sown crop is recommended. Intercultural operation using a tyne-harrow when crop is 30 days old is also recommended. In broadcast crop 1st weeding after 15 – 20 days of emergence of seedling and second weeding 15-20 days after first weeding is recommended. Irrigation for Kharif season require minimum or can be grown under rain fed condition. It is mostly grown as a rain fed crop. However, if the dry spell prevails for longer period, then 1-2 irrigations to be given. Summer crop requires 2-5 irrigations depending upon soil type and climatic conditions. Normally crop is ready for harvest in 80 - 90 days after sowing. The grain yield is 20-25 q/ha under ideal condition and Straw yield is 30-40 q/ ha.

Nutritive value of Foxtail millet

Foxtail millets are packed with the goodness of proteins, carbohydrates, vitamins like Vitamin A and E and minerals like phosphorus, calcium, magnesium, sodium, *etc*. Foxtail millet on dry weight basis contains protein 12.3 %, dietary fibre 8%, crude fat 4.3%, Phosphorus 290 mg, Potassium 250 mg, Magnesium 81 mg, Calcium 31 mg, Sodium 4.6 mg, Niacin 3.2 mg, Iron 2.8 mg, Zinc 2.4 mg, Vitamin A 32 mg, Vitamin E 31 mg, Vitamin B_9 (Folic acid) 15 mg.

Uses of Foxtail Millet

1. It is used as human food in Asia, Europe, North Africa and Japan.
2. Foxtail millet may be cooked and eaten like rice either entire or broken
3. It may be ground and made into porridge and puddings.

4. In Russia it is weed for brewing bear.

5. It is a well-known bird seed for feeding to case birds

6. It is an important fodder crop and is grown in United States for hay and silage.

Advantages of Foxtail millet

1. Foxtail millet requires less water and other factors for cultivation and can be cultivated even in poor and marginal lands.

2. It cannot tolerant water logged condition or extreme drought.

3. Foxtail millet might be a cost-effective alternative to animal protein source.

4. Its flour and protein concentrate may have excellent functional properties, making it versatile for various food applications.

5. Foxtail millet has the potential for developing affordable, protein-rich functional food products that can help manage lifestyle-related chronic diseases.

6. The crude fibre of Foxtail millet may act as a natural laxative, promoting a healthy digestive system.

7. Foxtail millets have a sweet and nutty flavour and are eaten as instant foods, ready-to-eat products, rice flour, *etc*.

8. Foxtail millet can be intercropped with Pigeon Pea, Groundnut and cotton.

Limitations of Foxtail millet

1. Foxtail millets are rich in C-glycosylflavones and excess consumption may lead to produce goitrogenic effects by inhibiting thyroid hormone production, which can eventually lead to goitre or enlarged thyroid.

2. Foxtail millets increase Vataja roga (diseases due to vata), so caution must be taken if we have complaints of dry skin, weight loss, joint pain, *etc*.

3. Foxtail Millet contain anti-nutrients like phytic acid and tannins, which may be reduced by soaking. Additionally, soaking can decrease the available nutrients.

Health benefits of Foxtail millet

1. Foxtail millets have a low glycaemic index and may stimulate the cells of pancreas to produce insulin, a hormone which regulates blood glucose. These actions can help lower the spike in blood glucose (Ren *et al*., 2018).

2. Foxtail millet contains *Angiotensin-converting enzyme inhibitors (ACE inhibitors) like phyto-compounds that can lower blood pressure.*

*3. The crude fibre of F*oxtail millets may help manage colorectal cancers.

4. Foxtail millet contains a novel antifungal protein molecule, which is known to show activity against fungi like *Botryrtis cinerea* and *Alternaria alternate*, responsible for allergies and asthma.

5. Adding Foxtail millet to the diet may help improve under nutrition due to the presence of nutritional components like methionine (an essential amino acid), calcium, protein and zinc, *etc.*,

6. Foxtail millets are rich source of iron, which is required for the formation of haemoglobin, thus an increased iron intake may help manage iron-deficiency anaemia.

Value addition in Foxtail millet

1. Traditional recipes: Foxtail millet can be highly useful for Breakfast foods such as Idli, Dosa, Idiappam, Rotti, Pittu, Upma, Adai, Porridge, Khakra, Paniyaram and Chappathi; preparing Sweets like Halwa, sweat Kozhukattai, Adhirasam, Kesari, Nutritious ball and Kheer and for preparing snacks like Pakoda, Ribbon pakoda, Omapodi, Murukku, Thattu vadai, Hot kozhukattai and Vadagam.

2. Bakery products: People of all ages are affectionate of different bakery products, because of their taste, colour and easy to digest nature. Celebrating any moment of happiness is incomplete with bakery products. Bakery products are becoming prominent day by day. Nowadays individuals have virtually no time to invest much on making breakfast it is the bread and bun or biscuits which had occurred instead of other sorts of stuff. They are good supply of snacks and therefore are broadly available. Small millets were incorporated in different variations from 10% to 50% levels to standardize bread (20%), Cake (30%), Cookies (50%), Soup sticks (20%) and Khari (40%) replacing refined wheat flour.

3. Pasta products: Pasta meals like vermicelli, noodles, macaroni etc., are commonly liked by children of today's generation and by other age groups for their taste, inexpensive and easy method of preparation. Foxtail millets to be competitive with important cereal foods, preprocessed or alternative millet based foods are required. Vermicelli, noodles Macaroni were prepared from refined wheat flour and blending with Foxtail millets at 30% incorporation levels.

4. Flaked and Popped products: Cereal popped products and flakes are popular breakfast foods and at present they are mostly made from corn. Value added products from Foxtail millet flakes - Aval uppma, Kitchadi, Payasam, Masala flakes, Boli, Sweet balls, Lemon bath, Tamarind bath and Tomato bath. Also, value added products from popped Foxtail millets - Uppma, Bhelpoori,Masala corn and Cheeian.

Fig. 2. Different value added recipes prepared from Foxtail millet

References

Sema A and, Sarita S. 2002. Suitability of millet-based food products for diabetics. J. Food Sci Technology. 39:423–426.

Chapke, R.R., Prabhakar, Shyamprasad, G., Das, I.K. and Tonapi, V.A. 2018. Improved millets production technologies and their impact. Technology Bulletin, ICARIndian Institute of Millets Research, Hyderabad 500 030, India, pp. 52-56. ISBN: 81-89335-69-3.

Vanithasri, J., Kanchana, S., Hemalatha, G., Vanniarajan, C. and Sahul Hameed, M. 2012. Role of millets and its importance in new mellinium. Int. J. Food Sci. Technol., 2(1): 35- 47.

Hadimani NA, Malleshi NG. 1993.Studies on milling, physicochemical properties, nutrient composition and dietary fiber content of millets. Journal of Food Science and Technology. 30:17-20.

Malleshi NG, Desikachar HS. 1985. Milling, popping and making characteristics of some minor millets. Journal of Food Science and Technology. 22:400.

Ren, Xin *et al*. 2018. The Glucose-Lowering Effect of Foxtail Millet in Subjects with Impaired Glucose Tolerance: A Self-Controlled Clinical Trial. Nutrients vol. 10,10 1509. 15 doi:10.3390/nu10101509. https://pubmed.ncbi.nlm.nih.gov/30326632/

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MEDICINAL BENEFITS OF TRADITIONAL RICE CULTIVARS

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Introduction

Rice is the staple food of India. Asian rice varieties account for 80 percent of the world's rice production. Currently cultivation of traditional rice varieties is gaining immense popularity. Moreover these traditional varieties fetch good price in the market and there is huge demand from health conscious people making its cultivation popular. Traditional rice varieties are generally low in sugar content, making them suitable for diabetics and overweight people. Medicinal properties of some of the major traditional rice varieties widely cultivated in Tamil Nadu are discussed below.

Medicinal benefits of traditional rice

Traditional rice also contains high levels of glutamic acid, fiber and vitamins. Also, traditional rice protects the health of the people by regulating body temperature, good nutrition to the body organs and good sperm production in accordance with the health. Traditional rice also has medicinal benefits such as antioxidant, anti-inflammatory and anti- carcinogenic.In general, people with chronic diseases and dietary side effects consume traditional rice-type foods, which contain tocopherols, tocotrienes, oryzol, polyphenols, flavonoids, and vitamin C to fight chronic diseases. Apart from that, the coloring and flavoring compounds found in it are anti-inflammatory. Medicinal properties of Paddy Commonly used in Ayurvedic and Unani medicine include coagulant, polyvirdi, aphrodisiac, aphrodisiac, diuretic, cholestatic and bilious.

Properties of traditional rice varieties

Karuppukavuni

This variety of rice called KaruppuKavuni is a traditional rice variety. Considered to be mostly cultivated in the rural area of Anumanthakudi in Sivagangai district of Tamil Nadu, it is said to be unsuitable for preparing food. It is a rice crop with total crop duration of about 150 - 170 days, Navarai season starting from January and Samba season starting from September are said to be suitable for long-term paddy cultivation.

And during this season, it is known to be cultivated in all the districts of Tamil Nadu. Suitable for direct seeding, this type of paddy crop is considered suitable for farming with natural fertilizers such as green manures and decomposed organic manures. Also, this variety of rice has unlimited branching capacity and high yield. KaruppuKavuniis a rice variety that thrives in relatively water-logged and dry soils, on sandy and loamy soils.

Mappilai Samba

Mappilai Samba is a traditional type of rice. Each of the native rice cultivated by our ancestors has its own medicinal properties. This rice variety "Mappillai Samba" increases masculinity. It has medicinal properties that control diabetes.„Mappillai Samba‟ rice is red in color. Like all other rice it also contains carbohydrates. The high fiber content in rice makes digestion easier. Vitamin B1 in it helps in healing the stomach and intestines. Additionally, it contains micronutrients, helping to absorb all the nutrients.

Poongaar

Poongaar, one of the traditional varieties of rice, is a short- duration rice variety. Suitable for cultivation in all seasons of the year, this variety can be cultivated three times a year in all soil types of Tamil Nadu districts. Different from the traditional varieties of rice, this Poongaarrice has the ability to germinate after forty days of seed dormancy.

This medium sized paddy variety is suitable for transplanting and direct sowing. It is a red rice variety. It is ready for harvest in seventy to ninety days when cultivated in every district in Tamil Nadu.This Poongaarrice variety is generally grown mainly in Regunathapuram area of Ramanathapuram district of Tamil Nadu. Also, it is considered to be more drought tolerant than other traditional rice varieties such as VarappukKudainjan and Kulyadithan.This type of rice with medicinal properties when consumed during pregnancyis good for health and immunity. By consuming regularly, the unborn child will also be healthy. It induces good secretion of breast milk. Mother and child's health will last longer.

Kattuyanam

Kattuyanam wascalled as KattudaiOnan and became obsolete with time and is now called Kattuyanam. It is a traditional rice variety that has been in use for a long time and has more medicinal properties than other traditional rice varieties.

Able to grow in any climate, this varietygives good yield drought and flood. This variety grows so large (seven feet height) that it can overshadow an elephant. (Hence the name “kattuyanam” for this rice crop).Among other traditional rice varieties, kattuyanam rice has additional medicinal properties. If the rice is cooked in an earthen pot, left overnight with the required amount of water and the rice and water are consumed the next morning for a period (48 days), it gives good results for any kind of disease and diabetes.The cooked kattuyanam rice porridge with curry leaves which is left overnight, if consumed regularly before breakfast is said to cure cancerous sores. Also, research is being done on the cancer-curing properties of the herb.

Kulakar

It has antioxidant properties and has higher zinc and iron content than the polished white rice. It strengthens regenerates and energizes the body, regulates blood pressure, prevents skin diseases and premature aging. The variety is ideal for preparing Idly, Dosa and also preparation of Porridge.

Conclusion

Traditional rice has rich fiber, anthocyanin, amino acids and antioxidant properties. The nutritional significance, therapeutic properties, and physiological effects of the traditional rice varieties has a greater health impact on the human body.

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SMART TECHNIQUES FOR THE CONSERVATION AND MANAGEMENT OF PLANT GENETIC RESOURCES: INDIAN SCENARIO

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Abstract

With the increase in risk of extinction of various plants, the trend has been shifted to employment of many biotechnological techniques for preservation of genetic resources of plant and is the area of research which needs to be revolutionized after a specific time period because it allows the production and selection of crop varieties with desirable characteristics during breeding process such as improved fuel, food and health facilities. Having immense research in conservation of non-threatened species, there is a small collection of knowledge available for conservation of endangered ones. In developing countries where most of agriculture depends upon food crops, the maintenance of genetic variation is of immense importance. On farm conservation provides the best example of preservation and evolution based on genetic variability which can occur ex-situ and in-situ environment in farms or gene bank. So, it presents the best option for conservation or maintenance of ecosystem and biodiversity which ensures survival of endangered species via germplasm. The most important point to consider is that germplasm or genes have to be conserved instead of genotype. In situ conservation involves preservation of plant crops in the field condition in ecosystem where plant is adopted to grow in order to maintain self –sustaining process in natural ecosystem. Similarly ex-situ involves the collections of seed banks of genes collected from plant under natural conditions to produce desirable varieties or from tissue culture in laboratory also referred as in-vitro methodology. *In–vitro* techniques include cryopreservation which include freezing at much lower temperature than that of freezing point i.e., -196 °C in liquid nitrogen for preserving species which are near to extent of endangerment. Cold storage and storing at lower

temperature provide best opportunity for protection against damage caused by rapid freezing. Germplasm exchange has become now a usual practice ensuring exchange of varieties between cultivated and wild types as for example in potatoes specie etc. DNA as well as gene or seed banks provide molecular sources for conservation at biotechnological level. The techniques of introgression and incorporation are basic approaches for germplasm conservation. So, there is need to revolutionize and practice germplasm conservation for fulfilling future needs being aimed at conserving endangered or threatened species from conservation hotspots.

Keywords: *Plant genetic resources, Conservation, ex-situ, Cryopreservation, Germplasm exchange.*

Introduction

Man's interest in agriculture started about 10,000 years ago and, during this long period, transition from 'gathering' to 'growing' of plants occurred. In this process, a wide array of crop variability got generated by natural means and through both conscious or unconscious selection. Gradually, a new wealth of variability also got generated/adapted and diversified by crop introductions in the exotic environment or through migration of human population. Associated with this process was the keenness of human mind to explore the rich global diversity of plant wealth i.e., PGRs in general, so as to judiciously tap the potential of useful flora.

Definitions of Plant Genetic Resources (PGRs)

FAO (1983) defines PGR as the reproductive or vegetative propagating material of (i) cultivated varieties (cultivars) in current use and newly developed varieties; (ii) obsolete cultivars; (iii) primitive cultivars (landraces); (iv) wild and weed species, near relatives of cultivated varieties; and (v) special genetic stocks (including elite and current breeder's lines and mutants).

According to the Convention for Biological Diversity (CBD, 1992), PGRS are any living material of present and potential value for humans. Plant genetic resources include all our agricultural crops and some of their wild relatives because they possess valuable traits.

Spectrum of Vegetable Genetic Resources (Form of Germplasm)

1) Land Races/ Primitive Cultivars

Cultivars which were selected and cultivated by farmers for many generations for adaptation to local conditions and food preferences. Land races were first collected and studied by *N.I Vavilov* in rice.

2) Obsolete cultivars/ Old varieties

Improved varieties of recent past are known as obsolete cultivars.

3) **Modern Cultivars**

These are the currently cultivated yielding varieties and are also known as improved cultivars or advanced cultivars. **e.g.,** Nantes in carrot, Pusa Rohini in tomato, etc.

4) Advanced Breeding Lines

Pre-released plants which have been developed by plant breeders for use in modern scientific plant breeding are known as advanced lines, cultures and stocks. They include advanced cultures which are not yet ready for release to farmers. Sometimes advanced breeding lines and stock are not very much productive, but constitute valuable part of gene pool for various economic characters. **e.g.,** genotypes/ varieties which are under evaluation trials.

5) Wild and Weedy Forms of Cultivated Species

Plants having generally high degree of resistance to biotic and abiotic stresses and are utilized in breeding programmes for genetic improvement of resistance to biotic and abiotic stresses. However, wild forms of many crop species are now extinct. These are used as last resort in crop improvement programmes, because their use in crossing leads to hybrid sterility and sometimes transfer of several undesirable genes to the cultivated species along with desirable alleles. This group constitute a small part of gene pool. For example, *Solanum khasianum* in brinjal (resistant to shoot and fruit borer), *Solanum peruvianum* and *Solanum pimpinellifolium* in tomato (resistant to tomato spotted wilt virus), *Solanum baccatum* in chilli (resistant to anthracnose) etc.

6) Mutant Lines

Lines which are produced with the help of mutations. Mutations do occur in nature as well as can be induced through the use of physical and chemical mutagens. Mutation breeding is used as when the derived character is not found in the genetic stocks of cultivated species and their wild relatives. For example, Gamma rays (300 Gy) used to develop Micro-Tom in tomato (extremely dwarf plant covered with red fruit) and EMS to develop lines which show resistance against Potato virus Y (PVY), a widespread destructive virus for potato and tomato. In seed propagated crops, 410 varieties have been released through the use of the mutants in the crosses. In tomato there are, CO-3 (Marutham – Mutant of CO-1) - capable of yielding as high as 40 tonnes/ha under a close spacing in a duration of 100-105 days. For example;

7) Future crops

These are wild economic and lesser-known/ underutilized species having potential use. For example, amaranthus, rumex, dandelion, lettuce, sorrel, etc.

Germplasm activities

There are six important activities related to plant genetic resources.

1. Exploration and collection
2. Conservation
3. Evaluation
4. Documentation
5. Multiplication and Distribution
6. Utilization

A. Exploration and Collection

Exploration refers to collection trips and collection refer to tapping of genetic diversity from various sources and assembling the same at one place. The exploration and collection is a highly scientific process. This process takes into account six important items, viz,

1. Sources of Collection

Collection can be done from five sources i.e., from diversity centres, gene Banks or sanctuaries, companies for seed collection, and finally through fields.

2. Priority of Collection

Secondly, germplasm collection is done based on endangerment i.e., the species or crops which are more at the extent of extinction are preferred more as compared to others.

Criteria for Prioritization

- *Threat of genetic erosion:* Species in danger of disappearing or becoming extinct.
- *Economic importance:* Crops which are important for national, regional or global food security and for use in crop improvement or direct utilization.
- *Gap-filling required:* Diversity in existing *ex-situ* collections is insufficient/missing.
- *Research use:* Patterns of diversity, study of the mating systems, taxonomic studies, evolutionary relationships among taxa, and other information.

3. Methods of Collection

The method of collection is done in presence of agricultural universities in collaboration with the National Bureau of genetic resources of the plant in New Delhi. For collection at the global level, it is done at the global level by IPGRI with Rome and Italy. The collection is done based on migration to areas of more genetic diversity, by visiting the gene bank by yourself, and finally via the exchange of genetic material.

4. Methods of Sampling

Similarly, there exist two methods which are employed for collecting the germplasm; random sampling - involving the collection of genetic traits for both the biotic or abiotic stresses and non-random sampling – involving collection of the specific traits.

5. Sample Size

Sampling size should be such that it can collect about 96% of diversity occurring in genetic traits.

6. Agencies of Collection

B. Germplasm Conservation

Conservation refers to protection of genetic diversity of crop plants from genetic erosion. There are two important methods of germplasm conservation or preservation.

1.*In - situ* conservation

Conservation of germplasm under natural conditions/ in their natural habitats or where they have been developed is referred to as *in situ conservation*. This is achieved by protecting the area from human interference, such an area is often called natural park, biosphere reserve or gene sanctuary. A gene sanctuary is best located within the centre of origin of crop species concerned, preferably covering the microcenter with in the centre of origin.

2.*Ex – situ* conservation

It refers to the conservation of germplasm away from its natural habitat in gene banks. This is the most practical method of germplasm conservation.

This type of conservation can be achieved in the following 5 ways:

1.Seed Gene Banks

Here, germplasm is stored as seeds of various genotypes. Seed conservation is quite easy, relatively safe and needs minimum space. On the basis of their storability, seeds are classified into two major groups.

Orthodox seeds

Seeds which can be dried to low moisture content and stored at low temperature without losing their viability for long periods of time. **e.g.,** Seeds of carrot, pepper, chickpea, etc.

Recalcitrant seeds

Seeds which show very drastic loss in viability with a decrease in moisture content below 12 to 13%. **e.g.,** seeds of some legumes.

Intermediate seeds

Seeds which tend to age faster than orthodox seeds and may have only a 5-year lifespan when stored at -20°C. They have greatest longevity when dried between 45 and 65% RH and most of our vegetable seeds fall in this category.

However, seeds of all crops cannot be stored at low temperature in the seed banks. The germplasm of only orthodox & Intermediate species can be conserved in the seed banks.

Based on duration of storage, seed bank collects are classified into three groups;

Base collections

It is also known as principal collection. These consist of seeds which are conserved for 50 to 100 years, at about -20^{0}C with 5% moisture content. These collections are disturbed only for regeneration purposes.

Active collections

Consisting of Seeds which are stored for 10-15 years, below 15^{0}C, often at 0^{0}C temperature and the seed moisture is between 5 and 8%. These collections are used for evaluation, multiplication, and distribution of the accessions.

Working collections

Consisting of Seeds which are stored for 3-5 years at 5-10^{0}C with about 10% moisture content. Such materials are regularly used in crop improvement programmes.

Core collection

The concept of core collection was proposed by *Franked*. It refers to a subset of base collection which represents the large collection. Or a limited set of accessions derived from an existing germplasm collection.

2.Field/ Plant Gene Banks

This method involves collecting materials and planting in field in another location. This method is used to conserve accessions of vegetatively propagated crops, species producing recalcitrant seeds and species producing little or no seeds. They are commonly used for cassava, sweet potato, yam, wild onion and garlic.

3.*In vitro* storage

It involves tissue culture techniques for conservation. It is commonly used for vegetatively propagated species, recalcitrant seeded species and wild species which produce little or no seeds. However, in-vitro culturing materials are not free from pathogens and cannot be exchanged without going via the quarantine system.

Shoot tip banks

In such gene banks, germplasm is conserved as slow growth cultures of shoot-tips and nodal segments. Their regeneration consists of sub-culturing the cultures, which may be done every 6 months to 3 years.

Cell and Organ Gene Banks

A germplasm collection based on cryopreserved (at -196^0C in liquid nitrogen) embryogenic cell cultures, somatic/ zygotic embryos they be called cell and organ bank. The techniques for cryopreservation of plant cells and tissues are being rapidly refined, and some such banks have been established, e.g., for potato in Germany.

DNA banks

In these banks, DNA segments from the genomes of germplasm accessions are maintained as cosmid clones, phage lysates or pure DNA (the last one being for relatively short periods) and conserved. These DNA segments can be evaluated and the desired ones may be used to produce transgenic plants. This approach is applicable to the conservation of genetic materials of already extinct species since DNA extracted from well preserved herbarium specimens can often be cloned. However, it is very expensive and highly sophisticated. A world - wide network of DNA banks for threatened / endangered species has been established.

4.Botanical Gardens

It is used for the conservation of wild, rare, endangered, threatened, ornamental species. It can also be considered as field gene bank. It is estimated that there are between 15,000 and 17,000 threatened species currently maintained in botanical gardens and arboreta (where trees are grown for study and display). The objectives of most of the gardens are:

- Maintaining essential ecological processes and life supporting systems.
- Preserving genetic diversity and
- Ensuring sustainable utilization of species and ecosystem.

5.Cryopreservation

The word cryopreservation is derived from two Greek words. i.e., '*Kryos'* means 'frosting' while '*preservation'* means 'storage for a longer time'. Thus, cryopreservation means preservation of cells or tissues in a frozen state at very low temperatures using solid carbon dioxide (at –79°C), with low temperature deep freezers (at –80°C), using vapor nitrogen (at –150°C) and liquid nitrogen (at –196°C) for unlimited periods. It is a sound alternative for long term conservation of plant genetic resources, since under these conditions biochemical and most physical processes are completely arrested. This technique includes stages like freezing, thawing, and re-culture. Any tissue from a plant can be used for cryopreservation, for example, meristems, embryos, endosperms, ovules, seeds, cultured plant cells, protoplasts, and calli. which prevents the damage caused to cells by reducing the freezing point and super cooling point of water. Cryopreservation research for conservation of plant germplasm was initiated in India in the 1970s. At NBPGR many clonally propagated species, 1243 accessions of various orthodox seed species of cereals, millets, pulses, vegetables, medicinal and aromatic plants and 65 accessions of about 16 species including Brassica species are being conserved using cryopreservation. The process of cryopreservation being followed by regeneration of the whole plant invoke the following steps (Figure 1);

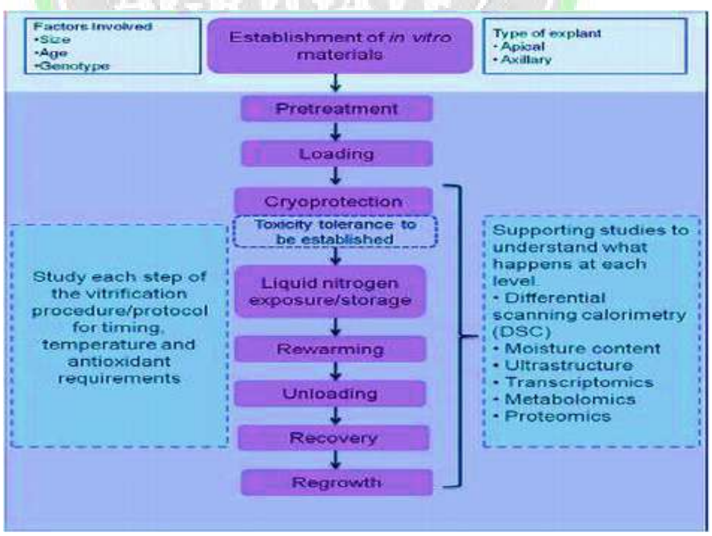

Fig.1.0. Schematic flow sheet representation of steps involved in cryopreservation of plant materials in biotechnology for genetic resource(germplasm) conservation of endangered plant species such as golden paintbrush from natural environment to cryobank in form of seeds, tissues, roots, meristem and shoots etc.

6.Cold storage

This is a slow growth conservation method that conserves the germplasm at a low and non-freezing temperature (1–9°C). The main advantage of this method over cryopreservation is that it slows down growth of the plant material at cold storage (1–9°C) in contrast to complete stoppage during cryopreservation, hence it protects the plants against cryogenic injuries. Moreover, this method is simple, cost effective, and yields germplasms with better survival rates.

7.Low pressure and low oxygen storage

In this method, atmospheric pressure (below 50 mmHg reduces plant tissue growth) and oxygen concentration surrounded by plant material are reduced, which causes the reduced availability of O_2, reduced production of CO_2, and hence photosynthetic activity is reduced, which inhibits plant tissue growth and dimension. These conditions may lead to slow and reduced growth of the plant material, which assists in increasing the shelf-life of many vegetables. Therefore, conservation of germplasm by conventional methods has several limitations such as seed dormancy, short-lived seeds, seed-borne diseases, and high inputs of cost and labor. These modern techniques, like cryopreservation (freezing cells and tissues at –196°C) and cold storage, help to overcome these problems.

Germplasm Conservation: Why conserve plant genetic resources?

Today, our nutrition anywhere in the world is supplied by a mere 30 plant species out of 30,000 edible species because they provide 95 % of dietary energy or protein.

While the number of cultivated plant species is relatively small and seemingly insignificant, nature has evolved an extraordinary intra-specific genetic diversity in crop plants and their wild relatives. It is this diversity within species that allows for the cultivation of crops across different regions and in different situations such as weather and soil conditions. These invaluable and irreplaceable plant resources are called *plant genetic resources* (PGR). They form the basis of all crop varieties that are bred to produce more, withstand stresses and yield quality output.

In addition to the interspecific reduction of crop diversity in agriculture, plant breeding contributes to diminution of the intraspecific diversity, through development of adapted breeding populations, selection of the 'best' genotypes, development of genetically homogeneous cultivars and promotion of few widely adapted varieties. The lack of inter- and intraspecific genetic variability among cultivated crops can lead to:

- Epidemics of pests and diseases (genetic vulnerability); examples are the *Phytophthora infestans* infestation of potato (Solanum tuberosum) in Western Europe in 1845/1846, the *Bipolaris maydis* disaster in T-cytoplasm maize in the USA in 1970 (Campbell and Madden, 1990) and the *Fusarium graminearum* epidemic in wheat and barley in the western USA (1994–1996).
- Lack of adaptation to increasing abiotic stresses like drought or high ozone concentrations;
- Lack of genetic variation for specific quality traits, e.g., Starch quality in maize fatty acid composition or male sterility in oilseed rape (*Brassica napus*).

Loss of genetic diversity (genetic erosion) was observed in many cultivated species. One of the reasons is loss of local populations and their wild relatives. The loss of wild relatives is related mainly to the reduction or loss of habitat due to land use for agriculture, urbanization and industrialization. These human activities have led to pollution of water, soil and air, and thus the extinction of many plant and animal species, which eventually leads to serious damage in world economy. One example is the *bee plague* due to the use of some pesticides. It is believed that the value of bee pollination is 1.3-5.2 billion euros, thus bee extinction is not a problem for beekeepers only, but for the whole society.

Researchers have found that the reduction in the vegetable crop landraces (about 80-90%) has occurred in the last 30 years due to the replacement of a large number of traditional varieties with a smaller number of modern varieties, and also because of gene flow from distinct cultivars to landraces. Finally, the continued erosion of crop genetic diversity hampers agro-ecosystem functioning and its provision of services (i.e., pest and disease control, pollination, soil processes, biomass cover, carbon sequestration and prevention of soil erosion) as well as potential innovation in sustainable agriculture.

As Plant genetic resources are vulnerable to "genetic erosion", (the loss of individual alleles/genes and of combinations of alleles/genes, such as those found in locally adapted landraces), according to FAO, replacement of local varieties by modern varieties. This is intensified by the emergence of new pests, weeds and diseases, environmental degradation, urbanization and land clearing.

The erosion of PGRs poses a severe threat to the world's food security in the long term. India is extremely rich with approximately 45,000 species of plants which roughly constitute 12% of global plant wealth. The world population is expected to reach 10 billion by the year

2057 and food grain production will have to be doubled from the current level of about 5 billion tonnes per year. To meet the need for more food, it will be necessary to make better use of a broader range of the world's plant genetic diversity.

PGRs, the only source of plant genetic diversity, provides valuable traits needed for meeting the challenges of adapting crop varieties. An individual genotype with seemingly useless set of characters today may suddenly become essential tomorrow due to changing climatic conditions or outbreaks of disease. Therefore, it has been long realized that we "conserve" all the diversity we have.

So, conservation is the only option left as it is critical to develop new crop varieties with higher tolerance/resistance to environmental pressures in order to maintain or enhance food supply to meet current and future difficulties.

To conserve the diversity found within species of cultivated plants, experts employ a strategy that combines ex situ conservation (storing diversity in gene banks) with in situ on-farm conservation in matching agro-ecosystems.

Causes of Genetic erosion in vegetable crops in India

1.**Loss of genetic diversity:** due to replacement of varieties landraces/ primitive cultivars with high yielding varieties; replacement with newer crops, pressures on farmers to take up cash crops or monoculture.

2.**Loss of habitat and cultivation land:** loss of vegetable growing areas due to natural calamities (cyclones, flood, and drought) or man-made changes (constructions of buildings, dams, expansion of cities, etc.).

3.**Deforestation:** Deforestation has led to the endangerment of many valuable varieties of plants which present an utmost need to preserve them.

4.**Economic causes:** promotion of crops with high commerce value (potato, soybean, new cole crops- lettuce, broccoli) thus decreasing areas under vegetable cultivation under traditional/ native vegetables.

5.**Low land holdings:** shrinking areas under vegetable cultivation.

6.**Low input conditions:** due to poor rainfall/irrigation facility.

7.**Labour intensive and high cost of cultivation:** vegetable cultivation is labour intensive and high input enterprise. Availability of labour has drastically reduced after schemes like Mahatma Gandhi National Rural Employment Guarantee Act (NREGA) is causing high cost of sustenance and increased cost of production.

8.**Climate change:** rising temperature is shifting the winter/summer vegetables towards high altitude in hills, increased frequencies of extreme weather events and repeated loss of crops (onion, garlic), and increased threat due to disease and pests.

C. Evaluation

Evaluation refers to screening of germplasm in respect of morphological, genetical, economic, biochemical, physiological, pathological and entomological attributes. Evaluation requires a team of specialists from the disciplines of plant breeding, physiology, biochemistry, pathology and entomology. First of all, a list of descriptors (characters) for which evaluation has to be done is prepared. This task is completed by a team of experts from IPGRI, Rome, Italy. The descriptors are ready for various crops. The evaluation of germplasm is down in three different places, viz., (1) in the field, (2) in green house, and (3) in the laboratory.

Why germ plasm evaluation is an essential?

- To identify gene sources for resistance to biotic & abiotic stresses, earliness, dwarfness productivity and quality characters.
- To classify the germ plasm in various groups.
- To get a clear picture about the significance of individual germplasm.

D. Documentation

It refers to compilation, analysis, classification storage and dissemination of information. In plant genetic resources, documentation means dissemination of information about various activities such as collection, evaluation, conservation, storage and retrieval of data. Now the term documentation is more appropriately known as information system. Documentation is one of the important activities of genetic resources. Large number of accessions are available in potato and other major crops. About 7.3 million germplasm accessions are available in 200 crops species. Handling of such huge germplasm information is only possible through electronic computers. In gene bank Database management system-relational database management system (RDBMS) is used for documentation of germplasm.

E. Distribution

Distributions are the most important activity for genetic resource centres. During this process, specific germplasm lines are supplied to the users on demand for utilization in the improvement of genetic traits. Distribution is the responsibility of the gene bank centre's where they are maintained and being stored and to those who are engaged in specific research activities of a particular crop. Germplasm is usually distributed after collection for at least two crop seasons because it is helpful in the adoption and purification of plant material.

- The germplasm is usually supplied to the workers who are engaged in research work of a particular crop species.
- Supplied free of cost to avoid cumbersome work of book keeping.
- The quantity of seed samples depends on the availability of seed material and demands.
- Proper records are maintained about the distribution of material.
- It helps in acclimatization and purification of the material.

F. Utilization

It refers to use of germplasm in crop improvement programmes. The germplasm can be utilized in various ways. The uses of cultivated and wild species of germplasm are briefly discussed below:

(a) Cultivated Germplasm

It can be used in three main ways: (1) as a variety, (2) as a parent in the hybridization, and (3) as a variant in the gene pool.

(b) Wild Germplasm

It is used to transfer resistance to biotic and abiotic stresses, wider adaptability and sometimes quality such as fibre strength in cotton.

Organizations Associated with Plant Germplasm Conservation and Maintenance

International organizations

1. Consultative groups on agricultural research institutes (CGAIR)
2. International Plant Genetic Resource Institute (IPGRI), Rome, Italy.
3. International Potato Centre (CIP), Lima, Peru.
4. International Crops Research Institute for the Semi-Arid Crops (ICRISAT), Hyderabad, India

National organizations

1. National Bureau of Plant Genetic Resources (NBPGR), Pusa, New Delhi

Is conservation our responsibility?

Today we may not as yet know everything about future demands for crop varieties. But we know the supply source and it has to be conserved in its entirety. To save life on earth, to preserve all species, to maintain the ecosystem and a healthy environment forever, so that it remains healthy for the next generation as well, we have to focus on the conservation of plant genetic resources.

Conclusions

Plant Genetic Resources (PGR's) are the foundation on which crop cultivation techniques and food chains integrated with them have been developed, and the genetic diversity present in small farms and germplasm collections is essential in efforts to eradicate hunger and poverty. They are the main gene reservoir for the production of new vegetables cultivars and the main supplier of genetic diversity. Therefore, plant genetic resources offer a huge diversity and variability, widely used in genetic studies and plant breeding programs, with undeniable benefits for global food production.

nt Genetic Resources (PGR's) are used both by traditional farmers to obtain safe and quality production and by researchers as the initial biological material for obtaining new cultivars. The genetic resources are also a reservoir of biodiversity that acts as an element of balancing sudden economic and environmental changes. Recent studies have shown that the main factor in the erosion of PGR's and biodiversity loss is the replacement in cultivation of local genotypes (old varieties, local populations) with modern cultivars.

Unfortunately, PGR's natural pools are strongly affected by the modern society activities – urbanization, habitat degradation through intensive exploitation, deforestation and arson, increased pressure from diseases and pests, to name just some of these activities

Modern industrial agriculture based on improved hybrids and cultivars limited and marginalized the use of landraces, causing a serious loss of genetic variability. Dias reported that, during the last 50-60 years the genetic diversity of vegetables has been severely eroded all over the world, so that the vegetable genetic resources are disappearing yearly on a global scale with a rate of 1.5-2.0%. This genetic erosion represents an alarm signal for the breeding activities in order to streamline the vegetable production under stressful environments.

In the light of this, the efficient conservation and sustainable use of the PGR's is extremely important and has never been more necessary. As genetic erosion continues "in situ" and on farms due to the reasons already mentioned and climate change as well as by replacing old local varieties with improved, super-productive genotypes, it is necessary to intensify the efforts of collection, characterization and conservation with a major focus on the wild relatives of cultivated plants and on the breeds of vegetables poorly represented by the major and minor groups of this class. The conservation of the diversity of local and underutilized plant crops should also be given greater attention.

References

Arora RK (1991) Plant diversity in the Indian Gene centre. In: Plant genetic resources - conservation and management (eds Paroda RS and Arora RK), Intern. Board for Plant Genetic Resources, Regional Office for South Asia and South East Asia and National Bureau of Plant Genetic Resources Campus, New Delhi, pp 25-54.

Arora RK (2003) Genetic resources of underutilized vegetables and their regions of diversity. Veg. Sci. 30(1): 1-9.

Bonner, F. T. (1990). Storage of seeds: potential and limitations for germplasm conservation. Forest ecology and management, 35(1-2), 35-43

Engelmann, F. (1997). In vitro germplasm conservation. Paper presented at the International Symposium on Biotechnology of Tropical and Subtropical Species Part 2 461

Kochhar SL (1998) Economic botany in the tropics. II edn. Macmillan India Ltd., New Delhi. Kohli UK, Amrit V, Manish Kumar, NP Dohroo (2010) Exotic vegetables. Westville Pub. 96 House, New Delhi.

Pandey Anjula, NS Panwar, Rakesh Singh and SP Ahlawat (2019) Vegetables: Status and Priorities for Exploration and Germplasm Collection in India. ICAR-National Bureau of Plant Genetic Resources, New Delhi, India, 97p + i-xxvii

Vavilov NI (1951) The origin, variation, immunity, and breeding of cultivated plants. Chronica Botanica 13: 1-366 (translated from Russian by K Starr Chester), West View Press, Colorado.

Rana R.S and Arora R.K. 2021. Indian National Plant Genetic Resources System - An Overview. https://www.bioversityinternational.org/fileadmin/bioversity/publications/Web_version/174/ch18.htm.

Sameer Quazi, Tanya Golani and Arnaud Martino Capuzzo (April 7th 2021). Germplasm Conservation, Endangered Plants, Sanjeet Kumar, IntechOpen, DOI: 10.5772/intechopen.96184. Available from: https://www.intechopen.com/chapters/76137

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RED GRAM POD FLY DIAGNOSIS AND THEIR MANAGEMENT

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Introduction

Pigeonpea (Cajanus cajan (L.) Millsp.,) commonly known as Redgram,Tur, Arhar etc., is an erect and short-lived perennial shrub legume. India accounts for about 75 % of world production. Economically it is the second most important pulse crop after chickpea in India accounting for about 20 percent of total pulse production. India annually produces about 2.0-2.5 million tones, which remained stagnant in the past 10 years. The ability of the crop to produce economic yields in soils characterized by moisture deficit makes it an important crop of dry land agriculture. India annually imports 3-4 lakh tonnes of pigeonpea to meet the domestic demand.

Myanmar contributes 95% of the total imports due to geographical advantages. Other sources of imports are Tanzania, Kenya and Pakistan. India also exports a small quantity (8000-10000 tonnes) of pigeonpea to countries like USA, UAE, Singapore and Malaysia, but the ratio of export to import is higher and is widening over a period of time. Apart from production shortage, the crop is highly sensitive to attack by a wide range of insect pests both in the fields (at various stages of crop growth) and storage. Most of the pests attack the crop at reproductive stage causing direct losses. Diseases, insect pests and viral diseases transmitted by insects are the major bottlenecks in realising higher yields (Dubey and Sharma, 2002).

Red gram pod fly: *Melonagromyza obtusa* (Agromyzidae: Diptera)

Hosts: Red gram, lady's finger, safflower, cowpea, soybean

Damage Symptoms

- Maggots after hatching feed on the developing seeds in the pods.
- First they mine on the under surface of pods and then burrow through the seeds deep forming galleries.

- They migrate from seed to seed in pods and make them unfit for human consumption.
- Adult emergence leaves pinholes on the pods.
- Up to 86 % pods are infested in the field resulting in damage to seeds as high as 60 %.

Life cycle

- Adults are very small, metallic black flies, about 1.5 mm long with a wing span of 4 mm.

- Female fly inserts minute eggs into the shell of a tender pod with the help of ovipositor. It lays about 4-7 eggs in a pod singly. A female can lay about 40-80 eggs during her life time. Incubation takes 3-5 days.
- Larval period lasts 8-12 days. The last instar maggot is creamy white in colour, 3-4 mm in length.
- Pupation occurs inside the pods. The adult emerges after drilling a hole after 6-10 days.

- One generation is completed in 3-4 weeks. Several generations occur per year.

Management

- Collection and destruction of damaged pods.
- Spray neem seed kernel extract 5 %, neem oil 2 %, phosalone 0.07 %, fenvalerate 20 EC 62.5 ml, Novaluron 0.2% or cypermethrin 25 EC 40 ml per acre.

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SUSTAINABLE AGRICULTURE PRACTICES IN AGRIBUSINESS MANAGEMENT

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Abstract

Sustainable agriculture practices have emerged as a pivotal component of modern agribusiness management. Sustainable agriculture encompasses a holistic approach to farming, focusing on ecosystem health, soil vitality, and reduced environmental impact. It emphasizes key principles such as soil health, water management, biodiversity, crop diversity, and organic farming. These principles, when integrated into agribusiness management, yield numerous benefits. In agribusiness management, the adoption of sustainable practices leads to long-term profitability through increased yields, reduced input costs, and market access opportunities. Sustainable agriculture practices also ensure compliance with evolving environmental regulations, mitigate risks associated with climate change, optimize resource use, and enhance brand reputation. While challenges exist in implementing sustainable practices, such as initial costs and operational adjustments, the long-term advantages in terms of profitability, environmental stewardship, and resilience outweigh these obstacles. The article concludes that sustainable agriculture is not only a responsible choice but an essential one for the future of agribusiness, contributing to a healthier planet and ensuring prosperity for generations to come.

Introduction

` In an era marked by increasing environmental concerns and the urgent need to address climate change, sustainable agriculture practices have taken center stage in the world of agribusiness management. Sustainability is not merely a buzzword; it has become a vital aspect of modern agriculture. This article delves into the significance of sustainable agriculture practices and their profound impact on agribusiness management.

The Essence of Sustainable Agriculture

The essence of sustainable agriculture lies in its commitment to meeting the needs of the present without compromising the ability of future generations to meet their own needs. It represents a profound shift in agricultural practices and philosophies, moving away from short-term gains and environmental exploitation toward a more balanced and responsible approach to food production. Here are the core principles and concepts that embody the essence of sustainable agriculture:

i. **Environmental Stewardship:** At the heart of sustainable agriculture is a deep respect for the environment. It seeks to minimize harm to ecosystems, reduce pollution, conserve biodiversity, and protect natural resources such as soil and water. Practices aim to regenerate and enhance the health of the land, rather than deplete it.

ii. **Economic Viability:** Sustainability isn't just about ecological concerns; it also recognizes the economic aspects of agriculture. Sustainable farming practices are intended to be financially viable for farmers, ensuring their livelihoods while promoting responsible resource management. This involves optimizing input costs, reducing waste, and improving profitability over the long term.

iii. **Social Equity:** Sustainable agriculture emphasizes fairness and social responsibility. It strives to create equitable systems that benefit all stakeholders, including farmers, farmworkers, local communities, and consumers. Fair labor practices, ethical treatment of workers, and community engagement are integral to this principle.

iv. **Resource Efficiency:** Sustainability requires efficient use of resources. This includes minimizing waste, optimizing water and energy usage, reducing greenhouse gas emissions, and adopting technologies and practices that increase resource efficiency.

v. **Biodiversity:** Sustainable farming encourages the preservation and enhancement of biodiversity. It recognizes the importance of diverse ecosystems, promotes crop rotation, polyculture, and integrated pest management to reduce reliance on pesticides and herbicides.

vi. **Soil Health:** Healthy soil is the cornerstone of sustainable agriculture. Practices like cover cropping, reduced tillage, and organic matter additions are employed to improve soil structure, fertility, and resilience.

vii. **Local and Seasonal Production:** Sustainable agriculture often advocates for local and seasonal food production. This reduces the carbon footprint associated with transportation and fosters stronger connections between producers and consumers.

viii. **Resilience to Climate Change:** Sustainable agriculture recognizes the challenges posed by climate change. It aims to build resilience in farming systems to cope with extreme weather events, changing rainfall patterns, and temperature fluctuations.

ix. **Reduced Chemical Use:** Sustainability promotes the reduction of synthetic chemical inputs such as pesticides and synthetic fertilizers. Organic farming, integrated pest management, and biological control methods are encouraged to minimize the ecological impact of farming.

x. **Continuous Learning and Adaptation:** Sustainable agriculture is not a static concept; it involves continuous learning and adaptation to evolving environmental and economic conditions. Farmers and agribusinesses are encouraged to stay informed and embrace new practices and technologies.

In essence, sustainable agriculture represents a holistic and forward-thinking approach to food production. It recognizes the interconnectedness of ecological, economic, and social factors, striving for a harmonious balance that ensures the well-being of the planet, its inhabitants, and future generations. By adhering to these principles, sustainable agriculture aims to create a world where agriculture nourishes the world while preserving the environment for generations to come.

Impact on Agribusiness Management

- **Long-term Profitability:** Sustainable practices can lead to increased yields over time as soil health improves. Reduced dependence on costly inputs like synthetic fertilizers and pesticides also enhances profitability.
- **Market Access:** Many consumers today prioritize sustainability and are willing to pay a premium for sustainably produced food products. Agribusinesses that adopt sustainable practices gain a competitive edge in the market.
- **Regulatory Compliance:** Governments and international bodies are imposing stricter environmental regulations. By embracing sustainable practices, agribusinesses can ensure compliance and avoid potential penalties.
- **Risk Mitigation:** Sustainable agriculture practices are often better equipped to withstand extreme weather events and changing climate conditions, reducing the risk of crop failure and financial losses.

- **Resource Efficiency:** Sustainable practices optimize resource use, including water and energy. This not only reduces costs but also minimizes the ecological footprint of agribusiness operations.
- **Brand Reputation:** Agribusinesses that prioritize sustainability build a positive brand image, enhancing customer trust and loyalty.

Opportunities for Sustainable Agriculture Practices in Agribusiness Management in India

Sustainable agriculture practices are crucial for the long-term viability of agribusiness in India, as they not only promote environmental stewardship but also enhance productivity and profitability. Here are some opportunities for sustainable agriculture practices in agribusiness management in India:

- **Organic Farming:** The demand for organic produce is steadily increasing both domestically and globally. Agribusinesses can explore organic farming methods, which eliminate the use of synthetic chemicals and focus on natural inputs and practices. This can lead to higher-priced organic products and greater market access.
- **Precision Agriculture:** Precision agriculture technologies like GPS-guided tractors, drones, and sensors can optimize resource use, reduce waste, and enhance yields. Agribusinesses can invest in these technologies to improve farm management and reduce their environmental footprint.
- **Diversification:** Encourage crop diversification to reduce the risk associated with mono-cropping and increase resilience to climate change. Introducing diverse crops can also open up new markets and value-added opportunities.
- **Water Management:** Implement water-efficient irrigation techniques such as drip and sprinkler systems. Invest in rainwater harvesting and water recycling to reduce the strain on water resources.
- **Soil Health Management:** Promote soil health by adopting practices like crop rotation, cover cropping, and reduced tillage. Healthy soils improve crop yields and reduce the need for chemical fertilizers.
- **Integrated Pest Management (IPM):** Implement IPM strategies to minimize the use of pesticides and insecticides. This includes biological control methods, pheromone traps, and regular monitoring of pest populations.

• **Agroforestry:** Integrate trees and woody perennials with crops and livestock. Agroforestry systems can provide multiple benefits, including enhanced biodiversity, improved soil fertility, and additional income through timber and non-timber forest products.

• **Sustainable Livestock Farming:** In addition to crops, consider sustainable livestock farming practices, such as rotational grazing, organic feed, and proper waste management, to reduce the environmental impact of animal agriculture.

• **Market Linkages:** Develop direct market linkages with consumers or food processors who value sustainability. Transparent and sustainable supply chains can often command premium prices.

• **Capacity Building:** Invest in training and education for farmers and farm workers to ensure they have the knowledge and skills to implement sustainable practices effectively.

• **Government Incentives:** Take advantage of government schemes and subsidies that promote sustainable agriculture, such as subsidies for organic farming, renewable energy installations, and water-saving technologies.

• **Research and Innovation:** Collaborate with research institutions to stay updated on the latest sustainable farming practices and explore opportunities for innovation in agribusiness management.

• **Certifications:** Pursue certifications like organic, Fair Trade, or Rainforest Alliance, which can help establish credibility and access niche markets that value sustainability.

• **Energy Efficiency:** Invest in energy-efficient technologies for farm operations, such as solar-powered irrigation pumps and energy-efficient processing equipment.

• **Waste Reduction:** Minimize waste generation and explore opportunities for recycling and composting agricultural waste products.

By embracing these sustainable agriculture practices, agribusinesses in India can not only reduce their environmental impact but also tap into growing markets for eco-friendly and ethically produced food products, ultimately leading to long-term success and profitability.

Challenges in Implementing Sustainable Practices

Implementing sustainable practices in agribusiness is essential for long-term viability and responsible resource management. However, this transition is not without its challenges. Here are some of the key challenges in implementing sustainable practices in agribusiness:

- **High Initial Costs:** Many sustainable practices, such as transitioning to organic farming, investing in renewable energy, or implementing precision agriculture technologies, can require significant upfront investments. Small and resource-constrained farmers may struggle to afford these initial costs.
- **Lack of Knowledge and Education:** Farmers and agribusiness managers may lack the necessary knowledge and training to effectively implement sustainable practices. Education and training programs are essential to bridge this knowledge gap.
- **Change in Farming Methods:** Sustainable practices often require a fundamental shift in farming methods and techniques. Farmers may be resistant to change, especially if they have been using conventional methods for many years.
- **Transition Period:** Transitioning to sustainable practices can lead to a temporary decrease in yields or productivity. It may take time for the soil and ecosystems to adjust to new practices, which can be financially challenging for farmers during this transition period.
- **Market Access and Certification:** Accessing markets that value sustainable products may require certification, which can be a complex and costly process. Meeting certification requirements and maintaining compliance can be challenging for some agribusinesses.
- **Supply Chain and Infrastructure:** The existing supply chain and infrastructure may not support sustainable practices. For example, there may be limited access to organic processing facilities or renewable energy sources in rural areas.
- **Climate Variability:** Sustainable practices are often designed with long-term environmental benefits in mind. However, they may not always be well-suited to coping with short-term climate variability, such as extreme weather events or droughts.
- **Pest and Disease Management:** Sustainable agriculture often relies on natural pest and disease management techniques. While effective, they may require more careful monitoring and intervention, which can be labor-intensive.
- **Access to Resources:** In some regions, access to essential resources like water, land, and seeds may be limited, making it challenging to implement sustainable practices effectively.
- **Government Policies and Incentives:** Government policies and incentives can either encourage or hinder the adoption of sustainable practices. Inconsistent or unclear regulations can create uncertainty for agribusinesses.

- **Consumer Demand:** Sustainable practices may not always align with consumer demand or preferences. Balancing sustainability with market demand can be a delicate task.
- **Data and Technology:** Many sustainable practices rely on data-driven decision-making and technology adoption. Agribusinesses without access to modern technology or data analysis tools may struggle to implement these practices effectively.

Despite these challenges, the benefits of implementing sustainable practices in agribusiness are substantial. Addressing these challenges often requires a combination of financial support, education and training, supportive policies, and collaboration among stakeholders in the agriculture industry. Overcoming these obstacles is crucial for the long-term sustainability of agribusiness and for addressing environmental and food security concerns.

Conclusion

Sustainable agriculture practices are no longer an option but a necessity in agribusiness management. They offer a pathway to increased profitability, reduced environmental impact, and market competitiveness. Agribusinesses that prioritize sustainability are not only contributing to a healthier planet but also securing a more prosperous future for themselves and the generations to come. As we look ahead, it is clear that sustainable agriculture is the cornerstone of responsible agribusiness management.

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BUFFEL GRASS - A FODDER FOR DRY TRACTS OF TAMIL NADU

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Introduction

Buffel grass, botanically called as *Cenchrus ciliaris* belonging to Poaceae family is also called as African foxtail grass, Foxtail buffalo grass, Blue buffalo grass, Black buffel grass, Rhodesian foxtail, Pasto buffel, Zacate buffel, Anjan Grass (in India), Dhaman grass and Kozhukattai Pull (in Tamil). Buffel grass is grown as forage perennial grass in tropics and subtropics across the world and it is a long-lived tussock grass with a deep, tough root system with high biomass yield, drought tolerant, temperature stress tolerance and some are tolerate to cold temperatures. It grows rapidly under warm, moist conditions and has high nutritional value for sheep and cattle, with an ability to withstand heavy grazing. It is utilized as a permanent pasture, but if harvested at a leafy stage, it can also be used to make hay or silage (Burson *et al.*, 2012). It is unsuitable for short-term grazing because it takes a while to establish, is too challenging to get rid of, and ties up nutrients.

ORGIN AND DISTRIBUTION

Buffel grass is native to Africa, Asia, and the Middle East. It is among the several African grasses that have been introduced as cow feed in tropical and subtropical areas of the world, including the southern United States. It was introduced to the United States in the 1930s to minimize erosion and provide feed for animals. Between the 1930s and the early 1980s, it was planted in several different places throughout southern Arizona. Buffel grass is planted and become invasive in Australia, North and South America, as well as several islands in the Pacific Ocean (including Hawaii), Indian Ocean, and Caribbean Sea (Gibbs *et al*., 1990). Now Buffel grass naturally occurs throughout Africa and from Arabia and the Middle East to India. It has been widely introduced and is naturalized throughout the semi-arid and sub-humid tropics and subtropics

BOTANICAL DESCRIPTION

It is extremely variable species, tufted, sometimes shortly rhizomatous perennial. The tough, clumped plants can grow to over 3.5 feet tall, and mature plants typically grow to 3-4 feet in diameter. Root is deep strong fibrous root system to more than 2m. Stem is culms are erect or decumbent, reaching up to 2 m in length which is ascendant to erect, and branched culms. Leaf blades linear, 2-13mm wide and 3-30 cm long, which are green, blue green to grey green in colour and scabrous, mostly glabrous, sometimes hairy at the base. The leaf blade contains small stiff hairs and ligule has delicate hairs. The inflorescence is a spike-like panicle, bearing deciduous spikelets which are surrounded by hairy bristles that is grey or purple coloured bristly, with fasicles inserted in a zig zag manner. Spikelets groups of 1-3 or rarely 4, 4-5 mm long, attached to main stem by very short stalks. Spikelets are enclosed in a ring of hairy bristles joined at the base, 5-15 mm long, which fall with the spikelet group at

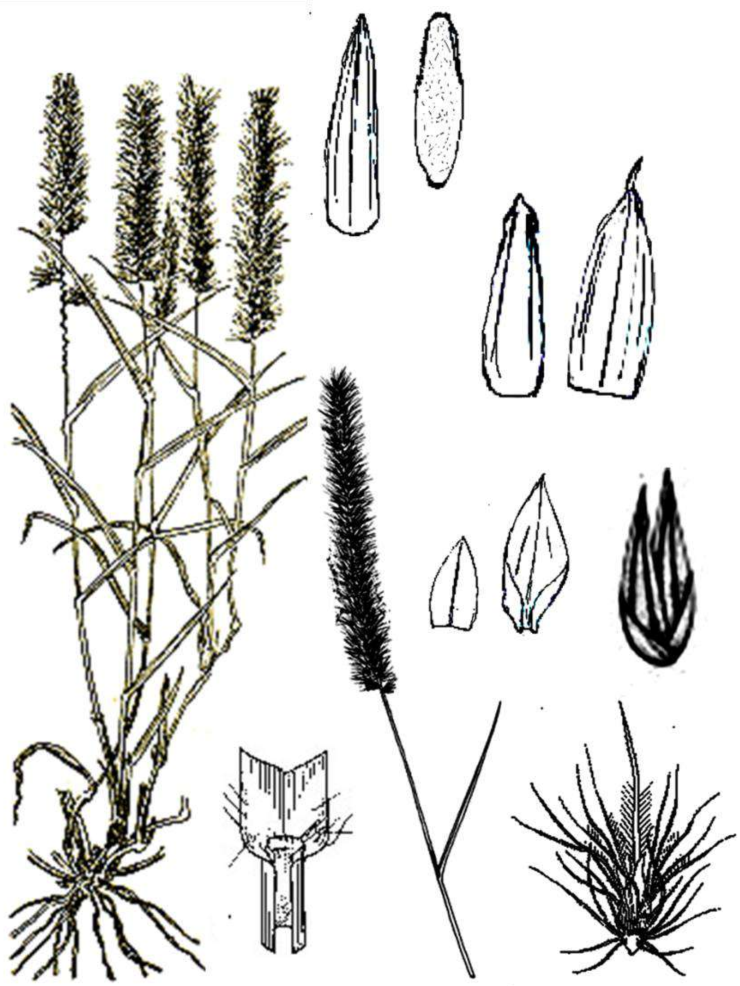

Fig. 1. Buffel grass- ***Cenchrus ciliaris***

maturity. Glumes are 2 and the first glume is 1-3 mm long by 1 mm wide and 1 nerved, and usually smaller than the second and the second glume is 1.3-3.4 mm long, 1-3 nerved. Second (fertile) palea hardened and second (fertile) lemma hardened. First and second lemmas are 2.5-5 mm long, 5-6 nerved with a minute awn. Flowers have single fertile floret per spikelet. Fruit is caryopsis obovoid, dorsally compressed with the size 1.5-2 × 1 mm, dark brown in color, glabrous, truncate or obtuse with apex unappendaged. The seed is an ovoid caryopsis, 1.4-2 mm long. Each bur-like seed unit may contain one or more seeds. Reproduces from seed that normally lies dormant 3 to 18 months and the seeds are viable for at least 3–5 year. All ecotypes are obligate apomicts although facultative apomicts that reproduce by sexual and apomictic means also exist. They are usually Cross-pollinated.

GROWING CONDITIONS

Buffel grass is commonly found on agricultural regions, disturbed sites, empty lots, rangelands, grasslands, south-, west-, and east-facing mountain slopes, and riparian zones. It grows well in arid and semi-arid conditions, on light, sandy, rocky, and shallow soils, and in dry calcareous places. It can be found on the sides of highways, in dry river beds, and on river banks. *Cenchrus ciliaris* grows from 33°S to 37°N and up to 2000 m in height. Annual rainfall of 375 to 750 mm, day temperatures of 30°C to 35°C, on light, rich, well-drained soils, and a soil pH of 7 to 8 are ideal growing conditions. Grow on sandy or sandy loam type of soil with drainage with good fertility. The optimum pH range is 7-8. It does not tolerate prolonged flooding or water logging especially in cold season. *Cenchrus ciliaris* is the most drought resistant of the regularly seeded grasses in desert places, with annual rainfall as low as 100 mm. It produces the finest results under irrigation. Buffel grass tolerates fire (Pengelly *et al*., 1992).

CULTIVATION PRACTICES

Seeding rates of 2 to 3kg/acre have been used with success in heavier rainfall areas adjacent to the coast and on more fertile soil types. Planting Time is March 1st to Mid-December and at the depth of 1/4 inches, suitable for both sandy and clay soils. A standard tyne cultivator or tandem disc harrows have both been employed for field preparation. It is advised to cover the seed after broadcasting it using harrows. Mixing with

Fig. 2. Buffel grass at flowering stage

fertilizer, cracked grain, or using pelleted seed improves distribution through airseeders and combines. Buffel grass seeds must be kept wet for three to five days for germination. It matures and flowers within 6 weeks following at least 0.75 inches of rain and moist soil occurring over a 3–5 days interval. 50 - 150 kg/ha superphosphate should be applied at sowing if available soil phosphate levels are low, depending on soil type, fertility and rainfall. It can be cultivated as a companion species with bluegrasses, digit grass, Rhodes grass, tall finger grass and Legumes such as burgundy bean, butterfly pea, Cassia, White, subterranean Clover, Desmanthus, Soybean, Lucerne, Siratro, and Stylosanthes. Seed yield can be obtained by getting the maximum number of tillers by cutting or allowing to graze te plants. Depending upon the cultivars and fertilizer application, seed yields range between about 150 and 500 kg/ha. Dry matter yields of 4 to 6 t/ha have been achieved from swards with no nitrogen fertiliser.

FODDER QUALITY AND NUTRITIVE VALUE

GREEN FODDER

It is an excellent type maintenance quality fodder and can support milk yield without concentrate up to a limited extent. The green fodder value is determined by several factors, including its nutritional content, palatability and yield. Early harvesting and feeding at levels allowing at least 30% refusals is recommended for growing sheep

PASTURE

This is mostly utilized as a permanent pasture, although it may also be used for hay or silage if cut at a leafy stage. It is unsuitable for short-term grazing because it is sluggish to develop, tough to remove, and binds up nutrients. Buffel grass takes a long time to grow, and grazing may have to be postponed for up to a year depending on the circumstances. If at all possible, grazing may need to be postponed for up to 12 months until after seed set. This guarantees that plants are well-established and allows lighter stands to thicken up in later years. Buffel grass is particularly tolerant of frequent cutting or grazing after it has been established. Buffel grass pastures should be grazed enough frequently and strongly to maintain in a green, more nutrient-rich stage since quality rapidly falls with age.

PALATABILITY

Generally less palatable than *Panicum coloratum* and *Panicum maxima*, but more palatable than *Setaria incassata*. Even when leafy, it is only moderately palatable, although there are differences between cultivars.

TOXICITY

Soluble oxalate levels of 1 - 2% in the DM of the plant can cause 'big head' in horses and oxalate poisoning in young or hungry sheep of 2.5-3.5% of dry matter. This disease is most prevalent during the wet season when grass is young and lush. The soluble oxalates are absorbed into the blood stream and bind to calcium ions. For particular groups of cattle, this can cause either acute hypocalcaemia or the formation of calcium oxalate crystals.

NUTRITIVE VALUE

Crude protein is about 9.6 per cent and In Vitro Dry Matter Digestibility (IVDMD) and Crude Protein (CP) digestibility ranges from 50-60 per cent. Lysine, Calcium and Phosphorus content are 0.96 g, 2.39 g and 1.38 g per kg respectively. Neutral Detergent Fiber (NDF) content ranging from 45% to 70% of dry matter and Acid Detergent Fiber (ADF) content in Buffel grass can vary from 30% to 55% of dry matter. Lower ADF values indicate less fibrous forage (Heuzé *et al*., 2016).

CULTIVARS AND VARIETIES

1. **CO-1 (Neela Kolukattai):** The variety was developed at TNAU, Coimbatore from clonal selection of fs-391. It is highly suitable for rain fed conditions yielding 55 t/ha green fodder. It has been recommended for cultivation in Tamil Nadu.
2. **American cultivar** - A medium-short, early maturing, non-rhizomatous type, with fine stems, green foliage, and purple inflorescence, suitable for light to medium textured soils. Selected for drought tolerance and forage production. Rapid growth from very early spring through late summer. Growth continues during hottest part of summer with brief showers. Fast recovery from grazing and drought.
3. **Gayndah cultivar** - Released in Australia (1934). Institutional collection from Kenya. Fine, medium-short, tufted, non-rhizomatous type, to 90 cm tall (commonly 30–60 cm), mid-season flowering, suitable for light to medium textured soils Tolerant of heavy grazing. Resistant to Pyricularia grisea in North America, but susceptible in Australia.
4. **Marwar Anjan (CAZRI-75):** this variety was developed by CAZRI, jodhpur using clonal selection method from exotic line EC 14369 from Australia. The variety is apomictic and can be propagated by seeds or rooted slips. It is recommended for growing in arid and semi-arid areas of the country. The variety remains green for longer period. Average yield under total rain fed condition is approx. 9–10 t/ha and DMY 4–5 t/ha.

5. **Bundel Anjan-1:** The variety was developed by intra-population selection of IGFRIS-3108, at IGFRI, Jhansi and released in the year 1989. The plants have semi-erect growth habit, thick stem, medium late maturing, high tillering, large compact spike, purple pigmented nodes and droopy, long and broad leaves. It has high regeneration ability, perennial, palatable and is highly nutritious at flowering stage. The potential yield for green fodder is 35–40 t/ha.
6. **Bundel Anjan -3 (IGFRI727):** The variety was developed by IGFRI, Jhansi and released in 2006. It is suitable for cultivation in arid and semi-arid tract of the country particularly in Rajasthan, western UP, Haryana, Punjab, Maharashtra and Andhra Pradesh under rain fed condition. The variety is significantly superior to other varieties for green fodder and dry matter yield

USES OF BUFFEL GRASS

1. **Livestock Forage:** It serves as a valuable source of nutritious feed for cattle, sheep, goats and horses especially in arid regions.
2. **Soil Erosion Control:** Buffel grass helps stabilize soil and prevent erosion, making it useful for soil conservation especially on hilly slopes. The tussock base and leaves help to impede overland flow of water and the erosive impact of raindrops.
3. **Land Rehabilitation:** It is employed to restore vegetation cover and improve soil quality in degraded areas.
4. **Wildlife Habitat:** Buffel grass can provide forage for wildlife, supporting herbivorous species.
5. **Allelopathic effect:** Its allelopathic effect controls the growth of *prosophis* species that is highly essential to have a control over it.
6. **Hay and Silage making:** At young leaves stage it is used to make hay and silage.
7. **Grain value**: In India the seeds may also be harvested in order to make bread or to be eaten raw by humans.

ADVANTAGE OF BUFFEL GRASS

1. It is very drought tolerant and quick to respond to rain.
2. Capacity to withstand heavy grazing.
3. Adapted to range of soil textures.
4. Very persistent on lighter-textured soils.

5. Buffel grass can make reasonable quality hay.
6. Buffel grass will survive and produce new growth after burning.
7. Prevent soil erosion and suppressing dust through its root system.
8. It has higher protein, phosphorus and digestibility than native grasses.

LIMITATIONS OF BUFFEL GRASS

1. Needs high fertility for production.
2. Establishment difficult on clay soils.
3. Does not survive prolonged flooding or waterlogging.
4. Buffel grass contains oxalates and can cause oxalate poisoning in young and hungry sheep.
5. Can cause 'big head' in horses.
6. "Fluffy" seed is difficult to sow.
7. Threat to biodiversity in favourable environment.
8. Buffel grass can create a fire hazard for infrastructure, animals and people.
9. Large and dense populations of buffel grass may impede overland flow of water in streambeds, increasing the extent of local flooding.

References:

Burson, B.L., J.M. Actkinson, M.A. Hussey, and R.W. Jessup. 2012. "Ploidy Determination of Buffel Grass Accessions in the USDA National Plant Germplasm System Collection by Flow Cytometry." South African Journal of Botany 79 (March 2012): 91–95. https://doi.org/10.1016/j.sajb.2011.12.003.

Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N.P., Anderson, H.M. and Dallwitz, M.J. 1990. Grasses of Southern Africa: An identification manual. Memoirs of the Botanical Survey of South Africa No. 58. Botanical Research Institute, Pretoria, South Africa.

Heuzé V., Tran G., Baumont R., Lebas F., 2016. *Buffel grass (Cenchrus ciliaris)*. Feedipedia, A programme by INRAE, CIRAD, AFZ and AO. https://www.feedipedia.org/node/482 *Last updated on April 1, 2016, 17:12.*

Pengelly, B.C., Hacker, J.B. and Eagles, D.A. 1992. The classification of a collection of buffel grasses and related species. Tropical Grasslands 26:1–6.

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LIVING ROOF: A NOVEL TECHNIQUE FOR URBAN DWELLERS

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Introduction

Today the yell of global warming is heard from all the nooks and corners of the Globe and it became one of the major threats to the very existence of living organisms on the mother Earth which pose a major challenge to human survival on the Earth. On a global basis, many cities in the world are becoming highly urbanised at alarming rate with the adaption of sky scrapers and their construction in close proximity to each other which is directly and indirectly contributing in rise in earth's temperature. As most of the modern buildings are constructed with reinforced concrete, this high concentration of thermal mass, together with the resultant loss of green areas, has created a basis for environmental issues such as the Urban Heat Island effect. This in turn causes a substantial increase in air temperature within the urbanised areas and results in higher energy consumption for cooling load of the building. Plants and the vegetation are known to help in trapping the dirt and dust in the air as well as to generate oxygen in the day through photosynthesis and with their destruction in urbanised zones, the air quality is deteriorated. Roof gardens or also known as "green roofs" and "eco-roofs" are the best choice available to mitigate such adverse effects of urbanisation and their benefits are well documented. Architects have introduced the green-roof technology worldwide and public become aware of green-roof benefits. Although green roofs are initially more expensive to construct than conventional roofs, the benefits extended by the green roofs are rather many.

History of green roofs

The history of the green roofs laid its roots during the period of Babylonia. The earliest documented roof gardens were the hanging gardens of Semiramis which is now Syria, considered as one of the seven wonders of the ancient world. These green roofs, known for their deep substrates and variety of plantings as "intensive" green roofs, have the appearance of conventional ground-level gardens and they can augment living and recreation space in densely populated urban areas. The modern green roof originated at the turn of the 20^{th} century in Germany, where vegetation was installed on roofs to mitigate the damaging physical effects of solar radiation on the roof structure. Early green roofs were also employed as fire retardant structures.

Green (or living) roofs are known as roofs that are purpose fully prepared or cultivated with vegetation.

A green roof usually consists of the following:

- Vegetation/plants
- Growing medium/ Substrate
- Root barrier
- A specialized drainage layer
- A waterproofing / roofing membrane, with an integral root repellent.
- Roof structure, with traditional insulation

Benefits of Roof gardens

A. Environmental Benefits

Alleviating Urban Heat Island Effect

The Urban Heat Island effect is caused by the absorption and retention of solar heat in buildings and hard structures in highly urbanised cities resulting in the air temperature in such areas becoming significantly warmer than in the rural areas. The use of roof gardens has been proven to lower the surface temperature by as much as 30°C and air temperature by about 4°C in tropical conditions through a field test. These reductions in temperature are due mainly to the shading of the heat absorbing roof surfaces as well as the evapo-transpirational cooling effects of the plants in the roof gardens.

During warm weather, green roofs reduce the amount of heat transferred through the roof surface, thereby lowering the energy demands of the building's cooling system.

Air Quality

Roof vegetation can improve the air quality by acting as a filter to trap airborne dust particles. In a study carried out in Frankfurt, Germany, streets without trees were noted to have an air pollutant count of 10,000 to 20,000 dirt particles per litre of air compared to one with trees in the same neighbourhood where only 3,000 particles per litre of air were noted A higher temperature at roof level tends to create a thermal draft drawing up dust particles from street level. Roof greening has been found to be effective in moderating the thermal draft by reducing the temperature differences between rooftop and street level.

Water Quality

Depending on the thickness of the various layers of the roof garden, a green roof is able to filter out heavy metals and nutrients present in rainwater. This advantage proved to be beneficial in urban places where precipitation is collected for domestic usage in addition to treated potable water supply from the utility provider.

Storm water Management

Roof gardens retain rainwater on the roof through various strata and significantly reduce the peak discharge flow rate into storm water drainage system. The ability to absorb and retain up to 75% of rainfall thereby reducing the immediate discharge to 25%, effectively ensures that the risks of flash flooding is reduced.

Green roofs as ecosystems

Green roofs represent the technology that can be considered as bio engineering or bio mimicry: the ecosystem created by a green roof's interacting components mimics several key properties of the ground-level vegetation that are absent from a conventional roof. Green roofs, like other constructed ecosystems (*e.g.*, sewage treatment wetlands, bio swales for storm-water management, or living walls), mimic natural ecosystems to provide ecosystem services. In particular, extensive green roofs represent the potential for the establishment of shallow soil habitats and their accompanying biodiversity.

B. Bio diversity: An added advantage

Most of the green roofs can provide undisturbed access to several microorganisms, insects and small birds also. Green roofs are commonly inhabited by various insects, including beetles, ants, bugs, flies, bees, spiders, and leafhoppers. Rare and un- common species of beetles and spiders have also been recorded on green roofs.

C. Influence on roof membrane

Waterproofing membranes on conventional dark roofs deteriorate rapidly in ultraviolet (UV) light, which causes the membranes to become brittle. Such membranes are consequently more easily damaged by the expansion and contraction caused by widely fluctuating roof temperatures. By physically protecting against UV light and reducing temperature fluctuations, green roofs extend the life span of the roof's water proofing membrane and improve the building energy conservation. Temperature stabilization of the waterproofing membranes by green-roof coverage may extend their useful life by more than 20 years.

D. Aesthetic value

When the people feel and come to lab of nature it has many beneficial effects on the health of those people, such as reducing the stress, lowering blood pressure and increases positive feelings also. Plants can add visual interest to bare roofs, soften the rugged surfaces of commercial properties and allow a new building to blend in better with rural or suburban surroundings.

E. Economic benefits

Increase property value

Sky rise greenery can enhance the value of the development it occupies. Rooftop gardens can provide outdoor amenity space and increase the aesthetic appeal of a building, which directly increase the value and marketability of that property.

F. Social benefits

Sky rise greenery offers opportunities for urban dwellers to manage the communal garden. This promotes the feeling of ownership for their roof garden and enhances community interaction. Roof gardens at office buildings can provide an alternative place for employees to mingle in a more relaxed setting.

Sky rise greenery provides enjoyment with the landscape defining the space and providing urban residents the setting for outdoor recreational pursuits, especially the elderly, handicapped and the young who are more dependent on near-home recreation spaces. Visual and physical contact with plants can result in direct health benefit. Plants can generate restorative effects leading to decreased stress, improve patient recovery rates and provide higher resistance to illness

Types of Green Roofs

Generally there are 2 types of roof gardens

1.Intensive Roof Gardens-These gardens are developed to be accessible and may involve elaborate landscaping requirements such as water features and hardscapes including paving stones and seating. They are usually heavy in loading and the roof must be specially designed to layer can varies between 40cms for turfing and shrubs to as much as 150 cm for bushes and trees. Intensive roof gardens require regular maintenance such as mowing, fertilising, watering and weeding accommodate such requirement. Soil is the common medium for planting and the average thickness of the soil.

The intensive roof gardening can be exploited for creating a well designed landscape as well as for vegetable growing.

2.Extensive Roof Gardens- Extensive green roofs are lightweight in design and developed mainly for aesthetic and environmental/ ecological benefits. The planting medium consists mainly of volcanic stones and pumice and the average thickness is about 10-20 cm. Plants are carefully selected to be dry resistant types and usually a rainwater storage reservoir is incorporated in the system to minimise maintenance.

Currently most of the roof gardens in this region tend to be intensive types and were developed mainly for aesthetic purposes. However, with the growing awareness of the needs to protect our environment against the Urban Heat Island effects, extensive roof gardens are expected to provide the ideal solution to the problem.

Selection of Plants for Roof Gardening

Intensive Roof Gardens

Intensive green roofs are characterized by greater weight, higher capital costs, more plantings and more maintenance requirements. Growing medium is soil-based, ranging in depth from 50-150 cm, with a weight increase of 290-967.7 kg per m^2. Due to increased soil depth, the plant selection is more diverse including trees and shrubs, which allows a more complex ecosystem to develop. Maintenance and watering are more demanding than extensive green roof.

Some of the common vegetation:

Trees:- *Eugenia oleina*, *Gustavia angusta*, *Melaleuca bracteata*, *Pisonia alba*,*Cordia sebestena*, *Ficus benjamina*, *Brownea spp*, *Plumeria spp*, *Erythrina crista-galli*, *Mussanda erythriphylla etc.*

Shrubs:- *Hamelia patens*, *Hibiscus rosa-chinensis*, Calliandra spp, *Adenium obesum* (Desert Rose), *Brunfelsia americana* (Lady of the Night) , Rose spp, *Cordyline terminalis, Duranta repens* (Golden Dewdrop), *Galphimia glauca* (Rain of Gold), *Ixora species, Jasminum nitidum,* *Lantana camara*, *Murrayaspp*, *Phyllanthus nivosus* (Snow bush), Dieffenbachia, Aglaonema, Aralia, Poinsettia, Plumbago, Begonia, Tecoma, Pentas etc.

Palms include *Rhapis excelsa*, *Licuala grandis etc*.

Herbaceous perennials include *Vinca rosea*, Geranium, Aloe spp, *Agave americana*, Bryophyllum *etc*.

Annuals:- petunia, Sweet William, *Mathiola incana*, annual chrysanthemum, Rudbeckia, Allium sps, Achillea etc. Succulents like *Agave americana* (Century Plant), *Ananas comosus* 'Variegata' (Variegated Pineapple) *etc*.

Climbers:- Vernonia, *Ipomoea quamoclit*, *Thunbergia allata*, *Combretum comosum*, Allamanda spp, Echits, Quisqualis *etc*.

Extensive Roof Gardens

Extensive green roofs are characterized by their low weight, low capital cost and minimal maintenance. The growing medium, typically made up of a mineral-based mix of sand, gravel, crushed brick, peat, organic matter and some soil, varies in depth between 10-20 cm - a weight increase of 72.6-169.4 kg per m^2. Due to the shallowness and the extreme desert-like microclimate on many roofs, plants must be low and hardy, typically alpine, dry land or indigenous.

Sedum, Sempervivum and moss are good choices. Common Sedum species used include Sedum acre, S. rupestre and S. album. Delosperma could be tried in a sunny frost-free area. Ferns such as Polypodium vulgare and Asplenium trichomanes, Euphorbia *could be used in dry shady conditions. Ground covers like Epipremnum aureum* (Money Plant), *Ficus pumila* (Creeping Fig), *Rhoeo spathacea* (dwarf variety), *Tradescantia pallida* 'Purpurea' (Purple Heart), *Wedelia trilobata* (Creeping Daisy) etc.

Media and Structure

Among the two types of roof gardens, intensive roof garden needs to maintain a greater variety of vegetation including ornamental shrubs and trees, a heavy layer of soil is used as the planting medium. The recommended minimum thickness of soil for turfing is about 40 cm while for shrubs and trees ranges between 1 to 1.5 m.

Extensive roof garden because of their light-weight nature uses a mixture of soil, coco peat, perlite, sphagnum moss, volcanic stones and pumice can be used. As light weight bearing is the character of extensive roofs, thickness of rooting media should be between 10 to 20 cm.

Garden accessories

Accessories of our choice *viz.*, seating arrangement includes chairs, benches and platforms, swings, lanterns, statues, bird bath, pot galleries, novel stands like poles and pillars for training climbers etc. can be included.

Areas of Application

Public and Private buildings, sky scrapers, educational institutes, shopping malls, and other buildings with a wide roof area are all potential applications for green roofs. Further, the roof tops of the passages, extended balconies can also be utilised for gardening.

Epilogue

Urban greening is necessary because, with the view of civic infrastructure trees are facing axe, the urban population is increasing and sky scrapers are converting the urban areas into concrete jungles because of which global warming and CO_2 level in the urban areas are reaching peak levels and the urban dwellers are posed with many health problems. In order to mitigate these situations we should pave a healthy path for urban greening. Considering the immense importance of greenery in the urban areas, green roofs seem to be a new trend inspired by the nature that only conceive to have a new type of support for the betterment of mankind, which is a clever structure and adaptable too in limited urban space.

As Vitousek indicated, "...the global consequences of human activity are not something to face in the future - they are with us now."

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CRISPR/Cas: AN EFFICIENT AND VERSATILE TOOL TO ALTER THE GENOME OF INTEREST

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Abstract

Technologies for genome editing alter DNA at the cellular level, changing physical characteristics. By cutting the DNA at a specified location like a pair of scissors, these methods remove, add, or replace nucleotides or other DNA components.. More recently, modifying DNA has become simpler than ever thanks to a new genome-editing technology called CRISPR, which was developed in 2009. Compared to earlier genome editing techniques, CRISPR is easier, quicker, less expensive, and more precise. CRISPR is currently widely used by scientists who conduct genome editing. Genome editing has advanced more quickly with the discovery of CRISPR, allowing scientists to create desirable animals and plants with modified genomes. Therefore, because of its advantages over all previous genome editing methods, CRISPR will take over in the future. However, ethical issues should be addressed carefully by taking all measures to benefit society and nature.

Keywords: CRISPR/Cas, genome, editing

INTRODUCTION

Deoxyribose nuclease's (DNA) chemical makeup and physical structure paved the way for scientists all around the world to become deeply motivated to uncover the truth about DNA. The scientific community was excited by genome editing as it rewrites the DNA sequence, changing the outcome of how an organism expresses itself in living things. In fact, work in this area has been ongoing since the 1970s and 1980s, and CRISPR/Cas's discovery marked a significant advance in the field. However, there were three main methods of site-specific genome editing before the development of the CRISPR approach, including meganucleases, zinc finger nucleases (ZFNs), and transcription activator-like effector nucleases (TALENs)(Kim and Kim,2014)

The most recent platform in the field of genome editing, clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated protein 9 (Cas9), has emerged as a rapid and effective tool to edit a gene of interest in comparison to previously developed genomic editing technologies (Sander and Joung, 2014). The target gene of interest is cleaved by the CRISPR and a collection of genes near the CRISPR locus that code for Cas proteins. These functional domains are comparable to those found in endonucleases, helicases, polymerases, and nucleotide-binding proteins. More than 40% of sequenced bacteria and 90% of archaea contain the clustered regularly interspaced short palindromic repeats as a natural defense against comparable bacteriophages (Marraffini and Sontheimer,2010).

After its discovery, the function of CRISPR as a tool for DNA editing was gradually established. The DNA recognition of the CRISPR/Cas system is based on RNA-DNA interactions, in contrast to ZFN and TALEN, where the recognition of the DNA site was based on the sequence recognition by artificial proteins necessitating interaction between protein and DNA. Compared to ZFNs and TALENs, this has a number of benefits, including straight forward design for any genomic targets, easy prediction regarding off-target sites, and the potential to modify many genomic sites at once (Carroll,2013). For the CRISPR-Cas systems to work, Cas proteins and crRNAs are necessary, and CRISPR/Cas results in the degradation of targets. To further simplify the procedure, by 2012, Jennifer Doudna and Charpentier created single-guide RNA (sgRNA), a single RNA molecule that combines CRISPR and tracr RNA components.

The protospacer adjacent motif (PAM), followed by the target sequence, is what the sgRNA identifies which is 20 nucleotides long. A distinctive PAM sequence, 5'-NGG-3', is present in the widely used wild-type Streptococcus pyogenes Cas (SpCas9) protein, where "N" can be any nucleotide base followed by two guanine ("G") nucleobases (Riordan,2015). In the genomic DNA, this segment is situated immediately after the target sequence.DNA cleavage is carried out by Cas9 nuclease after PAM identification and may cause DSB. In addition, DSBs brought on by Cas9 protein are repaired through the non-homologous end joining (NHEJ) and homology-directed repair (HDR) pathways. NHEJ is the most common and effective cellular repair method in mammals (Mao et al., 2008) but it is also the most error-prone, as it can result in minor random insertions or deletions (indels) at the cleavage site, resulting in frameshift mutations or premature stop codons (Bernheim et al., 2017). HDR is a less prevalent type of DSB repair than NHEJ, but it is extremely accurate and has a substantial impact on genome editing (Rothkamm et al., 2003). At last, it should be emphasized that the utilization of this approach in editing eukaryotes' genome only needs the manipulation of a short sequence and there is no need for complicated manipulations in the protein domain. This enables a faster and more cost-effective design of the to alter any gene under invitro and invivo.

Applications of CRISPR/Cas technology

I. Genome editing
II. Animal Models in research and biomedicine
III. Therapeutic applications
IV. CRISPR libraries for screening
V. Transcriptional activation and repression
VI. Epigenetic editing

Limitations of CRISPR/Cas9

Off-Targets

For the best advancement of Cas systems, it is necessary to address and fix limitations and issues that persist despite the tremendous advancements made by CRISPR. In complex eukaryotic organisms, off-target effects continue to be a major cause of worry (Zhang et al.,2015). The Cas9 gRNA and PAM sequences, as well as off-target cleavage everywhere around the genome, all affect the targeting selectivity. A well-optimized and custom CRISPR system can significantly lower. There are several Cas proteins with enhanced on-target selectivity, such as eSpCas9, HF-Cas9, HypaCas9, and Sniper Cas9. Another approach is to use Cas9 nickases, which catalytically inactivate one of the endonuclease domains and analyze the small off-target effect in the genome. Therefore, by limiting the length of Cas9 activity, off-target effects can be minimized to a great extent.

Ethical Concern

CRISPR/Cas9 technology stands out among them due to its advantages such as ease of use, high precision, and low cost. However, the bioethical difficulties that CRISPR/Cas9 technology may cause in humans, agriculture, and livestock have become a major focus of debate throughout the world (Shinwari et al.,2018). The germline genome editing raises a number of bioethical concerns, including the incidence of unwanted modifications in the genome. To ensure that CRISPR/Cas9 can be used safely in all areas and to address potential issues, global legislation should be developed, taking into account the views of both life and social scientists, policymakers, and all other stakeholders in the sectors, and CRISPR-Cas9 applications should be implemented in accordance with such legislation.

Conclusion

In the future, CRISPR technology will be a key tool for changing any gene of interest to suit human demands in plant and animal sector. A magnificent and astounding situation is being created by the CRISPR technique in plants such as the spicy tomato, animals such as the disruption of disease-causing genes, fish rich in omega-3 fatty acids, and the eradication of pests through gene drive. The aforementioned advancements are zooming in on the potential of CRISPR technology. However, in the near future, restriction through legislation is required in all nations to limit its usage to therapeutic levels in people. Thus, it is abundantly obvious that CRISPR will soon present a wide variety of opportunities.

Acknowledgement

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References

Kim, H., & Kim, J. S. (2014). A guide to genome engineering with programmable nucleases. Nature Reviews Genetics, 15(5), 321-334.

Sander, J. D., & Joung, J. K. (2014). CRISPR-Cas systems for editing, regulating and targeting genomes. Nature biotechnology, 32(4), 347-355.

Marraffini, L. A., & Sontheimer, E. J. (2010). CRISPR interference: RNA-directed adaptive immunity in bacteria and archaea. Nature Reviews Genetics, 11(3), 181-190.

Carroll, D. (2013). Staying on target with CRISPR-Cas. Nature biotechnology, 31(9), 807-809.

Riordan, S. M., Heruth, D. P., Zhang, L. Q., & Ye, S. Q. (2015). Application of CRISPR/Cas9 for biomedical discoveries. Cell & bioscience, 5(1), 1-11.

Mao Z, Bozzella M, Seluanov A and Gorbunova V. 2008. DNA repair by nonhomologous end joining and homologous recombination during cell cycle in human cells. Cell Cycle 7:2902–2906.

Bernheim A, Calvo-Villamanan A, Basier C, Cui L, Rocha E P C and Touchon M. 2017. Inhibition of NHEJ repair by type II-A CRISPR Cas systems in bacteria. Nature Communications 8:2094.

Rothkamm K, Kruger I, Thompson L H and Lobrich M. 2003. Pathways of DNA double-strand break repair during the mammalian cell cycle. Molecular and Cellular Biology 23:5706–5715.

Zhang, X. H., Tee, L. Y., Wang, X. G., Huang, Q. S., & Yang, S. H. (2015). Off-target effects in CRISPR/Cas9-mediated genome engineering. Molecular Therapy-Nucleic Acids, 4.

Shinwari, Z. K., Tanveer, F., & Khalil, A. T. (2018). Ethical issues regarding CRISPR mediated genome editing. Current issues in molecular biology, 26(1), 103-110.

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POST-TRANSCRIPTIONAL GENE SILENCING IN PLANTS

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Introduction:

Plants and their interconnected biological systems are fundamental components of a sustainable ecosystem, playing a crucial role in the long-term well-being of our planet. The concept of "plant systems science" extends well beyond crops that provide food and fibres, and its potential is bound only by our current understanding of science and our ability to utilize the advantages they offer. Post-transcriptional gene silencing (PTGS) in plants is a process similar to RNA interference (RNAi) in animals, which leads to the specific breakdown of similar RNAs. It was initially observed when an extra copy of a native gene or its corresponding cDNA, controlled by an external promoter, was introduced into plants. This phenomenon was originally termed co-suppression because it resulted in the degradation of RNAs from both the introduced transgenes and the native homologous genes. In plants, gene silencing occurs through two mechanisms: transcriptional gene silencing (TGS) and post-transcriptional gene silencing (PTGS). TGS involves inhibiting transcription by methylating the 5' untranslated region (5'UTR) of a gene, while PTGS leads to methylation of the coding region, causing degradation of the transcript.

Gene silencing is a powerful technique used to reduce or completely halt the production of a specific protein encoded by a particular gene. What makes gene silencing particularly remarkable is that it accomplishes this without altering the genetic code or modifying the DNA sequence itself. Instead, it employs mechanisms that can be thought of as "switching off" genes post-transcriptionally, after the genetic information has been transcribed into messenger RNA (mRNA).

I. The key aspects of the PTGS technique:

1. Reducing or Eliminating Protein Production:

Gene silencing is employed when there is a need to decrease or completely shut down the production of a specific protein in a cell. This can have various applications, from studying the function of a particular gene to developing therapies for genetic diseases.

2. Mechanisms Other than Genetic Modification:

Unlike genetic modification techniques, such as gene editing with CRISPR-Cas9, gene silencing does not involve altering the DNA sequence of the target gene. Instead, it acts on the mRNA or protein level to regulate gene expression.

3. Switching off Gene Expression:

In the context of gene silencing, the term "switching off" refers to the suppression of a gene's normal activity. This can be achieved by interfering with the translation of mRNA into protein or by destabilizing the mRNA itself, preventing it from being used as a template for protein synthesis.

4. Gene Expression Regulation:

Gene silencing methods encompass a range of strategies, including the use of small RNA molecules like small interfering RNAs (siRNAs) or microRNAs (miRNAs), which are capable of binding to target mRNA molecules and either preventing their translation or triggering their degradation.

5. Applications in Research and Medicine:

Gene silencing is a valuable tool in molecular biology and biomedical research. It allows scientists to investigate the roles of specific genes in cellular processes and diseases. Additionally, it holds great promise for the development of therapeutic interventions for genetic disorders, cancer, and other diseases.

6. Precision and Specificity:

One of the advantages of gene silencing is its precision and specificity. Researchers can design silencing approaches to target only the gene of interest while leaving other genes untouched. Gene silencing is a versatile technique that enables the selective inhibition of gene expression without altering the underlying genetic code. By "switching off" genes at the mRNA or protein level, it offers a powerful means to explore gene function and develop targeted therapies for a wide range of medical conditions.

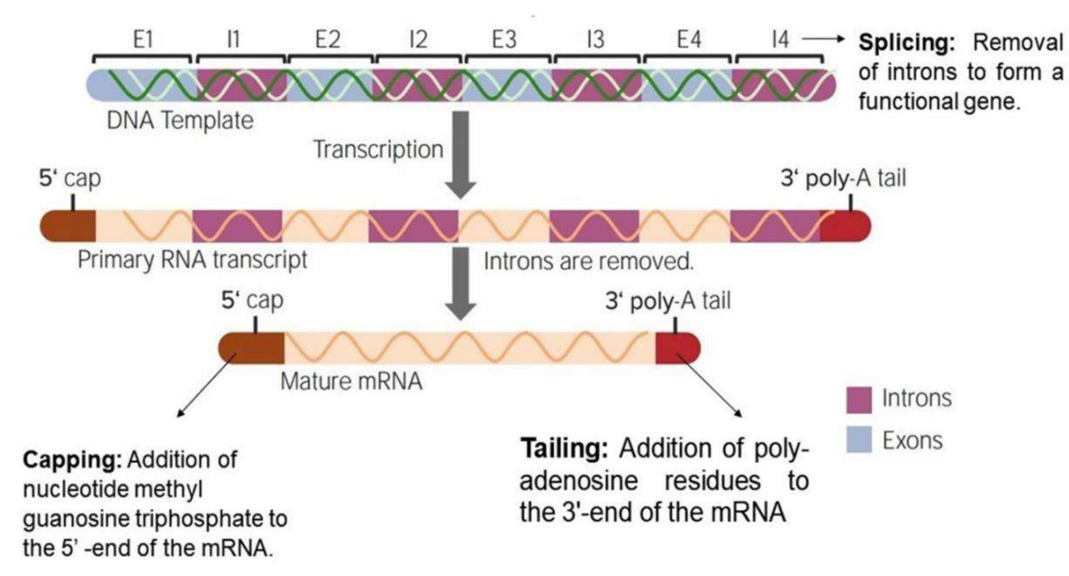

Fig. 1. Post-transcriptional Gene Silencing model (Frye *et al.*, 2016)

II. Post-transcriptional Gene silencing procedure

1. Introduction of Double-Stranded RNA (dsRNA)

Gene silencing begins when a double-stranded RNA (dsRNA) molecule enters the cell. This dsRNA can be of various origins, including viral RNA or artificially introduced RNA molecules.

2. Dicer Enzyme Processing

Inside the cell, an enzyme called Dicer takes action. Dicer's job is to cut the incoming dsRNA into smaller, manageable pieces. These smaller fragments are essential for the silencing process to proceed effectively.

3. Generation of siRNA and miRNA

Dicer's action results in the formation of two types of small RNA fragments: small interfering RNAs (siRNA) and microRNA (miRNA). These fragments are the key players in gene silencing.

4. Formation of the RNA-induced Silencing Complex (RISC)

The siRNA or miRNA fragments now join forces with a multiprotein complex called the RNA-induced silencing complex (RISC). RISC is like a molecular machine that helps target specific genes for silencing.

5. Strand Selection

Within the RISC complex, one of the strands from the siRNA or miRNA is chosen as the "guide" strand, while the other strand becomes the "passenger" strand. The choice depends on the stability and specificity of each strand.

6. Guide Strand Binding

The selected "guide" strand from the siRNA or miRNA binds tightly to the RISC complex. This interaction positions the guide strand like a homing missile, ready to seek out and silence its target.

7. Passenger Strand Degradation

Meanwhile, the "passenger" strand that wasn't chosen is typically degraded or discarded. This is to ensure that only the correct guide strand directs the silencing process, preventing any accidental or off-target effects.

8. Sequence-Specific Targeting

The guide or antisense strand of the siRNA or miRNA remaining bound to RISC contains a specific sequence that complements the target mRNA molecule. This sequence-specific binding is crucial for precision in gene silencing.

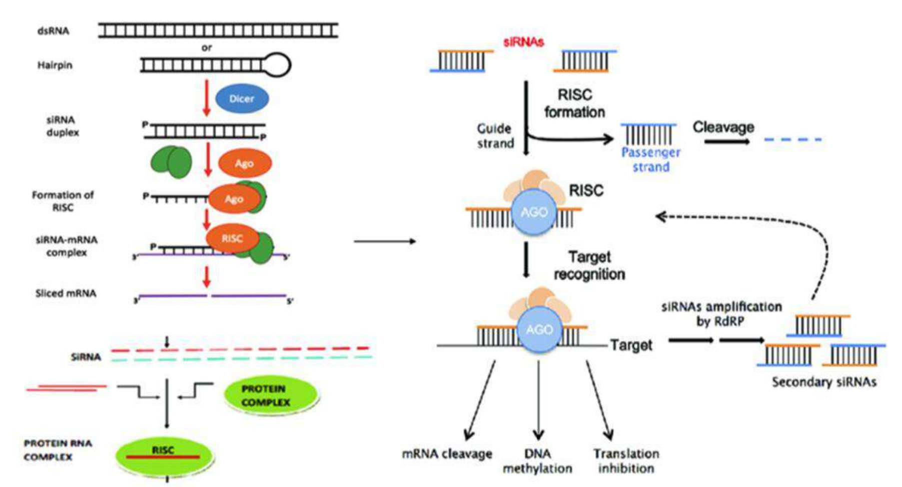

Fig. 2. Steps involved in the Post-transcriptional Gene Silencing process (Sharma *et al.*, 2022)

9. mRNA Cleavage and Degradation

RNA induced silencing complex (RISC), armed with the guide strand, searches within the cell for the target mRNA molecule with a matching sequence. When it finds a matching target mRNA, the guide strand guides RISC to bind to it. Once bound, RISC cleaves the target mRNA, effectively cutting it into pieces.

10. Gene Silencing

The cleaved mRNA is now marked for destruction by cellular machinery. This leads to the degradation of the mRNA, preventing it from being translated into a functional protein. As a result, the gene associated with that mRNA is silenced, and the protein it codes for is not produced.

III. Applications in agriculture and biotechnology:

1. Crop Improvement:

PTGS can be used to develop genetically modified crops with desirable traits, such as increased resistance to pests, pathogens, or environmental stressors. By silencing specific genes responsible for susceptibility, plants can become more robust and resilient.

2. Virus Resistance:

Gene-specific silencing through the Virus-Induced Gene Silencing (VIGS) system has become a widely adopted technique for a variety of monocot and dicot plant species. Consequently, researchers have developed numerous viral-derived vectors and fine-tuned various protocols to enhance its effectiveness. The Tobacco Rattle Virus (TRV) system, for instance, has been particularly well-refined for achieving efficient gene silencing in Solanaceous plants. Furthermore, this system has been successfully employed in tomato research to investigate the functions of genes involved in the ripening of fruits (Unver and Budak, 2009). VIGS allows researchers to study the function of specific genes by selectively silencing them. Barley Stripe Mosaic Virus (BSMV)-mediated Virus-Induced Gene Silencing (VIGS) is a technique used in barley research. BSMV possesses a genome divided into three parts, and scientists have adapted this virus to selectively silence target genes in barley plants (Holzberg *et al.*, 2002)

3. Delayed Ripening:

PTGS can be used to control the ripening of fruits and vegetables. By targeting genes involved in the ripening process, it is possible to extend the shelf life of produce, reduce spoilage, and improve transportation logistics. The photosynthetically active mature green fruits accumulate high amounts of MG. At the onset of ripening, SlGLYI4 curtails the enhanced levels of MG associated with the respiratory burst and several other metabolic activities so that the ripening can proceed in a normal way. In the absence of the glyoxalase detoxification system at the time of fruit maturation, soaring amounts of MG can potentially inhibit the ethylene biosynthetic pathway, thereby leading to fruits incompetency to ripen *Priya Gambhir et al., 2023.*

4. Enhanced Nutritional Content:

PTGS can be employed to increase the nutritional value of plants. By enhancing the expression of genes responsible for the synthesis of specific nutrients, such as vitamins or essential amino acids, plants can be engineered to provide more nutritionally beneficial crops.

5. Herbicide Resistance:

PTGS can be used to develop crops that are resistant to specific herbicides. By silencing the target gene that herbicides typically affect in weeds but not in the engineered crop, farmers can effectively control weed growth without harming their crops.

6. Functional Genomics:

PTGS is a valuable tool for studying gene function in plants. Researchers can selectively silence genes of interest to better understand their roles in plant development, physiology, and response to environmental conditions.

7. Plant Defence Mechanisms:

PTGS can be harnessed to activate plant defence mechanisms against pests and pathogens. By targeting genes involved in plant defence pathways, plants can be primed to respond more effectively to external threats.

8. Production of Bioactive Compounds:

PTGS can be used to increase the production of bioactive compounds in plants, such as pharmaceuticals or natural products with medicinal properties.

IV. Pros and cons of PTGS in plants:

The utilization of PTGS through RNAi-mediated gene silencing has resulted in numerous successful instances of developing transgenic crops with enhanced resilience to abiotic stresses. This approach offers clear advantages over alternative molecular methods. These benefits include the ability to precisely target multiple genes at the same time, fine-tune the level of gene silencing at particular developmental stages and in particular tissues,

Table 1. Examples of Crops with improved stress tolerance through PTGS

Traits	Crop	Tolerance / Resistance against	Genes targeted	References
Abiotic stress tolerance	*Oryza sativa*	Drought tolerance	*OsGRXS17*	Khare et al. (2018)
	Triticum aestivum	Salt tolerance	*TaPUB-1*	
	Solanum lycopersicum	Drought and salt tolerance	*SlbZIP1*	
	Brassica rapa	*Salt tolerance*	*GIGANTEA*	
	Nicotiana tabacum	Drought tolerance	*BrDST71*	
Bacterial resistance	*Arabidopsis thalia na*	*Agrobacterium tumefaciens*	*iaaM*	Hussain, (2015).
	Citrus limon	*Xanthomonas citri*	*CalS1*	
Fungal resistance	*Triticum aestivum*	*Fusarium graminearum*	*Chs 3b*	
	Zea mays	*Aspergillus flavus*	*Amy1*	
	Glycine max	*Phytophthora sojae*	*GmSnRK1*	
	Solanum lycopersicum	*Fusarium oxysporum*	*Fow2* *chs V*	
	Solanum tuberosum	*Phytophthora infestans*	*Avr3a*	
Nematodes Resistance	*Solanum lycopersicum*	*Meloidogyne incognita*	*Mi-cpl1* *PolA1*	
	Glycine max	*Heterodera glycines*	*Hg16B09*	

prevent additional metabolic burdens on transgenic plants because transgene protein expression is not present. Importantly, there aren't many biosafety worries with this approach.

There are certain disadvantages to this strategy, though. Despite being very sequence-specific, there is a chance of off-target effects, which might result in unexpected phenotypes in the transgenic lines that are produced. Consequently, despite achieving success in various aspects of crop enhancement, there remain substantial challenges in the development and commercialization of PGTS technology for optimal and efficient utilization. However this technology holds significant promise as a valuable approach for improving crops, contributing significantly to crop productivity. There are numerous prospects for harnessing PTGS-RNAi in crop breeding, particularly in enhancing stress tolerance and elevating nutritional content. Therefore, PTGS technologies have tremendous potential to substantially boost agricultural yields.

Conclusion:

In conclusion post-transcriptional gene silencing in plants has a wide range of practical applications that span agriculture, biotechnology, and environmental management, offering solutions to improve crop quality, yield, and sustainability while reducing the environmental impact of agriculture. The world of plant systems science offers immense potential for both scientific discovery and practical applications. PTGS is a remarkable technique within this field, enabling precise and controlled regulation of gene expression in plants. This versatile tool has far-reaching implications, from advancing our understanding of plant biology to revolutionizing agriculture and biotechnology. PTGS empowers researchers to explore gene function, improve crop traits, enhance nutritional content, and bolster plant defence, among other applications. By harnessing the power of PTGS, we are not only unlocking the secrets of plant biology but also paving the way for sustainable solutions to address global challenges related to food security, environmental sustainability, and human health. The potential of PTGS knows no bounds, limited only by our scientific knowledge and creativity in utilizing the advantages it offers in the service of our planet's long-term well-being.

References:

Holzberg, S., P. Brosio, C. Gross, and G. P. Pogue, "Barley stripe mosaic virus-induced gene silencing in a monocot plant," *The Plant Journal*, vol. 30, no. 3, pp. 315–327, 2002.

Khare, T., Shriram, V., & Kumar, V. (2018). RNAi Technology: The Role in Development of Abiotic Stress-Tolerant Crops. Biochemical, Physiological and Molecular Avenues for Combating Abiotic Stress Tolerance in Plants, 117–133. doi:10.1016/b978-0-12-813066-7.00008-5

Priya Gambhir, Utkarsh Raghuvanshi, Adwaita Prasad Parida, Stuti Kujur, Shweta Sharma, Sudhir K Sopory, Rahul Kumar, Arun Kumar Sharma, Elevated methylglyoxal levels inhibit tomato fruit ripening by preventing ethylene biosynthesis, *Plant Physiology*, Volume 192, Issue 3, July 2023, Pages 2161–2184, https://doi.org/10.1093/plphys/kiad142

Holzberg, S., P. Brosio, C. Gross, and G. P. Pogue, "Barley stripe mosaic virus-induced gene silencing in a monocot plant," *The Plant Journal*, vol. 30, no. 3, pp. 315–327, 2002.

Hussain, B. (2015). Modernization in plant breeding approaches for improving biotic stress resistance in crop plants. TURKISH JOURNAL OF AGRICULTURE AND FORESTRY, 39, 515–530. doi:10.3906/tar-1406-176

Unver, Turgay, and Hikmet Budak. "Virus-Induced Gene Silencing, a Post Transcriptional Gene Silencing Method." Edited by Chunji Liu. *International Journal of Plant Genomics* 2009 (June 15, 2009): 198680. https://doi.org/10.1155/2009/198680.

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MAJOR NUTRIENT DEFICIENCY IN BANANA AND ITS MANAGEMENT PRACTICES

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Abstract

Banana is a major fruit crop of the country as well as the state, known as "Poor man's fruit" owing to its rich content of carbohydrates, vitamins and minerals and affordable price to the consumers. In India, it is grown in different states under different climatic conditions (Butaniet *et al.*, 2012). Generally, banana is a heavy consumer of nutrients and requires large quantities of nutrients for its growth, development and yield (Hazarika and Ansari, 2010) and so it is considered as an exhaustive or nutrient mining crop.

Nitrogen deficiency

Nitrogen deficiency causes slow growth and paler leaves with reduced leaf area and rate of leaf production.

Yellowing of leaves symptoms

Slow growth of plants , reduced leaf size and number , leaf petioles short, thin and compressed, thin profuse roots and lesser number of suckers are produced due to lack of nitrogen.Excess nitrogen leads to rapid growth and poor pseudostem strength, which can cause stems bend under the weight of the bunch delays flowering, produces small bunches and reduces fruit shelf life

Poor stem strength can be caused by excess nitrogen

Management practices

- Foliar spray of urea @ 2 % (2 gram / litre) twice at weekly interval till disappearance of deficiency symptoms.

Phosphorus deficiency

The deficiency of P causes complete cessation of elongation, at a height of about two feet resetting of leaves with older leaves becoming increasingly irregularly necrotic, leaf production is reduced, and marginal chlorosis and premature death are caused. P deficiency causes a blue or dark green coloration of leaves.

Corrective Measure

40-60 g SSP / plant. Entire quantity of phosphorus fertilizer should be applied at the time of last ploughing or applied at the time of filling the pits.

Potassium deficiency

Deficiency symptoms first appear on mature leaves and petioles . Yellowing of leaf margins on older leaves followed by marginal necrosis. Chlorsis spread very rapidly and within two to three days the while leaf turn to yellow with downward curling. Leaf dried up and petiole breaks and Banana branches are short, slim and deformed

Marginal necrosis Symptom

Management practices

- Application of potassium based on soil test basis blanket recommendation of potassium @ 390 to 450 g / plant (depending opinion varieties) on 3rd, 5th and 7th after planting.

- Foliar spray of potassium sulphate @ 0.5 % (5 gram / litre) @ on 3rd, 5th and 7th after planting or Foliar spray of KCl 2% at weekly interval till the symptom disappear.

References

Butani, A. M., Chovatia, R. S., Patel, K. D., Vadaria, K. N., and Rankja, N. J. 2012.Effect of chemical fertilizer and vermi compost on yield and nutrient contentand uptake by fruit of banana MusaparadisiacaL. cv. Grand Naine. Asian J.Hortic. 1 (2): 594-59

Hazarika, B. N. and Ansari, S. 2010. Effect of integrated nutrient management ongrowth and yield of banana cv. Jahaji. Indian J. Hortic. 67 (2): 270-272

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LUCERNE - THE QUEEN OF FODDER CROPS

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Introduction

Lucerne is a legume fodder crop which is botanically called *Medicago sativa* L. (2n: 16, 32 & 64) belonging to subfamily Papilionoideae. It is commonly called as Alfalfa, Bastard medic, Buffal herb, Purple medic, Sand lucerne (in English), Kudirai Masal (in Tamil), Vilayati Ghas (in Gujarati), Lusan Ghas in Hindi), Lusarne Soppu (in Kannada), Vilayati Gavat (in Marathi): Dureshta (in Odhiya) and Sinjhi (in Sanskrit). It is a protein rich fodder crop and hence called "the queen of fodder crops" or "Green gold". This legume fodder crop could live for many years depending on the suitable climatic conditions and can live up to 10 years even in dry conditions (Fernandez *et al.*, 2019). It is usually harvested several times a year and fed as hay, silage, green chop, pellets or cubes. The name Alfalfa is commonly used in North America, while the name Lucerne is used more commonly in Commonwealth countries.

Origin and distribution:

It is generally believed that Lucerne (alfalfa) originated in South West Asia. It was introduced in India from north-west sometimes in 1900 and has become quite a popular legume fodder crop. Globally Alfalfa is cultivated in about 32 million hectares and in North Americ 41%, followed by Europe 25%, South America 23% and the least in Asia 8%. In India Lucerne is cultivated in irrigated areas of Punjab, Haryana, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra, Tamil Nadu and in Leh area of Ladakh.

Botanical description of Lucerne

Alfalfa is a perennial herbaceous plant that is vivacious and branchy and grows up to 1m height. Root system has a depth of 2-5 m but can reach up to 15 m, making it tolerant to drought condition. Stem is procumbent, ascending to erect, sometimes decumbent, arising from a woody base, 30 – 80 cm long; 5-25 or more per crown, much branched, 4 angled, glabrous or the upper part hairy. The leaves are alternate, pinnately trifoliate, petiolate, stipules triangular, 5-15 mm long, pubescent on lower surface. They have three leaflets like clover. The leaflets appear to be quite narrow, 2-3 times longer than the width of the leaf and jagged at the top. Inflorescence is a dense axillary racemes with 10–35 flowers; peduncle slender, firm, always exceeding the subtending leaf, glabrous or appressed-hairy. Each cluster contains 10-20 purple flowers in the ordinary legume shape. The flowers appear to be in a short single-sided cluster, similar to clover. Calyx is gamosepalous; five lobed, 3-6 mm long, tubular with linear-subulate teeth longer than tube. Corolla is paplionaceous, 6-15 mm long; yellow, purple or violet and rarely white. Androecium is diadelphous (9+1), Gunoecium is having superior ovary with few ovules in marginal placentation. The fruit is a pod or legume with superior ovary and few ovules in marginal placentation. The seed is castaneous or brown, ovoid, irregularly cordate or reniform; yellow to brown. Lucern is naturally cross- pollinated and their flower requires tripping by bees or insects for pollination to take place.. Many types of bees can serve as trippers, *e.g*. the alfalfa leaf- cutter bee (*Megachile rotundata*), alkali bee (*Nomia melandri*) and honey bees (*Apis mellifera*).

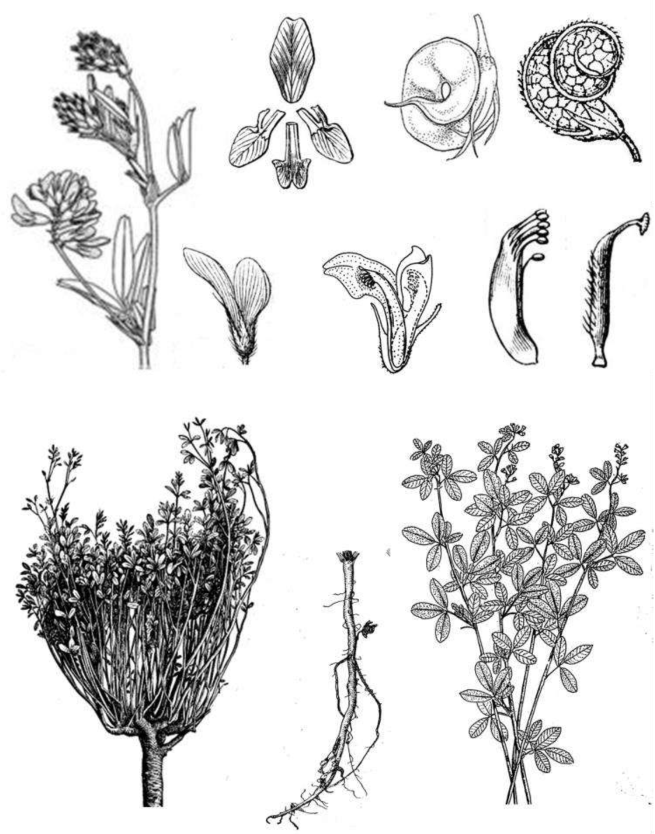

Fig. 1. Lucerne or Alfalfa- *Medicago sativa*

Growing conditions

Alfalfa is drought tolerant; grown in deep, well drained soils with neutral to slightly alkaline pH. It grows well in sands to moderately heavy clays, provided drainage is satisfactory. It is a resilient plant that thrives in a variety of climates, from warm to cold and drought-resistant. It is best grown in full sunlight and on soil that is level and free of potholes, making it an ideal choice for mountainous areas. However, it is not suitable for rocky terrain, acidic soils, or areas with shallow or eroding soils.

Cultivation techniques

Fig. 2. Seedof Lucerne

The recommended seed rate for Lucerne is 1-1.5 kg seed per ha with the aim of getting 3-7 plants per 300 mm in a row. A sowing density of 300 g/ha has, however, been used with great success. Small quantities of nitrogen and phosphate (15-20 kg/ha) can be applied at or before planting time to encourage growth and development of the young plants, which are not yet at a stage where they can fix sufficient N for themselves. Alfalfa needs high levels of phosphorus and potassium in order to grow well and prolifically. Therefore, it is essential to fertilize regularly with organic fertilizer. Lucerne plants draw their water from a soil depth of 1.2 m, but the best results in seed production are obtained when water absorption up to 0.5 m is well controlled. Overhead irrigation can be used successfully in seed production, especially on sandy soil where specific volumes of water must be given. Weeding of alfalfa is also important as weeds can reduce the yield and quality of the plant. For getting a quality fodder we need to harvest alfalfa before early flowering.

Fodder value of Lucerne

Fig. 3. Harvested green fodder of Lucerne

Green Fodder: Lucerne is considered as Queen of fodder. Protein and calcium levels are high relative to other fodders, but metabolizable energy and phosphorous levels go down when mature. Intake by livestock is higher than other forages. Alfalfa provides higher amounts of minerals (mainly calcium, but also magnesium, potassium, sulfur, iron, cobalt, manganese, and zinc) and vitamins (beta-carotene) than other fodders. Beta-carotene, a precursor of vitamin A, plays a major role in animal reproductive performances and it is also important for vision, growth and skin health. Alfalfa is one of the highest yielding forage legume (16 to 20 t/ha DM). Under irrigation, it can produce 25 to 27 t/ha DM with a production reduced in the 3rd year to 8-15 t/ha DM.

Pastures: It is an excellent pasture for hogs, cattle, and sheep, often in mixtures with smooth brome grass, orchard grass or timothy. Supplemental feeding of grain to dairy cows, sheep. Alfalfa does not tolerate close grazing well, and some form of rotational grazing is necessary to maintain the persistence and production of plants, with rest intervals that replenish the crown and roots of plants in carbohydrates and nitrogen. The duration of rest intervals depends on growth conditions, but 5 to 6 weeks are likely to be necessary.

Hay and Silage: Alfalfa may be cut several times a year (up to 14 in warm regions). The best stage for cutting is at 25-50% flowering as the nutritive value drops after that. After the first cut, it is advisable to wait for the young shoots to be 35 to 50 mm long before the next cut. The cutting height is important, and to avoid damage to the plant a 5-10 cm stubble should be left. This will help to ensure good regrowth. Silage is a good conservation method even in harsh conditions. Since alfalfa has a low carbohydrate content it has to be supplemented with carbon sources, such as ground cereal grains like wheat or barley, and inoculated to start fermentation. Alfalfa silage can be made using fresh alfalfa or pre-wilted alfalfa. The crop should be at 50-70% moisture before ensiling to prevent nutrient leaching.

Dehydrated Lucerne: Dehydration was found to be the best way as it dries and stabilizes alfalfa while preserving its high protein content, vitamins and overall nutritive value. Moreover, dehydrated alfalfa is a good source of xanthophylls and beta-carotens for poultry farmers. Dehydration requires pre-wilting and chopping in the field, transportation to the plant and drum-drying (between 250°C and 800°C) down to 10% moisture. After drying, long fibre dehydrated alfalfa may be compacted into big square bales. Alfalfa can also be ground to make alfalfa meal or ground and passed through a screw die to make pellets that can be included in big square bales: Pellets are often standardized to 17 to 18 per cent protein content.

Palatability: It is highly palatable by Hogs, cattle and sheep.

Nutritive value of Lucerne: Lucern is rich in protein, fibre, vitamins and minerals making it a quality fodder for cattles. The nutritional value of fresh lucerne, whole meal and leaf meal are listed below (Mielmann, 2013).

Fodder type	Moisture (%/100 g)	Protein (g/100 g)	Fat (g/100 g)	Fibre (g/100 g)	Ash (g/100 g)
Green forage	80.0	5.2	0.9	3.5	2.4
Whole meal	7.5	16.0	2.5	2.3	9.1
Leaf meal	8.0	20.4	2.6	17.1	11.5

Toxicity: Cattle and sheep fed on alfalfa as the sole source of forage occasionally suffer from bloat or tympanitis. The cause of bloat has not been clearly defined but it may be prevented by feeding corn or sorghum silage along with alfalfa hay or using mixed alfalfa-grass pasture. Forage cut at flowering time and dried in the field rarely causes bloating. Seeds contain trypsin inhibitors.

Advantages of Lucerne

1. **High Nutritional Value:** Lucerne is a highly nutritious forage crop for livestock. It contains a balanced mix of essential nutrients, including protein, vitamins and minerals.

2. **Treatment for various diseases:** The concentrate aids in the recovery from severe cancer-related disorders and supplements the treatment of certain diseases, such as tuberculosis, HIV, and malaria. (Gawel *et al.*, 2017)

3. **Drought Tolerance:** Lucerne is known for its ability to tolerate dry and arid conditions. Its deep root system enables it to access water from deeper soil layers, making it a resilient crop in regions with limited water resources.

4. **Soil Improvement:** Lucerne is a leguminous plant, which means it has a symbiotic relationship with nitrogen-fixing bacteria in its root nodules. This ability to fix nitrogen from the atmosphere enriches the soil with this essential nutrient, benefitting both self and subsequent crops grown in rotation.

5. **Weed Suppression:** A well-established stand of lucerne can suppress weed growth due to its dense canopy and rapid growth. This can reduce the need for herbicides in agricultural systems.

6. **Erosion Control:** Lucerne's deep root system also helps to prevent soil erosion. Its extensive roots hold the soil in place, making it useful for erosion control on slopes and in areas susceptible to erosion.

7. **Biomass Production:** Lucerne can produce a substantial biomass, making it a valuable option for biomass energy production, such as forage or biofuel.

8. **Livestock Health:** Lucerne is often used in animal diets because it can enhance livestock health and productivity. It provides essential nutrients, including protein and fiber, which can improve digestion and overall animal well-being.

9. **Crop Rotation:** In crop rotation systems, lucerne can break pest and disease cycles, improve soil structure, and contribute to sustainable farming practices.

Limitations of Lucerne

1. **High Water Requirements:** Alfalfa is a relatively thirsty crop, requiring consistent and adequate water supply for optimal growth. In areas with limited water resources or during drought conditions, maintaining alfalfa can be challenging and water-intensive.

2. **Pest and disease Susceptibility:** Alfalfa can be susceptible to certain insect pests like aphids, weevils, and leaf hoppers and various diseases, including root rot, leaf spot, and crown rot. Pest and disease management practices are often necessary to maintain healthy stands.

3. **Alkalinity Sensitivity:** Alfalfa is sensitive to high soil pH (alkalinity), which can limit its growth and nutrient uptake. Soil amendments may be necessary to address alkaline soils.

4. **Short Stand Life:** Over time, alfalfa stands can decline in productivity and quality. This often necessitates replanting or rotating to other crops, which can be labor-intensive and costly.

5. **Bloat Risk:** When grazed by livestock, alfalfa can pose a risk of bloat, a potentially fatal condition characterized by excessive gas accumulation in the digestive system. Proper management and precautions are needed when using alfalfa for grazing.

Recommended cultivars for Tamil Nadu

1. Co1: Perennial for 3-4 years, yielding 80-90 t/ha/year with a protein content of 20%.

2. Co2: Perennial, soft and dark green leaves, highly palatable for milch animals. Green fodder yield 130 t/ha/year. Seed yield 245kg/ha. High protein content of 23.5%.

3. Co3: Perennial, green fodder yield of 120 t/ha/year. Seed yield 250 kg/ha. Protein content 21%.

4. Co4: Perennial, green fodder yield of 120 t/ha/year with seed yield of 250 kg/ha and protein content 19-12%.

References

Fernandez, A. L., C. C. Sheaffer, N. E. Tautges, D. H. Putnam and M. C. Hunter 2019. Alfalfa, wildlife, and the environment. National Alfalfa and Forage Alliance.

Gaweł, E., M. Grzelak and M. Janyszek. 2017. Lucerne (*Medicago sativa L.*) in the human diet—Case reports and short reports. *Journal of herbal medicine*, *10*, 8-16.

Mielmann, A. 2013. The utilisation of lucerne (*Medicago sativa*): a review. *British Food Journal*, *115*(4), 590-600.

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ASYMMETRICAL OVARIAN DEVELOPMENT IN CHICKEN: AN OVERVIEW

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Abstract

In asymmetric chick gonads, the left and right female gonads go through different developmental processes, producing a functioning ovary exclusively on the left side. The overall embryogenesis time in chickens is 21 days. The gonads of both sexes consist of a germinal epithelial layer comprising somatic and germ cells, as well as an underlying medulla of epithelial cords interspersed with mesenchymal cells, before sexual differentiation. By stage 30, the commencement of gonadal sex differentiation may be recognized histologically (day 6.5). Despite considerable advancements in recent years, little is known about the genomics of the right ovary degeneration in chick embryo, and the mechanisms of molecular regulation remain poorly understood.

Keywords: Chicken; Ovary; Asymmetry

Introduction

The Chicken (*Gallus gallus domesticus*) is one of the most widespread domesticated poultry species. Among different cultures, religions, and societies across India. Chicken is widely accepted with little or no taboo. India's poultry population is around 851.81 million, which includes both commercial and backyard fowl. Commercial poultry has a population of 534.74 million, whereas backyard poultry has a population of 317.07 million (20th Livestock Census). Chicken serves as an important source of protein through meat and egg production around the world. India ranks sixth in the world in terms of meat output, having increased from 6.7 million tonnes in 2014-15 to 8.6 million tonnes in 2019-20, with a 5.98 % annual growth rate (FAO STAT, 2019). Chicken egg production has great economic importance. India accounts for around 7.22 percent of world egg production (FAO, 2021) and ranks 3rd in egg production (20th Livestock Census). Table eggs are abundant in nutrients and viable eggs are the backbone of the chicken business. The ovary is the primary site of egg production. The total egg and meat production from our country is around 114.38 billion eggs and 4.34 million tonnes respectively, with an annual commercial egg production being around 95.17 billion eggs. India ranks 5th in broiler meat production in the world (BAHS, 2020). In Chicken, during embryonic development, several genes encoding transcription factors and secreted growth factors play a crucial role in left and right ovary asymmetry. Presently, 37.2% of all poultry in India are native chickens and these birds produce about 17.8% of all eggs produced in the nation (Kanakachari et al., 2022).

The gonads form throughout development as thickenings along the ventromedial surface of the mesonephric kidneys (developmental stage 22; day 3.5) (Hamburger and Hamilton 1992). Although both the left and right ovaries are present in the embryonic stages of all birds, only the left ovary develops fully into a functional ovary. It has been noted that both the left and right gonads are typically functioning in falconiformes and brown kiwis (Johnson 2015). A rare case of a persistent and functional right ovary in hens and ducks was evident (Sturkie and Mueller 1976). The following wild bird species were found to have a right ovary: long-eared owl (*Asio otus*), common buzzard (*Buteo buteo*), sparrow hawk (*Accipiter nisus*), and goshawk (*Accipiter gentilis*) (Rodler *et al.,* 2015). Functional right oviduct was discovered in various chicken breeds (Champion 1955) and (Sell 1959). Chicken embryos gained the maximum weight throughout the embryogenesis during 12-13 days of incubation. During this phase, it was noticed the greatest growth in ovarian mass in the chicken embryo (Khokhlov et al., 2020).

Male Gonad Development

The male bird has a homomorphic (ZZ) chromosome, whereas the female is heteromorphic (ZW). The right and left testes to become tubular structures about 3 mm long and 0.5 mm wide and while the right female gonad is similar in appearance but slightly smaller than the testes in males, the left female gonad has acquired a broader, flatter appearance and is significantly larger at about 3.2 mm long and 0.8 mm wide (Guioli et al., 2014). However, DMRT1 is essential for chicken testis determination, and the Z dose hypothesis for avian sex determination is validated (Smith et al., 2009).

Female Gonad Development

In females, only the left functional ovary and oviduct are developed and the right ovary and oviduct become regressed. The differences in the right and left ovary and oviduct starts at the embryonic stage itself. In females during embryonic development, the right ovary is around 2.6 mm by 0.5 mm, while the left ovary, is approximately 8 mm by 1.5 mm (Guioli et al., 2014). The majority of modern flying birds have only one ovary and one oviduct, and bird fossils from the Cretaceous period [125 million years ago (mya)] have a single ovary on the left side, whereas non-flying dinosaur ancestors of birds had two oviducts and two ovaries (Zheng et al., 2013).

In females, substantial expression of the aromatase gene (around day 5–6) leads to estrogen production and selective expression of the estrogen receptor-mRNA in the left gonad leads to the creation of a functional left ovary. Other sex variations may be detected in the expression of inhibin subunit genes in chicken embryo gonads, as well as in circulating levels of inhibin, follicle-stimulating hormone (FSH), and steroids (Bruggeman et al., 2002).At embryonic 4.5 days, the left and right sides of the female chicken embryos initially had the same gonadal morphological appearance. The left gonads of the female chicken embryos were noticeably bigger than the right gonads on the embryonic 7th day as development progressed. As a result, by the embryonic 10th day, the left gonad's dimensions were over 2.5 times larger than the right gonad's (Li et al., 2022). The left gonad has considerably more germ cells than the right at stage 35. The expression pattern of ERNI(Ens1), a gene expressed in chick embryonic stem cells downregulated upon differentiation (Intarapat and Stern 2013).

The variations in left-right ovarian development are determined by the unique expression of oestrogen receptors in the left gonad, which in conjunction with estradiol production, leads to AMH suppression by estradiol action. The lack of estradiol in the right gonad of a female chick embryo prevents estradiol activity, and hence AMH inhibits cortical development, resulting in right gonad and Mullerian duct regression (Bruggeman et al., 2002).Left-right morphological asymmetry, with the epithelial layer on the left gonad being thicker than that on the right. By HH29, the epithelium around the right gonad has flattened and taken on a more squamous appearance, emphasizing the left-right asymmetry (Carlon and Stahl, 1985).Myostatin (GDF-8) is detected in different organs of chicken embryos, including the testis and ovary, throughout the embryogenesis stages. Its high levels of expression noticed in the testis and ovary (Kubota et al., 2007). FSH gene expression was lowest in the pituitary of the female embryo on E11 and increased on E17. The expression of FSH in the male pituitary gland did not alter across the days investigated. On E11, FSH mRNA expression was greater in the male pituitary gland than in the female pituitary gland. Luteinizing hormone (LH) mRNA expression in the female pituitary increased on D1 compared to E11 (Grzegorzewska et al., 2009).

The histological development of the right and left ovaries in an ostrich embryo (kheirabadi et al., 2014). The ovaries grew unequally, resulting in a bigger left ovary with a visible cortex and medulla. The cortex was made up of germinal cells, germinal epithelium, and somatic cells. The medulla of both ovaries included lacunar channels, blood vessels, interstitial cells, and germ cells (kheirabadi et al., 2014).The right ovary germinal epithelium had a thin layer. The left ovary has a cortex and a medulla, whereas the right ovary has only a medulla and no cortex.Stereological findings demonstrate that as development progresses, the overall volume of all ovarian medulla components increases in the left ovary(González-Morán 2011).

Conclusion

Further research on asymmetrical ovarian development and non-functional aspect of right ovary in chicken will add knowledge to the field and its further exploration about the know-how of the right ovary activation using the modern molecular genetic tools.

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References

BAHS 2020. Basic Animal Husbandry Statistics, Ministry of Agriculture, Government of India.

Bagniski, E.S. 1973. Clinical Chemistry Acta.

Bruggeman V, Van As P and Decuypere E. 2002. Developmental endocrinology of the reproductive axis in the chicken embryo. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* **131**(4): 839-846.

Carlon N and Stahl A. 1985. Origin of the somatic components in chick embryonic gonads. *Archives d'anatomie microscopique et de morphologie experimentale* **74** (1): 52-59.

Champion L R. 1955. A case of paired oviducts in the chicken. *Poultry Science***34**(1): 184-186.

FAO. 2019. FAO statistic database (http://www.faostat.fao.org).

FAO. 2021. FAO statistic database (http://www.faostat.fao.org).

González-Morán M G. 2011. Histological and stereological changes in growing and regressing chicken ovaries during development. *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology* **294**(5): 893-904.

Grzegorzewska A K, Sechman A, Paczoska-Eliasiewicz H E and Rząsa J. 2009. The expression of pituitary FSHβ and LHβ mRNA and gonadal FSH and LH receptor mRNA in the chicken embryo. *Reproductive Biology* **9**(3): 253-269.

Guioli S, Nandi S, Zhao D, Burgess-Shannon J, Lovell-Badge R and Clinton M. 2014 Gonadal Asymmetry and Sex Determination in Birds.. *Sexual Development*.

Hamburger V and Hamilton H L. 1992. A series of normal stages in the development of the chick embryo. *Developmental Dynamics* **195**(4): 231-272.

Intarapat S and Stern C D. 2013. Sexually dimorphic and sex-independent left-right asymmetries in chicken embryonic gonads. *PLoS One* **8**(7): e69893.

Johnson A L. 2015. Reproduction in the female. In *Sturkie's avian physiology* (635-665). Academic Press.

Kanakachari M, Rahman H, Chatterjee R N and Bhattacharya T K. 2022. Signature of Indian native chicken breeds: a perspective. *World's Poultry Science Journal*78(2): 421-445.

Kheirabadi M, Nabipour A, Behnam Rassouli M, Dehghani H. 2014. Asymmetrically developed ovaries in embryo of ostrich (Struthio camelus). یازدهمین کنگره سراسری علوم تشریحی ایران.

Khokhlov RY, Kuznetsov SI. 2020. Growth of the chicken embryo and its reproductive organs. *Volga Region Farmland*. **3**(3):73-6.

Kubota K, Sato F, Aramaki S, Soh T, Yamauchi N and Hattori M A. 2007. Ubiquitous expression of myostatin in chicken embryonic tissues: its high expression in testis and ovary. *Comparative Biochemistry and Physiology Part A: Molecular and Integrative Physiology* **148** (3): 550-555.

Li J, Sun C, Zheng J, Li J, Yi G and Yang N. 2022. Time-course transcriptional and chromatin accessibility profiling reveals genes associated with asymmetrical gonadal development in chicken embryos. *Frontiers in Cell and Developmental biology* 405.

Rodler D, Stein K and Korbel R. 2015. Observations on the right ovary of birds of prey: a histological and immunohistochemical study. *Anatomia, Histologia, Embryologia* **44**(3): 168-177.

Sell J. 1959. Incidence of persistent right oviducts in the chicken. *Poultry Science* **38**(1):33-5.

Smith CA. Roeszler K N, Ohnesorg T, Cummins D M, Farlie P G, Doran T J and Sinclair A H. 2009. The avian Z-linked gene DMRT1 is required for male sex determination in the chicken. *Nature* **461**(7261): 267-271.

Sturkie P D and Mueller W J. 1976. Reproduction in the female and egg production. In *Avian physiology* (302-330). Springer, Berlin, Heidelberg.

Zheng X, O'Connor J, Huchzermeyer F, Wang X, Wang Y, Wang M and Zhou Z. 2013. Preservation of ovarian follicles reveals early evolution of avian reproductive behaviour. *Nature*: **495**(7442): 507-511.

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PROCEDURE TO OBTAIN PLANT BREEDER RIGHTS FOR A NEWLY DEVELOPED VARIETY

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Introduction

In India, agricultural research including the development of new plant varieties has largely been the concern of the government and public sector institutions. Earlier, India did not have any legislation to protect the plant varieties and, in fact, no immediate need was felt. However, after India became signatory to the Trade Related Intellectual Property Rights Agreement (TRIPs) in 1994, such a legislation was necessitated. Article 27.3 (b) of this agreement requires the member countries to provide for protection of plant varieties either by a patent or by an effective *sui generis* system or by any combination thereof. Thus, the member countries had the choice to frame legislations suiting their own system and India exercised this option.

Protection of Plant Varieties and Farmers' Right act 2001

Consequently, in 2001, the Indian government introduced the Protection of Plant Varieties and Farmers' Rights Act (PPVFR, 2001) as a *sui generis* system. This legislative framework, under Article 160 and the accompanying PPVFR (Plant Varieties and Farmers' Rights) rules of 2003, was established to safeguard crop varieties while extending specific provisions to both breeders and farmers. The pivotal aspects of Plant Breeder Rights outlined in the 2001 PPVFR Act encompass various elements: Breeder's Rights grant exclusive authority to breeders, covering production, sale, marketing, distribution, import, and export of protected varieties within the PPVFR framework. The Act actively advances new crop varieties, fostering innovation in both public and private sectors. Act has 11 chapters and is divided in 97 clauses. The first chapter has title, and the definitions used in context of the Act. The last chapter is on miscellaneous clauses. The other nine chapters deal with PPVFR authority, registration of plant varieties, duration and effect of registration and benefit sharing, surrender and revocation of certificate, farmer's rights, compulsory licence, plant varieties protection appellate tribunal, finance, accounts, audit, infringement, offences and penalties, *etc*.

Procedure for applying for registration of a new variety

As stipulated by Section 14 of the Plant Varieties and Farmers' Rights Act of 2001 (PPVFR), plant breeders must initiate the process by submitting an application for Plant Breeder Rights (PBR) for their newly developed variety to the Registrar's office. The applicant could be the breeder, the assignee of the breeder, a farmer or group of farmers, a community of farmers, a university, or a publicly funded agricultural institution. Depending on the nature of the variety, the applicant should use either Form I or Form II. Form I is suitable for new varieties, extant varieties, and Farmer Varieties, while Form II is designed for Essential Derived Varieties (EDV) (Karuppaiyan *et al*. 2011).

Form I

In this category, the newly developed variety must possess unique characteristics that distinguish it from pre-existing varieties, such as in terms of yield, resistance to pests/diseases or quality parameters. Upon submission, the authority assigns a unique denomination. If the proposed denomination doesn't meet requirements, the Registrar suggests a new one within a specified timeframe. Subsequently, the applicant submits an application along with supporting documents, including passport data providing information about the variety, its source, geographical location and details about distinctness, uniformity, stability, and novelty. The breeder bears the responsibility to ensure that the seeds submitted to the Registrar's office maintain genetic purity, physical purity, viability and germination. A Grow-Out Test is conducted on the submitted sample and parental material to assess variety Distinctness, Uniformity and Stability. The Registrar then evaluates the application, test results, and provided information to accept, reject, or suggest amendments. Following acceptance, the Registrar publishes the variety details in the official journal, the Plant Variety Journal of India, allowing interested parties to raise objections. Opposition can be based on non-registrability, public interest, environmental impact, or challenges to the applicant's PBR title. Those interested may object by filing Form PV3 within three months of publication, notifying the Registrar under Section 21 and Rule 31 of the PPVFR.

Upon receiving an objection, the Registrar shares it with the applicant, who must provide a counter statement within two months to avoid abandonment. After this, the Registrar examines the case. If the counter statement is weak and evidence is strong against the applicant, the application is rejected. Conversely, if the evidence is weak, the opposition is dismissed. Following successful completion, the Registrar issues a certificate of registration, sealed with the Registrar's seal, and according to regulations, the breeder must deposit seeds or propagating materials in the national gene bank. Upon issuance of the registration certificate, its content is published, allowing interested parties to claim benefit sharing within the specified period. The claimant must consider factors such as the amount of benefit sharing, the utilization of genetic material, commercial utility, and availability of the claimed varieties. Once the certificate of registration is issued, the breeder or their successor gains exclusive rights to produce, market, distribute, import, or export the registered variety (Smulders *et al*. 2021).

FORM II

The once-popular variety fell out of cultivation. However, leveraging existing molecular techniques, efforts were made to enhance the inherent traits of this population. This innovative process is termed "Essential Derived Variety" (EDV). Once the EDV is developed, the responsible breeder is required to submit it for Plant Breeders' Rights (PBR) to the registrar. The procedural protocol resembles that of Form I (Smith, 2021).

Requirements of application for registration under Plant Breeder's Right

Every application for registration will have to be accompanied with the following information [Section 18 (a–h)]:

a) Denomination assigned to such variety by the applicant;
b) An affidavit sworn by the applicant that such variety does not contain any gene or gene sequence involving terminator technology;
c) The application should be in such form as may be specified by regulations;
d) A complete passport data of the parental lines from which the variety has been derived along with the geographical location in India from where the genetic material has been

taken and all such information relating to the contribution, if any, of any farmer, village community, institution or organization in breeding, evolving or developing the variety;

e) A statement containing a brief description of the variety, bringing out its characteristics of novelty, distinctiveness, uniformity and stability as required for registration;

f) Such fees as may be prescribed;

g) Contain a declaration that the genetic material or parental material acquired for breeding, evolving or developing the variety has been lawfully acquired; and

h) Such other particulars as may be prescribed.

The conditions stated above (a–h), shall not apply in respect of application for registration of farmers' varieties.

Period of protection

The certificate of registration issued under section 24 or sub-section 98 of section 23 shall be valid for nine years in the case of trees and vines and six years in the case of other crops, and may be reviewed and renewed for the remaining period on payment of such fees as may be fixed by the rules made on this behalf subject to the conditions that the total period of validity shall not exceed

i. In the case of trees and vines, eighteen years from the date of registration of the variety;
ii. In the case of extant varieties, fifteen years from the date of the notification of that variety by the Central Government under Section 5 of the Seed Act, 1996, and
iii. In the other case, fifteen years from the date of registration of the variety.

Payment of annual fee

The Authority may, with the prior approval of the Central Government, by notification in the Official Gazette, impose a fee to be paid annually, by every breeder of a variety, agent and licensee thereof registered under this Act determined on the basis of benefit or royalty gained by such breeder, agent or licensee, as the case may be, in respect of the variety, for the retention of their registration under this Act [Section 35(1)]. The fee for registration and other processes as well as annual fee should be reasonably determined keeping in view the possible commercial value of the crop, the national interests, and the desirability of generating enough resources for financial autonomy of the Authority. Section 19 of the Act requires a breeder to submit a quantity of seeds along with 'parental lines' according to the standards specified by the regulations. Also, the seeds deposited are to be conserved and regenerated if necessary for DUS testing for maintenance. A separate fee may be assigned for conservation and regeneration, besides a testing fee.

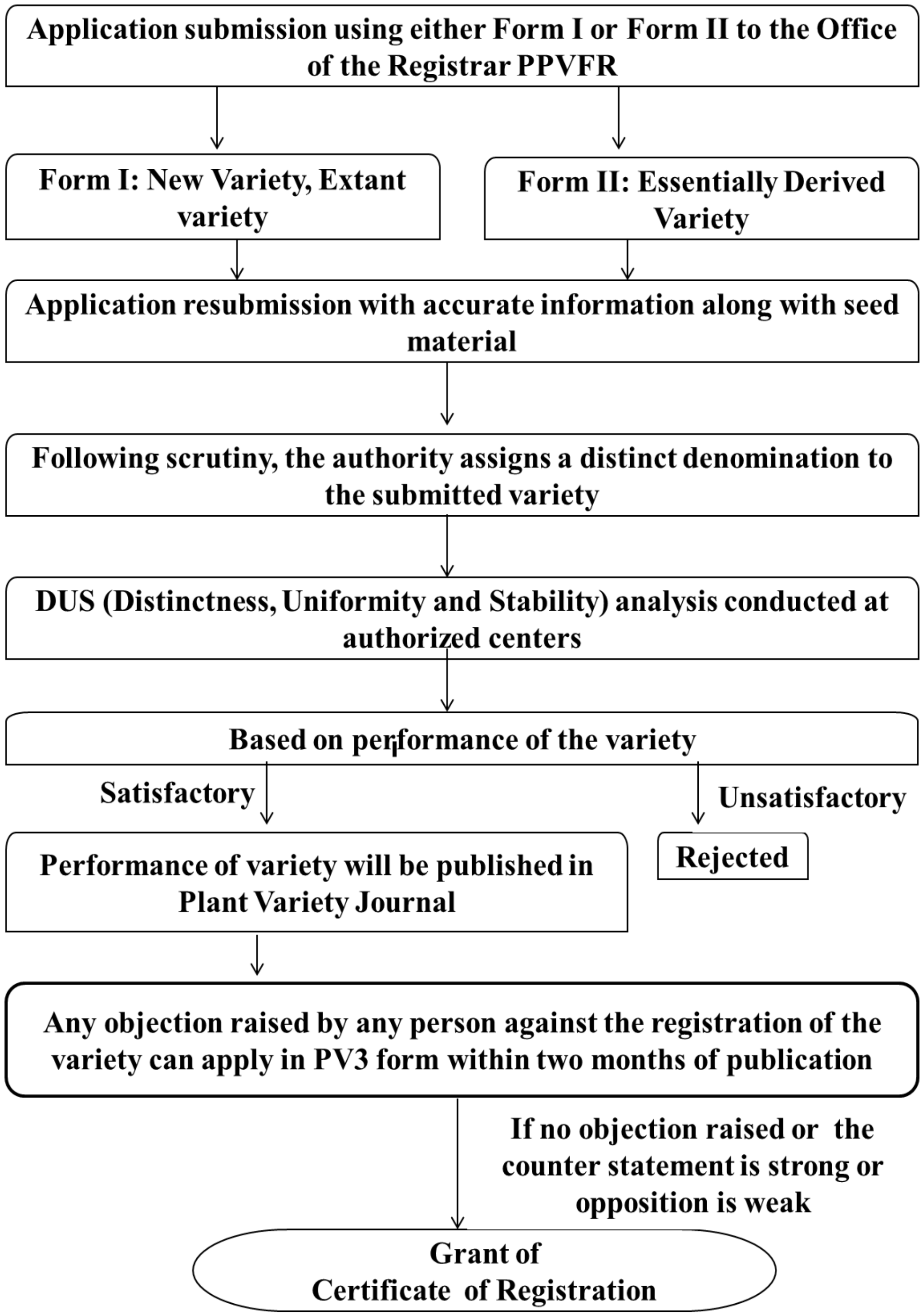

Fig. 1. Procedure for applying the Plant Breeder s' Right for newly developed variety

Scope of Plant Breeder Rights in India:

Plant Breeder Rights function as a harmonious equilibrium, promoting inventive strides while furnishing safeguards for breeders. This delicate equilibrium ensures a just and competitive landscape within the agricultural sphere. These facets not only ignite breeder interest in research and development but also fuel the ceaseless advancement of plant varieties, ultimately benefiting both cultivators and consumers. PBR acts as a catalyst for ingenuity in plant breeding, driving the emergence of crop varieties that boast high yields, resilience to diseases, and adaptability to diverse climates. The legal safeguarding of plant varieties secures the avenue for breeders to commercialize their creations, instigating economic growth across the agricultural sector and its associated sectors (Chaithanya *et al*. 2023).

Conclusion

The legal framework of PBR in India empowers plant breeders to develop and release new, improved varieties that address the challenges posed by a growing global population and limited resources. By providing economic rewards, preventing exploitation, allowing for breeding exemptions, and facilitating licensing, PBR incentive breeders to continuously strive for better varieties that enhance agricultural productivity and sustainability. Today Plant Breeders' Rights are an integral part of modern agriculture, providing protection and incentives for breeders' to develop new plant varieties that address the challenges of changing climate conditions, disease resistance and food security.

References

Chaithanya, G, Chinmayi, S and Ananda, K. R. 2023. PPVFR: Unlocking Farmer's Rights and Benefits. Vigyan Varta an International E-Magazine for Science Enthusiasts. 4: 133-137.

Karuppaiyan, R., Bakshi Ram and Mintu Ram Meena. 2011. Protection of Plant Varieties, Breeders' Rights and Farmers' Rights in India. Sugarcane Breeding Institute, Regional Centre, Karnal-132 001 (Haryana). Training Manual No. SBIRC-KNL-02/2011

Smith, J.S.C. The Future of Essentially Derived Variety (EDV) Status: Predominantly More Explanations or Essential Change. Agronomy 2021, 11, 1261

Smulders, M.J.M.; van de Wiel, C.C.M.; Lotz, L.A.P. 2021. The Use of Intellectual Property Systems in Plant Breeding for Ensuring Deployment of Good Agricultural Practices. Agronomy 2021, 11, 1163

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A COST-EFFECTIVE APPROACH FOR PRODUCTION OF HUMAN ERYTHROPOIETIN USING CHICKEN AS A BIOREACTOR

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Abstract

Erythropoietin belongs to cytokine family which plays an important role in regulation the of erythropoiesis. This protein is produced in the kidney and is transported to the bone marrow where it acts on the eryhroid progenitors for their maturation and regulation. Its production is affected in chronic kidney diseases and therefore need to be supplemented in anemic conditions. The production of erythropioetin from mammalian cell cultures are difficult to maintain and involves high cost. Therefore, the present article focusses on the efficient and cost-effective method of using chicken as a bioreactor for the production of the erythropoietin. Due to the short generation interval of chicken and less complex protein composition of egg the erythropoietin can be produced and isolated in transgenic chicken.

Keywords: Erythropoietin, Chicken, Anemia, Bioreactor

Introduction

Red blood cells homeostasis is an important process regulated by cross interaction between the kidney and bone marrow. Based on the arterial blood oxygen content, a healthy kidney regulates the release of erythropoietin for red blood cell generation in RBC (Jelkmann, 2013). In patients with chronic kidney disease (CKD) this homeostasis is compromised leading to called anemia. In anemia, the serum haemoglobin (Hb) levels are ≤12 gm/dL in women and ≤13 gm/dL in men. It is prevalent twice as much in the affected adult population (15.4%) as opposed to the general population (7.4%). Though many cytokines support erythropoiesis, erythropoetin (EPO) is the main physiological controller of erythropoiesis whose deficiency may cause anemia. Treatment of anaemia aims at replacing the endogenous EPO feedback through recurrent administrations of erythropoiesis stimulating agents (ESAs) such as recombinant human erythropoietin (rHuEPO).

Erythropoietin is a glycoprotein produced by the kidney which plays an important role in the production of red blood cells during hypoxic conditions that belongs to the super family, type I cytokine. The human erythropoietin has 165 amino acids with a molecular weight of 30.4 KDa (Jelkmann, 2007, Brines and Cerami, 2012). During the last gestation stage, the site of erythropoietin production shifts to the kidney which is the major site for erythropoietin production in adults. When there is decrease in the RBC levels, the renal tubular interstitial cells secrete erythropoietin into circulation to reach the bone marrow. Erythropoietin binds to the erythropoietin receptor (EPOR 2) on the erythroid progenitors (Peng *et al.*, 2020) and promotes erythropoiesis by stimulating the proliferation and maturation of erythroid precursor cells. Therefore, erythropoietin plays a vital role in treatment of anaemia caused due to renal disease and also due to cancer receiving chemotherapy (Marsden, 2006 and Jelkmann, 2008).

Chicken as a Bioreactor

Presently many biopharmaceuticals are made by employing expression systems from bacterial, yeast, or mammalian cell cultures. Many of the therapeutic proteins that are glycosylated are now made in animal cell culture systems. Although mammalian and bacterial cell cultures have shown to be helpful in the creation of recombinant proteins, they still have a number of drawbacks. It is widely known that bacterial cell culture systems are less capable of post-translational modification and glycosylation than eukaryotic systems (Raju et al., 2000). Chinese hamster ovary (CHO) cell lines, which are often used for mammalian cell lines, do typically permit for appropriate post-translational modifications (Houdebine, 2009) and involves high cost of production. This has led researchers to investigate potential alternatives like transgenic animal bioreactor systems that have the potential to alleviate the issues of classic cell based production system. Transgenic sheep, goats and cows were generated as animal bioreactors to produce high quality proteins in large scale, potentially at lower capital and production costs than cell culture systems (Lillico et al., 2005).

Despite immense investments of time and money, only a few trials were successfully commercialized (Niemann and Kues, 2003). However, use of a secretory organ, such as the mammary gland, as a bioreactor include the tremendous expenditure required for breeding and maintaining a large number of mammals. Also, there is difficulty in purifying recombinant therapeutic proteins from the complex composition of various milk proteins. The use of chicken eggs can circumvent these problems and is advantageous in other respects, including far shorter generation times, high fecundity, and lower costs for breeding and maintaining large populations (Ivarie, 2003). Most importantly, purification of the therapeutic recombinant protein is much easier because the composition of the egg white is less complex than that of milk. In addition, compared to mammalian livestock systems, the glycosylation patterns of avian proteins are more similar to those of their human homologues (Raju et al., 2000). Development of laying hen as a bioreactor is depend on the high protein synthetic capacity of hen. The egg of the hen contains around 3.5 g of protein in egg white. Egg white acts as a substrate where a protein of interest can be produced in large amounts and subsequently harvested for purification. The ovalbumin promoter can be modified for regulating the production of gene of interest in the oviductal cells from which the egg white is produced.

Recent advances have lead to the development of several methods for generation of transgenic birds. The most common successful method is of retroviral vectors (Kodama et al., 2008) such as CMV promotor (KOO et al., 2017). A viral construct is generated and then injected into the X stage avian embryo. Other methods also include injection of modified primordial germ cells into recipient embryos (Park, and Han, (2012). These primodial germ cells are priorly obtained from avian embryos, cultured, and transfected. In addition to viral vector-based methods electroporation method can also be used for transfection of recombinant proteins (Parham et al., 1998). this technique involves the use of high voltage electric shocks for introduction of DNA into cells which yields a stable transformation and transient gene as it requires fewer easy steps than the viral vector-based transformation in the oviductal cells of chicken. The transgenic chicken has mediated the production of various human cytokines, including human erythropoietin. The resulting transgenic chickens produced biologically functional hEPO as a component of egg whites at one of the highest levels ever reported. The stable germline transmission of this hEpo to next generations, is helpful for establishing transgenic chickens characterized by highest records of HEPO production in their egg whites.

Conclusion

From the recent studies it can be understood that tremendous efforts are being made so that avian eggs and their related cell culture can be modified so that a relative platform can be provided for the production of the therapeutic antibodies, recombinant proteins, and vaccine manufacturing. The same glycosylation pattern as human, cost effectiveness, shorter breeding cycle and easy purification of the proteins provide a beneficial aspect in the use of chicken as bioreactors in the production of erythropoietin as well as other theurapeutic proteins. Thus the use of this transgenic approach makes the avian species like chicken as a great bioreactor model in field of biotechnology and pharmaceutical industry.

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References

Brines, M. and Cerami, A. 2012. The receptor that tames the innate immune response. Molecular Medicine. 18, 486–496.

Doshi. S., Krzyzanski, W., Yue, S., Elliott, S., Chow, A., Pérez-Ruixo, J.J. 2013. Clinical pharmacokinetics and pharmacodynamics of erythropoiesis-stimulating agents. Clinical Pharmacokinetics.52(12), 1063–1083.

Dyck, M., Lacroix, D., Pothier, F., Sirard, M-A. 2003. Making recombinant proteins in animals- different systems, different applications. Trends Biotechnology. 21(9), 394–399.

Fandrey, J., and Bunn, H. F. 1993. In vivo and in vitro regulation of erythropoietin mRNA: measurement by competitive polymerase chain reaction. Blood. 81, 617–623.

Houdebine, L. M. (2009). Production of pharmaceutical proteins by transgenic animals. Comparative Immunology, Microbiology and Infectious Diseases, 2, 107–121.

Ivarie, R. (2003) Avian transgenesis: progress towards the promise. Trends Biotechnol. 21: 14-19.

Jelkmann, W. 2007. Erythropoietin after a century of research: younger than ever. European journal of haematology. 78(3),183-205.

Jelkmann, W. 2008. Developments in the therapeutic use of erythropoiesis stimulating agent. British Society for Haematology. 141, 287– 297.

Jelkmann, W. Physiology and Pharmacology of Erythropoietin. 2013. Transfusion Medicine and Hemotherapy ;40:302–309.

Kodama, D., Nishimiya, D., Iwata, K.I., Yamaguchi, K., Yoshida, K., Kawabe, Y., Motono, M., Watanabe, H., Yamashita, T., Nishijima, K.I. and Kamihira, M. 2008. Production of human erythropoietin by chimeric chickens. Biochemical and biophysical research communications. 367(4),834-839.

Koo, B.C., Kwon, M.S., Kim, D., Kim, S.A., Kim, N.H. and Kim, T.2017. Production of transgenic chickens constitutively expressing human erythropoietin (hEPO): Problems with uncontrollable overexpression of hEPO gene. Biotechnology and Bioprocess Engineering. 2017. 22,22-29.

Lillico, S.G., McGrew, M.J., Sherman, A. and Sang, H.M. 2005 Transgenic chickens as bioreactors for protein-based drugs. Drug Discovery Today. 10(3), 191–196.

Marsden. J.T. 2006. Erythropoietin-measurement and clinical applications. Annals of Clinical Biochemistry, 43:97–104

Masuda, S., Okano, M., Yamagishi, K., Nagao, M., Ueda, M., and Sasaki, R. (1994). A novel site of erythropoietin production. Oxygen-dependent production in cultured rat astrocytes. Journal of Biological Chemistry .269, 19488–19493.

Nakajima, O., Nakamura, K., Kondo, K., Akiyama, H. and Teshima, R. 2013.Method of detecting genetically modified chicken containing human erythropoietin gene. Biological and Pharmaceutical Bulletin. 36(9),1454-1459.

Niemann, H. and W. Kues. 2003. Application of transgenesis in livestock for agriculture and biomedicine. Animal Reproduction Science. 79, 291-317.

Parham, J. H., Iannone, M. A., Overton, L. K., Hutchins, J. T. 1998. Optimization of transient gene expression in mammalian cells and potential for scale-up using flow electroporation. Cell Culture Engineering VI, 147-155.

Park, T. S., and Han, J. Y. 2012. piggyBac transposition into primordial germ cells is an efficient tool for transgenesis in chickens. Proceedings of the National Academy of Sciences of the United States of America, 109(24), 9337–9341.

Peng, B., Kong, G., Yang, C., Ming, Y. 2020. Erythropoietin and its derivatives: from tissue protection to immune regulation. Cell death & disease.11(2), 79.

Penno, C.A., Kawabe, Y., Ito, A. and Kamihira, M. 2010. Production of recombinant human erythropoietin/Fc fusion protein by genetically manipulated chickens. Transgenic research. 19,187-95.

Raju, T. S., Briggs, J. B., Borge, S. M., & Jones, A. J. 2000. Species-specific variation in glycosylation of IgG: evidence for the species-specific sialylation and branch-specific galactosylation and importance for engineering recombinant glycoprotein therapeutics. Glycobiology, 10(5), 477-486.

Rapp, J.C., Harvey, A.J., Speksnijder. G.L., Hu, W. and Ivarie, R. 2017. Biologically Active Human Interferon α-2b Produced in the Egg White of Transgenic Hens. Transgenic Research. 12, 569–575.

Shukla, A.A., Wolfe, L.S., Mostafa, S.S. and Norman, C. 2017. Evolving trends in mAb production processes. Bioengineering & Translational Medicine. 2,58–69.

Sola, R.J., Griebenow, K. 2010. Glycosylation of therapeutic proteins: an effective strategy to optimize efficacy. BioDrugs. 24:9–21.

Suresh, S., Rajvanshi, P.K. and Noguchi, C.T. 2020. The many facets of erythropoietin physiologic and metabolic response. Frontiers in physiology. 17(10),1534.

Vick, L., Li, Y., and Simkiss, K. 1993. Transgenic birds from transformed primordial germ cells. Proceedings of the Royal Society of London, 251(1332), 179

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WINGED BEAN – UNDERRATED LEGUME FOR NUTRITIONAL SECURITY

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Introduction

Winged bean (*Psophocarpus tetragonolobus*) is an under utilized vegetable crops, belong to the family of Fabaceae and originated from Southeast Asia (Indonesia, Malaysia, and Papua New Guinea). The species *Psophocarpus grandiflorus* is the progenitor for cultivated winged bean, which has African centre of origin. This plays a major role in understanding the evolutionary history and distribution of this genus. The winged bean is also known as the Goa bean, Four-angled bean, Princess bean, Manila bean, Dragon bean or Asparagus pea.

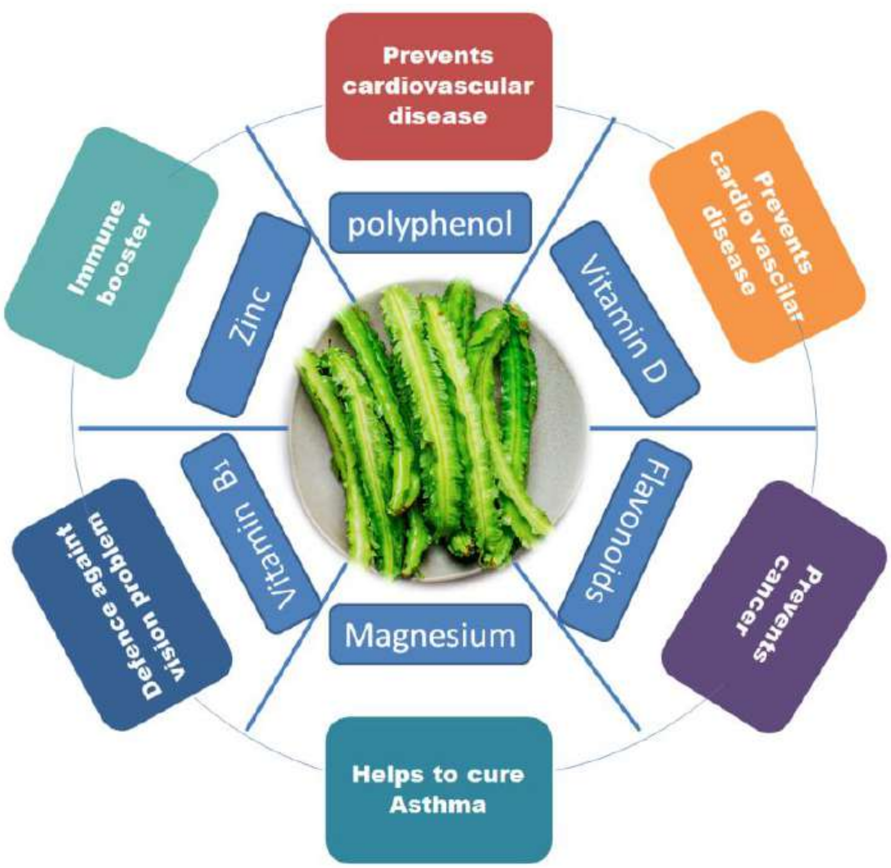
Malnutrition due to less protein uptake is prevailing in many developing countries. Hence, utilising non-traditional protein sources is necessary to increase protein supply to fulfil the demand of a rising population, where winged bean, helps to achieve the protein requirement of the developing population.The crop abundantly grows in the region with hot and humid condition i.e., equatorial countries. winged bean is grown in countries like India, Burma, Sri Lanka, Indonesia, Malaysia, Thailand, Philippines, Indo-China, China and New Guinea. In India, it is grown mainly in eight states, including Assam, Manipur, Mizoram, Kerala, Tamil Nadu and Karnataka by the tribals as a backyard crop.

Fresh young winged bean pods contains a good source of Protein (6.95 g), Carbohydrates (4.311 g), Fat (0.87 g), Vitamin A (128 IU), Vitamin C (1.3 mg), Calcium (4mg), Iron (1.5 mg), Manganese (0.218 mg), Phosphorus (37 mg), Zinc (0.35 mg) which is comparatively higher than other underutilized Leguminosae crops.

Health benefits of winged bean seeds: The seeds are the richest source of Phosphorus, iron and Vitamin D. The essential amino acids content in winged bean is very similar to the soyabean. It contains high amount of behenic acid which helps to restore the natural oil in human skin and the parinaric acid are known to have roles in defense response.

Health benefits of winged bean pods: Regular consumption of winged beans can help improve digestion, boost immunity, promote healthy skin, prevent diabetes and strengthens bones and promote healthy skin

Health benefits of winged bean leaves: The leaves are used as fodder for animals and as leafy vegetable in human diet. Leaf is an excellent source of fiber, Vitamin-C, Vitamin-A, and minerals. 100 g of fresh leaves provide 45 mg of Vitamin-C (75% of recommended daily value) and 8090 IU of Vitamin-A (270 % of RDA).



Health benefits of winged bean tubers: Vitamin B complex may help prevent infections and help support cell health, relieve stress, reduce symptoms of depression and anxiety, which also plays a vital role in releasing energy from carbohydrates, fats and proteins.

Winged bean also helps to overcome and prevent dryness and cracks on the skin of the feet and hands, prevents the risk of hair loss, premature aging (wrinkles on the face due to aging)

PRODUCTION TECHNOLOGY OF WINGED BEAN

Propagation
Seed propagated. Seed rate varies from 15-20 kg/ha. Seeds should be sown 2.5 cm deep and 60 cm apart from each other in a row.

Irrigation
Life irrigation should be given on 3rd day. Drip irrigation is suitable. Irrigate deeply, especially during dry spells

Fertilizer recommendation
N:P:K - 20:100:40 kg/ ha

Training
Install trellises or stakes in the stage to provide support as they are climbers.

Weeding
Remove weeds around the plants to reduce competition for nutrients and water

Pest incidence
Aphids, Bean beetles and Caterpillars

Harvesting
Starts from 60 to 90 days after planting. It yield 5 – 8 t of pod and 1.5 t of seeds

Maturity index
Pod: 2weeks after anthesis (immature)
Seeds: pods are allowed to dry and then seeds are extracted

Therapeutic Potential of winged bean

1. Aid in controlling malnutrition

Winged bean may be regarded as a natural source of important nutrient because they are packed with nutrients, as was already said. As a result, frequent consumption of these beans might help your diet make up for numerous inadequacies. Notably, the legume is rich in minerals including Copper, Phosphorus, Magnesium, Calcium, Manganese and Iron as well as Vitamins such as Vitamins A, B, C, and D

2. Immune booster

Winged beans are high in Vitamin A and Vitamin C, which plays a major role in boosting the immune system and helps the body to fight against diseases. Whereas the Vitamin A prevents the entry of pathogen and Vitamin C content in this vegetable helps to activate the white blood cell which is essential for body's defense system.

3. Helps in digestion

They are the richest source of prebiotic fibre, which helps to nourish the bacteria in the gut and thus supports healthy digestion.

4. Boosts heamoglobin level

Iron content in the pod helps in the formation of heamoglobin and thereby plays a vital role in respiration.

5. Prevents diabetes

By maintaining the body's glucose metabolism, the Fibre, Calcium and Vitamins, including Vitamin D, in winged bean reduce the risk of developing diabetes.

6. Encourages healthy eyes

Vitamin A content in winged bean helps to moisturize the cornea, keeping it hydrated and preventing injury. The Vitamin B_1 in this bean has the capacity to promote eye health, prevent various eye problems, including glaucoma and cataracts and it also helps to heal muscles and nerves in the eye.

7. Increases muscular mass

Consumption of adequate amounts of protein plays a major role in muscle growth and recovery, especially for people who are engaged in regular physical activity and hence include winged bean in their diet, The protein also helps to manage blood sugar, build strength and stamina, improve joint stability and strength, and improve balance and coordination.

8. Advantageous during pregnancy

Winged bean is one of the finest source of folic acid, which is essential for pregnant women. This folic acid facilitates the healthy development of the fetus. Iron is crucial during childbirth since it reduces the chances of maternal blood loss and low birth weight which is also present in winged bean.

9. Strengthens bones

The primary mineral found in bones and teeth, calcium, is abundant in winged beans. They also include phosphorus, which aids in the utilisation of calcium and the development of strong bones. Including winged beans in your diet helps to support bone health and avoid osteoporosis.

10. Prevents DNA damage

Since winged bean is the richest source of anti-oxidants and phytochemicals, they shield against DNA damage associated with UV radiation.

11. Reduce blood pressure

The potassium content helps to lower blood pressure and this bean also helps to balance the sodium, which at higher rate increase the blood pressure.

Ill effects of consuming winged bean

Although winged beans are renowned for their many health advantages, it's crucial to be informed of any risks and drawbacks before ingesting them. As they are rich in oxalic acid and hence people prone for kidney stones should use it with caution and the high fibre content in winged bean may occasionally make some people produce too much gastric and causes bloating. And the other anti-nutritional factors, namely, trypsin inhibitor, chymotrypsin inhibitor, hemagglutinins, amylase inhibitors, phytates, phytic acid, saponin, tannin and flatulence saccharides and other phenolic compounds of winged bean, were reported to be in higher range.

Botany of winged bean

Habit: Climber

Leaf: Leaves ranges from ovate to deltoid, ovate-lanceolate, lanceolate, and long lanceolate. It can grow upto 15cm

Pod: The texture of the plant varies from smooth to rough which depends on the variety. The typical length of the pod ranges from 15 to 22 cm and it has waxy skin. The colour of the pods may be cream, green, pink, or purple. When fully ripe, the pod turns to ash-brown color and splits open to disperse the seeds.


Seed: The seed shape is often round; oval and sometimes rectangular. Seeds may appear white, cream, dark tan, or brown, depending on the growing and storage conditions. The bean themselves are similar to soybeans in both use and nutritional content (29.8% to 39% protein).

Flower: The large flower is a pale blue with diadelphous stamen.

Root: Roots are tuberous; tuber ranges in size between 8 and 12 cm in length and 2 to 4 cm in width.

Genetic resources of winged bean

IIHR Selection-21, IIHR Selection-60, IIHR Selection-71 are the important varieties released from IIHR. and WBC-2 is the cultivar released from ICAR Mehalaya. Revathy, PT-62, PT-16, PT-49, PT-2 are the ruling varieties of winged bean from Kerala Agricultural University.

Varieties	Year of identifi-cation/ release	Economic part	Average yield (q/ha)	Recommended areas
AKWB-1	1991	Green pods	105.00	All winged bean growing areas
Indira Winged bean – 1	2015	Green pods & seeds	115.00	Chattisgarh, Jharkhand and Maharashtra
Chattisgarh Chaudhari Sem-2	2017	Green pods & seeds	124.0 and 20.0	Chattisgarh
Indira Winged Bean-2	2018	Green pods & seeds	128.0 and 19.0	Chhattisgarh, Jharkhand and Maharashtra

The popular winged bean recepies include fritters, Stir-Fried winged beans with garlic, Spicy Winged Bean Salad, Winged Bean Curry, stuffed Winged Bean Rolls.

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MICROBES: NATURE'S GUARDIANS - A LIFESTYLE STRATEGY FOR ENVIRONMENTAL AND PERSONAL WELL-BEING

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Abstract

Microbes, the unsung heroes of our planet, wield remarkable influence over both our environment and our well-being. In the grand scheme of life on Earth, these tiny, single-celled organisms play pivotal roles, often overlooked in our daily lives. This article explores the world of microbes, emphasizing their vital significance. From nutrient cycling to digestive support, environmental cleanup, and even climate change mitigation, microbes are intrinsic to our existence. By adopting a lifestyle that champions these minuscule marvels, we can nurture our health and safeguard the environment. The future holds exciting prospects for microbial biotechnology, health advancements, environmental remediation, sustainable agriculture, and more. As we journey forward, microbes will continue to guide us toward a healthier, more harmonious coexistence with the world that sustains us.

Keywords: Microbes, organisms, significance, climate change mitigation, prospects, environment

Introduction

In the grand tapestry of life on Earth, microbes fulfill a role of such paramount significance that it is all too often relegated to the periphery of our collective awareness. These minuscule, single-celled organisms, though unassuming in appearance, stand as the unheralded heroes of our world. They labor tirelessly behind the scenes, orchestrating a symphony of ecological processes that maintain the delicate balance of our environment. It is this equilibrium that, in a beautiful and intricate cycle, bestows upon us the gift of well-being. Microbes, the unsung architects of our world, operate on a scale so diminutive that they evade our everyday perception. Yet, it is their ceaseless efforts that underpin the very foundation of our existence. They are nature's invisible caretakers, silently toiling to preserve our surroundings in a state of harmony, and it is their diligent work that ultimately promotes the flourishing of our own health and vitality. As we journey deeper into the following paragraphs, we shall embark on an exploration of the awe-inspiring realm of microorganisms. Here, in this hidden world, where life unfolds on a microscopic scale, we will uncover the profound impact these remarkable organisms have on our lives and our planet.

We will unveil the intricate mechanisms by which they sustain the ecosystems that cradle us, the intricate dance they perform within our own bodies, and the profound role they play in shaping our collective destiny. Microbes may be inconspicuous, but they wield extraordinary power. These minute organisms, so easily overlooked in the hustle and bustle of our daily lives, emerge as the unsung champions of our environment and the bedrock upon which our well-being is built. Within the upcoming passages, we will embark on a captivating journey into the enigmatic universe of microorganisms, discovering how the adoption of a lifestyle that fosters their proliferation on a minuscule scale can serve as a triumphant strategy. This strategy, we shall see, not only enhances our personal health but also stands as a beacon of hope for the preservation of our cherished planet—a testament to the profound interconnection between our well-being and the world that cradles us.

The Microbial World

Microbes, short for microorganisms, are incredibly diverse and ubiquitous. They include bacteria, archaea, fungi, viruses, and various single-celled eukaryotes. While some are associated with diseases, the majority of microbes are beneficial and perform critical functions in ecosystems. Here are some fascinating aspects of their role in our lives and environment:

Digestive Allies**:** In our own bodies, trillions of microbes reside in our gut, aiding in digestion, supporting our immune system, and even influencing our mood and mental health. Maintaining a balanced gut microbiome is crucial for overall well-being.

Ecosystem Guardians**:** Microbes help maintain ecological balance by outcompeting harmful pathogens and supporting the growth of beneficial organisms. They're nature's guardians against disease.

Environmental Cleanup Crew**:** Microbes can detoxify pollutants and break down harmful chemicals. They're crucial for bioremediation efforts, helping clean up oil spills and industrial waste.

Fermentation and Food**:** Microbes are responsible for the transformation of raw ingredients into delicious foods and beverages like yogurt, cheese, beer, and bread. Fermentation, driven by microbes, enhances the nutritional value and shelf life of many foods.

Nutrient Cycling**:** Microbes are nature's recyclers. They break down organic matter into nutrients that plants can absorb, ensuring the health of our soil and vegetation. Without them, ecosystems would collapse.

Lifestyle Choices for Microbial Well-Being

Now that we understand the importance of microbes, let's delve into how we can adopt a lifestyle that supports them and, in turn, our own well-being and the health of the planet:

Composting**:** Starting a compost pile reduces waste and enriches your garden with beneficial microbes. It's a simple way to give back to the environment.

Diverse Diets: Eating a diverse range of fruits, vegetables, whole grains, and fermented foods supports the diversity of microbes in your gut. This promotes good digestion, a robust immune system, and mental health. It's a win-win for you and your tiny companions.

Natural and Sustainable Farming: Supporting natural and sustainable agriculture reduces the use of chemical fertilizers and pesticides, which can harm beneficial soil microbes. It also encourages biodiversity and healthy ecosystems.

Reducing Antibiotic Use: Using antibiotics judiciously is vital. Overuse can lead to antibiotic resistance, which threatens both human health and microbial balance in ecosystems.

Supporting Bioremediation: Encourage research and investment in bioremediation technologies. Microbes can play a pivotal role in cleaning up polluted environments.

Water Conservation: Responsible water use helps maintain aquatic ecosystems, which rely on a delicate balance of microbes. Conserving water resources is essential for the health of rivers, lakes, and oceans.

Future Prospects

As we peer into the future, the significance of microbes in shaping our world and influencing our well-being becomes increasingly apparent. The prospects for harnessing the power of these microscopic wonders to address pressing environmental and health challenges are both exciting and promising.

Agriculture and Food Security: Microbes play a pivotal role in soil health and crop production. As we seek sustainable and resilient agriculture practices, harnessing the power of beneficial microbes can enhance food security while reducing the need for chemical inputs.

Biodiversity Conservation: Protecting microbial diversity is integral to preserving broader ecosystems. Recognizing the importance of microbes in maintaining biodiversity will likely become a focal point of conservation efforts.

***Climate Change Mitigation*:** Microbes have a role in mitigating climate change. Research into carbon sequestration, where microbes are used to capture and store carbon dioxide, could be instrumental in combating global warming.

Education and Awareness: Increasing public awareness about the importance of microbes is essential. Educational programs and initiatives can empower individuals to make informed choices that support microbial well-being, both in their bodies and the environment.

Environmental Remediation: Microbes are increasingly being employed in environmental cleanup efforts. Bioremediation techniques, which use microbes to break down pollutants, offer sustainable solutions to environmental contamination, such as oil spills and toxic waste sites.

Global Collaboration: Collaboration on a global scale will be key. International efforts to share research, technologies, and best practices will amplify the positive impact of microbes on our world.

Health and Medicine: The study of the human microbiome is an area of burgeoning research. Understanding how the trillions of microbes in our bodies impact our health holds great promise for personalized medicine, treatments for various diseases, and even mental health interventions.

Microbial Biotechnology: The field of microbial biotechnology is poised for remarkable growth. Microbes can be engineered to produce valuable compounds, including biofuels, pharmaceuticals, and biodegradable plastics. This innovation has the potential to reduce our dependence on fossil fuels and mitigate pollution.

Policy and Regulation: Policymakers are beginning to recognize the importance of microbial stewardship. Future regulations may focus on preserving microbial diversity, reducing antibiotic misuse, and promoting sustainable agricultural and environmental practices.

Tthe future is brimming with potential when it comes to harnessing the power of microbes for the betterment of humanity and our planet. As we continue to unlock the secrets of these tiny but influential organisms, we are presented with unprecedented opportunities to shape a more sustainable, healthy, and harmonious world. Embracing a future where microbes take center stage in our environmental and personal well-being strategies is a step toward a brighter and more interconnected future for all.

Conclusion

Microbes are the unsung heroes of our world, quietly working to maintain balance in ecosystems, support our health, and improve our quality of life. Embracing a lifestyle that values and nurtures these microscopic powerhouses is a strategy for well-being that benefits both us and the environment. By making mindful choices in our diets, farming practices, and environmental stewardship, we can create a harmonious partnership with the microbial world, ensuring a healthier and more sustainable future for all. In the grand scheme of life on Earth, microbes, the unsung heroes, wield remarkable influence over both our environment and our well-being. These tiny, single-celled organisms play pivotal roles, often overlooked in our daily lives. This article explores the world of microbes, emphasizing their vital significance. From nutrient cycling to digestive support, environmental cleanup, and even climate change mitigation, microbes are intrinsic to our existence. By adopting a lifestyle that champions these minuscule marvels, we can nurture our health and safeguard the environment. The future holds exciting prospects for microbial biotechnology, health advancements, environmental remediation, sustainable agriculture, and more. As we journey forward, microbes will continue to guide us toward a healthier, more harmonious coexistence with the world that sustains us.

References

Dhyani, P., Goyal, C., Dhull, S. B., Chauhan, A. K., Saharan, B. S., Duhan, J. S., & Goksen, G. Psychobiotics for Mitigation of Neuro-Degenerative Diseases: Recent Advancements. Molecular nutrition & food research, e2300461.

Goyal, C., Dhyani, P., Rai, D.C., Tyagi, S., Dhull, S.B., Sadh, P.K., Duhan, J.S. and Saharan, B.S. (2023). Emerging trends and advancements in the processing of dairy whey for sustainable biorefining. Journal of Food Processing and Preservation, vol. 2023, Article ID 6626513, 24 pages, 2023. https://doi.org/10.1155/2023/6626513

Kamal, N.; Parshad, J.; Saharan, B.S.; Kayasth, M.; Mudgal, V.; Duhan, J.S.; Mandal, B.S. and Sadh, P.K. (2023) Ecosystem Protection through Myco-Remediation of Chromium and Arsenic. J. Xenobiot. 2023, 13, 159–171. https://doi.org/10.3390/jox13010013

Kumar, R.; Kumar, N.; Rajput, V.D.; Mandzhieva, S.; Minkina, T.; Saharan, B.S.; Kumar, D.; Sadh, P.K. and Duhan, J.S. (2022). Advances in Biopolymeric Nanopesticides: A New Eco-Friendly/Eco-Protective Perspective in Precision Agriculture. Nanomaterials 2022, 12: 3964-. https://doi.org/10.3390/nano12223964.

Kumar, R.; Nehra, M.; Kumar, D.; Saharan, B.S.; Chawla, P.; Sadh, P.K.; Manuja, A.; Duhan, J.S. (2023). Evaluation of Cytotoxicity, Release Behavior and Phytopathogens Control by Mancozeb-Loaded Guar Gum Nanoemulsions for Sustainable Agriculture. J. Xenobiot. 2023, 13, 270-283. https://doi.org/10.3390/jox13020020

Narender, Kumar, M., Kumar, A. and Saharan, B.S. (2023). Assessment of Soil Properties Using Geospatial Techniques at DDUCE-OF Farm. British J. Env. Climate Change, 13 (7): 283-290.

Saharan, B.S.; Brar, B.; Duhan, J.S.; Kumar, R.; Marwaha, S.; Rajput, V.D.; Minkina, T. (2022). Molecular and Physiological Mechanisms to Mitigate Abiotic Stress Conditions in Plants. Life 2022, 12, 1634. https://doi.org/10.3390/life12101634

Saharan, B.S.; Chaudhary, T.; Mandal, B.S.; Kumar, D.; Kumar, R.; Sadh, P.K.; Duhan, J.S. Microbe-Plant Interactions Targeting Metal Stress: New Dimensions for Bioremediation Applications. J. Xenobiot. 2023, 13, 252-269. https://doi.org/10.3390/jox13020019

Saharan, B.S.; Tyagi, S.; Kumar, R.; Vijay; Om, H.; Mandal, B.S.; Duhan, J.S. (2023). Application of Jeevamrit Improves Soil Properties in Zero Budget Natural Farming Fields. Agriculture 2023, 13, 196. https://doi.org/10.3390/agriculture13010196

Sharma, N., Parshad, J., Pathak, D.V., Saharan, B.S. and Kayasth, M. (2023). Biocontrol of citrus thrips using Achromobacter xylosoxidans bacteria. Allelopathy Journal, 60 (1): 93-106.

Singh, D., Satpute, S. K., Ranga, P., Saharan, B. S., Tripathi, N. M., Aseri, G. K., Sharma, D. and Joshi, S. (2022). Biofouling in Membrane Bioreactors: Mechanism, Interactions and Possible Mitigation Using Biosurfactants. Applied Biochem. Biotechnol., 1-20. [https://doi.org/10.1007/s12010-022-04261-4]

Verma, M. and Saharan, B.S. (2022). In vitro Antidiabetic, Antioxidant activity and Probiotic Attributes of L. casei NCDC 357 strain. Applied Biological Research 24(3):288-297

Verma, M., Saharan, B.S. and Kumar, A. (2023). Contributions of probiotic L. acidophilus 291 as biotechnological tool in therapeutic applications. Res. J. Biotech., 18(9): 147-154.

Vijay, Saharan, B.S., and Om, H. (2022). Impact of Natural Farming on soil health, microbial dynamics and crop productivity under north-western conditions of India. Agric. Mech. Asia, Africa Latin America, 53(07): 8779-8806

Yogita, Ranga, P., Saharan, B.S., Sindhu, M., Malik, K., Kayasth, M., Mehta, S. and Chauhan, S. (2022). Microbial Decolourization and Detoxification of Azo dye and Textile Effluent. Agri. Mech. Asia Africa Latin America, 53(06): 8469-8485

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POMEGRANATE - A REMUNERATIVE CROP OF ARID AND SEMI ARID REGIONS

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Introduction

Pomegranate (*Punica granatum* L.) is an important cash crop due to its high price value, pharmacologist and antioxidant properties. The survey and discussion with the farmers revealed the common constraints on pomegranate production in the region like lack of availability of genuine and disease free planting material, lack of knowledge on improved packages of practices specially training- pruning, INM and water management. Deficiency of micronutrients like boron has been observed as one of the major factors for fruit cracking. Out of many cultivars, Bhagwa is the most popular among the farmers due to its attractive red colour, high productivity and moderate tolerance to fruit cracking. Proper and timely management of biotic and abiotic constraints are required to be taken-up timely so that the benefit of high returns of this crop could be reaped by the peasant farmers of the region. The climatic and edaphic conditions like calcium rich soils, low ground water and dry conditions especially during fruiting stage makes it more adaptable to the diverse agro-climate of arid region of India.

Key Word: Pomegranate, Cash crop, Bhagwa, Arid region and Bahar regulation.

INTRODUCTION

Pomegranate (*Punica granatum* L.), family Punicaceae, is associated with the most ancient civilization in the Middle East 5000 years ago and is native to Persia and the surrounding area. It is one of the oldest known edible fruit and is capable of growing in different agro-climatic conditions ranging from tropical to temperate. In India, Maharashtra is the main pomegranate-producing bowl in India (Jadhav and Sharma 2007). In addition to Maharashtra it also commercially cultivated in Karnataka, Gujarat and Andhra Pradesh. Since last two decades, its cultivation is popularized in arid and semi-arid regions of India, not only because of its sweet acidic taste, precocious bearing and better self-life but as a remunerative crop as well. It is considered as an excellent fruit tree in arid and semi-arid areas due to its versatile adaptability, hardy nature, low cost maintenance and high returns (Sawarsan *et al*., 2011). It is considered as saline tolerant plant due to its ability to grow well in slightly saline soils. It became indispensible export oriented crop for the past decade in India due to ideal climatic conditions for quality fruit production.The best quality pomegranate fruits are produced in regions with cool winters and hot, dry summers. Globally pomegranate fruits are rather eaten fresh or used as syrup. (Abubakar *et al*., 2013). In recent past its wide significance in health, nutrition and livelihood security has been recognized which resulted in heavy demand for fruit consumption not only in India but throughout the globe. The fruit, flowers, bark, and leaves contain bioactive compounds that are antimicrobial, reduce blood pressure, and act against serious diseases such as diabetes and cancer (Sangeetha and Jayaprakash, 2016). It has enormous medicinal, nutritional value and one of the richest sources of antioxidants. The fruit is mainly used for dessert purpose and also processed for making juices, syrup, jelly and anardana. Owing to these medicinal and health benefits of the pomegranate, it is known as "Super food" (Singh, *et al*., 2011) and the consumption of its fruit, juice and other value added products increased significantly. From the pattern of CO_2 and ethylene production rates, pomegranate fruits are classified to be non-climacteric fruits and thus, maturation and ripening should take place on the plant before harvest to get quality fruits.

Climate and soil

Pomegranate plant requires mainly arid and semi-arid climate for successful cultivation, where cool winter and high dry summer enables quality fruit production. The shrub can tolerate frost to some extent and also considered as drought tolerant. It behaves as deciduous and evergreen under subtropical and tropical conditions, respectively. The optimum temperature for fruit development is 38^0 C. The region with 500 m above from sea level is best suited for its cultivation. In respect to soil requirements, it can be grown under the diverse type of soils, ranging from less fertile to high fertile land. It can tolerate soil having an electrical conductivity (EC) 9 dSm^{-1} and sodicity with 6.78 % exchangeable sodium percentage (ESP). But soil having pH range between 6.5 and 7.5 with EC < 2dSm^{-1} is ideal.

General crop observations at farmer's field

The land holding of the growers under pomegranate ranged from 1 to 50 ha, but majority of the farmers had more than 2 ha of pomegranate orchards. A spacing of 12x8 feet is common in the whole district for planting the crop. Among promising cultivars Bhagwa and Phule Super Bhagwa were preferred by the growers but the maximum area (>95%) is under Bhagwa. For irrigation and fertigation purpose almost all the farmers had a drip irrigation system. There are three main seasons of flowering known as *Ambe bahar, Mrig bahar* and *Hasta bahar*. To maintain productivity of the plants, generally one bahar fruiting is regulated, which depends upon market factors and availability of water. All three bahars crop viz *Ambe bahar* (January-February flowering), *Mrig Bahar* (June-July flowering) and *Hast Bahar* (September-October flowering) are taken but *Mrig* and *Hast bahar* are most popular among the growers. Multi-stem training system with 2-4 stems is common among the pomegranate growers. Generally, 35 to 55 days stress imposed by withholding water and nutrients. Light pruning is done during the last part of the stress period and subsequently, spray of the Ethrel (1-2 ml^{-1}) for the defoliation (senesce) of leaves which is common chemical among the growers. After defoliation manures and fertilizers are applied and then light irrigation is provided for induce of the flowering. The crop has a tendency to induce unwanted suckers from the stem at the ground level and affects the plant growth due to loss of nutrients by them therefore, removal of these suckers regularly 3 to 4 times in a year is essential to obtain better plant growth and yield. Intercropping with sagwan (Teak Plant), Mung bean (Grean gram) and vegetables were generally observed in the initial two years of the crop period in pomegranate orchards. Based on soil and water analysis, it was observed that soils was saline to alkaline in nature (7 to 9.0 pH) and low to medium in organic carbon (0.12-0.70%). Calcium carbonate content in soil varied from 0.5 to 25 %. Nitrogen and potassium in the soil varied from 169-301 and 134 to 500 kg/ha, with low to medium quantity of phosphorus. However, iron and zinc deficiency observed in many orchards. Water quality is moderately poor ranges from 500 TDS to 3500 TDS. The expenditure cost of orchards ranged from 2 to 2.25 lakh/ha and net income from 6 to 10 lakh/ha of 3 to 6 years old orchards. Nematode, fruit borer, thrips, wilt, fungal leaf and fruit spot diseases were found to cause considerable loss to crop. Some abiotic factors like sun scald and fruit cracking were also recorded causing economic losses to the growers.

Table: General parameters of the crop grown in the arid region of western Rajasthan

Sr. No.	Parameters	Observation
1.	Major variety grown in the district	Bhagwa
2.	Age at bearing	2 years
3.	Maximum fruit set observation	50 per tree
4.	Growth & Bearing habit	Bushy and profuse
5.	Flowering habit	Continuous
6.	Days to flower to fruit set	45-55 days
7.	Days to fruit set to maturity	4 months
8.	Days to maturity from flowering	6 months
9.	Fruit weight and size	200-400 g
10.	TSS content at maturity	15-16.5%
11.	Yield per tree	18 -30 kg
12.	Calculated yield per ha	16-20 tons

Potential of pomegranate for quality export in arid region:

In the present era of growing health conscience, the demand of safe food is increasing which has minimum residues level and without any harmful effects on human and environment health. There are many occasions when commodities exported by India have been rejected by importing countries. Importing countries are very stiff on this issue and do not accept the consignments.

- Arid regions have a vast amount of virgin land, free from use of chemical fertilizers and pesticides yet. It creates favorable environment for organic farming of pomegranate for exports.
- It has good number of large ports in the western costal region which may play a key role in exporting the pomegranate fruits in huge quantities.
- Organic farming can be supported through easily available low rates FYM here, which can be used to produce organic fertilizer.

- Animal husbandry is the second largest employment providing activities in arid region after agriculture. The huge population provides large quantity of organic manure, which can be used for organic farming of pomegranate for exports.
- Majority of the public in the world are nature loving and they believe in natural farming, so, this type of thinking easily adopts organic farming production of pomegranate.

CONSTRAINTS

- Lack of availability of genuine quality planting material:- The farmers of the arid region procured more than 99 per cent planting material from the private nurseries of Maharashtra state, which carry pathogens of challenging diseases like nematodes, bacterial blights and wilts, that is introduce disease inoculums in new orchards.
- Inadequate market information/ intelligence:- Most of the farmers in the region do not aware about the complicated and price strategies. And they accept whatever the price the dealer, broker or big farmer's tells them of their product.
- Lack of proper storing facility:- There is no any storage facility for the produce in the region and at the time of glut production the produce either sold at very low price by the marginal farmers or lost due to decay.
- Lack of post harvest infrastructure and value addition:- With the increasing in the area and production year by year, there is no proper pack house and pre-cooling units available in the region.
- Biotic (Nematode, Thrips, Wilt & Bacterial blight) & abiotic stress (cracking and Sun Scald):- Nematode is major problem in the district under biotic stress, however many insect- pests also affect the quality production of the fruits. Some abiotic stress problem like wilt and bacterial blight also prevalent in majority of the orchards.

CONCLUSION

Pomegranate is highly economical in arid region due to its high potentials to utilize wastelands and an ideal crop for diversification. For successful cultivation, availability of quality and disease free planting material in sufficient quantity is prerequisite.Strategies for the management of biotic and abiotic stress are required to get quality produce. Because of its low cost inputs and high nutritional value, demand of pomegranate has been increased tremendously. Integration of pomegranate cultivation into existing farming system in such undulated and less fertile areas could bring high return and better productivity. It could be a viable option for poor farmers for getting livelihood and nutritional security.

REFRENCES

Abubakar, A.R., Naira, A. and Moieza, A. (2013). Effect of plant biostimulants on fruit cracking and quality attributes of pomegranate cv. Kandhari kabuli. Scientific Res. Essays 8 (4):2171–2175. doi: 10.5897/SRE2013.5702.

Jadhav, V.T. and Sharma J. (2007). Pomegranate cultivation is very promosing. *Indian Horticulture* 52, 30-31.

Sangeetha, R. and Jayaprakash, A. (2016). Investigation on Antimicrobial Activity of *Punica granatum* Linn. Acetone Peel Extract. *J. Academia and Ind. Res.*, 5(5): 77-80.

Sawarsan, M.R., El-bolok, K.T. and Safia A. Abou-Taleb (2011). A comparative study on some pomegranate cultivars under the ecological conditions of Souhag Governorate, *Agriculture Research J. Suez Canal University,* 11 (12), 101-106.

Singh, D., Chaudhary, M.K., Meena, M.L, Wangchu, L. and Dayal, H. (2011). Drying of pomegranate seeds (Anardana) under different conditions. *Acta Horticulturae*, (890), 433–439. doi:10.17660/ActaHortic.2011.890.59.

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USE OF FLOWERS FOR INSECTICIDAL AND NEMATOCIDAL USES

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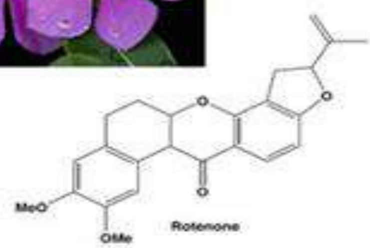
Introduction

Pesticides derived from plants have the potential to play a major role in pest management in sustainable agriculture production. They are renewable, non- persistent in the environment, and relatively safe to natural enemies, non-target organisms, and human beings. Plants produce a range of chemical substances to protect themselves from insect pests. Such chemicals are secondary metabolites and include alkaloids, terpenoids, flavonoids and acetogenins. Over 2,000 plants species have been reported to possess biological activity against insects. Amongst these, neem has been the focus of a large number of studies over the past four decades. They contain terpenoids that are phagodeterrent growth inhibitors and oviposition suppressant.

It is a well settled fact that plant parts like leaves, flowers exhibit insecticidal and nematocidal properties on account of some organic constituents that can act against insects and nematodes. Many plant-based mosquito repellents currently on the market contain essential oils from one or more of the following plants: citronella, cedar, eucalyptus, geranium, lemon-grass, peppermint, neem and soybean, chrysanthemum and marigold.

Leaves and flowers of marigold possess a good insect repelling properties. Hence, marigold oil is valuable in keeping insects at bay. The researchers intend to use marigold plant (*Tagetes erecta*) parts as suitable components of the mosquito coil/ incense stick to be produced. Simultaneous steam distillation extractions (SSDE) volatiles isolated from the flower of the *Tagetes erecta* species is believed to have higher insecticidal activity.



Flowers contain pyrethrin an ingredient found in many insect repellents. It does not contain harmful chemicals which are present in some commercial products and it repels mosquitoes without destroying the environment. It contains a particular smell that many insects find unappetizing. The smell is caused by a chemical known as “a-terthienyl” which lends a natural insecticidal property in marigold. It has juvenile hormonal and insect repellent activities against flies, ants and mosquitoes. Besides, marigolds have been reported as nematode trap crop as it is a source of Thiophane compounds which are nematocidal. Marigold is hence often in companion planting for tomato, chili, potato. Due to antibacterial thiophenes exuded by the roots, marigold should not be planted near any legume crop. Thiophenes repels aphid, white flies, maggots, and many other pests.

Organic constituents with insecticidal properties

The following is the list of species along with principal constituents and insecticidal effects exhibited by the respective compounds. Limonene is the active principle in *Tagetes sp.* whereas, Pyrethrum is the principle in Chrysanthemum. Periwinkle is known to contain Rotenone type constituents which are insecticidal.

Crop	Species	Principal Constituent	Effect
Marigold	*Tagetes sps*	Limonene	Repellent for flies and mosquitoes
Chrysanthemum	*Chrysanthemum cinerarifolium*	Pyrethrum	Knock down effect on Lepidoptera insects
Periwinkle	*Catharanthus roseus*	Rotenone type	Caterpillar and beetles
Sabadilla lily	*Schoenocaulon officinale*	Veratrine	Contact and stomach poison for caterpillars, leaf hoppers, thrips and bugs but toxic to honeybee

Works are conducted to standardise the ways and means for effective and economical methods of extraction of these principles for farmers use. Simultaneously bio activities of these extracts against several pests are also evaluated at different locations.

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MANAGEMENT OF RAGI ROOT GRUB

(Holotrichia consanguinea)

Article ID: AG-V03-I10-25

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Introduction

Ragi Millet, also known as Finger Millet, is a staple crop in India, particularly in the southern and central regions. Ragi Millet is highly valued for its nutritional and environmental benefits, as well as its economic value for farmers. Ragi Millet has been cultivated in India for over 5000 years. It is believed to have originated in Ethiopia and then spread to India, where it became an important crop in the diet of ancient civilizations such as the Harappan and Indus Valley civilizations. Ragi Millet was also used as a currency in ancient India, highlighting its economic importance. There are several types of Ragi Millet grown in India, including Finger Millet, Foxtail Millet, Little Millet, and Barnyard Millet. Finger Millet is the most commonly grown type of Ragi Millet, and is known for its high nutritional value and drought tolerance. Foxtail Millet is grown mainly in the dry regions of India, while Little Millet and Barnyard Millet are grown in the hilly regions. All types of small millets pests attacks highly reduces the yield.among the different types of pests ragi root grub is one of the major pests.

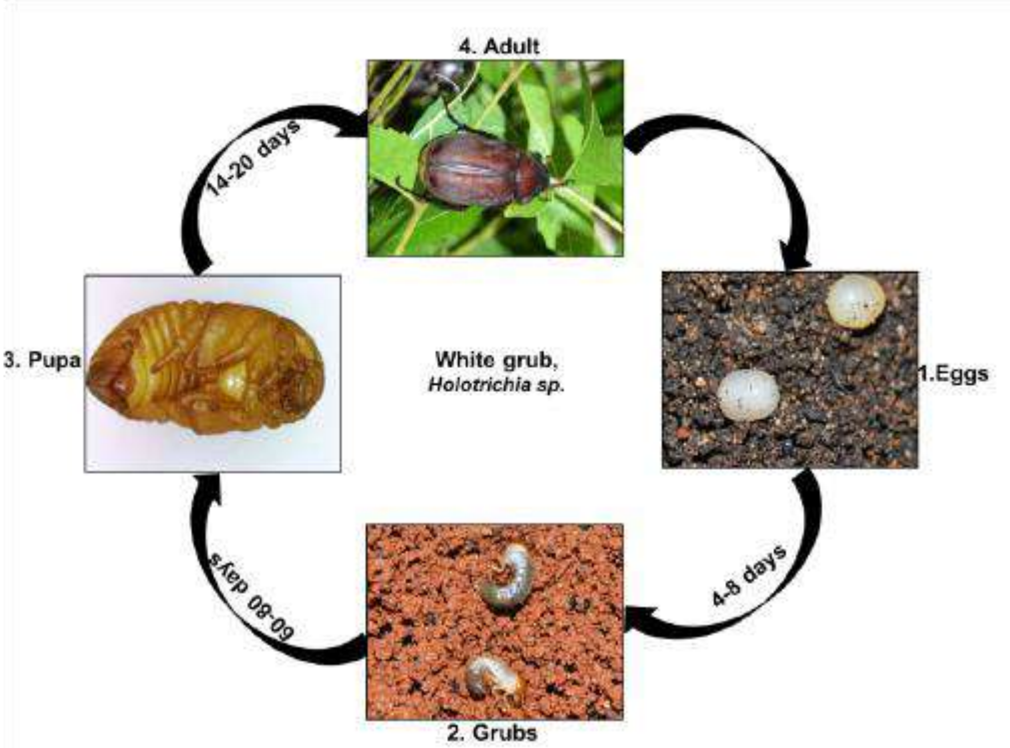
Seasonal occurrence

- Large numbers of newly hatched larve in June shows that this insect becomes active with the onset of monsoon.

Life Cycle

- Adult beetles lay eggs singly upto a depth of 10cm.
- Eggs hatch in 7-10 days. Newly hatched grub develops in 8-10 weeks.
- Grubs are white, having brown head and prominent thoracic legs.

- After the monsoon the full-grown larvae migrate to a considerable depth in the soil for pupation
- Pupa is a semi-circular and creamy white and the pupal stage lasts for about fortnight.
- Adults formed in November and remain in the soil at a depth of 10-20 cm and come out for feeding at night.
- Adult beetles are dull brown.
- Pupation is maximum in the rainy season and there seems to be only one generation in a year.



Life cycle of white/root grub

Ecology

- Partly decomposed organic matter encourages the grub multiplication. Optimum soil moisture with sufficient organic matter is congenial for beetles to lay eggs.
- 30-35°C is optimum soil temperature for pupation.

Nature and symptoms of damage

- Grubs eat away the nodules the fine rootlets and may also girdle the main root, ultimately killing the plants.
- The attacked plants can be easily identified and pulled out easily.

- Root grubs generally prefer young plants and their damage can be seen in the field upto the end of October.
- At nights the beetles feed on foliage and may completely defoliate the plant.

Control

- To prevent root grubs, only well rotten farm yard manure should be used along with 100kg neem cake per acre.
- Before sowing (July-August) use 20 kg of 2% Folidol dust.
- In case of severity apply 10 kg Phorate granules per acre thoroughly mixed up to 15cm deep in the soil.
- Seed treatment of insecticides for the control of white grubs, Phorate 10G 50g a.i/kg of seed or Quinalphos 5G @ 50g a.i/kg of seed.
- For treating the seeds with granular insecticides, slurry of clay was prepared and the mixture of this slurry and the required quantity of the granular insecticide were put into earthen pot and shaken to have uniform coating over seeds.
- After the treatment, seeds were dried in shade.
- Application of insecticides in the standing crop for the control of white grubs - Carbaryl 50% W.P 0.2% Or Isofenphos 5G @ 25kg/ha. Or Quinalphos 25 E.C 0.02%
- To control white grubs use of plant products like mustard seed powder @ 60 kg/acre or Neem seed powder @ 80 kg/acre.
- Use of plant products provides wide range of safety to the ecosystem, keeps away the crop from the Phytotoxic effect as well as from residual toxicity and pollution.

Conclusion

Ragi Millet is an important crop in Indian agriculture, with numerous benefits for nutrition, the environment, and the economy. Despite the challenges faced by farmers, the future of Ragi Millet cultivation in India looks promising, with opportunities for expansion, diversification and innovation. By investing in research and development, supporting farmers and promoting policies and programs that incentivize the production and consumption of Ragi Millet, India can harness the full potential of this valuable crop to achieve sustainable agriculture and food security for all.

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MILK PHOSPHOLIPIDS AND ITS NUTRITIONAL SIGNIFICANCE

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Introduction

Milk fat is an important constituent of milk. Milk fat is present in emulsion form. Phospholipids (PLs) belong to the class of polar lipids and it defined as a "lipids containing phosphorus". Polar lipids are important in milk for the emulsification of fat-in-water, because together with proteins, they are the main constituents of the milk fat globule membrane (MFGM), which covers the lipid droplets secreted by the mammary gland cells. Like other biological membranes, MFGM includes phospholipid, glycoproteins, glycolipids, total and partial glycerides, free fatty acid, and cholesterol (Singh, 2006). Milk fat in cow and buffalo milk is secreted as myriads of lipid droplets size is 0.1 to 15 µm. These lipid droplets are surrounded by a membrane composed of lipid bilayer and proteins. This membrane has been known as milk fat/ lipid globule membrane (MFGM). MFGM is composed of proteins and lipids in a 1:1 ratio. Bovine milk fat globule membrane is considered as a potential nutraceutical. The health beneficial factors are associated with the protein and non-protein components of bovine milk fat globule membrane. MFGM are contributing the various health benefits like cholesterolemia-lowering factor, inhibitors of cancer cell growth, vitamin binders, inhibitor of beta-glucuronidase of the intestinal *Escherichia coli*, inhibitor of *Helicobacter pylori*, xanthine oxidase as a bactericidal agent, butyrophilin, and phospholipids as agents against colon cancer, gastrointestinal pathogens, alzheimer's disease, stress and depression (Spitsberg, 2005). Milk phospholipids is a part of the milk lipids. It contains not more than 1 percent of total milk fat.

Major sources of phospholipids:

Bovine milk is a source for a commercial production of phospholipids as milk fat globule membrane (MFGM) phospholipids are unique in terms of phospholipid (Schneider, 2007). Phospholipids of animal origin were extracted from egg yolk or from bovine milk. The production of milk phospholipids, its process is more complicated. In the case of milk, it is a multistep approach to separate them from the milk fat globule membrane by the milk processing technology, followed by some solvent based steps. Concentrated phospholipids are made by solvent-based extraction or by the fractionation processes from lecithin, or followed by chromatographic purification steps. The qualitative and quantitative profile of phospholipids is varies with the type of raw materials used. The most important Phospholipids of milk fat are phosphatidylcholine (PC), phosphatidylethanolamine (PE), phosphatidylinositol (PI) and phosphatidylserine (PS). Sphingolipids are compounds lipid containing a long chain base, the so called sphingoid base (sphingosine), fatty acids and sugars or phosphoric acid or alcohols (Beare-Rogers, 2001). Milk phospholipids contain lecithin, cephalin and sphingomyelin but the soya phospholipids do not contain sphingomyelin (Schneider, 2007). Also, the fatty acid profile of phospholipids from different raw materials is variable in case of milk, soya, egg etc. Milk phospholipids contents high in saturated fatty acid (SFA) and mono unsaturated fatty acid (MUFA) but lesser in poly unsaturated fatty acid (PUFA) as comparison to soya phospholipids.

Table 1: Fatty acid profile (%) of phospholipids from different raw materials

	Soya	Egg	Milk	Marine
Saturated	22	41	50	17
Mono-unsaturated	12	35	35	21
Poly-unsaturated	66	24	15	62

Properties of phospholipids:

The molecular structure of phospholipids is bipolar and it is amphiphilic in nature. Phospholipid combines a lipophilic and a hydrophilic part i.e. polar head group combines a phosphoric acid ester like choline, ethanolamine, etc.

Nutritiona1 profile of phospholipids:

Phospholipids have a important nutritional properties. Some of the important nutritional properties of phospholipids are as below:

i. It is cholesterol reducing properties
ii. Its improvement of cognitive performance - stress symptom
iii. It used a liver tissue detoxification and regeneration
iv. Egg phospholipids are used to supplement infant formulae because of their content of long chain polyunsaturated fatty acids such as docosahexaenoic acid (DHA) and arachidonic acid (ARA).
v. It protecting against inflammation and
vi. It is inhibiting cancer cell proliferation

Properties of milk phospholipids:

Milk phospholipids are different from all other commercial lecithin and phospholipid products, both in phospholipid pattern and fatty acid profile contents. The average human dietary intake of phospholipids is 2–8 g/day in different types of food, like eggs, cereal grains, oilseeds, fish, beef and cow's milk (Cohn *at al*., 2010). Milk products are most likely to be the major source of sphingolipids.

Technological applications of milk phospholipids:

Milk phospholipids are relatively content high degree of saturated (50%) or mono-unsaturated fatty acids about 35%. It is quite stable against oxidation, are very important for food applications and stable against hydrolytic break-down in aqueous environments. It is widely used in dairy, foods, cosmetics and pharmaceutical applications. Lecithin is a type of phospholipids. The properties of the food additive lecithin relate to their phospholipid content. The major applications of lecithin are in margarine, chocolate, instant powders, baked products etc.

Fat is responsible for many benefits. It is responsible for flavor and taste. Hence, the taste and flavour profile are not negatively affected by liberated free fatty acids.

i. Milk phospholipids are used versatile ingredients for cosmetics. They possess excellent emulsifiers, creating a very good and soft skin feel, avoid trans-epidermal water loss and allow preparing efficient Iiposomal systems with good entrapment stability.
ii. Milk phospholipids are relatively stable against oxidation.
iii. They have a phase transition temperature of approximately 28°C, ideal for a lot of

cosmetic and food applications.

iv. At ambient temperature milk phospholipids liposome membranes are crystalline with excellent entrapment characteristics. At higher temperature milk phospholipids tend to release their payload – a simple approach to protect sensitive ingredients and to release them at targeted conditions (Schneider, 2007).

Nutritional application of Phospholipids:

The characteristic of phospholipids which is important to their function is the fact that they are amphipathic in nature. Amphipathic molecules have both a hydrophobic and hydrophilic portion. The hydrophobicity is derived from the two fatty acid chains, typically nonpolar in chemical nature. The consumption of nutraceutical or as a dairy food, or the consumption of food products enriched by the MFGM has health benefits due to the presence of phospholipids in the MFGM. Phospholipids of bovine MFGM constitute about 30% of the total MFGM lipids. The three main MFGM phospholipids are sphingomyelin, phosphatidyl choline, and phosphatidyl ethanolamine consisting (weight %) 19.2 to 23.0, 25.7 to 41.1, and 27.0 to 35.0% of total MFGM phospholipids respectively. It is considered that phospholipids, including milk-derived, affect the numerous cell functions including growth and development, absorption processes, memory, stress responses, molecular transport systems, development of Alzheimer's disease, and myelination in the central nervous system. Phospholipids also affect the development of colon cancer **(**Spitsberg, 2005**)**. Sphingolipids are abundant in the apical membrane in the absorptive epithelium in the gut (Danielsen *et al.*, 2006).

Phospholipids and glycosphingolipids:

Phospholipids and glycosphingolipids accounts to about 1% of total milk lipids. It plays important role in the dairy and food properties. They have functional roles in a number of reactions like binding enzymes on the globule surface, differentiation, cell-cell interactions, proliferation, immune recognition etc. Gangliosides is a phospholipids. It is structurally combined with the neuraminic acid derivatives of a glycosylatcd ceramide. Gangliosides is found in milk. The small amounts of gangliosides in milk polar lipid fractions has triggered interest to incorporate milk phospholipid compounds into infant formula products. Gangliosides having immune stimulating effects and can modulate the binding of microbial toxins in the intestinal tract (Haug, 2007).

Sphingomyelin:

Sphingomyelin is a type of phospholipids. Sphingomyelin contains N -acylsphingosine-l phosphocholine or ceramide phosphocholine. It located in the outer leaflet of the plasma membrane of most mammalian cells. In bovine milk, phospholipids contain 0.2-1.0g/l00g of total lipids, it is associated with the milk fat globule membrane (MFGM). Sphingomyelin represents about one third of total milk phospholipids, its concentrations are varied by season and the stage of lactation. Digestion products of sphingomyelin and other sphingolipids, the ceramides, sphingosines and sphingosine-phosphates are containing highly bioactive compounds and that are associated with cell regulation. They hold cell growth and induce differentiation and apoptosis mechanisms that are deregulated in carcinogenesis, ceramide and sphingosine are referred to as tumor suppressor lipids. The major metabolites, ceramide and sphingosine, pass from the lumen to intestinal cells where they are utilized to resynthesize sphingomyelin and other sphingolipids, which than largely pass to the circulation. Because the ceramide and sphingosine participate in major anti proliferative pathways of cell regulation that suppress oncogenesis, they have been termed tumor suppressor lipids. The study showed that dietary milk derived sphingomylein at the concentration of 0.025 to 0.1% of diet inhibited chemically induced colon tumors development in mice, reduced aberrant crypt foci early precursors of colon cancer (ACF) formation and suppressed the conversion of benign adenomas to malignant adenocarcinomas. The human clinical trials is sphingomyelin cholesterol lowering the activity by inhibiting intestinal absorption of food based cholesterol (Schneider, 2007; Chaudhary *et al*, 2008).

Conclusion:

Milk phospholipid is a part of lipids. It is a new class of natural phospholipids. Milk phospholipids present a broad spectrum of both technological and nutritional properties. It is unique to this kind of polar lipid extract and which are different from all other phospholipid products on the market. Milk phospholipid are a natural emulsifier. It is beneficial in many diseases and other things like cholesterol lowering, improving cognitive performance, stress dampening effects, colon cancer preventive effects, additive for infant formulae.

References

Beare-Rogers J., Dieffenbacher A. and Holm J.V. 2001. Lexicon of lipid nutrition. (IUPAC Technical Report) Pure Appl. Chem. 73:685–744.

Chaudhry I., Kathirvelan C. and Tyagi A.K. 2008. Anticancer property of milk. Indian

Dairyman. 60(5):37-53.

Cohn J.S., Kamili A., Wat E., Chung R.W.S. and Tandy S. 2010. Dietary phospholipids and intestinal cholesterol absorption. Nutrients. 2:116–127.

Danielsen E.M. and Hansen G.H. 2006. Lipid raft organization and function in brush borders of epithelial cells. Mol. Membr. Biol. 23:71–79.

Haug A., Hestmark, A. T. and Harstad, O. M. (2007). Bovine milk in human nutrition-a review. Lipids in health and disease. 26-32.

Schneider M. 2007. Milk phospholipids - technological and nutritional aspects. Bulletin of the IDF. 35-39.

Singh H. 2006. The milk fat globule membrane—A biophysical system for food applications. Curr. Opin. Colloid Interface Sci. 11:154–163.

Spitsberg, V. L. 2005. Bovine MFGM as a potential nutraceutical. J. Dairy Sci. 88:2289-2294

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HEALTH BENEFITS OF SUMMER FRUIT

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Introduction

Jamun is a refreshing summer fruit offering numerous health benefits and a tangy taste which is perfect for this season. We love that tangy explosion of flavour and our tongues going purple! Yes, we are talking about jamun, the healthy nutrient rich fruit, relished by everyone in summers. Jamun is a delicious low-calorie fruit that is loaded with vitamin C and minerals like iron, calcium, phosphorus, magnesium and folic acid. This fruit packs a punch as it has a high antioxidant content, contains diuretic and has antibacterial and properties. This solid nutrition profile allows this fruit to help manage diabetes, gastric issues and improve skin health.

1. Improves hemoglobin count

Being an excellent source of vitamin C and iron, this fruit increases hemoglobin count. While iron works as a blood purifier, the increased hemoglobin count allows your blood to carry more oxygen to the organs and keep your body healthy.

2. Keeps skin healthy

Jamun is rich in astringent properties which protect the skin from blemishes, pimples, wrinkles and acne. Moreover, the vitamin C content helps purify the blood, leaving your skin radiant and glowing.

***3.* Manage diabetes**

Those who are suffering from diabetes can safely consume jamun as it is low in calories. Additionally, the polyphenolic ingredients present in jamun play a significant role in the treatment of diabetes.

***4.* Boosts heart health**

Jamun is a good source of antioxidants and minerals like potassium, which are beneficial to keep heart diseases at bay.

***5.* Helps with weight loss**

Jamun is a low-calorie fruit that is rich in fibre, making it a perfect weight loss combination. Jamun also improves digestion and helps in reducing water retention in the body.

***6.* Improves gastric health**

Jamun can help treat digestive disorders. The diuretic properties keep the body and digestive system cool and provide relief from constipation.

***7.* Acts as an immunity booster**

Jamun is loaded with vitamins, minerals and antioxidants that help strengthen immunity and increase stamina of your body.

***8.* Maintain oral health**

Jamun has antibacterial properties which can protect teeth from oral infection and bacteria. In fact, jamun is used for strengthening teeth and gums and the leaves of it are astringent which is considered good for throat problems.

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SELF-INCOMPATIBILITY SYSTEMS IN PLANTS

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Introduction

One of the most prominent tools of plant breeding is the production of F1 hybrid plants. Resulting from differences in parental gametes, F1 plants show increased vigor and productivity based on heterosis (hybrid vigor). Hybrid varieties are produced by controlled crosses between two distinct inbred lines, the optimal combination of which has been ascertained by extensive crosses. Since positive effects based on heterosis are only observed in the F1 generation, hybrid seeds always have to be produced by the breeder. Farmers demand a uniform genotype of the seeds; therefore self-pollination of the seed producing plant has to be excluded. In order to prevent self-pollination in some plants like corn, tomato and cabbage, emasculation of the female line by hand is required, raising costs and labor expenses of seed production. Commercialization of any hybrid crop can only be achieved if reasonably priced technical solutions to hybrid seed production are available. The utilization of naturally occurring self-pollination preventing systems like male sterility and self-incompatibility are more efficient approach. Hence, with the use of genetic mechanisms i.e. male sterility, self-incompatibility etc., we can reduce the cost of hybrid seed production and ensure the availability of hybrid seed within the reach of poor farmers. Thus, the knowledge of molecular mechanism behind self-incompatibility systems in crop plants is foremost things for a breeder to exploit the heterosis in a successful manner.

Self-incompatibility

The majority of flowering plants produce perfect flowers that contain both the male and female reproductive organs in close proximity; consequently, they would have a strong tendency to self-fertilize if there were no mechanisms to prevent them from doing so. Because inbreeding can result in reduced fitness in the progeny, hermaphroditic plants have adopted a variety of reproductive strategies, including self-incompatibility (SI), by which inbreeding is prevented and outcrosses are promoted. SI allows the pistil of a flower to distinguish between genetically related (self) and unrelated (non-self) pollen. This self/non-self recognition results in the inhibition of germination of self-pollen on the stigmatic surface or the inhibition of growth of self-pollen tubes in the style. Thus, SI is a prezygotic reproductive barrier by which incompatible pollen/pollen tubes are prevented from delivering the sperm cells to the ovary to effect double fertilization.

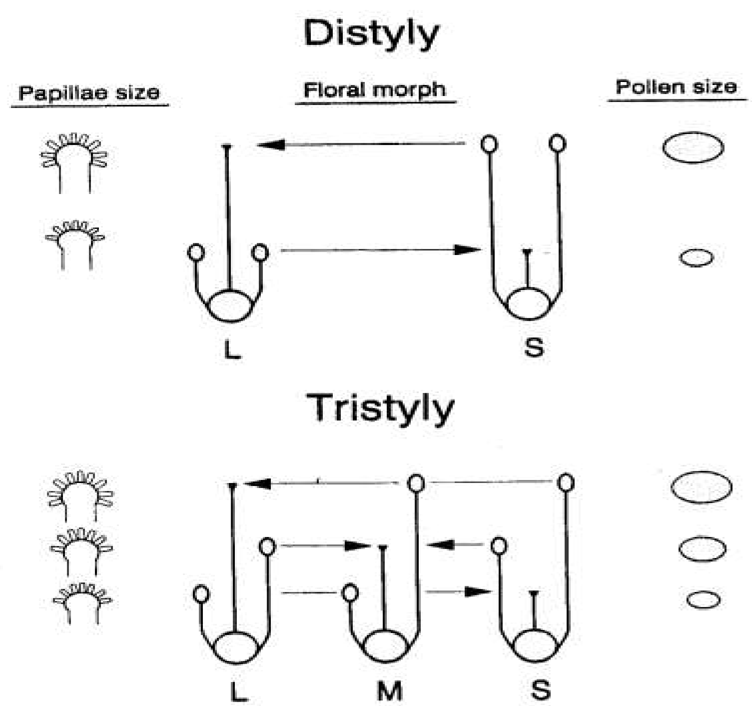

Fig. 1. The heterostylous genetic polymorphisms distyly and tristyly. Legitimate (compatible) pollinations are indicated by the arrows; all other pollen-pistil combinations are termed illegitimate and usually yield little or no seed set. In distyly there are two floral morphs whereas in tristyly there are three. L, M, and S refer to the long-, mid-, and short-styled morphs, respectively. Accompanying the reciprocal differences in stigma and anther height in the floral morphs are commonly ancillary polymorphisms of pollen and stigmas. Pollen size and stigmatic papillae length usually increase with stamen height and style length, respectively.

SI can be classified into homomorphic and heteromorphic types based on whether it is associated with floral polymorphism. Homomorphic SI are dispersed in an around fifty percent of angiosperms and only 25 families or few genera are found to be heteromorphic type of incompatibility in the earth. In species that exhibit homomorphic SI, all individuals produce the same type of flower and the outcome of pollination depends only on the genetic identity of the male and female partners. In contrast, species that exhibit heteromorphic SI produce two or three different flower morphologies (e.g., a flower with short anthers and long style or a flower with long anthers and short style). For successful pollination, pollen must come from genetically unrelated individuals whose anthers are of the same height as the style of the flower being pollinated. (Figure 1 shows the heteromorphic self- incompatibility)

For homomorphic SI, self/non-self discrimination between pollen and pistil is determined by one or more polymorphic loci, and this type of SI is further classified into gametophytic and sporophytic types (Figure 2) based on the genetic control of pollen behavior. To date, four of the families that exhibit gametophytic SI (GSI), *Solanaceae*, *Rosaceae*, *Scrophulariaceae*, and *Papaveraceae*, and one of the families that exhibit sporophytic SI (SSI), *Brassicaceae*, have been studied extensively at the molecular level.

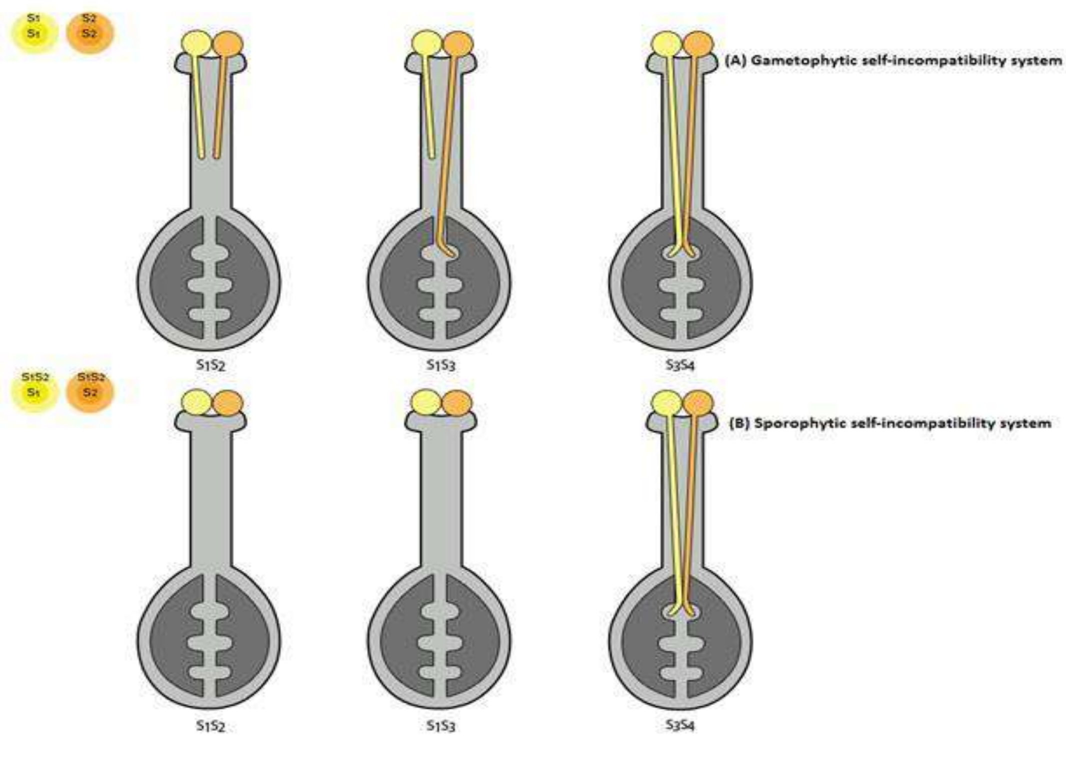

Figure 2. Homomorhic self-incompatibility

A single polymorphic locus, termed the S-locus, controls the SI response in all five of these families. As described below, other loci often are required for the full manifestation of the SI response, but by definition, the S-locus determines the specificity of the response. It is now known that two separate genes at the S-locus control male and female specificities. Thus, the term ''haplotypes'' is used to describe variants of the S-locus, whereas the term''alleles'' is used to describe variants of an S-locus gene.

For the four GSI families, SI occurs when the S-haplotype of the pollen matches either of the two S-haplotypes carried by the pistil. That is, the SI phenotype of the pollen (gametophyte) is determined by its own S-genotype. For the SSI family, in the simplest case, SI occurs when the pollen-producing parent shares one or both S-haplotypes with the pistil. That is, the SI phenotype of the pollen is determined by the S-genotype of its diploid parent. For SSI, complex relationships often exist between the different S-haplotypes of the pollen and pistil parents. One S-haplotype could be dominant over or recessive to another, or it could interact with another to result in mutual weakening or in an entirely new S-haplotype specificity (Thompson and Taylor, 1966).

Types of self-incompatibility (SI) mechanisms

During the past two decades, much progress has been made in identifying and characterizing the S-locus genes that control the specificity of the SI interaction in the five families mentioned above. Comparisons of the S-locus genes expressed in the pistil among the different families have revealed three biochemically distinct mechanisms. The *Solanaceae*, *Rosaceae*, and *Scrophulariaceae* use the same mechanism, the *Papaveraceae* uses another, and the *Brassicaceae* uses a third. For the *Solanaceae* and *Papaveraceae* mechanisms, the gene that controls female specificity has been identified; these genes were named the S-*RNase* gene and the S-gene, respectively. Our understanding of the *Solanaceae* mechanism has progressed further, with the recent identification of a promising candidate for the male specificity gene. The *Solanaceae* mechanism involves S-*RNase*–mediated degradation of RNA in self-pollen tubes. The *Papaveraceae* mechanism is mediated by a signal transduction cascade in pollen that involves a number of known components of signal transduction (e.g., Ca_2^{++}, phosphoinositides, protein kinases, and phosphatases). For the SSI mechanism found in the *Brassicaceae*, both the gene that controls male specificity, S-locus cysteine-rich protein (SCR)/S-locus protein-11 (SP11), and the gene that controls female specificity, S-locus receptor kinase (SRK), have been identified. The SI response is mediated via a signal transduction cascade in the stigmatic papilla, which is elicited by the interaction of a pollen-borne ligand, SCR/SP11, and SRK, a receptor kinase in the stigmatic papilla.

Conclusion

Self-incompatibility is a system used by many flowering plant species to prevent self-fertilization and thereby promote outcrossing. Over the years, considerable insight into the mechanisms regulating self-incompatibility has been obtained for the *Solanaceae* and *Papaver aceae* gametophytic self-incompatibility systems as well as for the sporophytic self-incompatibility system of the *Brassicaceae*. A combination of genetic and molecular studies has resulted in the identification and characterization of the self-incompatibility genes involved in this response. Although substantial progress has been made, our understanding of how these systems work is far from complete. In the *Solanaceae* and *Papaveraceae* self-incompatibility systems, the identification of the pollen S genes will contribute towards establishing a more comprehensive model of self-incompatibility. In addition, careful investigation of the components in the signalling cascades of both the *Papaveraceae* and the Brassicaceae is required for a complete understanding of the self-incompatibility response in these families. Self-incompatibility has fascinated biologists for over a century and will continue to be an area of intense research focus.

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BOOSTING THE FARMERS INCOME THROUGH CULTIVATION OF LEMONGRASS: A SUCCESS STORY OF UTTAR PRADESH

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Abstract

Lemongrass is cultivated for essential oil which is used in flavouring foods, drinks and bakery preparation and its leaves are used as a source of cellulose in the manufacturing of paper and cardboard. The aims of the present work to increased the lemongrass area and oil production through front line demonstration due to its growing demands for the industry. Lemongrass can be grown in poor, marginal and waste lands. The average production of essential oil is 0.2-0.4 percent and net remunerative return from this crop is Rs 1.4 lakh/ha /year. Thus it is emphasize that lemongrass cultivation is profitable and suitable for the cultivation in the eastern part of Uttar Pradesh.

Introduction

Lemongrass (*Cymbopogon flexuosus*) is a tropical perennial plant which is cultivated for aromatic oil. The essential oils of lemongrass are high demand for perfumery, medicinal and household uses. Typical lemon like odour of the essential oil present in the shoot used in many cosmetics and perfumery industry as a source of citral, linalool, geraniol, citronellol etc. The geraniol, linalool and citronellol are the most important acyclic terpene alcohols used as flavour and fragrance substances. The annual world production of lemongrass oil is around 1000t from an area of 16000ha. In India, it is cultivated in an area of 4000ha and the annual production is around 250t (Joy *et al*, 2006). On an average the herbage of *Cymbopogon flexuosus* contains 0.2 -0.4 percent oil and oil yield is 100-125Kg/ha/year (Gupta *et al*, 1987). Lemongrass is cultivated in the poor, marginal and waste lands as well as bunds. It is also successfully grown on moderate alkaline soils having the P^H up to 9.0. These crops are tolerant to moisture stress because well ramified root system of the plants help in soil and water conservation (Parmeshwar *et al*, 2021). Lemongrass is not grazed by wild animal and least attacks of pest and diseases therefore, it can be grown in place of rice -wheat cropping system. Lost few years, some farmers have started growing lemongrass in the eastern part of uttar Pradesh with the aim to sustainable and high profitable crop options for farmers as suggested by the scientists of the A.N.D. university and technology, Kumarganj, Ayodhya,(UP).

Methodology

The front line demonstration has been conducted at Village –Tetarpur, District Amethi, Uttar Pradesh during 2019-20 and 2020-21 in 1.0ha area, respectively. The primary data were collected from farmers on various parameters through well structured questionnaire. The costs of cultivation were calculating on the basis of variable cost, fixed cost and total cost. The net incomes were computing as per standard methods described by Saran *et al*., (2018). In variable and fixed cost following items were covered:

Total variable cost= Value of human labour(Hired and family)+ Value of planting materials(Owned and purchased)+Value of manure (Owned and purchased) + Value of oil extraction + Value of interculture operations + Irrigation charges + Charges for machineries(Owned/ hired) + other paid out expenses + Depreciation on farm building and implements + Interest on operational cost (@12%).

Total fixed cost = Rental value of land + Interest on fixed cost (@12%)

Total cost = Total variable cost + total fixed cost

Gross Return = Quantity of produce x Price of produce

Net Return = Gross return – Total cost

First year two poor crop harvests produce were done but subsequent other two years three times herbage were harvested at 90 to 120 days interval. The average fresh herbage was harvested 40-45t/ha at every year except first year. The essential oil was sold at the rate of Rs. 1500/kg.

Story

The farming communities of eastern part of Uttar Pradesh are traditionally growing paddy, wheat potato, vegetable and mustard. They are not getting benefit like other state farmers; hence it is need of hours to identify the alternate beneficial crops i.e. medicinal and aromatic. The farmers are growing paddy –wheat year to year and using heavy dose of chemical fertilizers and pesticides for getting high crop yield. Presently soil fertility become poor and crops are damaged by wild animal. . In this situation farmers could be grown medicinal and aromatic crops viz; Tulsi,, Brahmi, Satavar and haldi which are sustainable to farmers (Saran *et al.*, 2015, 2017and 2018, Parmeshwar et al 2021). The soil types of selected fields are sandy loam supplied with 10 t/ha farmyard manure (FYM). Front line demonstration (FLD) of lemongrass were conducted at two farmers field (1.0ha each) at Tetarpur village ,Amethi district during 2019-20 with the financial support of Mission integrated development of horticulture (MIDH), CSS,DASD Calicut, Kerala. Planting materials and other inputs were given free of cost to both farmers for good cultivation of lemongrass (Fig1 and 2).

Fig-1:Lemongrass plantation at Farmers field

These crops are grown for essential oil; the oil distillation unit has been installed by the farmers at their farm (Fig-3). After three year successful cultivation of lemongrass, they have received good amount of profit, improved physical condition of soil with low input cost. Wild animals were not damaged to lemongrass. The residue of lemongrass (After oil extraction) can be utilized as fuel for essential oil extraction purposes (Saran, 2020). After four year cultivation of lemongrass plant can be supplied as quality planting materials to the other farmers. The average net returns of the farmers were Rs 1.4lakh per year from one hectare lands.

plantation at Farmers field

Fig-2 : Overview of FLD of Lemongrass at farmers field

Fig-3: Oil distillation unit at farmers' field

Table 1: year wise cost and returns from lemongrass cultivation (Rs/ha)

S. no	Cost Items	1st Year	2nd Year	3rd Year	Average
1	Human labour	8040	10050	11055	9715
2	Tractor	4500	1500	2100	2700
3	Planting materials	60000	0	0	20000
4	Organic fertilizers	7400	7400	7800	7533
5	Intercultural operations	3015	5025	6030	4690
6	Irrigation	3000	5200	5800	4667
7	Oil extraction cost	2500	5500	5500	4500
8	Depreciation	1785	1695	1615	1698
9	Working cost (S.No 1+2+3+4+5+6+7+8)	90240	36397	39900	55513
10	Interest on working cost(@12%)	10829	4368	4788	6662
11	Total operating cost(@%)(S.No 9+10)	101069	40795	44688	62184
12	Rental value of land	10000	10000	10000	10000
13	Interest on fixed capital	4865	4865	4865	4865
14	Total cost (S.No 11+12+13)	115934	55630	59553	77039
15	Production of Fresh herbage yield(t/ha)	26.4	40	44	36.8
16	Oil Recovery(kg/ha)	105.6	160	176	147.2
17	Price of oil (Rs/kg)	1500	1500	1450	1483
18	Gross Return (Rs/ha)	158400	240000	255200	217867
19	Net Return (S.No. 18-14	42466	184370	195647	140828

References

Gupta, R.S 1987. Trial cultivation of some medicinal and aromatic plants in Malwa region of Madhya Pradesh (India), Part II Analysis of essential oils. *Indian Perfumer*, 31(4):370-374.

Joy,P.P., Samual Mathew., Baby, P., Sakaria., Gracy Mathew., Ancy Josheph and Sreevidya, P.P 2006. Lemongrass. Aromatic and Medicinal Plants Research Station Odakkali, Asamannoor, kerala, india. PP.32

Parmeshwar, L. Saran., Ram, R.Meena., Kuldeep, A. Kalariya., Ganga Devi., Hiteksha, I.Damor., Darshan, H.Lodaya and Suresh, B. Prajapati 2021. Farmers turn aromatic grasses to boost their income: A success story of North Gujarat. *Indian Journal of Arecanut ,Spices & Medicinal Plants* , 23(3):30-35

Saran, P.L., Kaniya Singh and Ganga Devi 2015. Economic impact of sole and biennial turmeric cultivation with mango and litch as an intercrop. *Annals of Agri. Res.New series*, 36(4):1-5.

Saran, P.L., Ganga devi and Jitendra Kumar 2017. Brahmi cultivation fetches more in degraded lands. *Indian Horti*, 62(2):23-24.

Saran, P.L and Ram Prasnna Meena. 2018. Methyl eugenol rich Tulsi chemotype (DOS-1) cultivation for sustainability and trap crop for fruit fly management. *Indian J. Arecanut, Spices and Medi. Plants*,20(3):30-34.

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SPICES BEYOND ITS FLAVOUR

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Introduction

Spices have been virtually indispensable in the culinary art of flavouring foods since antiquity. Spices are aromatic vegetable substances, in the whole, broken or ground form, whose significant function in food is seasoning rather than nutrition. Spices are esoteric food adjuncts that have been in use for thousands of years to enhance the sensory quality of foods, the quantity and variety consumed in tropical countries is particularly extensive. These spice ingredients impart characteristic flavour, aroma and pungency to foods. Spices enhance the sensory quality of foods. Volatile oil spices responsible for aroma and flavour and oleoresin contribute the pungency. Nearly all the spices except chilli and vanilla, that we use in cooking originated in Asia.

Beyond flavour of spices

Apart from flavouring and seasoning, spices are widely used in a) Indigenous medicines, b) Pharmaceuticals, c) Nutraceuticals, d) Aroma therapy, e) Preservatives, f) Beverages, g) Natural color, h) Perfumes, i) Cosmetics and pharmaceutical j) Pesticides botanicals and thus, play a significant role in the economy of the producing country. These properties are due to diverse array of chemicals synthesised by these spices.

Phytoconstituents in spices:

In general, these phytochemicals function to attract beneficial and repel harmful organisms, serve as photoprotectants and respond to environmental changes.

Table1: Major classes of photochemical that contribute to the properties of spices

Class of phytochemicals	Source
Terpenes	
Monoterpenes	Cumin, fennel and caraway
Tetraterpenes (carotenoids)	Paprika and saffron
Sesquiterpenes	Cinnamon, ginger and turmeric
Terpene derivatives	Coriander
Phenylproponoids	
Cinnamic acid	Cinnamon
Eugenol	Clove
Vanillin	Vanilla bean
Diarylheptanoids	
Curcumin	Turmeric
Sulfur compounds	
Thiols, sulfides, di and polysulfides	Garlic and Asafoetida

Spices in the Indigenous System of Medicine (ISM)

There is a long history of the use of spices in the traditional medicines of India. The indigenous system of medicine has given an extra special place to spices because of their unique medicinal properties. Spices stimulate digestion; this property of spices was mainly used in ayurveda. Spices have lot of other medicinal qualities, thereby proving the saying "let my food be the medicine" (Selvan and Kumar, 2005).

Spices in ayurveda:

In the recent past there has been increasing interest in the biological effects of spices, as they are safe and cause no side effects to humans. Currently, more than 25 spices are used in ayurvedic formulations. Among the spices, black pepper, turmeric, ginger, garlic, nutmeg, cardamom, fenugreek and saffron are importants ingredient of several indigenous preparations.

Trikatu-is a combination of three pungent spices products, namely dried black pepper, long pepper and ginger. It is used to improve the digestion and bronchial problems.

Multi-beneficial physiological effects of spices

In the past two to three decades, many more beneficial physiological effects of spices have been experimentally documented, which suggest that the use of these food adjuncts extended beyond taste and flavour. The salient features of a variety of health beneficial physiological effects of common spices so far documented are summarized here under

Table 2: Experimentally documented beneficial health effects of spices

Beneficial health effect	Spices
Lowering of blood cholesterol	Garlic, fenugreek, turmeric, red pepper
dissolution of cholesterol gallstones	Curcumin, capsaicin
Protection of erythrocyte integrity in hypercholesterolemic condition	Curcumin, capsaicin, garlic
Hypoglycaemic potential	Fenugreek, garlic, turmeric, cumin
Amelioration of diabetic nephropathy	Curcumin, fenugreek
Antioxidant effect	Turmeric, capsaicin, eugenol

Anti-inflammatory and anti-arthritic	Turmeric, Capsaicin, eugenol
Antimutagenic/cancer preventive	Turmeric, garlic, ginger, mustard
Digestive stimulant action	Curcumin, capsaicin, piperine, ginger, cumin, ajowan, fennel, coriander, mint
Antimicrobial	Turmeric, garlic, asafoetida

Hypocholesterolemic effect:

Consumption of a high fat diet may lead to an increase in serum cholesterol and plasma fibrinogen levels which in turn may result in decreased fibrinolytic activity and blood coagulation time. These changes of serum cholesterol levels and of lipoproteins in relation to atherosclerosis and coronary heart disease. It can be prevented by using spices like fenugreek, red pepper, turmeric, garlic and ginger. Dehydrated garlic powder containing a standardized level of the parent sulphur compound, allin, which is effectively used in daily diet with a relatively low and acceptable dosage of 300-900mg/dayreduces10-13 per cent blood cholesterol in humans.

Antidiabetic potential:

Diet has been recognized as a corner stone in the management of *Diabetes mellitus*. Fenugreek, garlic, turmeric, chilli and cumin were studied for their antidiabetic potential, but human trials are limited to fenugreek. Addition of fenugreek seeds to the diets of diabetic patients resulted in a fall in blood glucose and improvement in glucose tolerance. Daily diet of fenugreek seeds (25-50 g), garlic (5-6 cloves) and turmeric (1 pinch) by human beings could serve as an effective therapy in the prevention and management of long term complication of diabetes.

Digestive stimulant action:

Spices are well recognized to stimulate gastric function. They are generally believed to intensify salivary flow and gastric juice secretion, hence aid indigestion. Spices like turmeric, ginger, black pepper; cardamom, mint, ajowan, cumin, fennel, coriander, asafoetida and garlic are used as ingredients of commercial digestive stimulants as well as of home remedies for digestive disorders like flatulence, indigestion and intestinal disorders.

Spices stimulate bile acid production by liver and its secretion into bile. Some spices are shown to stimulate pancreatic digestive enzymes like lipase, amylase, trypsin and chymotrypsin, which play a crucial role in food digestion. A few spices have been shown to have beneficial effect on the terminal digestive enzymes of small intestine. Thus spices act as digestive stimulants by enhancing biliary secretion of bile acids, which are vital for fat digestion and absorption and by stimulating the activities of pancreatic and intestinal enzymes involved in digestion.

Black pepper and piperine- as bioavailability enhancer

Black pepper, the most widely traded spices of the world is the dried mature berries of the spices *Piper nigrum* L. often referred to as 'King of spices'. Piperine is an alkaloid responsible for pungency of black pepper, along with chavicine (an isomer of piperine). It has also been used in some forms of traditional medicine and as an insecticide. It is shown to possess bioavailability enhancing activity with various structurally and therapeutically diverse drugs.

Bioperine (Sabinsa) from black pepper

Bioperine is the product of piperine, it is a standardized extract obtained from South Indian black pepper. The product bioperine is patented in the US. Piperine content in the natural black pepper is 3 to 6 per cent, but bioperine contain not less than 95 per cent piperine. It is bioavailability enhancer for nutrients; clinical studies substantiate its safety and efficacy for nutritional use. Bioperine when co-administered with various nutrients, it is proven that when bioperine is taken either with vitamin, mineral or nutritional ingredients a greater amount of the supplemented nutrient is absorbed by the body of both human and animal.

Hydroxy citric acid- a natural drug antiobesity drug:

Kokam and cambodge are the only natural resources of hydroxy citric acid (HCA). It is a potent metabolic regulator of the obesity. These unique acids lower the blood lipids such as cholesterol and triglycerides, by triggering fatty acid oxidation in the liver via thermogenesis.

Antioxidant activity:

Spices have been investigated for their antioxidant potency in food systems for many years. Processes of spices that prevent free radical formation, remove radicals before damage can occur, repair oxidative damage, eliminate damaged molecules or prevent mutations are important mechanisms in cancer prevention.

Spices extracts also have been shown to inhibit lipid per oxidation. Among the spices, ginger exhibited highest antioxidant property. Interestingly, the antioxidant activity of the extracts was retained even after boiling for 3 min, suggesting that, unlike many antioxidants, the antioxidant in the spices were heat stable.

Antimicrobial activity of spices:

Spices and herbs have been used for thousands of centuries in preserving food. Some spices used in pickles and also to prevent food spoilage.

Table 3: Antimicrobial properties of spices

Inhibitory effect	Spices
Strong	Cinnamon, clove, mustard and garlic
Medium	All spice, caraway, coriander, cumin, rosemary, sage, oregano and thyme
Weak	Black pepper, red pepper and ginger

Nutraceutical

Dr. Stephen De Felice coined the term "Nutraceutical" from "Nutrition" and "Pharmaceutical" in 1989. Nutraceutical can be defined as, "a food or part of a food that provides medical or health benefits, including the prevention and/or treatment of a disease".

Nutraceuticals-drive up the global demand for spices:

Growing demand from the emerging segment of nutraceuticals is driving the global consumption of Indian spices further to meet the needs of the traditional food sector. Non-traditional use of spices including nutraceuticals now accounts for nearly 15 per cent of spice production in the country. Spices like turmeric, ginger, fenugreek, garlic and red pepper have found their applications in nutraceutical industry

Chyawanprash- The highest marketing nutraceutical product in India. It contains spice ingredients such as cinnamon, clove, curcuma spp. saffron and long pepper. It has multiple benefits, increases the immunity, increases the digestion, and prevents cough, asthma, fever, heart disease, impotency and coarseness speech. Also a good source of vitamin C and antioxidants.

Neuroprotection- by spice derived nutraceuticals:

Neurodegenerative diseases are a group of progressive neurological disorders (*viz*., Alzheimer's disease, Parkinson's disease, multiple sclerosis, brain tumour, and meningitis) that damage or destroy the function of neurons. Every year in global level, more than 10 million people suffer from neurodegenerative diseases.

The incidence of neurodegenerative diseases among people living in the Asian subcontinent is much lower than in North America. People from some countries are more prone to these diseases than from other countries like Asia is not fully understood. Lifestyle factors linked mainly food habit to development of neurodegenerative diseases. Spices like turmeric, red pepper, black pepper, clove, ginger, garlic, coriander, rosemary, saffron and cinnamon has been shown to exert its activity against neurodegenerative diseases (Ramaswamy *et al*., 2011).

a) Aroma therapy

Aromatherapy is a holistic treatment that can have a profound effect on the mind, body and emotions through stimulation of the immune system. Aromatic essential oils are used to preserve the mind and modify the mood or healing by many cultures for centuries. In perfumes, incense and extracts of aromatic plants have been extensively used for therapeutic purpose. Inhalation of aromatic volatiles triggers a neuro-chemical release in the brain through the receptors in the nose and mouth, causing induction of desirable mood.

Aromatherapy essential oils are associated with moods or notes are broadly categorized into three major groups. Top note (stimulating) biomolecules include caraway, basil, coriander, eucalyptus, and sage while middle note (neutral mood) include anise seed, fennel, thyme, black pepper, rosemary and peppermint. Base note (relaxing or sedative) biomolecules are derived from cinnamon, clove, ginger and nutmeg. Essential oils are often used as a part of aromatherapy massage, where the oils can be worked into the skin, muscles and joints (Gunasekar *et al.*, 2012).

b) Spices- as natural preservative

Natural preservatives: these are the chemical constituents extracted from natural sources that offer intrinsic ability to protect products against microbial growth. These include essential oil constituents, flavonoids, phenolic compounds etc.

History of spices used as preservative:

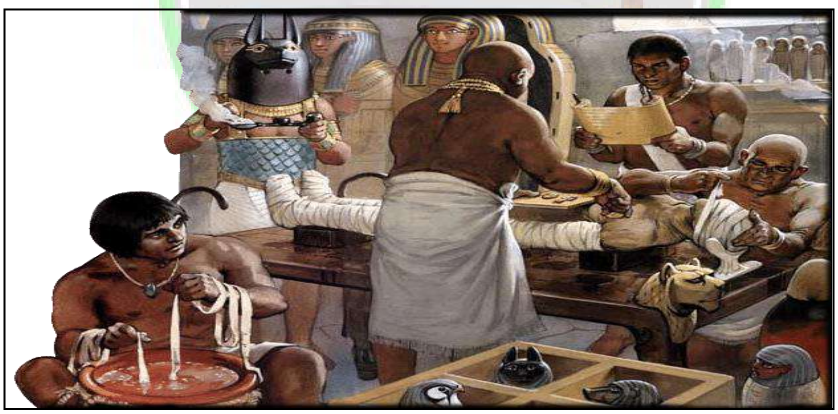

Fig: Egyptian mummies were preserved by using spices, cinnamon, cassia and black pepper

A growing awareness among consumers towards the health aspects has increased due to their interest on natural products. More emphasis on the use of natural preservatives as an alternative to chemical preservatives. Mode of action of these natural preservatives is inhibition of microbial growth, oxidation and certain enzymatic reactions occurring in the foodstuffs. Essential oils, flavonoids and phenolic compound present in spices possess the preserving action (Singh *et al.*, 2010).

Currently pharmaceutical, food and meat industries are emphasizing more on spice derived preservatives. Clove, garlic, ginger, cinnamon, thyme, oregano and rosemary are mainly used as preservative agents. *In vitro* test with *Staphylococcus aureus*, *Klebsiella pneumoniae, Pseudomonas aeruginosa*, *Escherichia coli and Candida albicans* found inhibition in growth of microbes against the spice extracts (Syed *et al*., 2010).

Spices used as beverages

Beverages made out of spices are of natural products valued highly due to natural antioxidant and antimicrobial properties. It helps to store for the long period and also act as a natural health drink. Cardamom, black pepper, ginger, mint, cumin, cinnamon, ginger, kokum and curry leaf are found their applications in beverage industry. Food safety and standards Act, 2006 allows making nutraceuticals drinks of spices.

Masala Chai: is a flavoured tea beverage made by brewing black tea with a mixture of aromatic Indian spices and herbs. It is originated in South Asia, the beverage has gained worldwide popularity. Spices used for the beverage are grounded ginger and green cardamom

Jal Jeera: is Indian beverage made with water with predominant portion of cumin. Along with cumin, jal jeera also contains other spices like ginger, black pepper, mint and chilli powder. Black pepper helps in digestion and mint contributes a cooling effect.

Kala khatta: is a tangy beverage prepared with jamun and pinch of black pepper.

Kokum Sharbat: very popular drink prepared from kokum (*G. indica*). Due to medicinal properties of kokum i.e., pharmaceutical and cosmetic properties. Hydroxy-citric acid present in the kokum helps for weight reduction or antiobesity.

Spices- as natural colourant

Paprika oleoresin- contains less capsaicin and more capsanthin, it is red pigment. Capsanthin and capsorubin are the main colouring pigments. This paprika oleoresin commonly found their uses in meat, sausage, salad dressings and condiments. Food coloured with paprika oleoresin include cheese, orange juice, spice mixtures, sauces and sweets. Paprika oleoresin use is limited due to colour fading over time. Also used as a natural colour in makeup. In poultry feed: it is used to deepen the colour of egg yolks. Commercial paprika is available in different colour strength upto 15,000 colour units (equivalent to 10.8 % total carotenoids). One kilo gram of paprika oleoresin replaces 12-15kg of paprika powder with respect to colour. Commercially available products are standardized by the addition of food grade. For example minimum total carotenoids of 7% capsanthin. Kashmiri chilli- selectively bred for colour and flavour. Valued for their bright red colour and colour retention mainly for powder. Byadgi chilli- heavily used in extraction of oleoresin due their excellent purity colour. Byadgi chilli varieties are Kaddi and Dabbi chilli. ASTA colour value of Byadgi Kaddi chilli very high and it is dark red in colour.

Turmeric oleoresin: commercial available turmeric oleoresin contains curcumin percentage of 25–40. Turmeric oleoresin used in food colour, paper, textiles and natural colour in makeup. This yellow pigment used in meat and condiment. Turmeric oleoresin mixed fish feed can promote pigment deposition, thus it attracts the consumer in market.

Clove bud oil- sweet spicy note adds to richness in rose perfumes

Cinnamon oil- cinnamon leaf oil has eugenol can easily converted into vanillin, it is an ingredient of oriental perfumes

Nutmeg oil- pale yellow oil with warm muscat odour distilled from seeds and used in men's colognes.

Pepper oil- extracted with ethanol or distilled for a warm, dry woody note

Ginger oil- distilled from tuberous rhizomes spicy note in men's aftershaves

Cardamom oil- has a pleasant fresh spiciness

Beauty care and cosmetics: The concept of beauty and cosmetics is as ancient as mankind and civilization. Herbs and spices have been used in maintaining and enhancing human beauty since time immemorial. For example- turmeric for skin care. The anti-ageing and cosmeceuticals is gaining importance in the beauty, health and wellness sector. Spice and Herbal extracts are primarily added to the cosmetic preparations due to several associated properties such as antioxidant properties. Spices helps increase skin elasticity, reduce skin wrinkles thereby reduce skin ageing and protection against UV radiation. Spices like turmeric, cardamom, clove, aniseed, coriander, basil, saffron, garlic and sage are used mainly in beauty and cosmetic industry.

Other uses of spices

Defensive spray: Piperine and capsaicin- ingredient of pepper spray, this can be used as self defensive spray

Pain reliever: Capsaicin present in chilli and myristicin present in nutmeg and mace can be used as pain reliever creams.

Aroma chemical: some spice oils can be easily converted into aroma chemicals. For example: Eugenol present in clove can be easily converted in to starter material for vanillin, which is present in vanilla. This starter material converted is natural.

Conclusion

Spices natural and necessary components of our daily nutrition, beyond their role in imparting flavour to our food, it also influence the many beneficial physiological effects.The optimum consumption of spices is not only proved to be safe, also leads to be offer various benefical effects. Spices possess more than one health beneficial property and there is also a possibility of synergy among them in their action, a spiced diet is likely to make healthy life.

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CROP SIMULATION MODELS

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Abstract

Crop simulation models used for quantitative descriptions of Eco physiological processes to predict the growth of plant and development of plant which influenced by crop management and environmental conditions, which are specified for the model as input data (Hodson and White, 2010). Crop modeling has been used primarily as a decision-making tool for crop management. Crop computer simulation models use plant physiology and environmental variables to calculate plant growth, or more specifically, yield and dry matter production. Both directions are increasingly coupled with molecular genetics to facilitate crop modelling. Crop model parameters are usually determined by constant parameter adjustment and comparison with observed data from field trials.

Introduction:

Prediction of productivity of any crop in a season has very important economic importance for a country. For yield improvements of crops, information about suitable management practices is rapidly increasing. The generation of new data through agronomic research methods is insufficient and time consuming to meet these needs. It is important for a country, where productivity of crops in any season may vary greatly depending on the prevailing weather conditions of that season (Jones et al., 2003). In recent years, several dynamic crop growth simulation models have been developed to help in such predictive process. A model is a simplified representation of a system or a process. Modelling is based on the assumption that any given process can be expressed in a formal mathematical statement or set of statements. Simulation is the process of building models and analysing the system. Crop model are simple representation of a crop. Crop models are tools of systems research which help in solving problems related to crop production (Bannayan et al., 2003). Model accuracy in prediction and their sensitivity also help in mid-course correction, so that farmer can adopt measure to avoid any drop in potential production of any crops. The main goal of a crop simulation model is to estimate crop production, resource use and environmental impact as a function of local weather and soil conditions and crop management (Hoogenboom, 2000).

Why we need simulation models?

- To incorporate knowledge gain from field experimentation.
- To provide a structure that promotes interdisciplinary cooperation.
- To promote the use of systems investigation for solving troubles.
- To offer dynamic, quantitative tools for analysing the difficulty of cropping systems.

For using crop models, it requires certain input data which is used by the model to further generate the required output.

Input data requirement: Crop modelling requires data related to weather, crop, soil, management practices and insect-pests.

a) **Weather data includes**: Maximum and minimum temperature, rainfall, relative humidity, solar radiation and wind speed. Weather data is required at daily time step to assess daily crop growth processes.

b) **Crop data includes**: Crop name, variety name, crop phenology (days to anthesis, days to maturity etc.), leaf area index, grain yield above ground biomass, 1000 grain weight.

c) **Soil data includes**: Thickness of soil layer, pH, EC, N, P, K, soil organic carbon, soil texture, sand and clay percent, soil moisture, saturation, field capacity and wilting point of soil, bulk density.

d**) Crop management data includes**: Date of sowing of crop is required to initiate the simulation process. Generally sowing date is taken as the start time for the simulation. In case of transplanted rice date of transplanting is used instead of sowing date. Seed rate and depth of seeding are also required. Use of inputs in the crop field, namely, irrigation, fertilizer, manure, crop residue etc. needs to be mentioned. Amount of these inputs are specified along with their type, date of application and depth of placement. If crop residues or organic nutrient sources are applied in the field then C: N ratio of those sources is quantified.

e) **Pest data includes**: Name and type of the pest, their mode of attack, pest population at different crop growth stages. Data on insects or pests are included only in those models which contains the pest module.

Steps in modelling:

- Define goals: Agricultural system is complex comprising of various disciplines. In order to develop or understand a crop model one requires strong knowledge base of different subjects. Depending upon the objective of study, knowledge base of different disciplines is integrated to develop a crop model.
- Define system and its boundaries: In agriculture, crop field is chosen as a system.
- Define key variables in system: Variables include state, rate, driving and auxillary variables. State variables are those which can be measured or quantified, e.g. soil moisture content, crop yield etc. Rate variables are the rates of different processes operating in a system, e.g. photosynthesis rate, transpiration rate. Driving variables are the variables which are not part of the system but the affect the system, e.g. sunshine, rainfall. Supplementary variables are the intermediated products, e.g. dry matter partitioning, water stress etc. These variables are identified in the crop field. After identification of these variables relationship among different variables is determined. This helps in better understanding of the whole process.
- Quantify relationships: Once the relationship is established it is then quantifies using different mathematical equations and functions.
- Calibration/Validation: When the model is developed, it requires calibration and validation. First the model is run with any experimental data set and calibrated accordingly. Calibration is done by the trial and error method. Calibrated model is then validated with another experimental dataset to check its simulation ability under different situations or environment.
- Sensitivity analysis: Validated model is further tested for its sensitivity to different factors (e.g. temperature, rainfall, N dose). This is done to check whether the model is responding to changes in those factors or not.

- Simplification: Any model is initially written in computer programming languages. But they are made simple by making it user friendly. λ
- Use of models in decision support: Once developed, calibrated and validated any model can be used in any decision support system for forecasting or making suitable decisions regarding crop management.

Possible applications of crop model:

1) Evaluation of potential yields.
2) Assessment of yield gaps: principal causes and their contribution.
3) Yield forecasting.
4) Impact assessment of climatic variability and climatic change.
5) Optimizing management- Dates of planting, variety, irrigation and nitrogen fertilizer.
6) Environmental impact- percolation, N losses, GHG emissions, SOC dynamics.
7) Plant type design and evaluation.
8) Genotype by environment interactions.

Limitations of modelling: Corp models required large amount of input data, which may not be available with the user along with it, required skilled manpower, good knowledge of computers and computer language. Crop modelling needs multidisciplinary knowledge. No model can take into account all the existing complexity of biological systems. Hence simulation results have errors.

Conclusion

A model is a tool for improving critical thought, not a substitute for it. Models can help formulate hypotheses and improve efficiency of field experiments, but they do not eliminate the need for continued experimentation. Models developed for a specific region cannot be used as such in another region. Proper parameterization and calibration is needed before using a model.

References

Hodson, D., and White, J. (2010). GIS and crop simulation modelling applications in climate change research. In “Climate Change and Crop Production” (M. P. Reynolds, Ed.), pp. 245–262. CABI, Oxfordshire, UK.

Ribaut, J., Jiang, C., and Hoisington, D. (2002). Simulation experiments on efficiencies of gene introgression by backcrossing. Crop Sci. 42(2), 557–565.

Yin, X., and Struik, P. C. (2010). Modelling the crop: From system dynamics to systems biology. J. Exp. Bot. 61(8), 2171–2183.

Zhang, W., and Smith, C. (1992). Computer-simulation of marker-assisted selection utilizing linkage disequilibrium. Theor. Appl. Genet. 83(6–7), 813–820.

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ALLELOPATHY IN WEED CONTROL

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Introduction

Allelopathy is a biological phenomenon in which one or more biochemicals produced by one organism affect the development, survival, and reproduction of other organisms. Allelochemicals, which are secondary metabolites produced by plants, algae, bacteria, and fungus. The crop with allelopathic properties can be utilized to manage abiotic stress, disease, pests, nutrients, and weed control in field crops. The growth of crops is likewise regulated and improved by allelochemicals. Allelochemicals created by bacteria, insects, higher animals, and plants may one day offer fresh ideas for sustaining and boosting agricultural and forestry production. The use of agrochemicals, which are harmful to the environment and human life, is reduced by the application of allelopathic compounds in crop fields. Allelopathy in the control of weeds

Application of Allelopathy in weed management

Allelopathic control of certain weeds using botanicals for instance dry dodder powder has been found to inhibit the growth of water hyacinth and eventually kill the weed. Likewise carrot grass powder found to detrimental to other aquatic weeds. The presence of marigold (*Tagetes erecta*) plants exerted adverse allelopathic effect on Parthenium spp. growth. The weed Cassia sp show suppressive effect on Parthenium. The eucalyptus tree leaf leachates have been shown to suppress the growth of nut sedge and bermuda grass.

Allelo chemicals are produced by plants as end products, by-products and metabolites liberalized from the plants

1) Allelopathic effects of weeds on crop plants.

- Root exudates of Canada thistle (Cirsium sp.) injured oat plants in the field.
- Root exudates of Euphorbia injured flax. But these compounds are identified as parahydroxy benzoic acid. Maize
- Leaves & inflorescence of Parthenium sp. affect the germination and seedling growth
- Tubers of *Cyperus esculentus* affect the dry matter production
- Quack grass produced toxins through root, leaves and seeds interfered with uptake of nutrients by corn. Sorghum
- Stem of Solanum affects germination and seedling growth
- Leaves and inflorescence of Parthenium affect germination and seedling growth Wheat
- Seeds of wild oat affect germination and early seedling growth
- Leaves of Parthenium affects general growth
- Tubers of *C. rotundus* affect dry matter production
- Green and dried leaves of *Argemone mexicana* affect germination & seedling growth Sunflower
- Seeds of Datura affect germination & growth

2) Effect of weed on another weed

- Thatch grass (*Imperata cylindrica*) inhibited the emergence and growth of an annual broad leaf weed (*Borreria hispida*)

Allelochemicals as natural herbicides

The need for environmentally safer herbicides and the difficulty of discovering a new mode of action coupled with an increase in herbicide-resistant weed strains have prompted the development of natural herbicides. Allelochemicals as natural herbicides can be of particular value for weed management since (Khamare et al. 2022) they offer new modes of action, more specific interactions with weeds, and are environmentally friendly. In addition, allelochemicals have been used as leads for the discovery of synthetic herbicides and can offer insights into new modes of action. Mesotrione was derived from a natural compound called leptospermone from the roots of bottle brush plant (Callistemon citrinus (Mitchell et al., 2001). Another example is cinmethylin, the first-ever commercial allelopathic herbicide that was derived from monoterpene 1,8-cineole. Monoterpene 1,8-cineole is present in essential oils of several plant species (Einhellig and Leather, 1988). Many other herbicides, such as AAL toxin, artemisinin, biolaphes, glufosinate, and dicamba have been developed from plant allelochemicals (Motmainna et al., 2021). In addition to offering us hints about new herbicide chemistry, allelochemicals may also be able to give us with natural substances that can be changed into active, selective, and long-lasting products.

According to Cordeau et al. (2016), there were 13 natural herbicides registered worldwide; nine of them were generated from fungi, three from bacteria, and just one from plant extract. Since then, six registered commercially accessible natural herbicides made from essential oils and/or their components will be on the market in the USA (Verdeguer et al., 2020). They are GreenMatch (55% d-limonene), Matratec (50% clove oil), WeedZap (45% clove oil + 45% cinnamon oil), GreenMatch EX (50% lemongrass oil), AvengerWeed Killer (70% dlimonene), and Weed Slayer (6% eugenol) (Verdeguer et al., 2020). The fact that natural herbicides require more quantity of application than synthetic herbicides to get the same results is one of their drawbacks. Allelochemicals at such high concentrations can be harmful to the environment, soil flora, and microorganisms. These large amounts not only have a negative impact on the environment, but they also increase the cost of treatment, even in high-value production systems. Furthermore, very few natural herbicides have any crop selectivity and are nonselective. There is a need for more natural herbicides with better selectivity on the market given the current concerns over synthetic herbicides and consumer desire for organic produce.

Allelochemicals from allopathic plants can be used to create novel organic herbicides or their chemistry can be exploited to discover new herbicide target locations. There are several allelochemicals that may act as natural herbicides, according to research. Artemisinin is a sequiterpenoid lactone, a principle allelochemical present in annual wormwood. It is a selective phytotoxin, and has shown increased oxygen uptake and decreased chlorophyll content in the treated plants (Dayan et al., 2009). Ailanthone is a quassinoid lactone, a major allelochemical present in the tree of heaven. It has the potential to be used as a post-emergence herbicide, but it degrades rapidly in the field, losing its effect after several days. In recent years, tricin has received a great deal of attention for an allelochemical-based herbicide discovery. An isomer of tricin has been synthesized called aurone, which has shown much stronger herbicidal activity than tricin itself, guiding research towards a useful molecule for new herbicide discoveries. A series of aurone-derived compounds, including substituted aurones and benzothiazine derivatives, have been synthesized and several of these derivatives have shown great pre-emergent activity against weeds. Multicolored morning glory contains resin glycosides with tricolorin A as the main allelochemical. Tricolorin A has shown to be highly phytotoxic and is a potent inhibitor of plasma membrane adenosine triphosphate. Numerous essential oils have been extensively used in research for their ability to act as natural herbicides in place of synthetic ones. Other plant species are toxic to many different types of allelochemicals, including phenolics, terpenoids, alkaloids, coumarins, tannins, flavonoids, steroids, and quinines. Many allelochemicals have been extracted recently and used commercially to control weeds. However, there is a huge potential for allelochemicals to be employed as a tool for the creation of novel natural herbicides.

Limitations and future prospective

The review above makes it very evident that many allelopathic plants have tremendous potential for weed management. Despite recent advances in the research of allelopathy, there is still a lot of work to be done to explore new allelochemicals and improve existing ones. Despite the benefits and usefulness of several allelopathic species in controlling weeds, there are a number of obstacles preventing more conventional or organic farmers from employing allelopathy.

To begin with, it is very expensive to separate and produce various allelochemicals. The public has the idea that anything in nature is presumably healthy. Several of the most toxic compounds known to humans, such as aflatoxin, fumonisins, and ricin are natural. AAL toxin and fumonisin are toxic to mammalian cells (Duke S. et al., 2000), while sorgoleone is reported to cause dermatitis. However, from an environmental toxicology perspective, the relatively short half-life of most allelochemicals in the field is desirable, but an herbicide must persist longer in the environment to get desired results.

Additionally, plant age, temperature, light, soil, microbiota, and nutritional condition have a significant impact on the generation and secretion of allelochemicals. Many plant species or their byproducts may not be suitable for use, despite the fact that they exhibit significant allelopathic potential. Despite the numerous difficulties in putting the allelopathy concept into practice for weed management, there is a tremendous opportunity to investigate allelopathy as a novel tool. There is not enough information on the safety of applying known extracted allelochemicals to different crops. Future studies should concentrate on the mechanisms of allelochemical selectivity, their mode of action, how they interact with other species, and practical applications. Furthermore, concentrating on the emergence of transgenic allelopathy in crops by genetic engineering can offer a novel method

We may manage weeds organically using the allelopathic principle and ease our dependency on synthetic herbicides. Intercropping, crop rotation, cover crops, and mulching are examples of conventional approaches that have been utilized for a variety of advantages; however, the addition of allelopathic crops would increase their weed-suppression potential. An alternate approach for a sustainable weed management program would be to use allopathic plant extracts in conjunction with pesticides in lower concentrations. The identification, testing, and usage of more allelochemicals for weed control will be facilitated by contemporary biotechnological technologies and enhanced extraction techniques. Currently, it is challenging to completely replace chemical weed control, but success may come from using an integrated weed management strategy. These allelochemicals or the byproducts of allelopathic species can be integrated with other weed management practices to get better weed control, reduce herbicide use, reduce production costs, and avoid any herbicide resistance.

References

Yuvraj Khamare, Jianjun Chen and, Stephen Christopher Marble. Allelopathy and its application as a weed management tool: A review. Frontiers in Plant Science. TYPE Review\ PUBLISHED 28 November 2022. DOI 10.3389/fpls.2022.1034649.

Mitchell, G., Bartlett, D., Fraser, T., Hawkes, T., Holt, D., Townson, J., et al. (2001). Mesotrione: a new selective herbicide for use in maize. Pest Manage. Sci. 57 (2), 120-128. doi: 10.1002/1526-4998(200102)57:2<120::aid-ps254>3.0.co;2-e

Einhellig, F., and Leather, G. (1988). Potentials for exploiting allelopathy to enhance crop production. J. Of Chem. Ecol. 14 (10), 1829–1844. doi: 10.1007/ bf01013480

Motmainna, M., Shukor B, A., Md. Kamal Uddin, J., Binti Asib, N., Mominul Islam, A., and Hasan, M. (2021). Assessment of allelopathic compounds to develop new natural herbicides: A review. Allelopathy J. 52 (1), 21–40. doi: 10.26651/allelo.j/2021-52-1-1305

Cordeau, S., Triolet, M., Wayman, S., Steinberg, C., and Guillemin, J. (2016). Bioherbicides: Dead in the water? a review of the existing products for integrated weed management. Crop Prot. 87, 44–49. doi: 10.1016/j.cropro.2016.04.016

Verdeguer, M., Sánchez-Moreiras, A., and Araniti, F. (2020). Phytotoxic effects and mechanism of action of essential oils and terpenoids. Plants 9 (11), 1571. doi: 10.3390/plants9111571

Dayan, F. E., Cantrell, C. L., and Duke, S. O. (2009). Natural products in crop protection. Bioorg. M Medicinal Chem. 17 (12), 4022- 4034. doi: 10.1016/ j.bmc.2009.01.046

Duke, S. O., Dayan, F. E., Romagni, J. G., and Rimando, A. M. (2002). Natural products as sources of herbicides: current status and future trends. Weed Res. (Oxford) 40 (1), 99–111. doi: 10.1046/j.1365-3180.2000.00161.x

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RENEWABLE ENERGY AS MAJOR SOURCE FOR ENERGY MANAGEMENT IN AGRICULTURE SECTOR

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Abstract

Resource has become one of the most significant components deciding the advancement of a country and prosperity; in actuality, a nation's quality life expectancy is strongly linked to the amount of energy consumed per capita. The sun provides almost all of the energy consumed on earth. The evaporation of water and accompanying waves and ocean currents are all caused by sunshine. Energy for crop production can be derived from a variety of sources, including people, animals, the sun, electricity, wind power, biomass power, fertilizer, seed, agrochemicals, petroleum products, etc. Agriculture and renewable energy make an effective mix. Energy from the wind, sun, and biomass may be brought together in perpetuity, enabling. The agricultural community have an established source of income. The present piece provides an overview of the agricultural sector and thoughts on how they might contribute to India's rural areas using renewable energy as an increasingly important form of revenue.

Introduction

Agriculture represents a sector than might benefit greatly from adopting renewable energy sources, whether financially and environmentally (Van-Campen *et al.*,2000). The use of renewable energy in agriculture has never been an entirely novel problem. The results they found imply that the most significant obstacle to the widespread use of these energy sources is likely to be the high beginning investment, which is costly and carries an important risk of financial ruin to the people involved in these campaigns. Recently have been numerous studies carried out regarding the utilization of renewable energy for greenhouse agriculture (Meah *et al*.,2008) have spoken about some of the rules required to create a solar PV water-pumping system as an appropriate innovation for the area. This is a successful usage in rural areas of developing nations, where in solar power's dependability and low cost have rendered it a desirable option for pumping water a distance. A major turning point in the global effort to tackle the effects of climate change has been reached with India's announcement that it plans to achieve net zero carbon emissions by 2070 and to meet 50% of its requirement for electricity from renewable sources by 2030. India has the fourth-most desirable renewable energy market in the world. India ranked fourth in the world for installed renewable energy capacity as of 2020, behind solar power in fifth and wind power in fourth (Renewables 2022 Global Status Report).

What is renewable energy

Renewable energy refers to energy derived from naturally occurring and replenishing sources that are essentially inexhaustible over human time scales. Unlike fossil fuels such as coal, oil, and natural gas, which are finite and contribute to environmental pollution and climate change when burned for energy, renewable energy sources are sustainable and have minimal or no harmful environmental impact.

Types of renewable energy sources:

(1) **Solar Energy**:

Solar power is harnessed from the sun's radiation using photovoltaic cells or solar thermal systems. Photovoltaic cells convert sunlight directly into electricity, while solar thermal systems use sunlight to heat a fluid that can generate electricity or provide heat for various applications.

Photovoltaic (PV) Solar Panels:

Photovoltaic cells, commonly known as solar cells, are used to convert sunlight directly into electricity. Solar panels consist of multiple PV cells connected in series or parallel to generate the desired voltage and current. These panels are widely used in residential, commercial, and industrial settings to generate electricity. Solar panels can be installed on rooftops, ground-mounted arrays, and even integrated into building materials.

Solar Thermal Systems:

Solar thermal systems capture the sun's energy to heat a fluid, typically water or a heat-transfer fluid like oil. The heated fluid can be used for various purposes, such as space heating, water heating, and industrial processes. Concentrated solar power (CSP) plants use mirrors or lenses to focus sunlight onto a central receiver, which produces steam to generate electricity.

Solar Water Heating:

Solar water heating systems use solar collectors to heat water for domestic or industrial use. These systems are common in many countries and can provide a significant portion of a household's hot water needs.

Solar Power for Off-Grid Applications:

Solar energy is particularly valuable for off-grid and remote applications where access to traditional grid electricity is limited or expensive. Solar-powered off-grid systems include solar home systems, solar streetlights, and solar-powered water pumps.

Net Metering and Grid-Tied Systems:

In grid-tied solar systems, excess electricity generated by solar panels can be fed back into the grid. This is often done through net metering arrangements, where consumers receive credits for the excess electricity they produce.

(2) **Wind Energy**: Wind turbines capture the kinetic energy of the wind and convert it into electricity. Wind farms can be found in areas with consistent and strong wind patterns.

Wind Turbines:

Wind turbines are the primary technology used to capture wind energy and convert it into electricity. They consist of rotor blades attached to a hub, which is connected to a generator. As the wind blows, it causes the rotor blades to turn, generating mechanical energy. This mechanical energy is then converted into electrical energy by a generator located inside the turbine's nacelle (the housing at the top of the tower).

Types of Wind Turbines: There are two main types of wind turbines: horizontal-axis wind turbines (HAWTs) and vertical-axis wind turbines (VAWTs). HAWTs are the most common and have a horizontal rotor shaft; they are typically used for utility-scale wind farms. VAWTs have a vertical rotor shaft and can capture wind from any direction; they are often used in smaller-scale applications.

Onshore and Offshore Wind Farms:

Wind turbines can be installed onshore, in locations like fields and open land, or offshore, in bodies of water such as the ocean or large lakes. Offshore wind farms often have the advantage of stronger and more consistent wind resources but require specialized technology for installation and maintenance.

Electricity Generation:

Wind turbines generate electricity when the rotational energy of the rotor blades is converted into electrical power by the generator. The electricity is typically transported to the grid for distribution and use in homes, businesses, and industries.

Grid Integration:

Wind power is integrated into the electricity grid to provide a stable and reliable source of electricity. Wind farms are strategically located to take advantage of prevailing wind patterns.

(3) Hydropower:

Hydropower, or hydroelectric power, harnesses the energy of flowing water, typically from rivers or dams, to generate electricity. It's one of the oldest and most widely used forms of renewable energy.

Hydropower Plants:

Hydropower plants are facilities designed to convert the energy of falling or flowing water into electricity. These plants typically consist of a dam, a reservoir, a penstock (pipeline), turbines, and generators.

Types of Hydropower Plants:

(1)Reservoir Hydropower: In this type, water is stored in a reservoir created by a dam. Water released from the reservoir flows through the penstock to drive turbines and generate electricity. The dam can release water in controlled amounts to meet electricity demand.

(2) Run-of-River Hydropower: These plants do not have a large reservoir. Instead, they use the natural flow of a river or stream to generate electricity. The water is diverted through the penstock, and excess water is returned to the river downstream.

(3) Pumped Storage Hydropower: These facilities use surplus electricity to pump water from a lower reservoir to an upper reservoir. When electricity demand is high, water is released from the upper reservoir to the lower reservoir, passing through turbines to generate electricity.

(4) **Biomass Energy**:

Biomass energy is generated from organic materials, such as wood, agricultural residues, and waste from plants and animals. These materials can be burned for heat and electricity or converted into biofuels like ethanol and biodiesel.

Sources of Biomass:

Biomass can be sourced from various organic materials, including: Wood, Logs, branches, and wood pellets.

Agricultural Residues: Crop residues like corn stalks and wheat straw.

Energy Crops: Dedicated crops like switchgrass or miscanthus grown for energy purposes.

Municipal Solid Waste: Organic waste materials from households and businesses.**Animal Manure**: Organic waste from livestock operations.

Algae: Some algae strains can be used for biofuel production.

Biomass can be burned directly to produce heat for residential heating, industrial processes, or electricity generation in biomass power plants.

Combined heat and power (CHP) systems, also known as cogeneration, simultaneously produce heat and electricity from biomass, increasing overall energy efficiency.

Biofuels:

Biomass can be converted into liquid biofuels, such as ethanol and biodiesel, which can be used as transportation fuels, heating fuels, or to generate electricity. Ethanol is commonly produced from crops like corn and sugarcane. Biodiesel is typically made from vegetable oils, animal fats, or used cooking oil.

Research continues to improve the efficiency of biomass energy conversion technologies and reduce costs. Efforts are also focused on developing advanced biofuels with properties similar to or better than fossil fuels. Biomass energy contributes to a more sustainable energy mix by utilizing organic waste and agricultural resources, reducing reliance on fossil fuels, and helping to mitigate climate change.

(5**) Geothermal Energy:**

Geothermal energy is a renewable energy source that harnesses the heat stored beneath the Earth's surface to generate electricity and provide heating and cooling for various applications. This energy source relies on the natural heat flux from the Earth's interior, making it a sustainable and reliable option. Here are the key aspects of geothermal energy:

Geothermal Heat Sources:

bThe Earth's internal heat is primarily derived from the original heat from the planet's formation, supplemented by the radioactive decay of elements in the Earth's crust. This heat exists at various depths beneath the Earth's surface and is accessible through geothermal reservoirs.

Geothermal Power Plants:

Geothermal power plants are designed to extract heat from these underground reservoirs and convert it into electricity. The primary components of a geothermal power plant include wells to access the reservoir, a heat exchanger system, a turbine-generator unit, and a cooling system.

Types of Geothermal Power Plants:

(1) Dry Steam Plants: These use high-pressure, high-temperature steam directly from the geothermal reservoir to turn turbines and generate electricity.

Flash Steam Plants: These use high-pressure, high-temperature water from the reservoir, which is depressurized to produce steam that drives turbines.

Binary Cycle Plants: These plants use lower-temperature geothermal fluids to heat a secondary working fluid (usually an organic compound with a lower boiling point) that vaporizes and drives a turbine.

(2) Direct Use Applications:

Geothermal energy is not only used for electricity generation but also for direct heating and cooling applications, such as space heating, district heating, and greenhouse heating. Geothermal heat pumps use the relatively stable temperature of the Earth's subsurface to provide efficient heating and cooling for residential and commercial buildings.

5. Geothermal Reservoirs:

Geothermal reservoirs are underground areas of permeable rock containing hot water or steam. Reservoirs vary in temperature and depth, and their characteristics influence the choice of technology used to extract heat. Geothermal energy provides a reliable and environmentally friendly source of electricity and thermal energy. Its versatility, with applications ranging from electricity generation to direct heating and cooling, makes it a valuable component of a sustainable energy mix, especially in regions with suitable geothermal resources.

Role of Renewable Energy in Agriculture

Renewable energy plays a significant and multifaceted role in agriculture, contributing to increased sustainability, cost-efficiency, and overall productivity in the agricultural sector. Here are some key roles of renewable energy in agriculture:

- **Power Generation**: Renewable energy sources like solar panels and wind turbines can provide electricity to power various farm operations. This includes lighting, machinery, irrigation systems, and climate control systems in greenhouses. This reduces or eliminates reliance on expensive and carbon-intensive grid electricity or diesel generators.
- **Water Pumping:** Solar-powered water pumps and wind-driven water pumps are increasingly used in agriculture, particularly in remote or off-grid areas. These systems can lift water for irrigation and livestock, ensuring a consistent water supply without the need for fossil fuels.
- **Heating and Cooling**: Renewable energy sources like solar thermal systems and geothermal heating and cooling can be used to maintain optimal temperatures in greenhouses and livestock facilities. This reduces energy costs and greenhouse gas emissions while extending the growing season.
- **Bioenergy**: Biomass energy sources can be used to produce heat, electricity, and biofuels for agricultural operations. Crop residues, animal manure, and dedicated energy crops can be converted into bioenergy, reducing waste and providing an additional revenue stream.
- **Carbon Sequestration**: Planting trees and other vegetation to generate biomass for bioenergy or carbon credits can help sequester carbon dioxide from the atmosphere, contributing to carbon neutrality and climate change mitigation.
- **Energy Independence**: By generating their own renewable energy on the farm, agricultural operations can become more energy independent and resilient to energy price fluctuations. This can improve the long-term financial stability of the farm.
- **Environmental Benefits**: Using renewable energy sources reduces greenhouse gas emissions and other environmental impacts associated with agriculture, such as air and water pollution from fossil fuel use. This promotes sustainable farming practices and reduces the carbon footprint of food production.

- **Rural Development**: Investing in renewable energy infrastructure in rural areas can create jobs, stimulate local economies, and improve the quality of life for rural communities.
- **Off-Grid Solutions**: In remote or underserved areas, renewable energy can provide off-grid solutions for powering agricultural activities, improving food security, and enabling economic development.
- **Government Incentives**: Many governments offer incentives and subsidies for farmers and agricultural businesses to adopt renewable energy technologies, making it more financially attractive to invest in these systems. Overall, the integration of renewable energy technologies into agriculture helps reduce the environmental impact of farming, improve energy efficiency, reduce operating costs, and enhance the sustainability and resilience of agricultural operations, which is increasingly important in the face of climate change and evolving energy markets.

Conclusion

Developing ways to produce renewable energy in addition to contemporary dwindling numbers of easily accessible and affordably priced petroleum and natural gas is the sole feasible reply to the problem of non-renewable energy. Organic solar energy is produced by a variety of sources, such as windmills, falling water, solar collectors, and photovoltaic cells. Plants with green foliage are some of the typical solar energy receivers. After all, plants were the initial organisms to harness the petroleum and petroleum products we currently use today. Consequently, it makes perfect sense for us to think about agriculture as an environmentally friendly source of energy alternatives in the future. Nevertheless must be practical about the degree to which energy from agriculture can replace the petroleum and natural gas that we already consume. Though energy professionals can differ on precise values or numbers, there are some broad limitations on the volume of energy that can be obtained through agriculture.

References

Meah K, Ula S and Barrett S. Renew Sustain Energy Rev 2008; 12: 1162–1175.

Van-Campen B, Guidi D and Best G. Solar photovoltaics for sustainable agriculture and rural development, 2000: 76

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IDENTIFICATION OF SWAMP BUFFALO BY KARYOTYPING

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Abstract

Karyotype of the blood samples of swamp buffalo revealed its number of chromosomes as 2n=48 by karyotyping. The difference in diploid chromosomes (2n=50) of the riverine and that of the swamp buffalo (2n=48) happened due to telomere-centromere tandem fusion of fourth (submetacentric) and ninth (acrocentric) chromosomes of riverine buffalo.

Keywords: Swamp buffalo, blood, karyotyping

Introduction

India has an enormous livestock population estimated as 536.76 million in the 20th livestock Census-2019 signifying a rise of 4.8 percent over previous census data. Livestock deliver nutritious food for human consumption as well as income to farmers for their livelihoods. They provide 4.9 percent to total GDP and 28.4 percent to agricultural GDP. Total number of world buffalo population is 201 million. Rank of India is first with 109.85 million buffalo accounting 54.65 percent globally. Buffalo produces about 91.82 Million tonnes milk with a share of 48.9% out of total milk production (187.75 Million tonnes) (BAHS-2019). In India there are two types of buffalo species seen i.e. Riverine and Swamp buffalo. Buffalo AnGR is registered with 17 breeds with 16 riverine and 1 swamp. Riverine buffalo and swamp buffalo differ in their chromosome number having 50 and 48 respectively.

Two domestic buffalo subspecies (*Bubalus bubalis*) are recognized based on cytogenetic variations and adaptation to different environments. The riverine buffalo (*B. Bubalis bubalis)* have 2n=50 and the swamp buffaloes (*B. Bubalis carabanensis*) have 2n=48 (Bongso and Hilmi, 1982). Categorisation of water buffaloes may be associated with geographic patterns, as riverine buffaloes originated in India and swamp buffaloes are generally restricted to East Asia. Crosses between the two groups have been recognized with chromosome number 49 (Bongso and Hilmi, 1982). Tandem fusions between chromosomes are the key differentiating mechanisms among the bubaline linage karyotypes. Tandem fusions of cattle chromosomes explain that the diploid number decreased from 2n=60 in cattle to 2n=50 in river buffaloes, but the FN=58, excluding sex chromosomes remains conserved between two species.

Methodology

Experimental animals

Blood samples of 20 swamp buffaloes were collected from the field at Senapati, Chandel and from the Swamp Buffalo Breeding Farm at Wabagai village of Thoubal district of Manipur (Figure 1). The random blood sampling of animals was performed in accordance with the relevant guidelines and regulations as approved by Institutional Animal Ethics Committee (IAEC) of National Bureau of Animal Genetics Resources (NBAGR), Karnal.

Blood collection

About 3 ml of the blood was collected from the animals in Heparin coated vacutainers and were transported to the lab in chilled condition (at about 4°C) for further karyotyping analysis.

Karyotyping

Setting up of blood culture

This step was carried out under strict sterilized conditions using laminar flow to avoid any contamination during the culture process. 5 ml of RPMI media was taken in a 15 ml sterilized tube and 0.7-1.0 ml of the whole blood was added to it. The content was mixed properly. The culture was incubated in an incubator at 37°C for 72 hours. The content in the tube was mixed almost every 12 hours interval as blood cells usually settled down in culture media after a few hours.

After completion of 72 hours, the culture was put out from the incubator and Colchicine (colcemid) was added at the rate of 28µl per sample and again incubated at 37°C for 1 hour.

The tubes were centrifuged at 2,000 rpm for 20 minutes and the supernatant was discarded cautiously.

Potassium chloride (0.075 M) as a hypotonic solution (7 ml) was added and mixed with glass/plastic pipette. The content was incubated in an incubator at 37°C for 20 minutes.

One ml of chilled fixative (3 Methanol: 1 Acetic acid) was added into the content and mixed properly with the help of glass/plastic pipette till the colour changes to blackish.

The tube was centrifuged at 2,000 rpm for 20 minutes. The supernatant was discarded cautiously and 5 ml of fixative solution was added. The content was mixed properly. Centrifugation was done at 2,000 rpm for 20 minutes. The supernatant was discarded very cautiously, as the sedimented content turns almost colourless and 4 ml of fixative solution was again added. The content was mixed properly. Centrifugation is done at 2,000 rpm for 20 minutes. The supernatant was discarded very cautiously and 3 ml of fixative solution was added. The content was mixed properly and centrifugation was done at 2,000 rpm for 20 minutes. Half of the supernatant was discarded and 1.5 ml of the supernatant was re-suspended for further slide preparation. Content was also preserved at -20°C.

Preparation of slide

The glass slides were washed and kept in ice cold water before making the spread. About 0.5 ml of the culture content was taken into the pipette and 4-5 droplets of the culture media were dropped from a height of about 1 meter. During this process, the slide was kept slightly tilted towards ground that caused the cells to burst and even spread to the chromosomes. The slide was air dried for overnight and marked after drying.

Staining and mounting

The slides were dipped in coupling jar containing 2% Giemsa staining solution for 15- 20 minutes and washed in running tap water. The slides were rinsed with distilled water and dried overnight in an incubator.

The dried slides were dipped in xylene for 15-20 minutes and 2-3 drops of DPX mountant was poured on the slide for mounting.

The xylene dipped coverslip was placed on the slide and fixed properly. The slides were air dried overnight and cleaned by using xylene.

Microscopic examination

The slides were then screened to identify "good" chromosome spreads (i.e. the chromosomes were not too far or too compact and were not overlapping).

Conclusion

All the blood samples (n=20) collected from Manipur were karyotyped using standard lymphocyte culture technique. Karyotype of the samples showed chromosomes as 2n=48which is in concurrence with the findings of Mishra *et al*. (2010), they randomly selected 40 animals from hilly and plain areas of Manipur and cytogenetic analysis of the samples revealed diploid chromosome number as 48 indicating the animals were typical of swamp type buffaloes. The cytogenetic screening in the present study also revealed that all the samples were of swamp type (Figure 1). The difference in diploid chromosomes (2n=50) of the riverine and that of the swamp buffalo (2n=48)happened due to telomere-centromere tandem fusion of fourth (submetacentric) and ninth (acrocentric) chromosomes of riverine buffalo with a loss of centromere of chromosome 9 and resulted into first chromosome (metacentric) of swamp buffalo (Berardino and Iannuzzi, 1981). Also Degrandi *et al*. (2010) using blood lymphocyte culture analysed that 2n=48, 50 and 49 in swamp buffalo, riverine buffalo and hybrid buffaloes, respectively.

References

Bongso TA and Hilmi M, 1982. Chromosome banding homologies of a tandem fusion in river, swamp and crossbred buffalo (*Bubalus bubalis*). Can J Genet Cytol 24:667-673.

Degrandi, T., Reimche, R. B., Marques, J. R. F., & Gunski, R. (2010). Cytogenetic characterization of swamp (B. bubalis kerebau) and river (B. bubalis bubalis) buffaloes and respective progeny. *Revista Veterinaria*, *21*, 358–362.

Di Berardino, D., & Iannuzzi, L. (1981). Chromosome banding homologies in Swamp and Murrah buffalo. *The Journal of Heredity*, *72*(3), 183–188.

https://dahd.nic.in/circulars/basic-animal-husbandry-statistics-2019

Mishra, B., Prakash, B., Kataria, R., Periasamy, K., Sadana, D. K., Das, G. C., Joshi, B. K., Bhasin, V., Rasool, T., & Bujarbaruah, K. M. (2010). *Cytogenetic profiling and mitochondrial DNA analysis reveal existence of swamp buffalo population in Manipur state*. *80,* 31–36.

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HERBIGATION: WHERE IRRIGATION MEETS WEED CONTROL FOR GREENER FIELDS

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Abstract

Herbigation is an innovative technique that has evolved as a game-changing answer to the dual problems of efficient irrigation and successful weed management in the quickly changing world of modern agriculture. Herbigation, which combines irrigation and herbicide application into a single process, provides environmental advantages as well as resource efficiency, labour and time savings, enhanced crop yields, and precision weed control. The historical setting of irrigation and the invention of herbicides served as the foundation for this paradigm shift in agriculture. It is a sustainable and successful weed management strategy because it makes use of technology, data, and real-time monitoring to ensure that herbicides are applied precisely where and when needed. Herbigation supports the worldwide objectives of sustainable agriculture and environmental responsibility by maximizing water use and enhancing crop output. This article explores the principles, operation, case studies, challenges, and the promising future of herbigation, shedding light on its potential to revolutionize modern agriculture.

Keywords: Herbicide, Herbigation, Irrigation, Weeds, Drip

Introduction :

In the ever-evolving landscape of modern agriculture, a remarkable innovation has emerged to address two fundamental challenges faced by farmers worldwide: efficient irrigation and effective weed control. This innovation goes by the name "**herbigation**," a *portmanteau that marries* "herbicide" and "irrigation" into a single, powerful farming practice.

In essence, **herbigation** is a cutting-edge agriculture method in which irrigation and herbicide application are synced into a single procedure. This clever method is a cornerstone of efficient and sustainable farming because it reduces time and labour costs and maximizes resource use.

As we start this investigation, we will explore the history of herbigation, the technologies that enable it, and the many advantages it gives to contemporary agriculture. Come along on this adventure as we learn how herbigation alters how we care for our crops, control weed growth, and produce greener and more productive fields.

The Herbigation Revolution :

Herbigation, the innovative fusion of irrigation and herbicide application, represents a significant advancement in the field of agriculture. To understand its evolution, we must first look back at the historical context of irrigation and herbicide use. Irrigation, the controlled application of water to land to assist in the production of crops, has been practiced for thousands of years. Early forms of irrigation, such as furrow and flood irrigation, date back to ancient civilizations like the Egyptians and the Indus Valley culture.

Herbicides, on the other hand, were introduced more recently with the development of synthetic chemicals in the 20th century. These chemicals provided an effective means of controlling weeds that competed with crops for nutrients, water, and sunlight.

Key Principles That Make Herbigation a Game-Changer in Agriculture:

1. Resource Efficiency: Herbigation optimizes the use of two critical resources and herbicides. It ensures that both are applied only where and when needed, reducing waste and environmental impact.

2. Precision Weed Control: Herbigation enables highly targeted herbicide application. Integrating real-time data on weed presence and growth minimizes the use of chemicals while effectively managing weed pressures.

3. Labour and Time Savings: Herbigation reduces the need for manual herbicide application, saving farmers time and labour. This efficiency is especially crucial in modern agriculture, where labour shortages can be a challenge.

4. Increased Crop Yields: By ensuring that crops receive the right amount of water and minimizing weed competition, herbigation can lead to increased crop yields and, consequently, higher profits for farmers.

5. Environmental Benefits: The precision and efficiency of herbigation reduce the environmental impact of herbicide use and irrigation by preventing over-application and runoff.

How Herbigation Works?

Herbigation was followed mostly in drip irrigation which involves a fertilizer injector pump for herbicide injection into the irrigation system and a pressure gauge was attached to the system to observe the water pressure. It mostly coincides with fertigation and involves steps viz.,

1. **Integration of Equipment:** Herbigation combines irrigation and herbicide application equipment.
2. **Mapping and Planning**: Field maps guide precise herbicide application.
3. **Herbicide Selection:** Specific herbicides are chosen for target weeds.
4. **Calibration:** Flow rates are set for accurate water and herbicide delivery.
5. **Timing and Scheduling**: Timely application maximizes effectiveness.
6. **Herbicide Mixing:** Herbicides are mixed with water for a uniform solution.
7. **Delivery During Irrigation:** Water carries herbicides for even distribution.
8. **Uniform Distribution:** Irrigation ensures consistent coverage.
9. **Monitoring and Control:** Real-time data adjusts application as needed.
10. **Completion of Application**: The application ends when planned amounts are delivered.
11. **Rinse and Clean:** Equipment is cleaned to prevent residue buildup.
12. **Data Recording and Analysis:** Data is stored for record-keeping and planning.

Cost saving and increased yields:

Herbigation systems make ensuring that herbicides are administered only, when necessary, precisely focusing on weeds. Thus, herbicide waste is reduced.

Reduced Need for Multiple Applications: Herbigation enables the precise timing of herbicide application, focusing on weed growth stages when they are most sensitive.

Economic Efficiency: Farmers can reduce overapplication and related costs by optimizing herbicide dosages via herbigation.

Effective Weed Control: Herbigation's accuracy ensures that weeds are effectively managed, reducing competition with crop plants for nutrients, water, and sunlight.

Reducing Stress: Crops that have enough water and faceless weed competition are less stressed, which results in healthier and more fruitful plants.

Case studies demonstration:

Kanimozhi *et al.* (2019)[1] carried out a field experiment to study the effect of herbigation through micro-sprinklers on weed flora, weed dry weight, and weed control efficiency & revealed that among the herbicides tried **oxyfluorfen** performed better in terms of weed control than the pendimethalin. Further, results revealed that weed density and its dry weight obtained under 100 % of the recommended dose applied as herbigation through a micro sprinkler was at par with a conventional method of spraying. Nalayani *et al.* (2013)[2] observed that no significant difference was observed between herbigation and conventional spraying methods on weed control efficiency in the pre-emergence application (3 DAS), while herbigation was found to be effective for post-emergence weed control habitat Protection: Efforts are underway to designate critical bat habitats as protected areas, limiting human disturbance and habitat destruction. Rankova *et al.* (2007)[3] illustrated that micro-irrigation could be successfully used for herbicide application in orchards and herbigation had no negative effect on both the tree growth and yielding and the soil microbial activity.

Challenges and future of herbigation :

Herbigation is a cutting-edge agricultural method that combines irrigation and herbicide application. The financial barrier posed by the cost of implementing herbigation technology, the need for specialized technical expertise to use and troubleshoot equipment, the possibility of equipment malfunctions that could thwart the herbigation process, and the environmental issues connected to ineffective practices, like herbicide runoff, are all challenges. Looking forward, the future of herbigation holds promise with advanced AI, global adoption, sustainability, climate resilience, and evolving regulations. This trajectory seeks not just efficiency but environmentally friendly agriculture, charting a sustainable future in food production.

Conclusion

Herbigation, an inventive blend of irrigation and herbicide use, has the power to completely change the agricultural industry. Using less herbicide, spending less money, and having less environmental impact are all benefits of this kind of weed management, which is in line with sustainable farming methods. Herbigation simultaneously improves irrigation by making sure crops receive the proper amount of water at the proper time, preserving water supplies, and raising yields. Herbigation serves as a ray of hope by demonstrating how technology can revolutionize weed management and irrigation to usher in a more effective, environmentally friendly, and fruitful future in agriculture as concerns about water scarcity and environmental sustainability spread across the globe.

References:

Kanimozhi, G., Sathayamoorthy, N. K., Babu, R., & Prabhakaran, J. 2019. Effect of herbigation through micro-sprinklers on weed flora, weed dry weight, and weed control efficiency, *IJCS*, 7 (3), 3528-3531.

Nalayini, P. & Sankaranarayanan, K. & Velmourougane, Kulandaivelu.2013. Herbigation in cotton (**Gossypium spp**): Effects on weed control, soil microflora, and succeeding green gram (**Vigna radiata**).*Indian Journal of Agricultural Sciences*. 83. 1144-1148.

Rankova, Z., Koumanov, K. S., Kolev, K., & Shilev, S.2007.Herbigation in a cherry orchard-efficiency of pendimethalin. *In I Balkan Symposium on Fruit Growing* 825 (pp. 459-464).

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SUCCESS STORY ON DOUBLING FARMERS INCOME (DFI)

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Abstract

Doubling Farmers Income Programme has been started by the K.V.K West Kameng from the year 2017 to uplift the socio-economic status of famers in the district. The seven villages from the various location of the district have surveyed for the said purpose by the KVK West Kameng where there was sufficient available resource to implement the programme beside some constraints. The name of villages is Sagar, Barchipam, Lachang, Khasso, Chug, Khalibhok and Yewang respectively. After the survey a meeting has been conducted by the K.V.K with the district administration, line departments and other related departments to select the one village among these villages for the said purpose. After the village selection the porogramme was immediately started by the K.V.K West Kameng through the involvement of farming community of the village including men and women both, as they play an important and major role especially at household level for the upliftment of their family socioeconomic status. The data recorded revealed that the programme has a very good response in term of improved income and nutritional status of the farmers and their dependents besides the new source of gainful employment opportunity through various suitable related sectors

Key words: D.F.I, socio-economic upliftment, diversified, commodity, I.F.S, Ducklings, culture material etc

Overview of the Programme and Selection of Village:

In India about 70% of the total population, depends on agriculture / allied sectors and lives in rural areas for their livelihood at subsistence or near subsistence level. These rural folk require not only a large supplement of nutritional food for their daily routine work but also needs new sources of gainful employment for their overall development.

Agriculture and its allied sectors play a significant role in the economy of Arunachal Pradesh, being the main occupation of the majority of the people. In the recent years, main emphasis is focused towards double the farmers income through all the possible means of agriculture and allied sectors. In view of the above facts a prestigious Doubling Farmers Income Programme has been started by the K.V.K West Kameng from the year 2017 to uplift the socioeconomic status of famers in the district. The seven villages from the various location of the district has surveyed for the said purpose by the KVK West Kameng where there were sufficient available resource to implement the programme beside some constraints. The name of villages is Sagar, Barchipam, Lachang, Khasso, Chug, Khalibhok and Yewang respectively. After the survey a meeting has been conducted by the K.V.K with the district administration, line departments and other related departments to select the one village among these villages for the said purpose. After meeting it has decided by District Administration and all the other stakeholders that we have to work in Chug Village which comes under Dirang circle of West Kameng District Arunachal Pradesh. This district lying approximately between 91° 30' to 92°40’ East longitudes and 26° 54' to 28° 01' North latitudes and covers about 7422 Sq.KM of geographical region accounting for 8.86% of the total area of the state. After the village selection the porogramme was immediately started by the K.V.K West Kameng through the involvement of farming community of the village including men and women both, as they plays an important and major role especially at household level for the upliftment of their family socioeconomic status.

Interventions made for improving income:

After the mass awareness as well as mass training programmes by the different experts of the K.V.K on related topics the seed of improved varieties of different crops like Pulses, Oil-Seeds, Vegetables and also fish fingerlings along with feed were distributed to farmers. They were also facilitated with different commodity which may be beneficial in integrated farming system, like poultry birds, Ducklings and goat also for rearing to improve their livelihood and nutritional status.

Various training Programmes for farming skill improvement of farmers and farm women

Aquaculture Related interventions for improving income

Income through Production of Palanting Material Vegetable and fish seed raising

Solar Fencing Instantiation to save the crops from animals

Vegetable Crop grown after fencing

Vegetable Production for income generation

The farmers were also trained about allied activities like mushroom farming vermi-composting, Seasonal Vegetable production, Production of planting material for temperate fruit plant and fish seed raising etc. for income generation

Vermi-compost production Technology for income generation and soil conservation

Impact/Outcome of the interventions made under DFI:

After the two years study (2017-2019) the data recorded revealed that the programme has a very good response in term of improved income and nutritional status of the farmers and their dependents besides the new source of employment opportunity through various suitable related sectors like nursery production of horticultural crops and seed rearing of different varieties of fish which provides not only the well acclimated culture material but also becomes a very good means of income generation.

Conclusion

As a DFI Nodal officer I personally feel that the interventions made by our Kendra along with help of line departments it has very good impact and played a pivotal role to uplift the socio-economic status of farmers/villagers in addition to improved nutritional security and gainful employment opportunity to un employed rural populace of the region. It has to be noted that this has been a continuous effort spanning many years (2017-2022) and the overwhelming response of the farmers towards new and improved ways has been rewarded with more benefits and profits.

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VARIOUS TILLAGE AND LAND PREPARATION TECHNIQUES

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Introduction

Land preparation is an essential step in agriculture and land development, where the goal is to create a suitable environment for planting crops or carrying out various land-based activities. Proper land preparation helps improve soil quality, control weeds, and create an environment conducive to successful crop growth or other land uses. The specific techniques and steps involved in land preparation can vary depending on the intended use of the land, but here are some general steps commonly involved:

Site Selection and Assessment: Before any land preparation begins, it's important to select the right site and assess its suitability for the intended purpose. Factors to consider include soil type, drainage, topography, climate, and proximity to water sources.

Clearing and Demolition: If the land is covered with vegetation, trees, or existing structures, these need to be cleared or demolished as necessary. This may involve removing trees, shrubs, rocks, and other debris.

Soil Testing: Soil testing is crucial to determine the composition and nutrient content of the soil. This information helps in making decisions about soil amendments, fertilization, and crop selection.

Plowing: Plowing is the process of turning over the soil using a plow or similar equipment. It helps to break up compacted soil, bury plant residues, and prepare a seedbed. The depth and type of plowing depend on the crop and soil conditions.

Harrowing: Harrowing follows plowing and involves breaking down clods of soil, leveling the surface, and creating a finer seedbed. This is typically done with a harrow or disk harrow.

Adding Soil Amendments: Based on soil test results, you may need to add soil amendments such as lime, organic matter (compost or manure), or specific fertilizers to improve soil fertility and pH.

Irrigation and Drainage: Install irrigation systems if needed to ensure proper water supply for crops. Likewise, assess and establish drainage systems to prevent waterlogging in low-lying areas.

Bed Preparation: In some cases, raised beds or rows may be created for planting, especially in vegetable farming. This involves forming elevated planting areas with defined rows for better drainage and organization.

Weed Control: Implement weed control measures such as herbicide application or manual weeding to reduce weed competition with crops.

Crop Rotation and Planning: If practicing crop rotation, plan the layout and order of crops to optimize soil health and minimize disease and pest issues.

Final Soil Preparation: Before planting, the soil should be well-prepared with a smooth surface. This may involve a final pass with a harrow or a roller to achieve the desired seedbed conditions.

Planting: Once the land is adequately prepared, you can proceed with planting the desired crops or carrying out the intended land use activity

Tillage

In agriculture, tillage refers to both the initial preparation of the soil for planting and the subsequent cultivation of the land. By using tools, the soil is mechanically moved or manipulated into the desired state by tillage (such as pulverization, cutting, or movement). Tilling the soil modifies its composition, eradicates weeds, and controls agricultural wastes. In order to improve water uptake, storage, and transmission as well as to provide a favorable environment for seeds and roots, soil structure alteration is frequently required. Weed control is essential because they compete with plants for resources like water, nutrients, and light. In order to create conditions favorable for planting and maintaining a crop, crop wastes that are visible on the surface must be controlled.

A hardpan, also known as a plow sole, is a compacted layer that may be formed as a result of tillage, especially traditional plowing. These layers are more common as mechanization levels rise; they lower agricultural yields and must be broken, allowing water to be stored in and below the broken zone for subsequent crops. Tillage also contributes to the erosion of fertile topsoil, a severe risk to the long-term viability of arable land.

Tillage's purposes in crop production

- To enable enough soil aeration for gaseous exchange in the seed and root zone and to allow water to flow to the seed and seedling roots.
- Soil that is not coated to allow seedling emergence
- A low-density soil that encourages root extension and growth
- To provide a weed-free environment that allows the seedling to receive enough light.
- To eliminate pests and pathogens, to mix the manures and fertilizers that have been applied with the soil, and, if necessary, to remove any hardpan to enhance the soil's depth for water absorption.

Types of Tillage

A. Primary Tillage

Depending upon the purpose or necessity, different types of tillage are carried out. They are deep ploughing, subsoiling and year-round tillage.

1. Deep Tillage

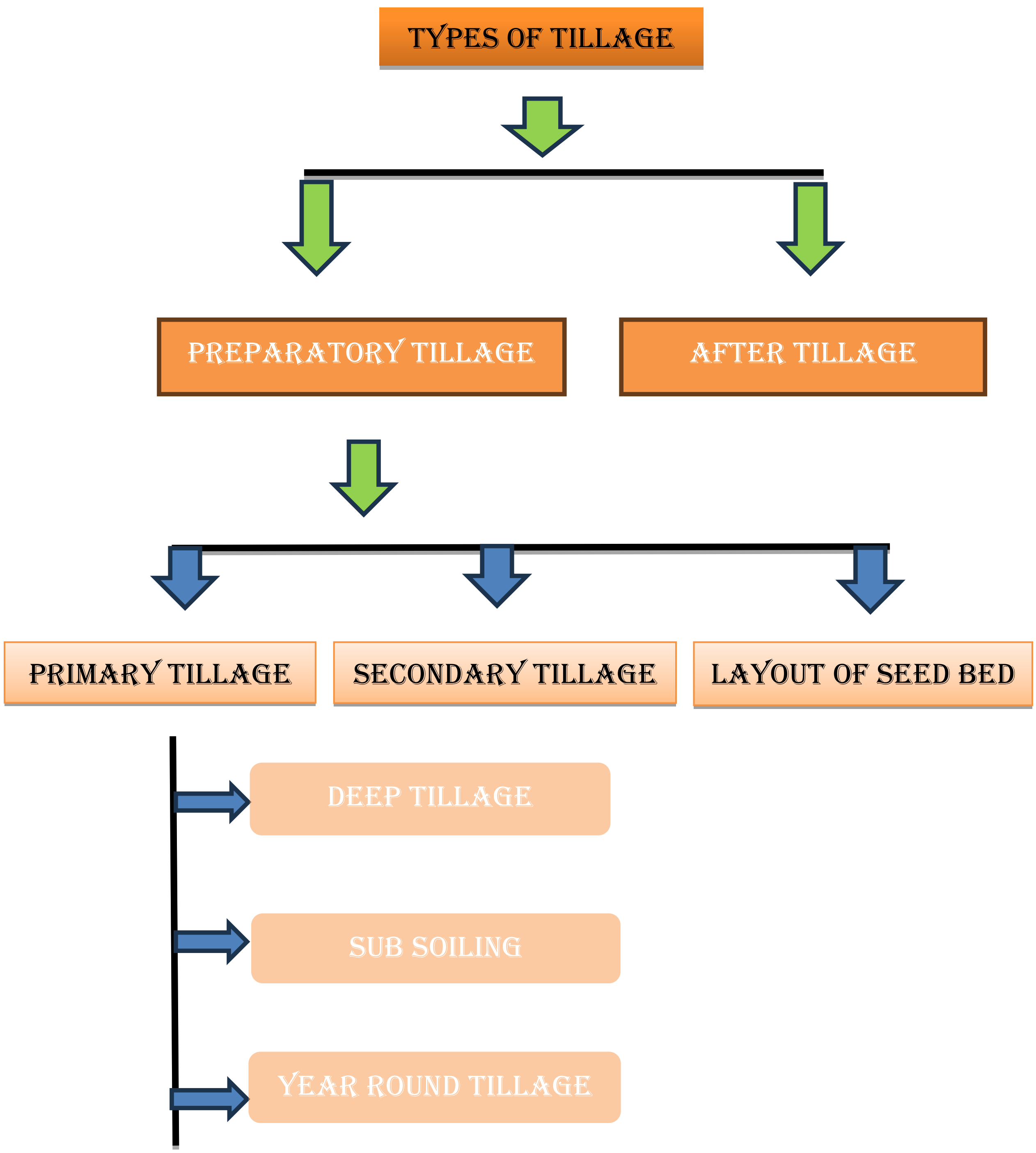
When done in the summer, deep plowing creates enormous clods that are cooked by the hot sun. These clods break apart as a result of intermittent summer showers, heating, and cooling. The progressive breakdown of clods enhances the structure of the soil. Perennial weeds, including the world's two most troublesome weeds, *Cynodon dactylon* and *Cyperus rotundus*, lose their rhizomes and tubers when they are exposed to the sun's heat. Due to the pupae being exposed to the intense sun, summer deep plowing eliminates pests.

For deeply rooted crops like pigeon pea, deep tillage of 25 to 30 cm is necessary, although maize only needs moderate deep tillage of 15-20 cm.

Additionally, deep tillage increases soil moisture content. The benefit of heavy tillage in dry farming conditions, however, depends on rainfall pattern and crop.

2. Subsoiling

In the soil, there could be hard pans that prevent plants from growing roots. These could be clay pans, silt pans, iron or aluminum pans, or pans that were created by humans. Pans caused by repeated tillage at the same depth are referred to as man-made pans. Crop roots can only grow in the first few centimeters of soil because hard pans prevent the roots from penetrating deeply.



3. Year-round Tillage

Year-round tillage refers to tillage activities performed all year long. Summer showers aid to start field preparation in arid farming zones. Up until the crop is sown, tillage operations are repeated. To prevent weed development during the off-season, the field is regularly plowed or harrowed even after the crop has been harvested.

B. Secondary Tillage

Secondary tillage refers to lighter or finer procedures done on the soil after main tillage. Large clods with some weeds and stubbles partially uprooted remain in the fields after plowing. To break up the clods and pull the last of the weeds and stubble, harrowing is done at a shallow depth. For this, tools like disc harrows, cultivators, blade harrows, etc. are employed.

To smooth the earth's surface and softly compact the soil, planking is done to smash the hard clods. So, following plowing, the land is prepared for sowing by harrowing and planking. Secondary tillage typically includes seeding operations as well.

C. Layout of Seedbed and Sowing

The field is correctly laid out for watering, sowing, or planting seedlings following the preparation of the seedbed. These procedures are tailored to certain crops. A flat seedbed is prepared for the majority of crops, including wheat, soybeans, pearl millet, groundnuts, castor, etc. These crops are seeded without any land treatments after the secondary tillage. The inability to tillage during the rainy season and the poorly drained conditions make it difficult to cultivate crops in deep black soils during this time. Therefore, broadbed and furrows (BBF) are made before the monsoon arrives, and dry seeding is used.

The field needs to be divided into ridges and furrows in order to accommodate some crops, such as vegetables and maize. Planting of sugarcane occurs in the trenches or furrows. To promote two-way inter culture, crops including tobacco, tomatoes, and chillies are planted with equal inter- and intra-row spacing. A marker is run in both directions after field preparation. At the intercepts, the seedlings are replanted.

After Cultivation

After tillage refers to the tillage procedures performed on the standing crop. It comprises intercropping, earthing up, and drilling or side dressing of fertilizers.

Earthing up is a process used to create ridges at the base of the crop using a country plough or ridge plough. It is done either to add more support against lodging, as in the case of sugarcane, to add more soil volume for better tuber growth, as in the case of potatoes, or to make irrigation easier, as in the case of vegetables.

Inter cultivation is the practice of using rotary hoes, blade harrows, etc. between crop rows to control weeds. Inter culture can help black soils with moisture retention by sealing up large fractures in the soil.

Modern concepts of Tillage

Energy is frequently lost in conventional plowing, and occasionally soil structure is destroyed. Significant changes have recently been made to tillage techniques, and various new ideas, such as minimum tillage, zero tillage, and stubble mulch tillage, have been presented.

The high expense of tillage as a result of the sharp increase in oil prices was the immediate reason for introducing limited tillage. Additionally, there are issues with traditional tillage. Heavy mechanical use over time ruins structures, creates soil pans, and promotes erosion.

Planting zones (row zones) have different requirements than water management zones (inter row zones). In row crops, providing fine tilth in the row zone is adequate to create the conditions for sowing and promote complete and quick germination and seedling establishment. Secondary tillage should be avoided in the inter-row zone where the soil structure is open and coarse in order to prevent weed germination and increase water infiltration. Herbicides can be used to control weeds, which is the main goal of tillage.

1. **Minimum Tillage**

It involves considerable soil disturbance, though to a much lesser extent than that associated with conventional tillage. Minimum tillage is aimed at reducing tillage to the minimum necessary for ensuring a good seedbed, rapid germination, a satisfactory stand, and favorable growing conditions.


Tillage can be reduced in two ways:

I. by skipping procedures that are not cost-effectively beneficial.

II. by mixing agricultural tasks like sowing seeds and applying fertilizer.

Advantages of minimum tillage

- Improved soil conditions as a result of in-situ plant residue breakdown;
- Increased infiltration brought on by vegetation on the soil and channels created by dead root decay;
- Better structure reduces barrier to root growth;
- Compared to conventional tillage, there is less soil erosion and less soil compaction caused by the decreased movement of large tillage trucks.

Note: After two to three years of little tillage use, these benefits are noticeable on coarse and medium-textured soils.

Disadvantages of minimum tillage

- Minimum tillage results in poorer seed germination.
- More nitrogen must be provided in minimum tillage because organic matter decomposition proceeds slowly.
- Some leguminous crops, like peas and broad beans, have impaired nodulation.
- Using standard equipment to sow is challenging.
- Herbicide use on a continuous basis contributes to weed dominance and pollution issues.
- Various minimum tillage techniques are used.

2. **Zero Tillage**

Zero tillage is also called no till. Zero tillage is an extreme form of minimum tillage. Primary tillage is completely avoided, and secondary tillage is restricted to seedbed preparation in the row zone only.

One way to practice zero tillage is through till planting. The equipment handles four jobs at once: cleaning a small area above the crop row, opening the soil for seed insertion, planting the seed, and carefully covering the seed. A small strip is opened by a planter shoe and into which seeds are sown and covered after a wide sweep and rubbish bars have cleared a strip over the preceding crop row.

In zero-tillage, herbicide functions are extended. Before sowing, the vegetation present has to be destroyed, for which broad-spectrum, nonselective herbicides with relatively short residual effects (paraquat, glyphosate, etc.) are used.

3. **Stubble mulch Tillage**

The conventional method of tillage results in soil erosion. Stubble mulch tillage, or stubble mulch farming, is a new approach to keeping soil protected at all times, whether by growing a crop or by crop residues left on the surface during fallow periods. It is a year-round system of managing plant residue with implements that undercut residue, loosen the soil, and kill weeds.

Sweeps or blades are generally used to cut the soil up to 12 to 15cm deep in the first operation after harvest, and the depth of cut is reduced during subsequent operations. When an unusually large amount of residue is present, a disc-type implement is used for the first operation to incorporate some of the residues into the soil. This hastens decomposition but still leaves enough residue on the soil.

Two methods are adopted for sowing crops in stubble mulch farming:

I. A wide sweep and trash bars are used, similar to zero tillage, to clear a strip, and a thin planter shoe opens a narrow furrow into which seeds are sown.

II. All plant remains are left on the surface after the soil is worked through with a narrow chisel that is 5 to 10 cm wide and 15 to 30 cm deep.

Tillage pans and surface crusts are broken using the chisel. Planting is carried out using specialized planters through wastes.

Conclusion

In conclusion, tillage is a critical aspect of agriculture, but its impact on soil health, the environment, and farm economics depends on the specific methods used. Farmers should carefully consider their goals and local conditions when choosing their tillage practices, with a growing emphasis on conservation tillage methods to mitigate negative environmental effects and promote long-term sustainability.

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ddRADseq: TYPES AND TOOLS FOR DATA ANALYSIS

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Abstract

The Restriction Associated Digestion (RAD) sequencing is a rapid, inexpensive method compared to Whole genome sequencing method. The ddRAD method has its own advantage of size selection of reads for better accuracy compared to all other RAD sequencing methods. The different individual bioinformatic tools to identify and annotate the SNPs has been discussed in this article to attain better results.

Keywords: ddRAD, data analysis, online tools*)*

Introduction

In order to address the limitations associated with whole genome sequencing/re-sequencing for genome wide SNP/marker discovery, the research community has been developing alternative strategies, which are cost effective. These alternative techniques are NGS-based and aim at reducing genome complexities and are known as reduced representation approaches. In contrast to whole genome sequencing/re-sequencing, a basic feature associated with these techniques is to have a subset of a genome sampled and sequenced without loss of much information of genome. Various methods which use restriction enzymes to reduce the genome complexity is known as Restriction-Site Associated DNA sequencing (RADseq).

History and types of RADseq

RADseq is a reduced representation next generation sequencing and genotyping technique using restriction enzymes where homologous tags spread throughout the genome are sequenced. Here SNPs are identified and genotyped simultaneously. This method is cheaper and faster. Also known as Genome Wide Sampling Sequencing (GWSS).

The term RADseq was originally used to describe one particular method (Baird et al., 2008) but has subsequently been adopted to refer to a range of related techniques that rely on restric-tion enzymes to determine the set of loci to be sequenced. These methods are also grouped under the term 'genotyping by sequencing' (GBS). As with RADseq, the term GBS was also originally used to describe one specific method (Elshireet al., 2011); however, this term is less descriptive than RADseq, which captures the fundamental feature of these methods, like, the use of restriction enzymes to obtain DNA sequence at a genome-wide set of loci.TheRADseq methods (Baird et al., 2008 Andrews et al., 2016) involves the following steps.

1. Digestion of multiple samples of genomic DNA with one or more restriction enzymes, and attachment of adaptors to the fragment ends
2. A size selection or reduction of the resulting restriction fragments
3. NGS of final set of fragments which is normally less than 1 kb in size

The RADseq family consists of different methods like:-

1. Complexity reduction of polymorphism sequencing (CRoPS):

Complexity reduction of polymorphic sequences (van Orsouwet al., 2007) uses two enzymes and AFLP primers for complexity reduction

2. Reduced representation libraries (RRL):

Reduced representation libraries (Van Tassellet al., 2007) use a blunt-end common-cutter enzyme, followed by a size selection step.

3. Restriction site associated DNA sequencing (RAD seq):

Restriction site-associated DNA sequencing (Baird et al., 2008; Miller et al., 2007) digests the genomic DNA with one restriction enzyme, followed by mechanical shearing to make fragments size suitable for sequencing. A modification of RADseq, the 2bRAD (Wang et al., 2012; Guoet al., 2014) method uses type IIB restriction enzymes, which cleave DNA upstream and downstream of the recognition site, thus producing short fragments of uniform length

4. **Genotyping by Sequencing (GBS):**

Genotyping by sequencing (Elshire et al., 2011) uses a common-cutter enzyme, and PCR preferentially amplifies short fragments.

5. **Double-digest RAD (ddRAD seq):**

This is a modified form of RADseq method. Double-digest RAD (Peterson et al., 2012) uses two restriction enzymes along with adaptors specific to each enzyme, and size selection by automated gel cut. These modifications have given ddRAD the following advantages over other methods:

a) Low cost and less time to prepare the sequencing libraries
b) High level of multiplexing
c) Precise size selection
d) Less reads to achieve high confidence SNP calling

RADseq method has been extensively used in plants, non-model organisms and livestock species.The SNPs identified and genotyped using RADseq method have been used for a wide range of downstream applications like development of SNP arrays, construction of genetic maps, MAS, GWAS, GS,genetic introgression and genomic diversity studies conservation and phylogenomics studies.

Bioinformatic analysis

Quality Control of reads

After sequencing, the reads needs to be de-multiplexed to obtain reads for each sample. QC check of the raw reads has to be done using PRINSEQ and STACKS. The barcode in the reads need to be trimmed using PRINSEQ to avoid noise during processing of rad tags.

Aligning the reads with reference genome

The index of the reference genome has to be built using Bowtie2-2.3.3.1(http://bowtie-bio.sourceforge.net/bowtie2). Reads passing QC can be aligned to the *Gallus gallus* reference genome [2] (https://www.ncbi.nlm.nih.gov/genome) using Bowtie2-2.3.3.1(http://bowtie-bio.sourceforge.net/bowtie2).The parameters can be set to very sensitive local paired end alignment and the maximum fragment length including gaps for the valid paired end alignment can be set to 1000 bp.

Variant calling

Samtools (https://github.com/samtools/samtools/releases/) can be used to convert the resulting SAM sequence alignment files to BAM format, followed by sorting, indexing and merging. BCFTOOLS (https://github.com/samtools/bcftools/releases/) can then be used to call the variants.To call the variants, the aligned files have to be viewed, sorted indexed and merged for final variant calling. Further, the variants can be filtered for read depth and basecall quality score for final separation of INDELs and SNPs.

Annotation of SNPs

The SNPs identified versus the reference genome can be annotated for their position, contig location, reference allele, alternate allele, effect and functional variation using SNPEFF (http://snpeff.sourceforge.net/). For gene wise annotation, the candidate genes responsible for the major traits can be collected from various literature or online databases. The genomic location of the candidate genes can then be drawn from the NCBI database and the SNPs position can be captured and annotated using VCFTOOLS.The SNPs identified versus the reference genome can be annotated by capturing the SNPs at different chromosomes using VCFTOOLS software program.

Conclusion

An understanding of the free online tools available for the analysis of ddRAD data is required and is explained. Moreover, usage of command line tools has its own advantage of having more flexibility as well its free availability and regular update.

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Conflict of interest

The authors declare that there is no conflict of interest.

References

Sambrook J, Fritschi EF, Maniatis T. (1989) Molecular cloning: a laboratory manual, Cold Spring Harbor Laboratory Press, New York.

https://www.ncbi.nlm.nih.gov/genome

http://prinseq.sourceforge.net/manual.html

http://catchenlab.life.illinois.edu/stacks/comp/process_radtags.php http://bowtie-bio.sourceforge.net/bowtie2/manual.shtml

http://www.htslib.org/doc/samtools-1.6.html

https://samtools.github.io/bcftools/bcftools.html

https://vcftools.github.io/man_latest.html

http://snpeff.sourceforge.net/SnpEff_manual.html

http://snpeff.sourceforge.net/SnpSift.html

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AIR LAYERING IN MORINGA

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Abstract

Moringa (*Moringa olerifera*) or drumstick or horseradish tree is an important vegetable crop with impressive range of medicinal uses with high nutritional value. It is also called as miracle tree as almost all parts of the tree like leaves, flowers, fruits, root bark and seed are consumed and have various importance in medicine and cosmetic industry. The tree have rich source of vitamins (vitamin A,B,C,D), minerals (iron, potassium, zinc, calcium), antioxidants, anti-inflammatory, anti-diabetic, anti-cancerous, anti-ulcer and anti-arthritic and anti-microbial properties). It also have flavonoids, phenolics, terpenoids, saponins, alkaloids, phytovhemicals, sterols compounds, Poly unsaturated fattyacids (PUFA) like linoleic acid, linolenic acid and oleic acid (lakshmipriya et al., 2016).

Air Layering in moringa

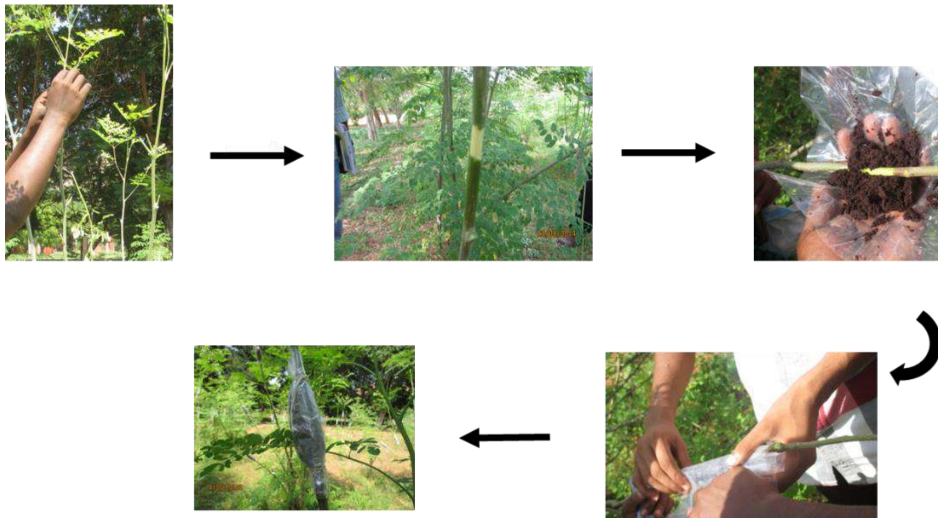
The growth habit of moringa tree is of two types, perennial and annual, both are cross pollinated. Seed propagation is common in moringa crop. But the demand for seeds is very high in the market as it is used for preparation of oil for cooking and industrial requirements. Seed oil of moring is called as Ben oil which is also used as lubricants. Limb cutting for perennial moringa and seed propagation for annual and perennial moringa are followed commercially. One of the problems related to moringa cultivation is maintaining the genetic purity of the tree. In case of seed propagation, selfing and storage are tedious and also a quantum of pods is used for seed extraction purpose and hence, alternate method of propagation is the need of the hour. To overcome economic loss and to maintain genetic purity asexual propagation is an alternate method. In annual Moringa limb cutting was not successful and hence, air layering was chosen for propagation. By this method the product may be heterozygous or homozygous, but the parent genetic background can be maintained.

Methodology

Air layering is the type of layering where the propagative material are generated from the branches with formed roots on the parent plant. After root development the propagative material is detached, hardened and transplanted.

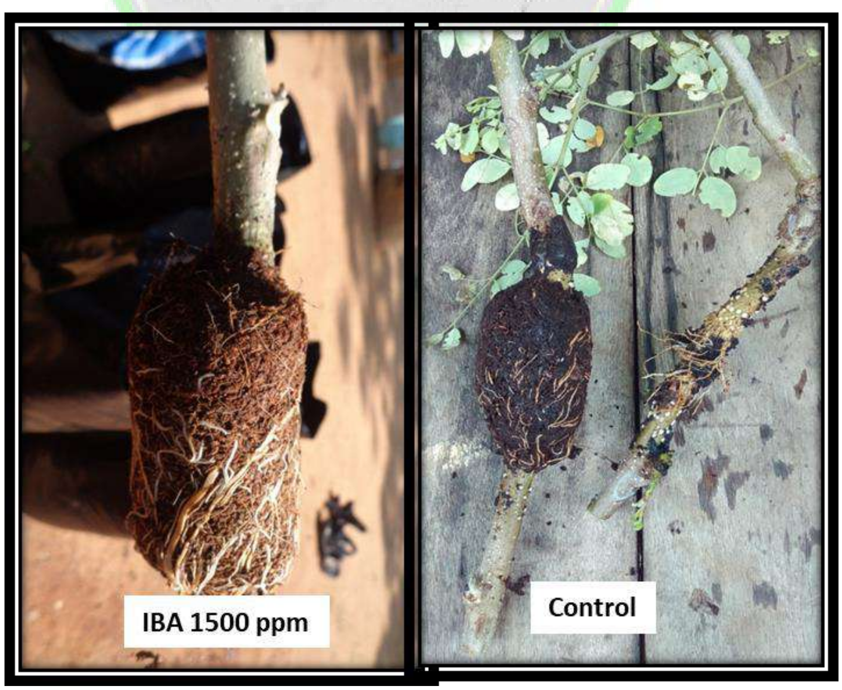
1. The good healthy straight branch/stem of approximately one-two year was selected. Remove the basal nodes, leaves for about 30cm
2. The selected stem is given a wound by removing a ring (approx. 1 to 1.5 cm length) like cut and remove the bark of that portion.
3. Here the medium used for layering is cocopeat treated with different concentrations of rooting hormone indole 3-butyric acid (IBA).
4. The hormone treated cocopeat is kept over the wound portion and tied both side with the help of plastic sheets and thread. In order to protect it from weather
5. The air layered plants are maintained properly till the root initiated are visible from the outside (approx. 5- 6 months)
6. After examination of proper root growth the new shoots are detached from mother plant and hardened
7. After hardening of one to two months the air layered shoots are transplanted to the main field.

The physiology behind the creation of wound and application of rooting hormone IBA is that the branch girdling could cause blockage in the acropetal and basipetal flow of photo-assimilates in the phloem, causing an accumulation of several metabolites (organic compounds, carbohydrates, auxins, etc.) in the cut portion which initiates the callus for root primordium. And also the IBA triggers the rooting as auxin levels generates regional concentration gradients for establishing and maintaining a root primordium. The air layered branch is not separated from the mother plant and therefore, receives continuous supply of water and mineral nutrients through the xylem and remains alive (Hartmann *et al*., 2010) and intact shoots (with leaves) possibly synthesize auxillary substances, which can help to induce of adventitious roots (Singh *et al.*, 2004).

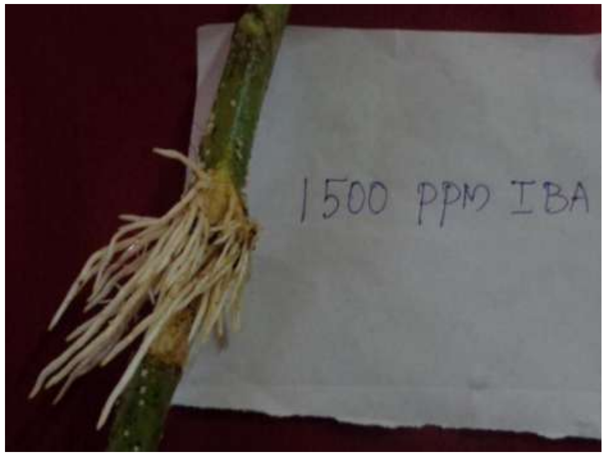


After transplantation of air layered shoots

After transplanting the air layered moringa shoots were assessed for its growth and development. The IBA treated air layers had good root establishment, increased plant girth, short in stature and early flowering compared to the normal air layered shoots. The IBA concentration of 1500 PPM for air layering showed positive results with high success percentage and seedling establishment in the main field of moringa. The dwarfness may be attributed due to higher root biomass in the treated plants as compared to the control and also due to higher branching in the treatment with IBA 1500 ppm.



Root development in IBA 1500 ppm and control



Root development in moringa layered plants

Hence air layering with rooting hormone IBA sounds as good alternate source to produce genetically pure planting material and for asexual propagation of annual moringa. This method of production of planting material will reduce the demand of economic parts of moringa which is very nutritive.

References

Gopalakrishnan, L., Doriya, K., & Kumar, D. S. (2016). Moringa oleifera: A review on nutritive importance and its medicinal application. *Food science and human wellness*, *5*(2), 49-56.

Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2002). Plant propagation: principles and practices, *Prentice-Hall. Inc*. New Jersey. USA.

Singh, S. P., Kumar, A.K, Mandal & Ansari, S.A. (2004). Air-layering of trees with differential adventitious rooting response. *Indian Forester, 130* (3): 318-322.

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JUBLIANT JHONSON GRASS

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Introduction:

Johnson grass, botanically called ***Sorghum halopense*** **(2n: 40)** is an herbaceous perennial fodder grass belonging to Poaceae family. It is a wild relative to cultivated Jowar (*Sorghum bicolor*) which is widely adapted to variety of habitats. Johnson grass is adapted to a wide variety of habitats including open forests, old fields, ditches and wetlands. It spreads aggressively and can form dense colonies which displace native vegetation and restrict tree seedling establishment. *Sorghum halepense* has naturalized throughout the world, but it is thought to be native to the Mediterranean region. It was first introduced into the United States in the early 1800s as a forage crop from where it spread throughout the world. Though it is the most prominent weed species affecting growth and cultivation of maize and sorghum, Johnson grass is high-quality forage and cattle tend to select it in pastures to graze.

Origin and distribution:

The tetraploid *Sorghum halepense* (2n: 40) emerged less than 2 million years ago during a natural hybridization and chromosome duplication between diploid (2n: 20) *Sorghum bicolor*, a drought resistant crop native to tropical Africa, and rhizomatous southeast Asian *Sorghum propinquum* gaining the ability for vegetative reproduction by rhizomes (Paterson et al., 2020). *Sorghum nitidium*, *Sorghum dochna*, *Sorghum arundinaceum* and *Sorghum propinquum* are the four related species, where *Sorghum propinauum* is the putative parent of the Johnson grass through natural cross with cultivated *Sorghum. bicolor*. Jhonson grass is native to the Mediterranean region of Europe and Africa, and possibly to Asia Minor. Its range as a weed extends from 55° N to 45° S in latitude on worldwide. It was widely introduced in North America, Europe, Africa, and southwestern Asia, and was also introduced in Brazil, Argentina, and northern Australia. Johnson grass also occurs in Hawaii and the Caribbean (Venkateswaran et al., 2019). Johnson grass was introduced in South Carolina in the United States, from Turkey around 1830. William Johnson, whom the plant is named after, established Johnson grass along the Alabama River in the 1840s as a forage species, and Johnson grass spread rapidly across the South (Garber, 1950). Johnson grass is now widely escaped from cultivation in much of the United States. It is most invasive in the Southeast, although it is widespread in central California and New Mexico. Johnson grass is not persistent in the Pacific Northwest, upper northern Great Plains, extreme northern portions of the Great Lake states, the Northeast, or in Arizona, Colorado, and Utah. Plants database provides a state distributional map of Johnson grass. Occurrence of Johnson grass is not well documented for all plant communities where it may occur.

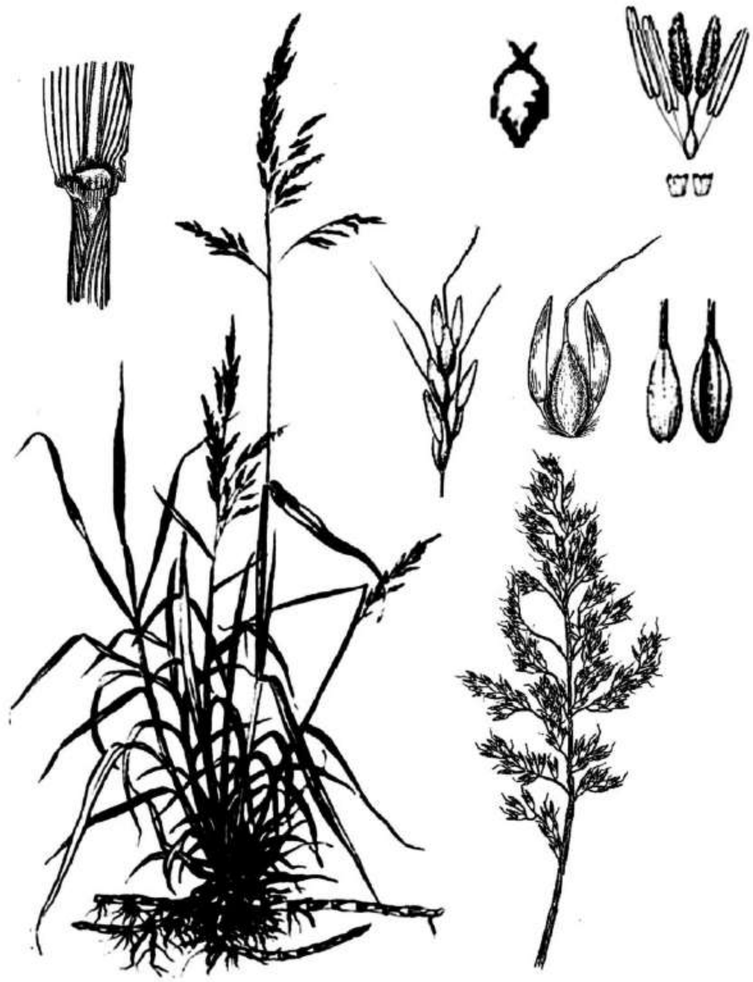

Fig 1. Jhonson grass - *Sorghum halopense*

Botanical description:

Jhonson grass is a perennial grass from extensive thick creeping scaly rhizomes, or annual by winter killing. Johnson- grass plants is having both roots and rhizomes (*i.e.*, horizontal underground stems). Rhizomes are white to brown in color and may contain purple spots and nodes covered by brown scaly sheaths. It is 50-150 cm tall, simple or branched and glabrous; a stout and sheathe stem is called a culm. Leaves blades 20-70 cm long, 5-30 mm wide, flat, somewhat narrowed towards the rounded base, drooping, margins mostly rough. The upper blade surface is medium to dark green, while the lower blade surface is pale; both are smooth. The larger leaf has prominent central veins that are pale-colored. The junctions of leaf blades and sheaths have narrow strips of fine white hairs. Leaves occur primarily along the lower half of each stem. Sheaths are usually shorter than the internodes; Ligule membranous, ciliate, 2-3 mm. long. The Inflorescence of Johnson grass is panicle lanceolate to pyramidal in outline, soft white hairs in basal axil; primary branches solitary or whorled, spreading, lower part bare, upper part branched, the secondary branches tipped by racemes; racemes fragile, composed of 2-5 spikelet pairs. Usually, spikelets are in pairs although towards the tip of the inflorescence they may occur in three; when the spikelet is in pairs, the lower is sessile and perfect with the upper pedicelled, narrow, long and stamen-bearing; when the spikelet is in threes, one is sessile and perfect, the others are pedicelled and staminate. Sessile spikelet is elliptic, callus obtuse, bearded; lower glume is sub leathery, often pale yellow or yellowish brown at maturity, shortly pubescent or glabrescent, 5-7veined, veins distinct in upper part, apex tridenticulate; upper lemma is acute and mucronate or bilobed and awned or not, awn 1-1.6 cm long. They have pedicelled spikelet which is staminate, narrowly lanceolate, often violet purple. The fruit is called caryopsis, nearly 3mm long, oval, reddish brown, and glossy, marked with fine.

Growing conditions

Jhonson grass is adapted to a wide range of soil types within a pH range of 5 to 7.5. It is mainly found in arable lands, orchards, open waste grounds, roadsides, pastures, irrigated canals and ditches. It grows best in fertile lowland soils. It is not adapted to poorly drained clay soils, but it can tolerate short periods of flooding

Cultivation practices:

Jhonson grass, it is propagated easily without much after care cultivation practices. In case of sexually propagation, seed is sown in a nursery seedbed and only just cover the seed.

Germination takes place within two weeks. Prick out the seedlings into individual pots once they are large enough to handle and plant them out when large enough. Division as the plant comes into new growth. Larger divisions can be planted out direct into their permanent positions. We have found that it is best to pot up the smaller divisions and grow them on in a lightly shaded position until large enough to plant out. In case of asexual propagation, rhizomes are used. But it is cultivated in some areas with the recommended cultivation practices viz. Plough the land 2-3 times to obtain a good tilth and form ridges and furrows of 6 m long and 60 cm apart. For manuring the land, Spread 25 tonnes of FYM/ha before ploughing and incorporate well. Seeds are sown at a rate of 5 kg / ha with a spacing of 30 x 15 cm (Sow on both sides of ridges). Irrigate the field once in 7-10 days depending upon soil condition. Nutrient management is recommended as basal fertilizer of 45 : 40 : 40 kg NPK/ha, top dressing of nitrogenous fertilizer at rate of 45 kg at 30 days after sowing and finally after each harvest, apply 45 kg N/ha as basal. First weeding is done on 25-30 DAS to reduce the competitiveness, and there after based on necessity. Harvest at 75-80 days after sowing and subsequent harvests once in 50 days.

Fig. 2. Jhonson grass in flowering stage

Fodder quality of Johnson grass:

Green fodder: S*orghum halepense* yield around 17-18 t DM/ha/year under irrigated conditions. Addition of N, as well as planting with a companion legume, improves yields. It can be cut 2-3 times a season. It can be cultivated in combination with forage legumes such as soybean, sweet clover. As a green fodder, it yields 17-18 t/ha were obtained under irrigated condition. If grown with legume crop as a companion crop, it improves the yields of green fodder. It can be cut 2 to 3 times a season.

Pastures: Deer grazes all above ground portions of the plant but it make light to moderate use of Johnson grass. Rodents also make use of Johnson grass. In honey mesquite (*Prosopis glandulosa* var. *glandulosa*) plains of Texas, Heerman's Kangaroo rat and Great Basin pocket mouse used Johnson grass. Although they are susceptible of heavy grazing, Johnson grass is a good pasture grass and used to make fair-quality hay when cut in the boot stage. Dairy cattle gains weight and yields more milk when they pasture on Johnson grass.

Hay and silage: Johnson grass is considered as an excellent grass for hay and silage. Jhonson grass can supply winter hay provided frosted grass is not fed within two weeks after frost so that HCN has dissipated

Palatability: It is very palatable and nutritious in the early growing stage and hay quality is the highest at boot stage. It is moderately palatable and nutritious at later stage of growth. All the cattle and other domesticated livestock make moderate to good use of fresh Johnson grass.

Nutritive value: Per 100 g, the forage is reported to contain 9–15.5 g protein, 1.8–3.4 g fat, 34.5–44.6 g of non-fiber carbohydrate, 25.2–30.1 g fiber, 13.3–18.5 g ash, 1,290–1,340 mg CaO, 490–910 mg P_2O_5.

Toxicity: Johnson grass is most toxic when culms are actively growing. Generally, seedlings and sprouts have higher levels of dhurrin than plants are at flowering stage. They are also shows higher levels of dhurrin during secondary growth of plant which is nothing but the growth after it is grazed heavily. Environmentally, Johnson grass is most toxic after drought, extreme heat, frost, or when plants are wet with dew or light rain. Livestock poisoning can be prevented by waiting until new growth is 15 to 18 inches tall (38-46 cm) tall after drought, or deferring grazing until plants have dried after frost since HCN is formed as a result of dhurrin hudrolysis. Matured Johnson grass contains dhurrin, a cyanogenic glycoside that releases hydrogen cyanide after hydrolysis. Consuming Johnson grass can be lethal to cattle, with signs of dyspnoea, anxiety; muscular tremors and incoordination appearing 15 minutes after the animals begin to graze, followed by death 3 hours later. In order to prevent poisoning, grazing after frost or water stress should be avoided and it is recommended to dry the forage since HCN resulting from dhurrin hydrolysis is volatile. Ruminants, especially cattle, are more susceptible to dhurrin poisoning than monogastric herbivores like horses. Prolonged consumption of fresh Johnson grass can cause nitrate poisoning in ungulates but it is safe while grazing the plant having 46 cm height.

Uses of Jhonson grass

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1. Jhonson grass is an excellent grass for hay and pasture and it is palatable and nutritious when fed early.
2. A system of grazing Johnson grass and rough peas is often used to good advantage.

3. Elsewhere, the seeds are eaten in times of scarcity
4. Its root is used as a diuretic and coolant.
5. It is successful in reducing soil erosion as a plant cover alternative.
6. It can be grown as a fence line and also used for cut and carry forage crop.

Potential grass for hybridization with Sorghum:

Jhonson grass naturally hybridizes with various *Sorghum* species resulting in new perennial and rhizomatous hybrids able to persists harsh environment and establish themselves in new habitats. For example, up to 72% of *S. bicolor* and *S. halepense* F_2 hybrid off-springs develop rhizomes and able to withstand sub-zero winter temperatures with a survival rate of up to 71%. Studies on *S. halepense* crossings with various other *Sorghum* species result also in rhizomatous progenies. *S. halepense* may also open new doors to sorghum improvement, with synergy between gene duplication and interspecific hybridity nurturing the evolution of genes with new or modified functions (Ohno, 1970).

Advantages of Jhonson grass

1. It is used as valuable forage due to its high yield, palatability and quality.
2. It can be successfully used in reducing soil erosion as a plant cover alternative
3. It can be raised as a fence line along the border of the farm.
4. Sprouts from rhizomes develop faster than seedlings by taking advantage of rhizome carbohydrates accumulated during the winter.
5. Plants start to produce new rhizomes after five to seven true leaves have developed.
6. This grass is adapted to a wide range of soil types within a pH range of 5 to 7.5.

Limitations of Jhonson grass

1. Its palatability and quality quickly decrease after flowering, and cattle will avoid it.
2. It can be a nitrate accumulator and cause nitrate poisoning in cattle and horses causing severe cases leading to death 4 to 6 hours, or caused abortion 3 to 5 days after ingestion.
3. It is very difficult to eradicate because of its high seed yields and extensive rhizome development.
4. The first is its high susceptibility to overgrazing. Grazing all of the leaves and stems before flowering will eventually starve the plant to death.
5. Jhonson grass serves as an alternate host for many of the diseases of sorghum and maize.

References:

Garber ED (1950) Cytotaxonomic studies in the genus *Sorghum*. Univ Calif Publ Bot 23:283–362.

Ohno S. (1970). *Evolution by Gene Duplication.* Berlin: Springer.

Paterson AH et. al. (2020). The evolution of an invasive plant, *Sorghum halepense* L. ('Johnsongrass'). Front Genet 11:317. https://doi.org/10.3389/fgene.2020.00317

Venkateswaran K, Elangovan M, Sivaraj N (2019) Origin, Domestication and Diffusion of *Sorghum bicolor*. Breeding Sorghum for Diverse End Uses, pp 15–31.

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FARM MECHANIZATION: A BOON FOR FARMERS

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Introduction

Agriculture, being the mainstay of India's rural economy, contributes to employment and livelihood creation. The sector remains crucial for the economy, to meet food and nutritional requirements of population. Despite its vital role, the sector suffers from major hindrances and roadblocks in production, intermediaries and water scarcity, which have restrained growth. The rapidly growing population is leading to increased food demand. Hence, the food secu rity for the Nation has to be achieved. Hence, it is imperative to focus on increase in production, productivity and profitability in agriculture by improving the intensity of farm mechanization in the country.

Farm mechanization refers to the development and use of machines, which replace human and animal power in agriculture. In other words Farm Mechanization is the operation of using Agricultural Machinery to in agriculture to increase productivity and reduce the drudgery.

The farm mechanization aids in increasing production, productivity and profitability in agriculture by achieving timeliness in farm operations, bringing precision in placement of inputs, increasing utilization of costly inputs (seed, chemical, fertilizer, irrigation, water etc.) and by reducing labour cost and drudgery of farmers/farm women.

Advantages of mechanization

- ✓ Increase the land productivity by facilitating timeliness and precision/quality of farm cultivation
- ✓ Meet the labour shortages and manages the increasing demand for labour
- ✓ Decrease the environmental footprint of agriculture when combined with adequate conservation agriculture practices
- ✓ Reduces the drudgery and musculo- skeletal disorders of farm women caused by performing the farm activities continuously
- ✓ The amount of farm women/farmers work is significantly decreased as mechanization takes less man power to complete operations
- ✓ Need of lesser man power with the inception the mechanization results in decreased labour costs, as well as increased profits
- ✓ Production is completed in a shorter amount of time with the introduction of mechanization thus saves the time
- ✓ Boosts crop output and farm income

Limiting factors in farm mechanization:

Mechanical power is largely consumed in large land holdings. It is still beyond the reach of small/marginal holdings which constitutes around 80% of the total land holdings. This is due to the fact that the small/marginal farmers, by virtue of their economic condition are unable to own farm machinery on their own or through institutional credit. Apart from these there are various limitations in adopting farm mechanization:

- ✓ Small and fragmented land holdings leads to lack of access to farm power
- ✓ Low investment capacity of farmers to efficiently own such equipment
- ✓ Unchallenging agricultural labour in India
- ✓ Availability of adequate draught animals
- ✓ Lack of availability of appropriate farm machines for different farm operations.
- ✓ Difficulty in maintenance machines because of
- ✓ Lack of co-ordination between University/Agriculture department/ Research organization and Manufacturers.

- ✓ Expensive machines, hence difficult to for the farmers to purchase
- ✓ The after-sale service is a major concern due to the inadequacy of proper maintenance of machines in remote regions of rural areas
- ✓ Lack of trained and skilled man power in rural areas
- ✓ The unwillingness of commercial banks to finance the famers to purchase farm equipment

Therefore in order to bring farm machinery available within the reach of small/marginal holdings, collective ownership or Custom Hiring Centres needs to promote in a big way.

Custom Hiring Centers

Custom Hiring Centre (CHC) is a unit composing a set of farm machinery, implements and equipment meant for hiring to farmers. The main objective of CHC is to supply of farm implements to small, marginal and poor farmers at subsidized rates on hire. Though certain implements and equipment are crop specific, the traction units like tractors, power tillers etc., and self-propelled machinery like combine harvesters etc., are used in common. The CHCs identify the farm machinery to be kept based on the local cropping pattern and demand from the farming community.

Potential for Custom Hiring Centers :

The availability farm machines for small/marginal land holdings are the lowest. The small/marginal holdings constitutes around 80 per cent of total land holdings, the potential for CHC is quite huge. The Government of India, after acknowledging potential of Custom Hiring Centre has envisaged increase of farm power availability from the present level (0.93 kw/ha) to 2kw/ha during the 12th plan period. The initiative towards this objective is The Sub Mission on Agricultural Machinery (SMAM).

The subsidy schemes are also being formulated to encourage entrepreneurs and agri graduates to set up custom hiring centres. Therefore, keeping in view the emphasis of agricultural farm machinery and the need for taking the of farm machinery within the reach of small/marginal farmers, institutional credit needs to be made available for CHCs.

Location of the CHCs

One CHC is anticipated to cater to the demands of four to five villages and therefore a common place equidistant from the villages is preferable. The CHCs are maintained by the Department ofAgriculture.

Income and Expenditure

The investment on made for purchase of the identified equipments/implements/ farm machines. While the major recurring cost involved includes fuel / lubricant cost for the machinery, driver charges, repair maintenance charges, salary of employees, interest on bank loan and insurance. Later the income is generated by the CHCs by hiring the farm machinery to the farming community. The hiring charges are hourly based and bigger the machines, higher the chargers will be.

Conclusion

Thus, the expanding needs of the agricultural mechanization in the country can only be accomplished by taking definite policy measures and the strategic planning. Keeping abreast with the recent advances & development in agricultural mechanization, up gradation of technology is needed to be a continuous process.

However the Agricultural Universities especially, All India Co-ordinated Research Project on Women in Agriculture (Family Resource Management) at national level are working on development and medication of drudgery reducing farm tools. These tools are gender friendly, portable, reduces drudgery of farm women and labour cost. The farm tools are developed based on the needs and demands of the farming community. Later they are ergonomically tested, filed validated. Further, after conducting the studies in farmers acceptability, they are popularized among the farming community. The research on aforementioned has to be encouraged and supported for the benefit of the farming community.

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ROLE OF ORGANIC MANURES IN ENHANCING SOIL QUALITY

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Abstract

Soil is the key element in increasing crop yields. Maintaining its quality is therefore, of great importance for the sustainable management of agricultural lands. The effects of agricultural practice on carbon fixation in soils might also be of great interest with respect to climate change. Soils are the basis of food production, preserving their quality by the use of manure and less chemicals for sustainable land management. Manures and fertilizers have similar effects on the long term productivity of soils, relative to no fertilization and thus addition of nutrients either form must be regarded an essential for maintaining soil quality. The combined use organic and inorganic source enhances the soil capacity to function and sustain productivity.

Keywords: Organic manures, Soil Quality, Soil Productivity, Soil health

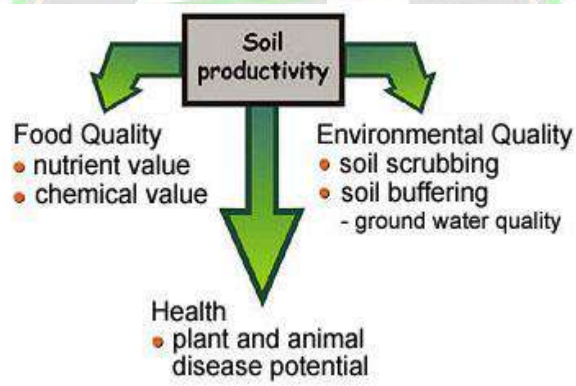
Introduction

Soil provides a list of services to all users of terrestrial ecosystems and is crucial to our agricultural societies. The value of soil services to human societies has changed during history and thus the value we give to soils has also changed over time as it depends upon the economic and cultural basis of a society for a given context. While throughout history human awareness of the soil services has been mainly reduced to food, fibre and bio energy production, nowadays the list of soil services has largely increased and we are beginning to realize that soil management is no longer a local but a global issue affecting not only food and goods supplies but also to the human welfare and health. In other words, this societal awareness of the multiple functions of soils is not limited to a specific land use but to the whole landscape.

Soil Quality V/S Soil Health

The terms soil quality and soil health are often used interchangeably to describe the soil's ability to support crop growth without becoming harming the environment. The term also gives the idea of soil as a living, dynamic entity that functions. Soil quality is defined by the interactions of various soil chemical, physical, and microbiological properties. Soil quality, therefore, should be identified by a soil's inherent properties. The properties are determined by various soil forming factors such as climate, topography, vegetation, parent material and time. From a productivity stand point, each soil has an innate capacity to function, and some soils will be inherently more productive than others. In organic farming, Soil having good quality provides an environment for better root growth, thereby improving crop health and productivity.

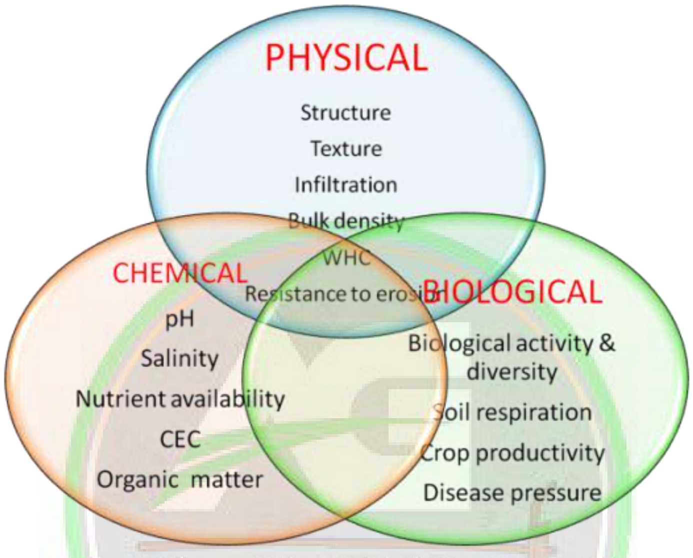
Soil quality is fitness for use (Pierce and Larson, 1991), Capacity of the soil to function (Karlen and Stott,1994). Soil quality is the capacity of soils within landscapes to sustain biological productivity, maintain environmental quality, and promote plant and animal health (Doran and Parkin, 1994).



Soil Health is the change in Soil Quality over time due to human use and management or to natural events. Organic farming is one of practice, but it gives much more than simply substituting one set of management practices and inputs for another. Organic farming is a best tool and a body of methods and rules that focus on building soil health. In fact, to fulfill the many requirements for certification of a farm as organic, a farmer must establish a plan to improve soil quality or health.

Soil Quality Indicators

While overall soil health can be measured by the soil's contribution to how well an ecosystem functions, soil quality can be measured by certain parameters or *indicators*. Examples of such indicators are soil water-holding capacity, organic carbon content, and microbial respiration. Checklists of physical, chemical, and microbial indicators are commonly assembled in a *minimum data set* (MDS). MDS indicators can be measured *quantitatively* at regular intervals. In other words, these indicators can be defined with specific units of measure, and the measurements can be judged against some common standards or analyzed for improvements over time. The relative importance of indicators within a data set is likely to change as land use changes. Comparisons between data sets are usually restricted to sites having similar conditions.



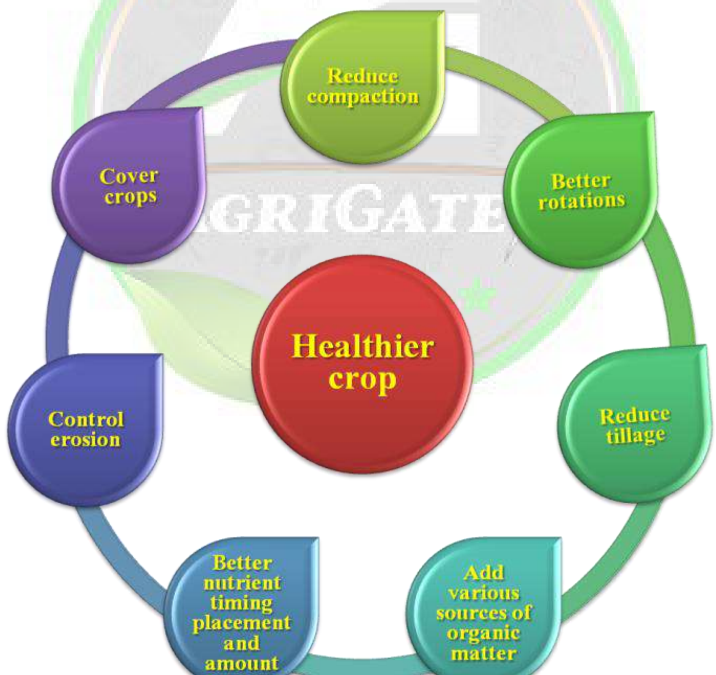
Soil Quality Assessment

Soil quality assessment typically includes the quantification of indicators that are often derived from reductionist studies or general qualitative observations of the soil. Overall, soil quality indicators condense the enormous complexity of the soil in an attempt to describe the capacity of the soil to function. In spite soil quality indicators will not give a complete picture of the soil system we think they should attempt to cover, as much as possible, all soil functions relevant to human life although the relative weight of each one may change according to the land use and/or the environmental context. Thus, soil quality indicators should address the most relevant threats to soils in a given context and should be referred to their respective soil degradation thresholds. Soil degradation thresholds are specific to soil type and environmental conditions and should also cover all soil functions. Management thresholds can be defined as the most severe disturbance any management may accomplish without inducing significant changes towards unsustainable conditions. These management thresholds must consider the soil type and environmental context that define the soil degradation context, may be specific to the soil use and management context, and may thus stress one of the general soil functions but not forget about the rest. In general these soil indicators are mainly related to soil productivity and only address the old threats to soils (erosion, Stalinization, loss of organic matter, compaction …). These soil quality indicators hardly address the processes associated to the new threats to soil such as contamination.

Soil quality is not an end in itself

- The ultimate purpose of researching and assessing soil quality is not to achieve high aggregate stability, biological activity, or some other soil property
- The purpose is to protect and improve long-term agricultural productivity, water quality, and habitats of all organisms including people
- Soil characteristics are used as indicators of soil quality, but in the end, soil quality must be identified by how it performs its functions

Management strategies



Solutions for Soil quality improvements

- Mulching and recycling organic residues
- Improve soil structure and quality
- Water conservation and water use efficiency
- Adoption of diversified cropping systems

- Agro-forestry and mixed farming
- No-till agriculture
- On-farm experimentation and adaptation
- Use of micronutrient rich fertilizers
- Inoculating soils for improved Biological Nitrogen Fixation
- Microbial processes to increase P-uptake

References

Doran, J.W., Parkin, T.B., 1994, Defining Soil Quality for a Sustainable Environment. Soil Sci. Soc. America., Madison, Wisconsin USA, pp. 3–21.

Karlen, D.L. and D.E. Stott., 1994, A framework for evaluating physical and chemical indicators of soil quality. Soil Sci. Soc. America., Madison, Wisconsin USA,

Larson, W.E. and F.J. Pierce., 1991, Conservation and enhancement of soil quality. Evaluation of Sustainable Land Management in the Developing World, Int. Board Soil. Res. and Mant., Bangkok, Thailand.

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JASMINE DEVASTATING PESTS

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Introduction

A number of insect pest attack jasmine crop and cause considerable damage. Among them the most important ones are the bud worm (*Hendecasis duplifascialis)*,leaf webber (*Nausinoe geometralis*) and the blossom midge (*Contarinia maculipennis*) and recently the mite (*Tetranychus urticae*) attack due to prevailing drought and hot weather. Among the different insect pests recorded, bud worm are known to poses a serious threat to flower production.

Jasmine bud worm: *Hendecasis duplifasialis* (Pyraustidae: Lepidoptera)

This is a major pest of jasmine and it may cause about 50 % loss in flower yield.

Bore hole on flower buds. A caterpillar attacks two on three buds. The buds are webbed together with faecal matter on the web. Infested flowers may turn purple and they may fall off.

Biology

Freshly laid eggs are creamy white in colour. They are laid singly on the unopened immature buds. They hatch in about 3-4 days. The larva is creamy yellow to greenish in colour with a dark black head and porthoracic shield. They are smooth with fine hairs on the body . Pupation mostly takes place in the soil and sometimes on the leaves, at the junction of petioles and leaf blade. Adult is a small, pale white moth with wavy markings on the wings.

Management

- Collect the damaged flowers once in a week to arrest population buils up.
- Rake the soil during the off-season to expose the pupae.
- Apply carbaryl 10 D around the basin during August – September.
- Set up light trap during the peak emergence of adult moths.
- Spray Neem Seed Kernel Extract (NSKE) 5 %.
- Spray Novaluron 2 ml/litre

The gallery worm: *Elasmopalpus jasminophagus* (Phycitidae: Lepidoptera)

Small, dark grey moths lay eggs on the terminal shoot. Young larvae feed inside the buds. Mature greenish larvae possess a red head and prothorax with lateral brown streaks on the body. They web together the terminal leaves, shoots and flower buds and feed on them. Faecal matter can be seen attached to the silken web. Pupation takes place in the web itself.

The leaf web worm: *Nausinoe geometralis* (Pyraustidae: Lepidoptera)

Caterpillars web the leaves together and skeletonize them. Moths are of medium size with light brownish wings and white spots. The greenish caterpillar bears thin hairs arising from warts, and black streaks on the sides of the thorax. The eggs are laid singly in batches and they hatch in 3 to 4 days. The total life cycle is completed in 20-30 days.

Whitefly: *Dialeurodes kirkaldyi* (Aleyrodidae: Hemiptera)

These whiteflies often infest the under surface of leaves in large numbers and cause yellowing. Honeydew invites the sooty mould fungus. Flower production is arrested.

The blossom midge: *Contarinia maculipennis* (Cecidomyiidae: Diptera)

Larvae of these tiny midges feed on the inner parts of the flower buds of gundumalli (*Jasminum sambac*), which turn characteristically purple before drying.

As many as 12 larvae can be seen in a single bud. They are colourless to yellowish.
Mature larvae drop to the ground to pupate in the soil. Rake up the soil well to expose the pupae to the sun. Adults are highly attracted to light traps. Spray Cartap hydro chloride 1.5g/litre on the flower buds.

The jasmine eriophyid mite: *Aceria jasmine* (Eriophyidae: *Acari*)

These microscopic mites infest the leaf surface, tender stems and buds and cause velvet-like hairy outgrowth on the surface of leaves and flowers (erineum). The plant growth is stunted and the flower production suppressed. The attack starts in March to reach a peak during the rainy season. Maximum damage is seen in September. Host crops: Jasmine, *Jatropha intergrima*

Management

- Remove and destroy the infested twigs at the initial stages.
- Grow resistant varieties such as *Jasminum auriculatum* variety Parimullai released by TNAU.
- Replanting may be done whenever the attack is severe.
- Spray Triazophos 1.5 ml/litre in combination with neem oil 3 ml/litre or dicofol 18 EC 2 ml/litre. Avermectin can also be tried.

Conclusion

Managing the jasmine pests through bio-intensive approach would keep the pests under check in an ecofriendly way since residues are concerned not only in fruits and vegetables but also in flowers.

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OIL PALM CULTIVATION SCENARIO - PROS AND CONS IN INDIAN CONDITION

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Introduction

Oil palm is one of the perennial crops and among all it is one of the highest oil yielding crop hence, it is considered as golden palm. It produces both edible palm-oil and palm kernel-oil. Oil palm produces around 4 - 5 tonnes per ha of crude palm oil (CPO) and 0.40 - 0.50 tonnes per ha of palm kernel oil (PKO) in a productive life span from 4 - 30 years. In India 56-60% of the edible oil imported constitutes palm oil worth of more than Rs. 69,900 crores per annum. Palm oil is one of nine major oils traded in the global edible oil and fat market. At present, it is the largest source of vegetable oil in the world. The world Oil palm area is 241.34 lakh ha and production is 731.68 lakh MT during 2020 (USDA). Five countries mainly Indonesia, Malaysia, Nigeria, Thailand and Columbia account for over 90% of the world's total production of FFBs. Small amount of oil palm areas are grown in many countries, but the global market is dominated by only two countries i.e., Indonesia (119.50 lakh ha/435 lakh MTs and Malaysia (54 lakh ha.,/185 lakh MTs) during 2020 (USDA). Together Indonesia and Malaysia account for over 85% to 90% of world production of Crude Palm Oil. At present in India, especially states like Telangana are more focusing on cultivation of oil palm to lessen the burden on import and to make it as one of the remunerative crops to the farmers. Government is also providing subsidies to purchase oil palm plants, and to some extent cultivation charges to the farmers to encourage them. Oil palm can be used for manufacturing of various biproducts in food industry apart from oil alone.

History of oil palm in India

Oil palm is alien crop and was introduced to India at National Royal Botanical Gardens, Kolkata during the year 1886. The Maharashtra Association for Cultivation of Sciences (MACS), Pune later introduced African dura palms along canal bunds, home gardens and, to some extent, in forest lands near Pune during 1947 to 1959. The horizontal expansion of planting of oil palm was launched from 1971 to 1984 in Kerala by Plantation Corporation of Kerala Ltd and andaman Forest and Plantation Development Corporation Ltd., in Andaman and Nicobar Islands during 1976 to 1985. Oil palm, as a small holders' crop under irrigated conditions grown under varied agro-climatic conditions, is totally new to India (https://horticulture.tg.nic.in/OilPalm/OilPalm).

The rate of consumption increased ten times since last 4 - 5 years. The consumption of edible oil in India is at 22 million MTs per annum with a per capita consumption of 16 kg/person whereas, the production is only 7 million MTs. The government of India has implemented many promotional programme *viz.*, TMOP (Technology Mission on Oilseeds & Pulses), OPDP (Oil Palm Development Programme), ISOPOM (Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize), OPAE (Oil Palm Area Expansion), NMOOP National Mission on Oilseeds and Oil Palm) until 2020 to increase the area and yield levels of oil palm in India. To narrow down the gap between the demand and supply of vegetable edible oils and to reduce dependency on imports, the central government has proposed to promote oil palm cultivation in a big way. In this direction at the national level cabinet approved for ₹ 11,040 cr scheme to boost oil palm farming. To encourage palm oil production in India and decrease its import, the center has approved a Mission on Edible Oils – Oil Palm" with the main objective to reduce the dependency on import of palm oil.

The major oil palm producing states in India are Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Gujarat, Chhattisgarh, Mizoram, Assam and Orissa. Andhra Pradesh ranks 1st in Area and Production of Oil Palm in the country. Telangana stands 6^{th} in Oil palm area, 2^{nd} in production of Fresh Fruit Bunches and 1^{st} in Oil Extraction Rate (OER) with 19.22% (2019-20) in the country.

Consumption of palm oil

With regard to Palm oil consumption globally, Indonesia stands 1st in consumption with 150.25 lakh MTs per annum followed by India with 87.55 lakh MTs per annum during 2020 (USDA). The details of major countries consuming Palm Oil are given below:

Sl. No	Country	Pam oil consumption (LMT-2020)
1	Indonesia	150.25
2	India	87.55
3	China	67.80
4	EU-27	68.05
5	Malaysia	34.35
6	Pakistan	34.00
7	Thailand	22.27
8	Bangladesh	16.10
9	US	13.96
10	Nigeria	16.65

Uses of palm oil

Food products	**Nonfood products**
Coking oil, Dough fat, Vanaspati	Bio fuel and bio lubricants
Vegetable ghee	Cosmetics products/Aromatherapy
Margarine	Pharmaceutical products
Salad oil	Toiletries, Detergents including soaps and soap blends
Chocolates, Ice creams, Frying fats, Specialty fats for coatings	Esters
Cocoa butter substitutes	Oleo chemicals, fatty acids and fatty alcohols

(Reference: https://nmoop.gov.in/Publication/Status-Paper)

Additional income by Intercropping

Generally, oil palm is a wide spaced perennial crop with a long juvenile period of 3 years. The additional space called inter and intra row space can be used to generate income during the juvenile phase of the crop. The only major thing is inter crop selected should be compatible with the main crop and should not compete with oil palm for light, water and nutrients. The most suitable crops are vegetables, banana, flowers, tobacco, chillies, turmeric, ginger, pineapple etc which can be grown very conveniently. In mature oil palm gardens of 10 to 12 years age, intercrops should be able to grow under partially shaded conditions and should not compete with oil palm for water, sunlight and nutrients (eg. cocoa, pepper, heliconia and ginger lilly). Do not tie oil palm fronds close to the stem for intercropping, which will reduce photosynthetic activity. Of the plants and thus growth potential in long run. Do not plough close to the palm base, which will cut the absorbing roots and thereby reduce intake of water and nutrients. Maximum number of green leaves should be retained on the palm. According to Tonye *et al* (2004). Intercropping has a social advantage as well. Intercrop income leads to increased social connectedness within families (both immediate and extended).

Misconceptions in oil palm cultivation

The area achieved (4.5 lakh ha) and productivity levels gained are very meager due to following misconceptions in farming community.

i. Palm oil takes four to five years to bear fruit and to be profitable to farmers.
ii. Farmers are encouraged to cultivate only in the presence of processing industries.
iii. Fear of price fluctuation over a period
iv. Suitability of soil, water and climatic conditions to augment the growth and productivity of the crop.

Challenges and constraints (SWOT) in oil palm cultivation:

Strengths –

- ✓ Suitability of climate and soil
- ✓ Sufficient rainfall
- ✓ Bore wells provide guaranteed irrigation.
- ✓ Access to markets / availability of marketing facilities
- ✓ Conservation of soil and water

- ✓ Resource utilization that is as efficient as possible

Weakness

- ✓ Difficulty in mechanization
- ✓ Labour intensive
- ✓ Adverse competitive effect or allelopathy if any

Opportunities

- ✓ Value addition in different crops to women farmers
- ✓ Impart training and skills to the farmers and local youth
- ✓ Provision of year-round employment

Threats

- ✓ Weed infestation and its management
- ✓ Occurrence of different pests and diseases
- ✓ Mechanical damage to plants

References

https://horticulture.tg.nic.in/OilPalm

https://nmoop.gov.in/Publication/Status-Paper

https://nmoop.gov.in/Publication/Status-Paper

https://www.nfsm.gov.in/

Indiastat. 2020-21. *https://www.indiastat.com/data/agriculture/*

Tonye, J., Bayomock, L.A., Zoa, J.M. 2004. Development of oil palm-based agroforest at the slash-and-burn agriculture project zone of Cameroon: agronomy and economics of the establishment phase. *Cameroon journal of agricultural science.*1(1):42-45.

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ADAPTIVE PRIMING: FORTIFYING CROP RESILIENCE AND SUSTAINABILITY

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Introduction

The concept of adaptive priming in crop plants represents a pivotal frontier in agricultural science with profound implications for crop improvement and sustainable agriculture. Adaptive priming entails the pre-exposure of plants to mild, non-lethal stress conditions, which subsequently enhances their capacity to withstand more severe stresses. This phenomenon has garnered increasing attention due to its potential to bolster crop resilience against a range of environmental stressors, including drought, heat, pathogens, and pests. This innovative approach aligns with the evolving demands of modern agriculture, where climate change and the imperative to reduce chemical inputs necessitate the development of more robust and resource-efficient crop plants. Therefore, understanding and harnessing adaptive priming holds significant promise in ensuring global food security while promoting sustainable agricultural practices. Over the years, various studies have unravelled the intricate mechanisms and consequences of adaptive priming, shedding light on its significance in plant physiology and agriculture.

The study of adaptive priming can be traced back to pioneering works that laid the foundation for subsequent research. One of the seminal works in this regard is the study by Bruce et al. (2007), which demonstrated that priming with the hormone Abscisic acid (ABA) enhanced stress tolerance in *Arabidopsis thaliana*. This work highlighted the role of hormonal signalling in adaptive priming. Hormonal signalling is a central aspect of adaptive priming, and several key studies have explored this phenomenon. Conrath et al. (2006) provided important insights into the role of salicylic acid (SA) in priming plants for enhanced defense responses against pathogens.

Beckers et al. (2009) expanded our knowledge by investigating Mitogen-Activated Protein Kinases (MAPKs) as essential components of priming. They demonstrated that MAPKs play a critical role in preparing plants for stress responses, revealing a complex network of signalling events underlying adaptive priming. Luna et al. (2012) explored the epigenetic landscape of primed plants, revealing significant alterations in DNA methylation and histone modifications. Their findings underscored the importance of epigenetic changes in establishing a primed state. The role of antioxidant defense mechanisms in adaptive priming has been elucidated through multiple studies. Slaughter et al. (2012) investigated the priming of *Arabidopsis* plants for enhanced resistance to aphid infestation. They demonstrated that primed plants exhibited increased expression of antioxidant enzymes, providing a mechanistic link between priming and oxidative stress management.

The understanding of adaptive priming has profound implications for agriculture. Conrath (2011) reviewed the potential applications of priming in crop protection, highlighting its role in reducing pesticide dependency and enhancing stress resilience. This work underscored the practical relevance of adaptive priming in agricultural contexts.

Mechanisms of Adaptive Priming

Adaptive priming is a complex phenomenon in plants that involves intricate molecular and physiological mechanisms. This pivotal process relies on intricate mechanisms, including hormonal signalling, epigenetic modifications, and antioxidant defense mechanisms, which equip plants to better cope with subsequent stressors.

1. Hormonal Signalling:

Hormonal signalling plays a central role in adaptive priming. The hormone Abscisic acid (ABA) has been a focal point of research in this context. Studies, such as the work by Beckers et al. (2009), have highlighted ABA's role in priming plants for stress responses. ABA acts as a signalling molecule, initiating a cascade of events that prepare the plant for impending stress. Furthermore, Jasmonic acid (JA) and Salicylic acid (SA) are also implicated in adaptive priming, as shown in the research by Conrath et al. (2006). These studies underscore the intricate hormonal pathways involved in priming.

2. Epigenetic Modifications:

Epigenetic modifications are another critical facet of adaptive priming. Research by Luna et al. (2012) has revealed that exposure to mild stress conditions induces changes in DNA methylation and histone modifications. These epigenetic changes impact gene expression patterns, thereby facilitating the plant's readiness to respond to future stressors. The work of Luna et al. highlights the significance of epigenetic modifications as a mechanistic link in the priming process.

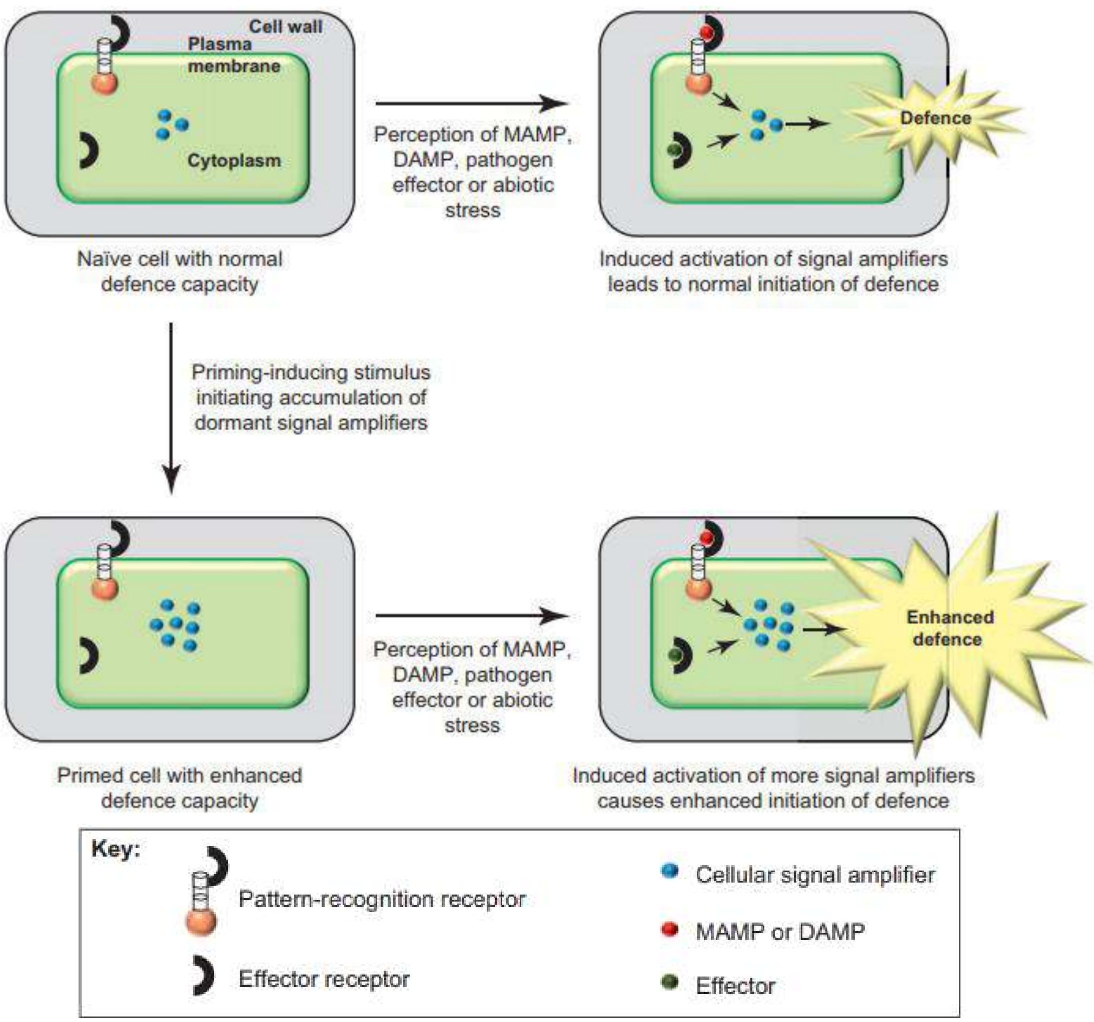

Fig: 1. Basic Mechanisms in Defense Priming (Conrath, 2011)

3. Antioxidant Defense:

Adaptive priming also involves the activation of antioxidant defense mechanisms. Plants exposed to mild stress conditions often exhibit increased expression of antioxidant enzymes, such as superoxide dismutase (SOD) and catalase. These enzymes help plants manage oxidative stress induced by reactive oxygen species (ROS). Research by Slaughter et al. (2012) demonstrated that primed plants exhibit heightened antioxidant capacity, establishing the connection between priming and oxidative stress management.

Applications of Adaptive Priming in Agriculture

Adaptive priming in crop plants holds significant promise for addressing the challenges faced by modern agriculture, including environmental stresses and pest pressures. This section discusses the practical applications of adaptive priming in agriculture, focusing on how it enhances stress resilience and reduces pesticide dependency, referencing studies that have explored these applications.

1. Enhancing Stress Resilience:

Adaptive priming provides a potent means of enhancing stress resilience in crop plants. By exposing plants to mild stress conditions during their growth, they can be primed to respond more effectively to subsequent, more severe stresses. Research conducted by Bruce et al. (2007) demonstrated that priming with Abscisic acid (ABA) in *Arabidopsis thaliana* significantly improved the plant's drought tolerance. This finding underscores the potential of adaptive priming to mitigate the detrimental effects of drought, a common environmental stressor in agriculture.

2. Reducing Pesticide Dependency:

One of the most promising applications of adaptive priming is its potential to reduce pesticide dependency in agriculture. When plants are primed to activate their defense mechanisms, they become less susceptible to pest and pathogen attacks, reducing the need for chemical interventions. A study by Conrath (2011) reviews the applications of priming in crop protection and highlights its role in reducing the reliance on synthetic pesticides. This not only has economic benefits for farmers but also aligns with sustainable agriculture practices, as it minimizes the environmental impact associated with pesticide use.

3. Resource-Efficient Agriculture:

Adaptive priming can contribute to resource-efficient agriculture by optimizing resource utilization in plants. Research by Rasmann et al. (2012) demonstrated that priming can lead to resource reallocation in plants, resulting in improved resource use efficiency. This has implications for sustainable farming practices by potentially reducing water and nutrient requirements per unit of crop yield, thus making agriculture more environmentally friendly.

4. Application in Various Crop Species:

Adaptive priming is not limited to specific crop species. Studies have explored its applications in various crops, including cereals, fruits, and vegetables. For instance, Ramegowda et al. (2014) investigated the role of adaptive priming in enhancing stress tolerance in rice. Their research demonstrated that primed rice plants exhibited improved resistance to multiple stresses, including drought and salinity. This suggests that adaptive priming can be applied across diverse crop types to address specific stress challenges.

Conclusion:

In conclusion, the concept of defense priming, particularly adaptive priming in crop plants, represents a paradigm-shifting approach with profound implications for modern agriculture. As discussed in this article, adaptive priming empowers crop plants to develop enhanced stress tolerance and defense responses through exposure to mild stress conditions. This mechanism relies on intricate processes such as hormonal signalling, epigenetic modifications, and antioxidant defense mechanisms. The potential of adaptive priming in crop plants is immense. It offers a promising avenue to address the challenges confronting agriculture in the 21st century, including climate change, soil degradation, and emerging pests and diseases. By understanding and harnessing the underlying mechanisms of adaptive priming, researchers and farmers can work together to develop crop varieties that are more resilient, require fewer external inputs, and contribute to sustainable food production.

However, the realization of adaptive priming's potential is contingent on addressing the challenges discussed in this article. Standardizing priming protocols, managing potential trade-offs between stress tolerance and yield, and navigating ethical considerations are critical steps in the responsible deployment of this technology. As we advance in our understanding of adaptive priming, the agricultural community must collaborate to ensure that its benefits are harnessed while minimizing potential risks, ultimately shaping a more resilient and sustainable future for agriculture.

References

Ahmad, S., et al. (2016). Nitric oxide and hydrogen peroxide function as signalling molecules in the ethylene-induced expression of PR genes in rice. Plant Signalling & Behavior, 11(3), e1139276.

Beckers, G.J., et al. (2009). Mitogen-activated protein kinases 3 and 6 are required for full priming of stress responses in Arabidopsis thaliana. The Plant Cell, 21(3), 944-953.

Conrath, U. (2011). Molecular aspects of defense priming. Trends in Plant Science, 16(10), 524-531.

Conrath, U., et al. (2006). Priming: getting ready for battle. Molecular Plant-Microbe Interactions, 19(10), 1062-1071.

Jaskiewicz, M., et al. (2011). Arabidopsis mitogen-activated protein kinases Mpk3 and Mpk6 target a subclass of 'VQ-motif'-containing proteins to regulate immune responses. New Phytologist, 193(3), 713-725.

Ramegowda, V., et al. (2014). Plant omics: Genome-wide analysis of alternative splicing in plants. Trends in Plant Science, 19(11), 717-727.

Rasmann, S., et al. (2012). Herbivory in the previous generation primes plants for enhanced insect resistance. Plant Physiology, 158(2), 854-863.

Slaughter, A., et al. (2012). Descendants of primed Arabidopsis plants exhibit resistance to biotic stress. Plant Physiology, 158(2), 835-843.

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GLOBALISATION AND AGRICULTURE

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Introduction

Globalisation, also known as mundialisation, is a commonly used term that describes the processes of international integration resulting from the growing interconnectedness of people and the exchange of worldviews, goods, ideas, and various cultural elements. Its primary objective is to break down barriers, particularly in trade. Interestingly, globalisation has a more extended history than one might initially think. It involves the removal of impediments to work, communication, and the sharing of cultures. The underlying theory behind globalisation posits that fostering worldwide openness will enhance the prosperity of all nations. It can be referred to as improving the connectivity and interdependence of global markets and businesses. In essence, globalisation represents the framework for interaction among nations worldwide, aimed at fostering the global economy. It signifies the integration of economies and societies across the globe. Over the past two decades, globalisation has rapidly accelerated. This surge can be attributed primarily to advancements in telecommunications infrastructure and the ascent of the internet. Generally, as economies become more intertwined, they offer increased opportunities and face heightened competition. Consequently, as globalisation becomes a more prevalent aspect of the global economy, influential proponents and opponents of globalisation have emerged. Advocates for globalisation argue that it brings forth numerous opportunities for nearly everyone, asserting that increased competition is beneficial as it enhances the efficiency of production agents. The two most prominent organisations supporting globalisation are the World Trade Organization and the World Economic Forum. Conversely, opponents of globalisation contend that certain groups lacking resources may struggle to cope with the intensified competitive pressures of greater economic integration. Notable anti-globalisation organisations include environmental groups like Friends of the Earth and Greenpeace, international aid organisations such as Oxfam, third-world government bodies like the G-77, and business associations and labour unions whose competitiveness is threatened by globalisation, such as the U.S. textiles sector and the European farm lobby, as well as the trade union movements in Australia and the United States (Leichenko and O'Brien, 2008).

Effects of Globalization

According to economists, globalisation and integration are associated with numerous global developments, and the transformative effects of globalisation are readily identifiable.

1. Enhancement of International Trade: Globalization has significantly expanded the number of countries where products can be bought and sold.

2. Technological Advancements: In response to the imperative of global competitiveness, governments have upgraded their technological capabilities.

3. Augmented Influence of Multinational Corporations: Multinational companies, with their headquarters often in their country of origin, have subsidiaries across different nations. For instance, a Japanese car company may have branches in various countries, with production decisions typically made by these subsidiaries. Penetrating local markets empowers these subsidiaries to boost production and profits. The rise of multinational corporations began after World War II, and their presence in host countries has grown as a result of globalisation.

4. Strengthened Roles of the WTO, IMF, and WB: Globalization has contributed to the increased power and influence of international institutions such as the World Trade Organization (WTO), International Monetary Fund (IMF), and World Bank (WB), according to experts.

5. Heightened Mobility of Human Resources Across Borders: Globalization enables countries to tap into the labour force of nations with cost-effective labour. For instance, countries like Taiwan, South Korea, and Malaysia facing labour shortages offer opportunities for labour-exporting countries like the Philippines to provide their workforce for employment.

6. Expanded Outsourcing of Business Functions to Foreign Countries: Nations like China, India, and the Philippines have greatly benefited from the trend of global business outsourcing. U.S. and European global companies leverage the cost-effective labour and highly skilled workers available in countries like India and the Philippines.

7. Influence of Civil Society: An essential facet of globalisation is the global civil society's growing influence and broader reach, often represented by non-governmental organisations (NGOs). These are institutions established and operated by citizens and encompass various societal aspects, including family. In globalisation, global civil society comprises organisations advocating for specific issues or causes, such as women's rights or environmental preservation. These organisations aim to shape policies for the collective good rather than opposing government policies. Both governments and NGOs share the common goal of serving the people. Globalisation has further amplified the influence of NGOs, particularly in critical areas like human rights, the environment, children's welfare, and workers' rights. Simultaneously, multinational corporations have seen their power grow.

World Trade Organization (WTO)

The WTO is the global international body responsible for regulating trade between nations. At its core, the WTO operates through agreements collectively negotiated and ratified by most of the world's trading nations through their parliamentary processes. Its fundamental aim is to facilitate the activities of producers of goods and services, exporters, and importers. The primary mission of the World Trade Organization, or WTO, is to promote open trade to the advantage of all participants. It serves as a platform for negotiating agreements to reduce barriers to international trade, fostering equitable conditions for all stakeholders, thereby promoting economic growth and development. Moreover, the WTO furnishes the legal and institutional framework necessary for enforcing and overseeing these accords and resolving disputes arising from their interpretation and application. The current collection of trade agreements under the purview of the WTO encompasses 16 distinct multilateral contracts (to which all WTO members are signatories) and two distinct plurilateral agreements (entered into by select WTO members). Over the past six decades, the WTO, established in 1995, and its precursor, the GATT, have played pivotal roles in forging a robust and prosperous global trading system, thus contributing to unparalleled worldwide economic expansion. Currently, the WTO counts 155 member nations, with 117 classified as developing countries or separate customs territories. The WTO's activities are facilitated by a Secretariat comprised of around 700 personnel, led by the WTO Director-General, and headquartered in Geneva, Switzerland. The Secretariat operates with an annual budget of approximately $180 million. English, French, and Spanish serve as the three official languages of the WTO. Decisions within the WTO are typically reached by consensus among its entire membership. The supreme governing body is the Ministerial Conference, convened roughly every two years, while the General Council oversees the organisation's functions between Ministerial Conferences. Both of these entities include representation from all member nations. Specialised subsidiary bodies such as Councils, Committees, and Subcommittees, composed of all member nations, administer and supervise the implementation of the various WTO agreements by its members. The main activities of WTO include:

— Engaging in negotiations aimed at reducing or eliminating barriers to trade, such as import tariffs and other impediments to trade, and establishing regulations governing international trade conduct (e.g., addressing issues like antidumping practices, subsidies, product standards, and more)

— Overseeing and ensuring the implementation of the agreed-upon rules for trade in goods, services, and intellectual property rights related to trade

— Monitoring and assessing the trade policies of member nations while promoting transparency in regional and bilateral trade agreements

— Resolving disputes among member countries concerning the interpretation and application of the agreements

— Developing the capabilities of government officials in developing countries in matters related to international trade

— Facilitating the accession process for approximately 30 countries seeking membership in the organisation

— Conducting economic research and collecting and disseminating trade-related data to support the WTO's primary functions

— Educating and informing the public about the WTO, its mission, and its activities.

The WTO's foundational and guiding principles focus on pursuing open borders, ensuring the most favoured nation code and non-discriminatory treatment among its members, and a commitment to transparent conduct in its operations. The opening of national markets to international trade, with exceptions or flexibilities as needed, is anticipated to promote sustainable development, improve the well-being of populations, alleviate poverty, and foster global peace and stability (Hufbauer and Cimino-Isaacs, 2015).

General Agreement on Tariffs and Trade (GATT)

GATT is a multinational accord governing global trade. As outlined in its preamble, its stated objective is substantially reducing tariffs and other trade barriers and eliminating preferences through reciprocal and mutually advantageous means. GATT emerged during the United Nations Conference on Trade and Employment and came into being after negotiations for establishing the International Trade Organization (ITO) proved unsuccessful. GATT was initially signed in 1947 and remained in effect until 1993, when it was succeeded by forming the World Trade Organization (WTO) in 1995. The original GATT text (GATT 1947) continues to be in force under the WTO framework, albeit subject to the amendments of GATT 1994. In 1993, GATT underwent an update (GATT 1994) that introduced new obligations for its signatories, with one of the most significant changes being the establishment of the WTO. The WTO was established on January 1, 1995, with the 75 existing GATT members and the European Communities becoming its founding members. Over the following two years, the remaining 52 GATT members joined the WTO, the last being Congo in 1997. Since the inception of the WTO, 21 new members, not originally part of GATT, have joined, and 29 others are currently negotiating their membership. The WTO comprises 155 member countries, including Montenegro and Samoa, which became new members in 2012. Syria and the former Socialist Federal Republic of Yugoslavia (SFR Yugoslavia) have not rejoined the WTO. Since Yugoslavia underwent changes, becoming Serbia and Montenegro and later splitting into two entities, its application is considered new (non-GATT). The WTO's General Council established a working party in 2010 to assess Syria's request for WTO membership. The original contracting parties of GATT concluded their official agreement under the "GATT 1947" terms on December 31, 1995. Serbia and Montenegro are currently in the decision phase of negotiations and are anticipated to become the WTO's newest members shortly. While GATT primarily consisted of agreed-upon rules among nations, the WTO is an institutional body. The WTO expanded its purview beyond the goods trade to encompass marketing within the service sector and intellectual property rights. Although designed to facilitate multilateral agreements, several rounds of GATT negotiations, such as the Tokyo Round, led to the creation of plurilateral agreements, resulting in selective trading and some fragmentation among member nations. Essentially, WTO arrangements generally function as a multilateral agreement settlement mechanism derived from GATT (Finalyzson and Zacher, 1981).

Consequences of Globalization on Indian Agriculture

A) Positive Consequences (Shinde, 2015)

Availability of modern Agro- technologies

New breeds of high-yield crops and contemporary agrotechnologies, including pesticides, herbicides, and fertilisers, enhanced food production. These technologies included up-to-date irrigation projects, herbicides, synthetic nitrogen fertiliser, and improved crop types created using the then-current conventional scientific techniques. They were using HYVs, such as the semi-dwarf rice variety IR8. With sufficient irrigation, herbicides, and fertilisers, HYVs significantly outperformed traditional cultivars.

Rise in production and productivity

The country's production of food grains grew significantly due to the implementation HYV technology. Wheat was produced from 8.8 million tonnes in 1965–1966 to 184 million tonnes in 1991–1992. Other food grains now have more food with greater efficiency. Between 1965–1966 and 1989–1990, it was 71% for cereals, 104% for wheat, and 52% for paddy. Although food grain output has expanded significantly, coarse cereals, pulses, and a few cash crops have not benefited from the green revolution. In other words, not all crops have benefited equally from the green course.

Growth of National Income

Farmers' agricultural output has increased due to receiving the global market for their products. The farm product was grown with innovative technologies, seeds, farming methods, etc. From a financial perspective, the agriculture sector's contribution to the economy has increased to 14.2% of GDP (2010–11).

New areas of employment

When exporting agricultural goods, it is required to classify the products, standardise their processing, bundle them, etc. As a result, the agro-allied industries have generated employment in several sectors, including cold storage, packing, exporting, standardising, and processing. Agriculture-dependent enterprises are being stored, which has increased engagement.

The largest unorganised sector of the Indian economy, accounting for more than 90% of the disorganised labour force, is agriculture. 52.1% of the workforce is employed in agriculture.

Agriculture as a prime moving force

According to the presumption, a 1% rise in agricultural growth results in a 0.5% increase in industrial output and a 0.7% increase in India's national revenue. The farm sector in India is expanding quickly, especially following LPG. As a result, the Indian government declared agriculture the main driver of the country's economy in 2002.

Rise in the share of trade

The WTO's rules ensure that all nations have equal possibilities, which has led to a growth in agricultural exports. In the five years following the onset of globalisation, from 1990 to 1999, India's percentage of exports (goods and services) increased from 0.54% to 0.67%, according to figures published by the World Bank. The same era saw a 103% increase in Indian exports.

Growth of Agro exports

The prices of agricultural goods are higher in the international market than in the Indian market. If the developed countries reduce grants, they have to increase costs. So, there will be an increase in the exports in the Indian market, and if the prices grow, there will be profit. Agricultural products account for 10.23% of the total export income of the economy, while agrarian imports account for just 2.74% of the total imports.

Reduction in poverty

Furthermore, globalisation is frequently cited as widening the gap between the rich and the poor, but this depends on how one defines poverty. India's top priority is eradicating poverty, which is worse than dying. If India makes an effort, globalisation can help India achieve this goal. Additionally, the proportion of impoverished individuals has steadily declined, from 36 per cent in 1993–1994 to 21.9 per cent in 2011–12.

B) Negative Consequences (O'Brien *et al.*, 2004)

Vicious debt trap and farmers' suicides

It is necessary to investigate each contributing factor to the current agricultural sector crisis and evaluate the impact of liberalisation measures. For instance, the state of Andhra Pradesh forged the first-ever state-level deal with the World Bank, which included an 830-million-dollar loan in exchange for several changes to the state's economy and administration. It has enthusiastically and zealously adopted the World Bank's liberalisation programmes, and as a result, the state's rate of farmer suicides has increased. According to the National Sample Survey Organisation (NSSO) Report 2005, one in two farm households is in debt, with just 10% of that debt being used for non-production activities.

Migration of labours

The lack of post-harvest storage facilities has led to a significant loss of produce and income for Indian farmers, who are already crippled by low production. It is only because of the low import tariffs brought forth by liberalised import duties, which was a shocker. The domestic farmer could not compete in the global market, which led to a shift in employment from agriculture to other industrial pursuits.

Lower-income of rural farmers

According to Nobel Prize-winning economist Joseph Stiglitz, Trade agreements now forbid most subsidies except agricultural goods. This depresses the incomes of those farmers in developing countries who do not get grants. And since 70 per cent of those in the developing countries depend directly or indirectly on agriculture, the incomes of the developing countries are depressed. But by whatever standard one uses, today's international trading regime is unfair to developing countries. He also pointed out that the average European cow gets a subsidy of $ 2 a day (the World Bank measure of poverty); more than half the people in the developing world live on less than that. It appears it is better to be a cow in Europe than a poor person in a developing country.

Lessening international competitiveness

In India, 60% of the population depends on agriculture. This pressure on agriculture is increasing daily because of the increasing population. Because of marginal land holding, the production cost of Indian farmers is higher, and the quality and standardisation of agro-produce are much neglected. On the contrary, before the WTO reduced grants, developed countries had distributed gifts on a large scale. They had grown the amount of the large-scale contributions in agriculture from 1988-1994. So, they need to avoid many difficulties if there is a reduction in subsidies. On this background, the farmers need to be able to compete in the international market.

Abnormal hike in Fertilizers and Pesticide prices

Indian farmers were encouraged to switch from growing traditional crops to export-oriented "cash crops" like tobacco, cotton, and chilli after the rupee was devalued by 25% shortly after globalisation and Indian crops became very affordable and appealing on the international market. These demand much more insecticides, fertilisers, and water than conventional crops. The cost of pesticides and fertiliser automatically increased by 300%.

References

Finalyzson, J. A., and Zacher, M. W. 1981. The GATT and the regulation of trade barrier: regime dynamics and functions. *International Organization*, *35*(4), 561-602.

Hufbauer, G. C., and Cimino-Isaacs, C. 2015. How will TPP and TTIP Change the WTO System?. *Journal of International Economic Law*, *18*(3), 679-696.

Leichenko, R., and O'Brien, K. 2008. *Environmental change and globalisation: double exposures*. Oxford University Press.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., and West, J. 2004. Mapping vulnerability to multiple stressors: climate change and globalisation in India. *Global environmental change*, *14*(4), 303-313.

Shinde, U. R. 2015. Globalisation and Indian Agriculture-General Consequences. *Asian Journal of Management*, *6*(2), 141-145.

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CLIMATE-SMART AGRICULTURE: CULTIVATING FOR PROFITABILITY AND SUSTAINABILITY

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Introduction

Water Management in Agriculture is mostly required to reduce the water shortage. Due to climate change and global warming, agriculture needs to embrace water management measures more than ever. In many developing countries, the agricultural sector is a crucial one since it helps the rural population improve their standard of living while also creating job possibilities. Regional hydrological cycles are impacted by climate change and global warming, which decreases water availability in many areas that already experience water scarcity. Water shortage decreases the yield of the crops in rainfed and irrigated areas, it provides the scientific information (Steenwerth, 2014). Climate-smart technologies will increase the yield of the crops effectively and reduce the wastage of water in Agriculture. The data from the smart technologies will improve the collection of speed information about pest attacks which helps to take the necessary measures immediately (Chandra et al., 2018). In this article, we'll explore some of the most promising climate-smart agriculture technologies that are not only helping farmers thrive but also contributing to a greener, more sustainable planet.

CLIMATE SMART TECHNIQUES

1. Precision Farming

Precision farming, often referred to as "smart farming," employs advanced technologies such as GPS, sensors, and drones to monitor and manage crop production more precisely. Farmers can improve the planting, irrigation, and harvesting procedures to make sure every square foot of the field is effectively utilized. This increases yields while minimizing waste and resource use. Data-driven decision-making also enables farmers to adjust to climate change and reduce hazards. Climate-smart agriculture improves the productivity of the food and in turn reduces food security (Lipper et al., 2014).

2. Modern Irrigation Techniques

Agriculture faces a serious water shortage, which is made worse by shifting climatic trends. Drip irrigation and sensor-based irrigation systems are examples of advanced irrigation technologies that provide water precisely where and when it is needed, reducing waste. In addition, recycling treated wastewater and collecting rainfall are becoming more and more well-liked as sustainable water sources.

3. Carbon Farming

Carbon farming involves implementing practices that sequester carbon dioxide from the atmosphere into the soil and vegetation. Different techniques like agroforestry, cover cropping, and zero-till farming techniques will enhance soil health while mitigating climate change..

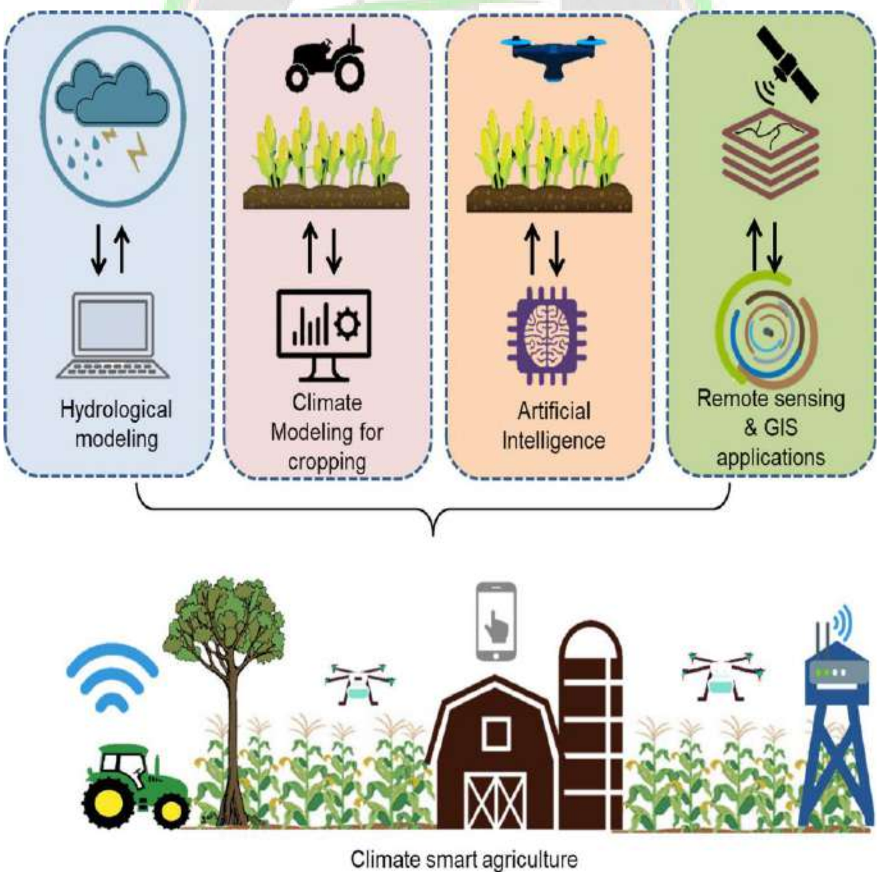

Figure 01. Climate Smart Agriculture

Many of the governments have been providing incentives for carbon farming by providing financial rewards to farmers who implement these practices.

4. **Remote Sensing and GIS Applications**

Innovative technologies like Remote Sensing (RS) and Geographic Information Systems (GIS) are making the farming easier with accurate results. These tools will empower farmers using data-driven insights, helping them make informed decisions and adopt sustainable practices as shown in Figure 01. Geo mapping all the points and getting the accurate results will make to get the better production.

5. **Drought-Resistant Crops**

One of the most significant challenges posed by climate change is increasing drought frequency and severity. To combat this, many of scientists are developing drought-resistant crop varieties by utilizing the genetic modification. These crops require less water to grow, making them ideal for regions with water scarcity issues. Such crops include different drought-tolerant maize, rice, and wheat varieties that can survive in adverse conditions.

6. **Controlled Environment Agriculture (CEA)**

CEA technologies, including hydroponics, aquaponics, and vertical farming, allow for year-round crop production in controlled environments. These systems use less water, reduce the need for chemical inputs, and eliminate the impact of adverse weather conditions. This not only ensures consistent crop quality and quantity but also offers an opportunity for urban agriculture, bringing food production closer to consumers and reducing transportation emissions.

7. **Climate-Resilient Livestock Farming**

Climate-smart agriculture extends beyond crops to livestock farming. Farmers are adopting practices such as rotational grazing, improved breeding techniques, and climate-controlled housing for animals. These measures enhance animal welfare, reduce greenhouse gas emissions, and improve the overall efficiency of livestock production.

8. **Big data Analytics and Predictive Models**

Big data and predictive analytics are becoming invaluable tools in modern agriculture. Farmers can access real-time weather data, soil information, and market trends to make informed decisions. Predictive models can help them anticipate crop diseases, pests, and extreme weather events, enabling proactive interventions to protect yields.

9. Renewable Energy Integration

Agriculture can contribute to climate-smart practices by integrating renewable energy sources such as solar panels and wind turbines into farm operations. These technologies not only reduce the carbon footprint of farming but also provide additional revenue streams through the sale of excess energy to the grid.

Conclusion

Climate-smart agriculture (CSA) technologies are not only profitable but also vital for securing the future of our planet. By adopting these innovative practices, farmers can adapt to the challenges posed by climate change, reduce environmental impact, and ensure sustainable, profitable agriculture. Moreover, CSA promotes resilience and food security, making it a win-win solution for farmers and the global community. As we move forward, investing in and supporting climate-smart agriculture will be essential in building a greener, more prosperous future for all.

References :

Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., ... & Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nature climate change*, *4*(12), 1068-1072.

Chandra, A., McNamara, K. E., & Dargusch, P. (2018). Climate-smart agriculture: perspectives and framings. *Climate Policy*, *18*(4), 526-541.

Steenwerth, K. L., Hodson, A. K., Bloom, A. J., Carter, M. R., Cattaneo, A., Chartres, C. J., ... & Jackson, L. E. (2014). Climate-smart agriculture global research agenda: scientific basis for action. *Agriculture & Food Security*, *3*(1), 1-39.

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HYDROPONICS – A HIGH-TECH FARMING TECHNIQUE FOR GREEN FODDER PRODUCTION UNDER URBAN AND FLOOD AFFECTED AREAS

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Abstract

Apart from unfriendly climate, we have problem of large human & animal population, pressure on land, scarcity of pasture land, shortage of feed & fodder, resulting in comparatively low productivity & consequently the low economic returns. Moreover, in case of forages, the regional and seasonal deficiencies are more important than the national deficiencies, as it is not economical to transport the forages over long distances. Furthermore, the available forages are poor in quality and deficient in available energy, protein and minerals. As water becomes scarce and important as a resource, the use of hydroponics and other water saving technologies for crop production is needed now and is poised to popularize in time. Hydroponics uses substantially less water as compared to the soil farming. In India, a limited research has been done on feeding value of hydroponic fodder for small ruminants. Therefore; the nutritional benefit and economic values of feeding hydroponically grown maize, wheat, oats and barley fodder for livestock's. As green-fodder is an integral part of the dairy ration, in urban areas, flood situations, where fodder cannot be grown successfully or the modern progressive dairy farmer specially in urban areas, who wants in his dairy fodder production along with elite dairy herd, green-fodder can be produced hydroponically for feeding animals. Savings in irrigation water, fertilizer and increase in water productivity under hydroponic system as compared to conventional agriculture. It is possible to effectively grow good quality green fodder under controlled hydroponic conditions using 85 to 90% less water than traditional soil based

production. About 7.5 kg and 8.5 kg hydroponics green-fodder was produced from each kg of seed (yellow maize and white maize) respectively. Hydroponics green-fodder contained more crude protein (17.6 V/s 10.7%) and less crude fibres (14.1 V/s 25.9%).

Key point: Hydroponic technology, sustainable fodder production and quality fodder.

Introduction

Livestock plays a key role in the natural resources based livelihood, which is mostly confined to rural areas. In fact livestock rearing in our country is quite different for subsistence farmers, where risk management is more important than the developed market driven systems. With a livestock population of 536.76 million, India's livestock sector is one of the largest in the world. There is a tremendous pressure of livestock on available feed and fodder, as land available for fodder production is decreasing. India has a 30.65 and 11.85 per cent deficit in green fodder and dry fodder availability, respectively; which is expected to diminish but still persist at 18.4 and 13.2 per cent respectively by the year 2050 (Table 1). Today, most of the farmers depend on crop residues for feeding the livestock, which is far from a balanced nutrition. At present, the country faces a net deficit of 35.6% green fodder, 10.95% dry crop residue and 44% concentrate feed ingredients. The demand of green and dry fodder will reach to 1012 and 631 million tonnes of by the year 2050 (*Vision document-2050, ICAR-IGFRI, Jhansi*). According to their requirement and avoiding wastage is the basic point in exploiting the production potential for economic growth and sustainability since feed costs is the dominant parts of production that accounts more than 70%. To resolve livestock's nutrient deficiency, supplementation of inferior quality roughages with hydroponic green fodder coming up as a practical approach for improving roughages utilization and digestibility. In India, a limited research has been done on feeding value of hydroponic fodder for small ruminants. Therefore; the nutritional benefit and economic values of feeding hydroponically grown maize and barley fodder for livestock. As green-fodder is an integral part of the dairy ration, in situations, where fodder cannot be grown successfully or the modern progressive dairy farmer, who wants in his dairy fodder production along with elite dairy herd, green-fodder can be produced hydroponically for feeding animals.

Feed and Fodder Scenario in India

About 143 M ha an area is under cultivation in India but only 8.4 m ha (5.1 %) area of the total cropped area under forage cultivation. There is no shortcut to sustain livestock husbandry without focusing the issue related to the development of fodder and feed resources in the country. Fodder production and livestock feeding are the two important aspects for the sustainability of products and productivity in animal husbandry.

Table 1: Demand and supply estimates of dry and green forages (million tonnes)*

Year	Demand		Supply		Net deficit		% Deficit	
	Dry	**Green**	**Dry**	**Green**	**Dry**	**Green**	**Dry**	**Green**
2010	508.9	816.8	453.2	525.5	55.72	291.3	10.95	35.66
2020	530.5	851.3	467.6	590.4	62.85	260.9	11.85	30.65
2030	568.1	911.6	500.0	687.4	68.07	224.2	11.98	24.59
2040	594.9	954.8	524.4	761.7	70.57	193.0	11.86	20.22
2050	631.0	1012.7	547.7	826.0	83.27	186.6	13.20	18.43

*Source: IGFRI Vision: 2050

Due to multiplicity of forage crops grown in different seasons and regions, surplus and deficit in different regions, non-commercial nature of crops and production of forage with minimal inputs from degraded and marginal lands has led to huge gap in fodder availability and requirement. In soil farming, most of the water that we supply to the plants gets leached deep into the soil and is unavailable to the plants roots, whereas in hydroponics, plant roots are either submerged in water or a film of nutrients mixed in water is constantly encompassing the root zone, keeping it hydrated and nourished. No doubt livestock rearing is one of the major occupations in India which makes significant contribution of the country's GDP but future growth of this sector will be depending upon of the availability of the green forage for livestock feeding. Due to tremendous pressure of livestock on available feed and fodder, as land available for fodder production is decreasing day by day.

What is Hydroponic Technology?

The term Hydroponics was derived from the Greek words *hydro'* means water and *ponos'* means labour and literally means water work. The word hydroponics was coined by Professor William Gericke in the early 1930s; describe the growing of plants with their roots suspended in water containing mineral nutrients. Researchers at Purdue University developed the nutriculture system in 1940. During 1960s and 70s, commercial hydroponics farms were developed in Arizona, Abu Dhabi, Belgium, California, enmark, German, Holland, Iran, Italy, Japan, Russian Federation and other countries. Most hydroponic systems operate automatically to control the amount of water, nutrients and photoperiod based on the requirements of different plants (Resh, 2013). Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium such as gravel, vermiculite, rockwool, peat moss, saw dust, coir dust, coconut fibre, etc. to provide mechanical support

Modification in growth medium is an alternative for sustainable production and to conserve fast depleting land and available water resources. In the present scenario, soil less cultivation might be commenced successfully and considered as alternative option for growing healthy food plants, fodder crops and vegetables (Butler and Oebker, 2006). The nutritional benefit and economic values of feeding hydroponically grown maize, oats, wheat and barley fodder for livestock. Hydroponics fodder is being regularly produced in greenhouses under the controlled environment. Water is not wasted in this process, as it gets recovered, filtered, replenished and recycled. Waste nutrient solution can be used as an alternate water resource for crop cultivation under hydroponic system. Hydroponics green fodder is a viable option for fodder scarcity (in urban and flooded area) is a very promising technology for sustainable livestock production in India. The hydroponics fodder as well as vegetables is produced in greenhouses, which can be hi-tech or low cost devices. The hi-tech greenhouse is associated with a control unit and may be with or without air conditioner. The control unit regulates input of water and light automatically through sensors.

Green fodder production using hydroponics

Hydroponics green fodder is being regularly produced in greenhouses under the controlled environment. Under this technology selected seeds viz. maize, oats and barley-seeds, soaking time of 4-8 hours is sufficient. Hydroponics green-fodder looks-like a mat, consisting of roots, seeds and plants. About 7.5 kg and 8.5 kg hydroponics green-fodder was produced from each kg of seed (yellow maize and white maize) respectively. Hydroponics green-fodder contained more crude protein (17.6 V/s 10.7%) and less crude fibres (14.1 V/s 25.9%). Intake of hydroponics green-fodder by dairy animals was up to 18-20 kg/ animal/ day. Dry matter digestibility of the hydroponics green-fodder maize based ration was higher than the conventional green-fodder. Before using the seeds of maize, barley and wheat are considered the seed of choice for production of hydroponic fodder. Seeds of these crops are inexpensive and easily available in the local market. The seeds of these crops (around 1 kg each) were placed in small plastic trays which were arranged in controlled conditions.

Benefits of hydroponics Technology

Recently hydroponic technique is becoming popular because this is clean and relatively easy method and there is no chance of soil-borne disease, insect or pest infection to the crops thereby reducing or eliminating use of pesticides and their resulting toxicity. Besides, plants require less growing time as compared to crop grown in field and growth of plant is faster as there is no mechanical hindrance to the roots and the entire nutrient are readily available for plants. Although soil-less cultivation is an advantageous technique but some limitations are significant. Some benefits and limitations is given below-

- This technique is very useful for the area where is environmental stress (cold, heat, dessert etc.), urban and flood effected areas. Crops in hydroponic system are not influenced by climate change therefore, can be cultivated year-round and considered as off season.
- Further, commercial hydroponic systems are automatically operated and expected to reduce labour and several traditional agricultural practices can be eliminated, such as weeding, spraying, watering and tilling.
- The problem of pest and disease can be controlled easily while weed is practically non-existent.

- Higher yields can be obtained since the number of plants per unit is higher compared to conventional agriculture.
- No soil is needed. The water stays in the system and can be reused; thus, lower water costs.
- Hydroponics fodder produces all the macro-micronutrients that are needed by the animals.
- Hydroponics can reduce irrigation water usage by 70 to 90 % by recycling the run-off water.
- Hydroponics eliminates the possibilities of root diseases by allowing sufficient porosity for drainage of excess water as well as increases oxygen availability to the root zone.
- Weeds are a major problem in soil cultivation and calls for the use of harmful herbicides. Most farmers spend an enormous amount of money on labour for weeding.
- All labour inputs associated with soil management, such as digging and weeding are eliminated with hydroponics.
- The use of Integrated Pest Management (IPM) in protected environments is ideally suited to hydroponic growing techniques, especially when carried out in a protected environment such as a glasshouse or plastic/polythene tunnels.

Limitations

- Technical knowledge and higher initial cost is fundamental requirement for commercial scale cultivation.
- Plant in a hydroponics system is sharing the exact same nutrient, and water borne diseases can easily spread from one plant to another (Ikeda *et al.*, 2002).
- Hot weather and limited oxygenation may limit production and can result in loss of crops.
- Maintenance of pH, EC and proper concentration of the nutrient solution is of prime importance.
- Finally, light and energy supply is required to run the system under protected structure.

Conclusion

Due to increasing pressure on farm land, urbanization and limited water resources for production of food grains, oil seeds and pulses, the challenge here is to produce a system viable and adaptable throughout the year in a cost effective and energy sustainable manner. There exists a great need for scientists and engineers across the globe to take up research in this challenging and interesting field for application in hydroponics. It is expected that research efforts on hydroponic technology would be help to development of safe and healthy foods as livestock feeding in urban and flooded areas and it will be the next best alternative to supplement the fulfil the demand of fodder including human and animal health.

SINGLE SOLUTION MULTIPLE BENEFITS

References:

Annual Report (2013-14) Department of Animal Husbandry, Dairying and Fisheries; *Ministry of Agriculture, Government of India, New Delhi.*

Butler, J.D. and Oebker, N.F. (2006) Hydroponics as hobby growing plants without soil. Circular 844, Information Office, College of Agriculture, *University of Illinois, Urbana, IL 6180p.*

Domingues, D.S., Takahashi, H.W., Camara, C.A.P. and Nixdorf, S.L. (2012) Automated system developed to control pH and concentration of nutrient solution evaluated in hydroponic lettuce production. *Computers and Electronics in Agriculture* **84**: 53-61.

Ghosh P K, Palsaniya D R, Rai A K and Sunil Kumar (2015) Strategies for higher nutrient use efficiency and productivity in forage crops. In: Nutrient use efficiency: from basics to advances, Rakshit A, Singh HB and Sen A (eds.), Springer India, pp. 329- 42.

J.J. Gupta, (2014) Fodder production and livestock feeding management in Eastern India (Unpub.), *ICAR Research Complex for Eastern Region, Patna*.

Ghosh PK, Sunil Kumar and Palsaniya D R (2013) Forage and livestock production strategies for integrated farming systems. In: Integrated farming systems for enhancing resource use efficiency and livelihood security of small and marginal farmers, Behera UK, Chaudhary AK, Anchal Dass and Vyas AK (eds.), IARI, New Delhi-110012, India. pp 143-56.

Resh, H.M. (2013) Hydroponic Food Production: a Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower. *CRC Press, Boca Raton, FL.*

Rouphael, Y. and Colla, G. (2005) Growth, yield, fruit quality and nutrient uptake of hydroponically cultivated zucchini squash as affected by irrigation systems and growing seasons. *Scientia Horticulturae* **105** (2): 177- 195.

Shrestha, A. and Dunn, B. (2013) Hydroponics. Oklahoma Cooperative Extension Services HLA-6442.

IGFRI Vision, (2050) Indian Grassland and Fodder Research Institute, Jhansi, ICAR-IGFRI (UP).

ESNC, (2010) Egypt second national communication under the United Nations framework convention on climate change, UNFCCC, *Published by Egyptian Environmental Affairs Agency*.

H.N. Pandey, and N.N. Pathak (1991) Nutritional evaluation of artificially grown barley fodder in lactating crossbred cows. Indian Journal of Animal Nutrition, **8(1):** 77–78.

Sharma (2018) Hydroponics as an advanced technique for vegetable production: An overview *Journal of Soil and Water Conservation* **17**(4): 364-371

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BALANCING RISK AND REWARD: INTERCROPPING AS A FARMER'S INSURANCE POLICY

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Introduction

Intercropping is a sustainable agricultural practice that involves growing two or more crops simultaneously in the same field or growing area. Unlike monoculture, where a single crop is cultivated exclusively, intercropping promotes the cultivation of different crops in close proximity, creating a diverse and mutually beneficial ecosystem. This agricultural technique has been practiced for centuries across various regions of the world and has gained renewed interest in recent years due to its numerous ecological, economic, and agronomic advantages.In intercropping systems, crops are strategically selected and planted together based on their compatibility, growth patterns, and nutrient requirements. The goal is to optimize resource utilization, enhance crop yield and quality, reduce pest and disease pressure, and improve overall land productivity. Intercropping can involve various combinations of crops, including cereals, legumes, vegetables, or even trees and shrubs, depending on the specific goals and local conditions.

Crop insurance is designed to provide financial protection to farmers in the event of crop losses due to various factors. However, the process of acquiring and maintaining coverage can be complex, presenting several hurdles such as limited awareness, the cost of premiums, access to insurance providers, documentation and record-keeping, policy complexity, crop diversity, delayed payouts, adverse selection, and weather variability. To overcome these hurdles, farmers can consider natural crop insurance options, such as cultivating intercrops.

Intercropping, on its own, cannot replace traditional crop insurance; however, it can act as a valuable complement to crop insurance in various ways, bolstering risk management strategies for farmers. The following discussion elucidates how intercropping can function as a means of risk mitigation within the framework of crop insurance:

Crop Diversity in the Field

Foxtail millet + groundnut (4 : 1)

Kodo millet + Green gram (1 : 1)

Finger millet + Black gram (3 : 1)

Foxtail millet + Niger (4 : 1)

Diversification of Income Streams:

Intercropping involves growing multiple crops simultaneously in the same field. Different crops have varying growth patterns and susceptibility to pests and diseases. By diversifying their crops through intercropping, farmers reduce the risk of a complete crop failure. If one crop is affected by adverse conditions, other crops in the same field may still thrive, providing some income.Farmer's income derived from the intercropping farming system is higher than the monoculture was indicated by Muhammad Arsyad *et al*.,(2020). The canopy in an intercropping system encompasses the collective above-ground growth of all crops, profoundly impacting resource competition, sunlight capture, and microclimate modification. Variations in canopy height, density, and growth rates among different crops can either optimize or intensify competition for essential resources like sunlight, water, and nutrients, necessitating thoughtful crop selection and arrangement. This canopy diversity not only influences pest and disease dynamics through habitat disruption but also aids in weed suppression, efficient harvesting, and biodiversity enhancement by attracting beneficial insects and pollinators. Furthermore, it fosters interactions with the root zone, such as soil moisture conservation through shading, contributing to the overall success of intercropping in enhancing agricultural sustainability.

Reduced Pest and Disease Pressure:

Specific intercropping combinations can effectively mitigate pest and disease pressures in agriculture. Some crops possess natural repellent properties against certain pests, while others attract beneficial insects that act as natural predators, helping to control pest populations. This natural pest management approach can significantly decrease the risk of widespread infestations, ultimately minimizing the reliance on costly chemical treatments and potential crop losses. Research, such as that conducted by Trenbath in 1993, has demonstrated that components of intercropped systems tend to experience fewer instances of damage from pest and disease organisms compared to when they are grown as sole crops.

Optimal Resource Use:

To attain optimal resource utilization within an intercropping system, meticulous planning and multifaceted management are essential. This entails the careful selection of complementary crop combinations, taking into account their nutrient requirements, growth habits, and root structures to mitigate resource competition, including water, nutrients, and sunlight. Deliberate spacing and arrangement of crops prevent overcrowding and potential conflicts over resources. The efficient management of nutrients and water, encompassing practices such as companion planting and drip irrigation, guarantees that each crop receives its requisite resources. Simultaneously, the implementation of weed and pest control measures, along with the maintenance of soil health through strategies like cover cropping and reduced tillage, is crucial. The incorporation of crop rotation and the continuous evaluation of system performance, supported by thorough record-keeping, play pivotal roles in adapting and refining resource management. Ultimately, these efforts contribute to an enriched agricultural sustainability and heightened overall productivity within intercropping systems.

Improved Soil Health:

Intercropping provides a multifaceted approach to improving soil health. Firstly, it aids in preventing soil erosion by harnessing the diverse root structures and canopy covers of different crop species, collectively offering superior ground cover protection against the erosive forces of rainfall and wind. Secondly, through the cultivation of crops with varying nutrient requirements and root systems, intercropping optimizes nutrient cycling within the soil. For instance, legume crops contribute by fixing atmospheric nitrogen, making it available to neighboring non-legume crops, thus diminishing the need for synthetic fertilizers and bolstering overall soil fertility. Additionally, intercropping fosters the development of a more stable soil structure, because of the varied root systems of intercropped plants that create a network of roots at different depths, enhancing soil aeration, water infiltration, and overall structural integrity. Furthermore, the inclusion of diverse crops in an intercropping system results in various root exudates that support a rich and diverse microbial community in the soil, contributing to improved nutrient cycling, disease suppression, and overall soil health.

Climate Resilience:

Climate change can bring unpredictable weather patterns, including drought and excessive rainfall. Intercropping can enhance resilience against extreme weather events. For instance, a drought-resistant crop combined with a water-intensive crop can help ensure some yield even during water scarcity.

Staggered Harvests:

When crops with different growth rates are intercropped, it results in a longer harvest period. Some crops can be harvested early, while others continue to grow and mature. This extended harvesting season ensures a continuous flow of income throughout the year, reducing income fluctuations.

Risk Reduction in Organic Farming:

For organic farmers who rely less on chemical inputs, intercropping can be particularly beneficial. It can help control weeds naturally and reduce the risk of pests and diseases, which can be challenging to manage without synthetic pesticides (Gomiero *et al.*,2011).

Conclusion

Intercropping presents a promising strategy for farmers to mitigate the challenges associated with crop insurance. The complexities and hurdles in the traditional crop insurance process, including limited awareness, high premiums, and delayed payouts, often discourage farmers from obtaining adequate coverage. Intercropping offers a natural form of crop insurance by diversifying crops within the same field, reducing the risk of total crop failure due to adverse weather conditions or other unforeseen factors.By cultivating multiple crops together, farmers not only spread their risk but also enhance soil health and yield potential. This practice aligns with sustainable agriculture principles, contributing to long-term food security and environmental conservation.

While intercropping can serve as a risk management tool, it is important to note that it may not completely replace traditional crop insurance. Farmers should explore a combination of both approaches to effectively safeguard their livelihoods. Furthermore, policymakers and insurance providers should work towards simplifying insurance processes, lowering premiums, and improving the accessibility of insurance products to ensure that farmers have comprehensive protection against the uncertainties of agriculture.In the face of climate change and increasing agricultural risks, the synergy between intercropping and crop insurance can play a crucial role in supporting resilient and sustainable farming practices, ultimately benefitting both farmers and global food security.

References

Annonymus. 2020. Annual report , Centre of Excellence in Millets, Athiyandal

Deshmukh, R., Saxena, A. K., Swarnkar, C. P., & Gupta, R. K. 2014. .Intercropping of Legumes with Cereals Improves Soil Microbial Community Composition and Functioning. Brazilian Journal of Microbiology, 45(1), 1-10.

Gan, Y., Liang, C., Chai, Q., Lemke, R. L., Campbell, C. A., &Zentner, R. P. 2015. Intercropping Enhances Productivity and Maintains the Most Soil Fertility Properties Relative to Sole Cropping. European Journal of Agronomy, 62, 17-24.

Gomiero, T., Pimentel, D., &Paoletti, M. G.2011. Environmental Impact of Different Agricultural Management Practices: Conventional vs. Organic Agriculture. Critical Reviews in Plant Sciences, 30(1-2), 95-124.

Muhammad Arsyad, YusmiatiSabang, NurariatyAgus, SittiBulkis and Yoshio Kawamura.2020.Intercropping Farming System and Farmers Income.AGRIVITA Journal of Agricultural Science www.agrivita.ub.ac.id.

Peoples, M. B., Brockwell, J., Herridge, D. F., Rochester, I. J., Alves, B. J. R., Urquiaga, S., &Boddey, R. M.2009.The Contributions of Nitrogen-Fixing Crop Legumes to the Productivity of Agricultural Systems. Symbiosis, 48(1-3), 1-17.

Trendbath, B.R.1993. Intercropping for the management of pests and diseases.Field Crops Research.Volume 34, Issues 3–4, Pages 381-405.

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IMPACT OF CLIMATE CHANGE ON HORTICULTURAL CROPS

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Abstract

Many areas of the world are currently experiencing the effects of global warming. Accelerated warming-induced abnormality in climate patterns has already begun to have an impact on a particular catchment's hydrologic cycle. In some parts of the world, higher temperatures cause a high rate of evaporation and dry conditions. The frequency of severe weather events has increased. In addition to certain natural oscillations, scientists think that human-induced changes in the atmosphere are primarily to blame for the recent rapid warming. Crops are suffering significant harm, particularly as a result of temperature and water stress brought on by climate change. Stress due to high or low temperatures has a negative biochemical impact on plant health. Similarly, during the growth season, the crop's performance is impacted by drought and water stress.

Key words: climate change, temperature, global warming, crops

Introduction

These days, we frequently hear the terms "climate change," "global warming," and "global cooling." We have experienced climate change relatively recently, and it is accelerating at an alarming rate. It's possible that this is the most significant issue that the developed world has ever faced. Through the Intergovernmental Panel on Climate Change (IPCC), which was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme, there is significant international cooperation on it. Temperature is an important abiotic signal that controls plant activity throughout its development. Temperature fluctuations during growth operate as a trigger to initiate metabolic changes and promote developmental transitions. Temperature on earth changes along attitudinal and attitudinal clines and also with season, most plants are specially adopted to grow over a limited range of temperatures. Temperature extremes hinder plant survival and reproduction, and hence temperature is required as one of the most important factors of plant development and metabolism (Smith, B.N *et.al,* 1999). Warming temperatures associated with climate change will affect plant growth and development along with crop yield.

1. Limitations Due to High Temperature

High temperatures have two main consequences that have a limiting effect on crop production: reduced vegetative development and poor fruit set. The considerable transpiration that occurs in conjunction with exposure to excessively high temperatures obviously limits vegetable crops that are vulnerable to very high transpiration losses. Because heat tolerance and cold tolerance in fruit setting have only moderate heritabilities and such inheritance is complex, plant breeders are having trouble creating more heat-tolerant cultivars. The fact that the maximum fruit set can be associated with humidity levels adds another layer of complexity. In citrus fruit setting can also be hampered by extremely high temperatures. Because they are shielded from direct sunlight by the leafy canopy, flowers within this situation appear to be another limiting element in the intensity of insolation. (Samedi and Cochran 1976).

High temperature adversely affects mineral nutrition, shoot growth and pollen development resulting in low yield. The critical temperature above which plants gets killed is called thermal ‘death point’. The temperature above 50°C may kill many annual crops. The growth and development of plants involves a countless number of biochemical reactions, all of which are sensitive to some degree to temperature (Zrobeksokolnik 2012).

2. Limitations due to low temperatures:

The evident restriction brought on by cold temperatures is the freezing-induced death of plant tissues. When unexpectedly imposed at a phase of rapid growth, freezing temperatures can kill the majority of plant tissues. Given enough time and the right circumstances, some plants can adapt to cold temperatures while others cannot.

In plant tissue, exposure to freezing but nonlethal temperatures can result in a number of chemical changes. For instance, oranges that survive a freeze frequently acquire white crystals that are easily apparent in the space between the segment membranes. These are hesperidin, the main flavonoid found in citrus fruits, and while their presence can occasionally raise suspicions, they are entirely safe (Grierson and Hayward 1959).

3. Increasing Carbon Dioxide:

A doubling of atmospheric CO2 and an increase in other so-called greenhouse gases (methane, nitrous oxide, and chlorofluorocarbons) would raise the average world temperature, possibly by as much as 4.5 to 6 °C, as CO2 is to blame for 61% of global warming. Decreased soil water availability will likely occur in many parts of the world as a result of changes in regional precipitation patterns brought on by rising atmospheric CO2 (Keeling *et al*. 1995; Wigley and Raper 1992; Allen 1994). For life to exist on Earth, atmospheric CO2 is a necessary element. Plants gather carbon for growth and supply food for other living things, including humans, through photosynthesis. In photosynthesis, inorganic atmospheric CO2 is fixed and reduced into organic compounds while sunlight energy is absorbed by a system of pigments. Given that plant organic matter contains around 45% carbon on a dry weight basis, it is possible to quantify the reduction of carbon, which is a key function of photosynthesis.

4. Plant Responses to Rising CO:

Many crop plants' ability to photosynthesize, grow, and produce are restricted by the current atmospheric CO2, but C 3 species among them have the greatest potential to adapt to rising CO2 levels (Allen 1994; Bowes 1993). It is estimated that approximately 95 % of terrestrial plant species fix atmospheric CO 2 by the C 3 (i.e., photosynthetic carbon reduction or PCR) pathway, 1 % fix by the C 4 pathway, and 4 % by the CAM (Bowes 1993). It has been noted that plants cultivated in environments with increased CO 2 have more mesophyll cells and chloroplasts. As it relates to the physiology and biochemistry of leaf photosynthetic processes, accumulation occurs, with species-specific variations in the A/Ci (accumulation rate vs. intercellular CO 2) curves as well as changes in dark respiration and biochemical elements, with Rubisco playing the primary role (Bowes 1996).

The control of acid invertase and sucrose phosphate synthase (SPS) has also been reported to be impacted by increased CO2, in addition to Rubisco. According to studies (Sheen 1994; Jang and Sheen 1994; Smeekens 1998), levels of soluble sugars in plant cells can affect how many genes encoding essential photosynthetic enzymes are expressed.

5. Effect on yield and quality:

For optimal yields, various crops require various temperature and soil moisture regimes.

In terms of crop output, water is typically the main limiting issue. The majority of plants are extremely sensitive to temperatures above 35–40 °C because their ability to photosynthesize may be hampered. Additionally, increased temperatures have a tendency to shorten the time between sowing and harvest, which reduces the amount of light absorbed and the associated biomass production.

Extremely high or low temperatures can significantly hinder the development of fruits during crucial growth stages, such as flowering time. In certain circumstances, the plants never reproduce because too much heat makes the pollen sterile. Extreme weather conditions are predicted to increase in frequency and severity as the world heats, and this will have a greater impact on yields. Surface ozone concentrations are also anticipated to have an impact on yields since they can harm plant growth even at very low concentrations. Ozone produces reactive chemicals that kill the essential photosynthesis enzyme Rubisco.

Conclusion:

One of the top priorities for attaining future sustainability is improving agriculture. Future agriculture will need to undergo significant advances in order to effectively feed the world's population. A variety of techniques must be used to control the detrimental environmental consequences on agriculture, such as loss of soil fertility, soil erosion, aquifer depletion, soil and water pollution, and air pollution.

There are several ways to prevent topsoil loss, agricultural land deterioration, save water, energy, and lessen the need for agricultural chemicals. Furthermore, planting more vulnerable horticultural (perennial) plants can help mitigate the consequences of climate change by absorbing more radiation than annual or seasonal crops.

Reference:

Smith BN, Jones, AR, Hanson LD, Criddle RS. Growth, respiration rate, and efficiency response to temperature. Hand book of plant and crop stress. 2nd edition, Marcel Dekker, New York, 417-440 (1999)

Samedi M, Cochran LC (1976) HortScience 10:593

Zróbek-sokolnik A. Temperature stress and responses of plants. In: Ahmad P, Prasad MNV (eds) Environmental adaptations and stress tolerance of plants in the era of climate change. New York: Springer; c2012, p. 113-134.

Grierson W, Hayward FW (1959) Evaluation of mechanical seperators for cold-damaged Oranges Proc Am Soc Hort Sci 73:278–288

Keeling CD, Whorf TP, Wahlen M, Van der Plicht J (1995) Interannual extremes in the rate of rise of atmospheric carbon dioxide since 1980. Nature 375:660–670

Wigley TML, Raper SCB (1992) Implications for climate and sea level of revised IPCC emissions scenarios. Nature 357:293–300

Allen Jr, L.H., 1994. Carbon dioxide increase: Direct impacts on crops and indirect effects mediated through anticipated climatic changes. *Physiology and determination of crop yield*, pp.425-459.

Bowes G (1993) Facing the inevitable: plants and increasing atmospheric CO 2 . Annu Rev Plant Physiol Plant Mol Biol 44:309–332

Bowes G (1996) Photosynthetic responses to changing atmospheric carbon dioxide concentration. In: Baker NR (ed) Photosynthesis and the environment. Kluwer, Dordrecht, pp 387–407

Sheen J (1994) Feedback control of gene expression. Photosynth Res 39:427–438

Jang JC, Sheen J (1994) Sugar sensing in higher plants. Plant Cell 6:1665–1679

Smeekens S (1998) Sugar regulation of gene expression in plants. Plant Biol 1:230–234

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AN ECONOMIC PERSPECTIVE OF NATURAL FARMING FROM SOIL TO SAVING

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Abstract

Natural farming is a traditional farming approach rooted in Vrikshayurveda. With industrialization and urbanization, there has been a big transition in traditional farming practices towards the conventional farming system. This farming system helped India to become self-sufficient in food grain production through high-yielding varieties, chemical fertilizers, and pesticides. The excessive use of these inputs not only risks the exhaustible natural resources but also impacts the livelihood of small and marginal farmers. Due to the high input cost of conventional farming, there has been seen migration of agricultural labour towards other sectors resulting in decreasing farming practices in the nation. The cost-intensive farming practices not only affect the livelihood of the farming communities but also increase the unemployment rate affecting the growth of other sectors. In order to attain sustainability in its economic, environmental, and social facets, natural farming is emerging as a viable option for small and marginal farmers. It has been observed that this farming system has the potential over other farming practices. Timely and accurate information about natural farming can help farmers to make rational risk management decisions. Innovative development in agriculture policy can promote its wider adoption among farmers at a faster rate and help them to manage their land and water sustainably.

Keywords: Agriculture intensification, agroecology, conservation agriculture and sustainability

Introduction

Agriculture is the world's largest sector employs more than one billion of the population and produces over 1.3 trillion dollars' worth of food annually (Whitman, 2023). To meet the ever-growing food demand of the human population there is a need for intensification of the agriculture system. In farming practices where resource use efficiency is influenced by all agronomic, environmental, economic, social, and global aspects, agriculture intensification aims to maximize the efficient utilization of resources. Agricultural intensification is characterized by increasing physical, managerial, and capital inputs resulting in increased production or output, and has been a common strategy for many decades, in both developed and developing countries (Rose *et al*., 2021).

In developing nations like India, agriculture intensification is a big challenge where the majority of the farmers are small and marginal having less excess to purchase market-based inputs, and face difficulty in employing this approach at smaller scales. To prevent the situation of famine, conventional farming was developed during the Green Revolution period, which helped to save the lives of many due to the introduction of high-yield varieties, synthetic fertilizers, and pesticides. Although conventional agriculture remains an important source of food supply, an excessive dependency on the resources has exploited the overall welfare of society. The term "green" originally meant "to grow more," but it has evolved to "environmentally friendly farming" which means no negative impact on ecosystems, using chemical crop protectants and resources judiciously while taking into account the needs of future generations for better life.

When India achieved a note-worthy position in food production through conventional farming, unfortunately, farming itself became non-profitable over time due to intensifying production costs, and decreased soil fertility due to excessive use of chemical fertilisers and pesticides. In agriculture, sustainability is the ability of farmers to continue harvesting crops and animal products without degrading the environment or the resource base while maintaining economic profitability and social stability (Struik and Kuyper, 2017).

Therefore, the counter approach to conventional forms of agriculture is required which works on agroecological principles to achieve sustainability. Natural farming is the best sustainable farming solution taking into account both the physical and social aspects of agriculture.

The evaluation of the sustainability of the agri-food system is characterized by the optimization of resource use between and within the farming system.

Concept of Natural Farming

It is a diversified farming system that integrates crops, trees, and livestock by allowing the optimum use of functional biodiversity. Natural farming is capable of enhancing the farmers' income while delivering many other benefits, such as restoration of soil fertility and environmental health, and mitigating and/or reducing greenhouse gas emissions. In this farming, the soil is supplemented with microbial inoculum of bijamrit and jivamrit in order to increase the soil microbial account. These practices address a broad range of goals, including stimulating microbial activity, increasing soil carbon, adding nitrogen through green mulching, and accelerating the availability of existing nitrogen in the topsoil (Kumar *et al*., 2023).

Principle of Natural Farming

1. Principle of improved natural resource efficiency
2. Principle of sustainability/no dependency
3. Principle of resilience
4. Principle of social equity/responsibility

Economic Aspects of Natural Farming:

The economic aspect of any farming system depends on various factors, including the cost-benefit ratio, yields, and overall profitability. Farmers aim to maximize their benefits while minimizing costs to achieve favourable returns. A high cost-benefit ratio indicates that the returns from farming outweigh the expenses, which is essential for economic sustainability. Profitability is a key indicator of the economic health of a farming system. It considers not only the cost-benefit ratio but also other financial factors such as revenue, fixed and variable costs, depreciation, interest expenses, and taxes.

Cost:

India is dominated by small and marginal who have less access to financial facilities for agricultural practices. The conventional farming system is capital-intensive and depends upon outsourced factors that compel farmers to take loans and fall into the vicious trap of indebtedness. Moreover, the conventional farming system relies on the monocropping farming concept that lacks the resources to diversify farming into more lucrative or resilient agricultural activities. This restricts their ability to earn money and exacerbates their dependency on loans.

In contrast, the natural farming system is the mixed cropping system that aims to follow crop diversification which is accessible to all the farmers to practice it on their farms. Farming in natural farming is based on locally available inputs prepared at on farm level such as cow dung, cow urine, gram flour, jaggery, etc. to which the cost of cultivation is very low. Koner and Laha, 2020 study revealed that the total production cost under ZBNF was decreased by Rs. 587 per ha. The average input cost dropped under ZBNF for Rice and Maize was Rs. 13918 and 15925, respectively reported by (Gupta *et al.*, 2020). Similar results were supported by (Bharucha *et al.* (2020), Shyam *et al.* (2019), Reddy *et al.* (2019), and Chandel *et al.* (2021)), among others, that natural farming has a lower cost of cultivation than the conventional farming system. In addition, the natural farming system operates on the principle of conservation agriculture, which protects the environment and resources for the long term, by reducing the dependency on exhaustible inputs. As per the report of the Centre for Study of Science, Technology and Policy in Andhra Pradesh on 'Life Cycle Assessment of Natural Farming (NF) and Non-NF', fertilizer's contribution to materials cost is 10%–20% in NF viz-a-viz 50%–70% in non-NF Overall of cost of cultivation is lower in NF than in non-NF for paddy, maize (Suresh *et al.*, 2020).

Yield and Returns:

Yield is a critical factor in determining the profitability of any agricultural venture. It's important to understand that the yield differences between natural farming and conventional farming can vary depending on factors such as location, crop type, management practices, and the specific methods employed. While natural farming may not always produce higher initial yields in the short run, its focus on sustainability, soil health, and long-term resilience over time. Beside this, consistently practices natural farming in the fields can give better yield advantages over conventional farming system.

Sulok *et al.* (2018) reported that yield of black pepper has increased by 25 per cent under natural farming system. (Kumar, 2018) also stated that the yield obtained under the ZBNF system was 36 per cent more in Groundnut (rainfed), 26 per cent more in Chillies and 11 per cent more in Cotton. In intercropping with vegetables, the yield was found to be maximum under complete natural farming system (Das *et al.*, 2023). Similar findings from the Himachal Pradesh Agriculture University in Palampur presented in the 2019 NAAS meeting, indicated that yields under natural farming increased upto 2017 for crops such gram, lentil, soybean, black gram, and red mash (Kumar, 2020). The benefit-cost ratio of the ZBNF method was 1.67 which was greater than the ratio of conventional method (Jessica *et al*., 2021). Similar results supported by Mishra (2018), Dharmender (2019), Galab *et al.* (2019), Khadse and Rosset (2019), Reddy *et al*. (2019) and Shyam *et al.* (2019) stated that natural farming system has high net returns than any other non-natural farming system.

Risk Management

Agriculture farming is subject to various risks, such as adverse weather, pests, diseases, and market volatility. Natural farming employs risk management strategies, through crop diversification and reduces the dependency on a single crop for their revenue to mitigate these uncertainties. In terms of demand, the market has grown from US $ 84 billion in 2015 to US $ 129 billion in 2020 indicating the rise in demand for chemical-free organic produce on the global market (IFAOM, 2023).

Overall Economic Viability of Natural Farming System

According to a survey of ZBNF in Karnataka and Andhra Pradesh by the National Academy of Agricultural Research Management, Hyderabad, ZBNF decreased farming costs, boosted farmer income, and had positive ecological and social effects. The yield under natural farming was variable and depends upon many factors. Some crops showed increased ZBNF yield, while others showed decreased yield. (Kumar, 2020). The overall economic viability of farming systems can be influenced by various factors, including market conditions, government policies, access to credit, technology adoption, and environmental sustainability. Farmers often need to adapt to changing circumstances and make informed decisions to ensure their farming activities remain economically viable and provide a sustainable livelihood.

Efforts to improve the economic aspect of farming systems often involve promoting good agricultural practices, providing access to training and technology, supporting efficient marketing and distribution channels, and ensuring fair pricing mechanisms for agricultural products. Sustainable and profitable farming is not only essential for individual farmers but also for food security and the overall economic development of a region or country.

Conclusion

Natural farming has emerged as a sustainable farming approach to fulfill the economic, social, and environmental aspects of sustainability. Although the yield under the natural farming system may differ from region to region, the cost incurred in the natural farming system is low as compared to any other farming system which is able to generate profitable returns to the farming community. The multi-cropping concept of the natural farming system help farmers to diversify and manage the risk which yields them better returns than the mono-cropping of conventional farming systems. Therefore, natural farming stands out as the best choice in economic terms, offering not only sustainable agricultural practices but also promising higher returns compared to conventional farming methods.

References

Bharucha, Z. P., Mitjans, S. B. and Pretty, J. (2020). Towards redesign at scale through zero-budget natural farming in Andhra Pradesh, India. *International Journal of Agricultural Sustainability*. 18: 1-20.

Chandel, R. S., Gupta, M., Sharma, S., Sharma, P. L., Verma, S. and Chandel, A. (2021). Impact of Palekar's Natural Farming on Farmers' Economy in Himachal Pradesh. *Indian Journal of Ecology*. 48: 873-878.

Das, S. K., Kumar, A., Yadav, A., Laha, R. and Mishra, V. K. (2023). Zero budget natural farming practices on yield of crops (Maize + soybean and Pea + coriander) in mid hill of Sikkim Himalayas. *Journal of Agriculture and Ecology*. 16: 37–42.

Dharmendar, G. R. (2019). Andhra Pradesh 'Zero-Budget' Natural Farming Vision 2024: A Systemwide Transformation, Government of Andhra Pradesh. 52p.

Galab, S., Reddy, P. P., Raju, S. R., Ravi, C. and Rajani, A. (2019). Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh – Kharif 2018-19, Centre for Economic and Social Studies, Nizamiah Observatory Campus, Begumpet, Telangana. 60p.

Gupta, N., Tripathi, S. and Dholakia, H. (2020). Zero Budget Natural Farming save input, Andhra Pradesh. New Delhi: *Council on energy, environment and water*. 52p.

IFOAM, (2023). Demand and Consumption of Organic Farming Products. Ministry of Agriculture & Farmers Welfare. Available at: https://www.pib.gov.in/PressReleasePage.aspx?PRID=189701:

Jessica, G., Ratnaparkhe, A. N. and Yadav, J. P. (2021). Costs and returns in zero budget natural farming vis-àvis Conventional farming in Paddy crop in Kurnool district of Andhra Pradesh. *The Pharma Innovation Journal*. 10: 397-399.

Khadse, A. and Rosset, P. M. (2019). Zero Budget Natural Farming in India – from inception to Institutionalization. *Agroecology and Sustainable Food Systems*. 8: 21-35.

Koner, N. and Laha, A. (2020). Economics of Zero Budget Natural Farming in Purulia district of West Bengal: Is it economically viable? *Studies in Agricultural Economics*. 122: 22-28.

Kumar, R., Kumari, S., Chauhan, S. and Chaudhary, P. L. (2023). Zero-Budget Natural Farming. *Just Agriculture*. 3: 309-314.

Kumar, S., Kale, P. and Thombare, P. (2019). Zero Budget Natural Farming (ZBNF): Securing smallholder farming from distress. *Agriallis science for Agriculture and Allied Sector*. 1: 1-4.

Kumar, V. (2020). Indian states step up natural farming adoption. Agriculture. Available at: https://www.downtoearth.org.in/blog/agriculture/indian-states-step-up-natural-farming-adoption-73281.

Mishra, S. (2018). Zero Budget Natural Farming: Are This and Similar Practices The Answers, Nabakrushna Choudhury Centre for Development Studies, Bhubaneswar, Odisha. 23p.

Reddy, B. G., Reddy, V. R. and Mandala, S. R. (2019). Potential and Constraints of Zero Budget Natural Farming (ZBNF): A Study of Andhra Pradesh. *Indian Journal of Agricultural Economics*. 74: 321-332.

Rose, S., Halstead, J. and Griffin, T. (2021). Zero Budget Natural Farming in Andhra Pradesh: A Review of Evidence, Gaps, and Future Considerations. CREATE Solutions for a Changing World.1-28p

Shyam, D. M., Dixit, S., Nune, R., Gajanan, S. and Chander, G. (2019). Zero Budget Natural Farming - An empirical analysis. *Green Farming*. 10: 661-667.

Struik, P.C., Kuyper, T.W. (2017). Sustainable intensification in agriculture: the richer shade of green. A review. Agronomy Sustainable Development. 37, 39.

Sulok, K. M. T., Ahmed, O. H., Khew, C. Y. and Zehnder, J. A. M. (2018). Introducing Natural Farming in Black Pepper (*Piper nigrum* L.) cultivation, Sawarak, Malaysia. *International Journal of Agronomy*. 18: 1-6.

Suresh, N. S., Ravuri, S., Bose, A., Haritha, H., Shanker, A. and Lakshmi, A. P. (2020). Life cycle assessment of ZBNF and non-ZBNF. A preliminary study in Andhra Pradesh. Center for Study of Science, Technology and Policy (CSTEP).1-58.

Whitman, A. (2023). Agriculture Manomet. Available at: https://www.manomet.org/project/agricultural-investment-sustainability-metrics

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HUMAN RESOURCE MANAGEMENT IN AGRI BUSINESS

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Abstract

Human Resource Management (HRM) in agriculture plays a pivotal role in shaping the sustainability and productivity of the agricultural sector. This abstract provides a concise overview of the key aspects and challenges associated with HRM in agriculture. In the dynamic context of modern agriculture, effective HRM practices are essential to address a range of complexities. This includes managing a diverse and often transient labour force, adapting to technological advancements, and ensuring the well-being of agricultural workers. The integration of HRM principles into agricultural operations is crucial not only for optimizing resource allocation but also for enhancing the social and economic outcomes of the sector. Key themes explored in this abstract include workforce recruitment and retention, skill development, labour rights, and safety considerations. The agricultural sector's unique characteristics, such as seasonality and susceptibility to climate change, require tailored HRM strategies to ensure stability and sustainability. Additionally, this abstract highlights the role of technology in transforming HRM practices within agriculture. The adoption of digital tools and data-driven decision-making has the potential to revolutionize labour management, leading to increased efficiency and productivity. Nevertheless, HRM in agriculture also faces substantial challenges, such as labour shortages, rural-urban migration, and disparities in labour conditions. Balancing the need for increased mechanization with the preservation of livelihoods for agricultural labourers remains a critical concern. This abstract underscores the importance of a holistic approach to HRM in agriculture, recognizing the interplay between workforce management,

technological innovation, and broader sustainability objectives. Effective HRM practices not only contribute to agricultural productivity but also support the well-being of those engaged in this vital sector, making it an essential component of the global food system's future success.

Introduction

Agriculture has been the backbone of human civilization for millennia, providing sustenance and livelihoods to countless communities worldwide. However, as the world evolves, so does agriculture. Today, the agricultural sector faces multifaceted challenges ranging from climate change and resource scarcity to a growing global population. In navigating this complex landscape, effective Human Resource Management (HRM) in agriculture has emerged as a pivotal element for ensuring both productivity and sustainability.

The Changing Landscape of Agriculture:

Modern agriculture is undergoing a transformative shift. Traditional farming practices are giving way to innovative, technology-driven approaches. As a result, the workforce engaged in agriculture is evolving as well. Herein lies the importance of HRM in agriculture, as it not only addresses the needs of the agricultural labour force but also optimizes resource allocation and ensures long-term sustainability.

Key Aspects of HRM in Agriculture:

- **Workforce Recruitment and Retention:**

  Attracting and retaining skilled agricultural workers is a pressing challenge. The agricultural sector often grapples with issues such as seasonality and variable income, making it challenging to secure a stable labour force. Effective HRM strategies are essential for developing incentives and benefits that encourage talented individuals to remain in the sector.

- **Skill Development:**

  The agricultural workforce must adapt to technological advancements, requiring continuous training and skill development. HRM plays a crucial role in identifying skill gaps and providing relevant training opportunities. This empowers workers to harness the potential of modern farming technologies, ultimately boosting productivity.

- **Labour Rights and Welfare:**

  Ensuring the well-being of agricultural workers is paramount. HRM in agriculture must advocate for fair wages, safe working conditions, and access to essential amenities.

Empowering workers with knowledge of their rights and avenues for grievance redressal is fundamental to a thriving agricultural sector.

- **Safety Considerations:**
  Agriculture can be a hazardous occupation, with risks ranging from chemical exposure to machinery accidents. Robust HRM practices include comprehensive safety protocols and the promotion of a safety culture, mitigating risks and protecting workers.
- **Technological Integration:**
  Agriculture is rapidly becoming data-driven and technology-intensive. HRM must oversee the integration of digital tools and data analytics into farm operations, helping agricultural businesses make informed decisions and optimize their workforce.

Significance of HRM in Agribusiness

Human Resource Management (HRM) holds significant importance in the agribusiness sector for various reasons. It plays a crucial role in ensuring the efficiency, productivity, and sustainability of agricultural operations. Here are the key aspects highlighting the significance of HRM in agribusiness:

- **Workforce Management:** HRM is responsible for recruiting, training, and retaining a skilled and motivated workforce in agribusiness. Agriculture requires a diverse range of skills, from traditional farming techniques to modern technology use. Effective HRM ensures that the right people with the right skills are available when needed.
- **Seasonal Labour Management:** Agriculture often relies on seasonal labour for planting, harvesting, and other activities. HRM helps in planning and coordinating these labour needs, ensuring that there is an adequate workforce during peak seasons and managing labour costs during off-peak periods.
- **Labour Safety and Welfare:** Safety is a significant concern in agriculture due to the use of heavy machinery, exposure to chemicals, and the risk of accidents. HRM is responsible for implementing safety protocols, providing training, and ensuring that workers have access to necessary safety equipment and facilities.
- **Skill Development:** The agribusiness sector is constantly evolving, with new technologies and farming practices emerging. HRM identifies skill gaps within the workforce and organizes training and development programs to keep employees updated on the latest techniques and tools.

- **Resource Optimization:** HRM plays a critical role in optimizing resource allocation, including labour, land, and machinery. By ensuring that labour is used efficiently, agribusinesses can reduce costs and improve overall productivity.
- **Compliance with Regulations:** Agriculture is subject to various regulations related to labour laws, environmental standards, and food safety. HRM ensures that the agribusiness complies with these regulations, reducing the risk of legal issues and penalties.
- **Labour Rights and Fair Compensation:** HRM advocates for fair wages, working conditions, and labour rights for agricultural workers. It helps agribusinesses strike a balance between offering competitive compensation and managing labour costs effectively.
- **Environmental Sustainability:** HRM can promote sustainable farming practices among the workforce. This includes adopting conservation practices, reducing chemical use, and promoting responsible land management to minimize the environmental impact of agribusiness operations.
- **Community Engagement:** Many agribusinesses are deeply embedded in rural communities. HRM can engage with these communities to build positive relationships, support local development initiatives, and ensure that the agribusiness is a responsible and valued member of the community.
- **Succession Planning:** HRM can assist in planning for the future of agribusinesses by identifying and developing talent within the organization. Succession planning ensures a smooth transition of leadership and management roles, preserving the long-term sustainability of the business.
- **Technology Integration:** As agriculture becomes increasingly technology-driven, HRM can facilitate the adoption and integration of digital tools and data analytics into farm operations, improving decision-making and efficiency.

In conclusion, HRM is integral to the success of agribusinesses. It not only addresses the immediate labour needs but also contributes to the overall sustainability and growth of the sector. Effective HRM practices in agribusiness help create a safe, skilled, and motivated workforce, leading to higher productivity, profitability, and environmental responsibility.

Challenges in HRM for Agriculture:

Human Resource Management (HRM) in agriculture faces several unique challenges due to the specific characteristics of the agricultural sector. These challenges can vary from region to region and depend on the scale and type of agricultural operations. Here are some of the key challenges in HRM for agriculture:

- **Seasonal Labour Demand:** Agriculture often requires a fluctuating and seasonal labour force. HRM must effectively manage this seasonality by recruiting, training, and accommodating workers during peak planting and harvest times while minimizing labour costs during off-seasons.
- **Labour Shortages:** Many agricultural regions experience labour shortages, often exacerbated by rural-to-urban migration. Attracting and retaining a stable workforce in agriculture can be challenging, especially as younger generations may view farming as less attractive compared to urban job opportunities.
- **Skill Diversification:** The modernization of agriculture requires a diverse skill set, from traditional farming practices to using advanced technologies. HRM needs to ensure that agricultural workers are trained and equipped with the necessary skills to adapt to evolving farming techniques and machinery.
- **Health and Safety:** Agriculture carries inherent risks, including exposure to chemicals, heavy machinery operation, and adverse weather conditions. HRM must prioritize worker safety by implementing comprehensive safety training and protocols to prevent accidents and injuries.
- **Fair Compensation:** Ensuring fair wages and compensation packages for agricultural workers is essential to attract and retain talent. HRM in agriculture must navigate the balance between offering competitive wages and managing labour costs, which can be particularly challenging for small-scale farmers.
- **Housing and Amenities:** In remote rural areas, agricultural workers often lack access to proper housing and amenities. HRM may need to address these challenges by providing or facilitating access to suitable housing, sanitation facilities, and healthcare services.
- **Gender Equity:** In many agricultural societies, gender disparities exist in access to resources, training, and decision-making. HRM should work to promote gender equity in agriculture by providing equal opportunities and support for female workers and farmers.

- **Climate Change Uncertainties:** Climate change has introduced greater uncertainty into agriculture. HRM must plan for more erratic weather patterns, adapt crop choices, and provide support for farmers during periods of extreme weather events like droughts or floods.
- **Access to Education and Training:** HRM faces the challenge of ensuring that agricultural workers, especially in rural areas, have access to education and training programs to develop new skills and stay updated on best practices.
- **Technology Adoption:** While technology can improve productivity, not all agricultural workers may be familiar with or receptive to using modern farming equipment and digital tools. HRM should facilitate technology adoption through training and support.
- **Rural Development:** The development of rural infrastructure, including transportation, electricity, and internet access, is crucial for agriculture and HRM. These infrastructural challenges can affect labour recruitment and retention.
- **Environmental Sustainability:** Balancing the need for increased productivity with sustainable and environmentally friendly practices is a significant challenge. HRM should encourage the adoption of sustainable agricultural practices and educate workers on their importance.

In addressing these challenges, HRM in agriculture plays a critical role in not only optimizing labour management but also contributing to the overall success and sustainability of the agricultural sector. Effective HRM strategies can help agricultural businesses and communities thrive in an ever-evolving landscape.

Conclusion

Human Resource Management in agriculture is not merely an administrative function but a strategic imperative. It plays a pivotal role in addressing the myriad challenges facing modern agriculture while nurturing growth and sustainability. By focusing on workforce recruitment and retention, skill development, labour rights, safety, and technological integration, HRM ensures that the agricultural sector can thrive in an ever-changing world. As we look to the future, it is clear that effective HRM in agriculture will be a driving force behind the success of the global food system and the well-being of the millions of individuals who depend on it.

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TRAINING NEEDS ASSESSMENT ON INCOME GENERATING ACTIVITIES OF TRIBAL FARM WOMEN OF NORTH 24 PARGANAS, WEST BENGAL

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Introduction

Training is one of the important methods for developing and enhancing the capacities of individuals to improve their performance. Training and demonstration are important extension tools to take the technology from lab to land. Before planning for any developmental program a base line study of the selected beneficiaries is generally conducted along with their training need assessment. Knowles et al. (2005) claimed that farmer training is an education that most frequently takes place outside formal education institutions. It varies from school education because it is based on adult life, and it is the basis for a formal philosophy of adult learning, because adult education will be based on their real needs and wants, not on a predetermined educational programs . In fact, a need is a deficiency or absence of something in a person that must be improved in order to be completed or to reach a better situation (Goli et al 2020) . A training plan based on the needs of the beneficiaries is the prerequisite for the successful achievement of the training objectives. A training need exists when an individual lacks the knowledge and skills to perform an assigned task satisfactorily. Training Needs Assessment seeks to accurately identify the current levels of knowledge, skills and practices existing in the target area through surveys, interview, observation, secondary data and/or workshop. Training needs assessment is the process of identifying whether or not a training gap exists and, if so, what training is necessary to resolve it. In the target surveys, interviews, observations, secondary data, and/or workshops, training needs assessment aims to properly determine the levels of the current situation. The difference between the current and the desired situation highlights issues that may become training needs (Cigularov and Dillulio, 2020). The five phases of the Training

Needs Assessment process are as follows: (i) identifying problem and needs, (ii) determining the design of needs assessment, (iii) collecting data, (iv) analyzing data, and (v) providing feedback (Castleberry and Nolen,2018]. The assessment of training needs is pre-requisite to any type of training for successful implementation of the training objectives. In Agricultural extension, it is the most important activity undertaken for human resource development and capacity building of different stakeholders like farmers, fishers, extension personnel, researchers, department officials' students etc. These consequences can increase production per unit area and improve quality, food security, and economic and social growth(Goli et al, 2013). In the present study, A training need assessment was done in the tribal villages of Makaltala and Farmania before implementing the tribal sub plan programmes in the village in order to effectively plan the program.

Methodology

Training need assessment was found out separately for farming activities and other allied activites.The data was collected from fourty farm households selected randomly from the beneficiary list of 100 households. The data for training need assessment was collected in a 3 point continuum scale as Very Important (VI), Important (I), Not Important (NI) by assigning scores 3, 2 and 1 respectively.

Table Training needs assessment

Response Category	Score
Very Important (VI)	3
Important (I)	2
Not Important (NI)	1

The results were calculated as weighted score for each of the thrust area identified for the training.

Weighted Score (WS) = (No. of VI*3) + (No. of I*2) + (No. of NI*1)

Total no. of VI+I+NI

Results and Discussion

Training needs assessment regarding farm activities

The training needs of the farm women regarding agriculture and allied activities were identified during preliminary survey. These identified training needs were given to respondents for scoring during the survey.

The weighted scores were calculated for the training needs and depicted in table

Table :1 Training needs assessment regarding farm activities

n= 40

Name of Training need	Very Important	Important	Not Important	Wt. Score
Integrated Disease Management	22	8	10	230
Weed Management	10	23	7	207.5
Seed Production	17	6	15	195
Integrated farming	6	25	9	192.5
Soil water conservation	0	32	8	180
Integrated Nutrient management	2	18	20	155
Integrated Pest Management	9	0	31	145
Nursery management	1	12	27	135
Crop Diversification	1	7	32	122.5
Water Management	0	9	31	122.5
Soil Fertility management	1	7	32	122.5
Soil & Water testing	1	1	38	107.5

An assessment on training needs regarding farm activities showed that training on integrated disease management (230) was the most sought after by the farm women. The reason behind this was they were not able to identify the disease properly and hence the management of crop was difficult.

Training on weed management (207.5) was another important training need reported by the participants. Because of lack of awareness and technical knowhow of improved implements and chemicals for weed management hand weeding was followed by the farm women. Training can be given to tribal women for using implements like nail weedier, pre emergence, post emergence herbicides etc, which will reduce the drudgery of farm women. Need on training on Seed production had also scored high. Because purchasing seed for farming activities was too high which they could not afford.

The tribal farm women also showed interest to training on integrated farming (192.5), soil water conservation (180), integrated nutrient management (155), integrated pest management (145), nursery management (135), crop diversification (122.5) etc.

Table 2 Training needs assessment regarding allied activities

n= 40

Name of Training need	**Very Important**	**Important**	**Not Important**	**Wt. Score**
Piggery Management	28	6	6	255
Mushroom Production	30	2	8	255
Dairy Management	27	7	6	252.5
Poultry Management	26	6	8	245
Bee-keeping	14	10	16	195
Household food security by kitchen gardening & nutrition gardening	4	21	15	172.5
Tailoring	3	7	30	132.5
Women & Childcare	1	9	20	102.5

Assessment of training needs regarding allied activities showed that the training need highly scored was mushroom production (255 wt) followed by piggery management (255), dairy management (252.5), poultry management (245), bee keeping (195) and kitchen gardening and Nutrition (172.5). A few of the tribal farm women succeeded in mushroom enterprise and this have motivated the other women to experiment with mushroom production enterprise. This is the reason for scoring mushroom training need.

Training on piggery management was also equally sought after by the tribal farm women. They expressed that it is a good source of income. The tribal women also revealed that the men folk were very font of Pork. Many of the poultry birds of these tribal farm women died due to poor disease management. The tribal women are not aware of the disease control measures and as a result most of them felt the need of training on poultry management as important. The tribal farm women also showed interest to training on Tailoring (132.5), Women and Childcare (102.5).

Conclusion

Training need assessment on farming activities revealed that there is a greater need for training on pset and disease management in crops followed by weed management. The results show that though many technological interventions are introduced in the rural areas there remains a gap on technical knowledge among the farmers. Unless and until this is addressed the technology will not yield its potential results. Similarly, there is a need on training on mushroom production, piggery, Dairy and poultry among the tribal farm families. These allied sectors would not only help farmers in enhancing their livelihood security but also would help to achieve nutritional security. Any development program aimed at overall development of farm house -holds should consider training need analysis before planning and implementing the program so that need based interventions can be incorporated for the successful implementation of the program. These training would have to be essentially focused on raising awareness, enhancing indigenous traditional skills, and converting them to more scientific ones in order to raise output, reduce drudgery, and boost sale profit margins.

References

Castleberry, A.; Nolen, A. Thematic analysis of qualitative research data: Is it as easy as it sounds? *Curr. Pharm. Teach. Learn.* **2018**, *10*, 807–815.

Cigularov, K.P.; Dillulio, P. Does rater job position matter in training needs assessment? A study of municipal employees in the USA. *Int. J. Train. Dev.* **2020**, *24*, 337–356.

Goli, I.; Charmchian Langerodi, M.; Shahbazi, I. Modeling the Educational Needs of the Rice Cultivating Women in Sari, a township of Mazandaran Province, using Borich's Model. *Int. J. Agric. Crop. Sci.* **2013**, *6*, 583–592.

Goli, I.; Omidi Najafabadi, M.; Lashgarara, F. Where are We Standing and Where Should We Be Going? Gender and Climate Change Adaptation Behavior. *J. Agric. Environ. Ethics* **2020**, *33*, 187–218.

Knowles, M.S.; Holton, E.F.; Swanson, R.A. *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development*, 6th ed.; Els Sci Tec Books: San Diego, CA, USA, 2005; Volume 391.

Umunna, M.O.; Adeeko, A.; Adigun, O.; Adebayo, O.A.; Awoleke, O.K. Training needs on aquaculture value addition among fish farmers in borogu local government area, niger state, Nigeria. *J. Res. Forest Wild. Environ.* **2019**, *11*, 41–47.

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MINERAL NUTRITION-PHYSIOLOGY OF NUTRIENT UPTAKE BY ACTIVE AND PASSIVE ABSORPTION IN PLANTS

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Introduction

The term, mineral nutrient is generally used to refer to an inorganic ion obtained from the soil and required for plant growth. The supply and absorption of chemical compounds needed for growth and metabolism of plants may be defined as Plant Nutrition and the chemical compounds in which elements are required by the plants are termed as Nutrients. The nutrients indispensable for the growth and development of higher plants are obtained from three sources viz., atmosphere, water and soil. The atmosphere provides carbon and oxygen as carbon dioxide. Carbon is reduced during photosynthesis and oxygen is utilized during aerobic respiration. Soil provides the mineral ions. Higher plants are autotrophic organisms that can synthesize their organic molecular components out of inorganic nutrients obtained from their surroundings. For many mineral nutrients, this process involves absorption from the soil by roots and incorporation in to the organic compounds that are essential for growth and development. This incorporation of mineral nutrients into organic substances such as pigments, enzyme cofactors, lipids, nucleic acids and amino acids is termed as nutrient assimilation. Nutrition and metabolism are thus very closely related.

Essential Plant Nutrients and Criteria of Essentiality

Plants contain about 80 to 90 percent of water by weight and the remaining 10 to 20 percent is the dry weight. The dry matter consists of a number of organic compounds such as carbohydrates, proteins, lipids and others. Nearly 90 percent of the dry weight of the plant consists of carbon, hydrogen and oxygen. All the mineral elements together contribute only about 6 percent of the dry weight of the plant. The finding of certain element in plant does not signify that this element is essential for the growth of the plant. For finding out whether an element is essential or not, Arnon and Stout (1939) proposed the criteria of essentially.

These criteria essentially are as follows:

1. A deficiency of the element makes it impossible for a plant to complete its life cycle.
2. The functions of an element cannot be replaced by another element.
3. The essential element must be directly involved in the metabolism of plant or it may be required for the activation of an enzyme system.

Based on the above criteria the following elements are now known to be essential for higher plants.

Carbon	C	Magnesium	Mg
Hydrogen	H	Iron	Fe
Oxygen	O	Manganese	Mn
Nitrogen	N	Copper	Cu
Phosphorus	P	Zinc	Zn
Sulphur	S	Molybdenum	Mo
Potassium	K	Boron	B
Calcium	Ca	Chlorine	Cl
		Sodium	Na
		Silicon	Si
		Cobalt	Co

Macro and Micro Nutrients:

Based on the element concentration in plant material, the essential plant nutrients may be divided into macronutrients and micronutrients.

Macronutrients: The nutrient elements which are required for the growth of plants relatively in larger quantities are called as major nutrients or macronutrients. The major elements required for growth of plants are C, H, O, N, P, K, Ca, Mg and S. Among these nutrients, C, H and O are taken up by the plants from the atmosphere and water. The N, P, K, Ca, Mg and S are taken up by the plants from the soil and they are applied in the form of chemical fertilizers either through the soil or foliage.

Micronutrients: The nutrient elements which are required comparatively in small quantities are called as minor or micro nutrients or trace elements. The micronutrients required for the plant growth are Fe, Mn, Cu, Zn, Mo, B, and Cl.

Beneficial elements: Sodium (Na) has beneficial effect and in some cases it is essential. There are some plant species, particularly the chenopodiaceae plants and species adapted to saline conditions that take up this element in relatively high amounts. Na is also required for turnips, sugar beets and celery. The same is true for Silicon (Si), which is an essential nutrient for rice. Cobalt is an essential element for the growth of the blue- green algae, but it has not been shown to be essential for other algae or for higher plants. It is also required by certain legumes to fix atmospheric nitrogen. Here, however the cobalt ion is necessary for the symbiotic bacteria present in the nodules associated with the roots.

Tracer elements or labeled elements: The nutrient elements that are required for plants are sometimes labeled and used to study their movement or tracing out the involvement of such nutrients in metabolism in different organs of plants, are called as tracer elements. They may either be stable or radioactive types and they are also called as isotopic elements.

E.g. Stable isotopes: 15N, 12C, 31P

Radioactive: 14C, 32P, 65Zn, 56Fe, 60Co, etc.

Hidden hunger: When the plants are not able to meet their requirement either one or more of these essential elements, the plants will undergo starvation for such elements. At the initial stage of deficiency of such elements plants will not show any characteristic symptoms which could be exhibited morphologically and due to want of those elements some activities of plants would rather be affected and the internal deficiency is called as Hidden hunger.

Mobility (Phloem Transport) of Inorganic Solutes: The mineral nutrients initially acquired by the roots move upward in xylem. Many of them are then subjected to redistribution via the phloem but a few are not. Immobility in the phloem presumably is caused by failure of these elements to enter the sieve tube.

Mobile	**Intermediate**	**Immobile**
Nitrogen	Iron	Calcium
Phosphorus	Manganese	Boron
Potassium	Zinc	
Magnesium	Copper	

Chlorine Rubidium Sodium Sulphur	Molybdenum	

Bukovac and Wittwer (1957) studied the mobility of many radio actively labeled mineral elements applied to leaves of bean plants and classified them into three groups based on the mobility in phloem.

Classification of plant nutrients based on their biochemical role and physiological function

Essential elements are now classified according to their biochemical role and physiological function. Based on the biochemical behavior and physiological functions, plant nutrients may be divided into four groups.

Nutrient elements	Uptake	Biochemical function
1st group C,H,O,N,S	In the form of CO2, HCO-3, H2O, O2, NO3, NH+4, N2SO42-, SO2. The ions from the soil solution, the gases from the atmosphere.	Major constituents of the organic compounds of the plant. Essential elements of atomic groups which are involved in enzymatic processes. Assimilation by oxidation reduction reactions.
2nd Group P, B, Si	In the form of phosphates, boric acid or borate, silicate from the soil solution.	They are important in energy storage reactions or in maintaining structural integrity. Elements in this group are often present in plant tissues as phosphate, Borate and silicate esters in which the elemental group is bound to the hydroxyl group of an organic molecule

		(i.e sugar-phosphates) (Esterification). The phosphate esters are involved in energy transfer reactions.
3rd Group K, Na, Mg, Ca, Mn, Cl	In the form of cations from the soil solution except chlorine.	Present in plant tissues as either free ions or ions bound to substances such as the pectic acids present in the plant cell wall. Of particular importance of their roles as enzyme cofactors and in regulation of osmotic potentials.
4th Group Fe, Cu, Zn, Mo	In the form of ions or chelates from the soil solution.	Present predominantly in a chelated form Incorporated in prosthetic groups. Enable electron transport by valency change.

Physiology of Nutrient Uptake:

Mineral nutrients are found either as soluble fractions of soil solution or as adsorbed ions on the surface of colloidal particles. Various theories proposed to explain the mechanism of mineral salt absorption can be placed in two broad categories:

I) Passive Absorption

II) Active Absorption

After several decades of research on this process of ion uptake it is now believed that the process involves both passive and active uptake mechanisms. Whether a molecule or ion is transported actively or passively across a membrane (Casparian band, Plasma Membrane or Tonoplast) depends on the concentration and charge of the ion or molecule, which in combination represent the electrochemical driving force.

Passive transport: Across the plasma membrane occurs along with the electrochemical potential. In this process Ions and molecules diffuse from areas of high to low concentrations. It does not require the plant to expend energy.

Active transport: In contrast, to passive transport energy is required for ions diffusing against the concentration gradient (electro chemical potential). Thus active transport requires the cell to expend energy.

1. Passive Transport Mechanism:

A) Diffusion: Simple diffusion to membranes occurs with small, non-polar molecules (i.e. O_2, CO_2). In this process ions or molecules move from the place of higher concentration to lower concentration. It needs no energy.

B) Facilitated diffusion: For small polar species (i.e H_2O, Ions and amino acids) specific proteins in the membrane facilitate the diffusion down the electrochemical gradient. This mechanism is referred to as facilitated diffusion.

a) Channel proteins: The specific proteins in the membrane form channels (channel proteins), which can open and close, and through which ions or H2O molecules pass in single file at very rapid rates.

A K^+ and NH^{4+} channel also operates by the same process of facilitated diffusion. In addition Na^+ can also enter the cell by this process.

b) Transporters or Contransporters: Another mechanism involves transporters or contransporters responsible for the transport of ions and molecules across membranes. Transporter proteins, in contrast to channel proteins, bind only one or a few substrate molecules at a time. After binding a molecule or ion, the transporter undergoes a structural change specific to a specific ion or molecule. As a result the transport rate across a membrane is slower than that associated with channel proteins.

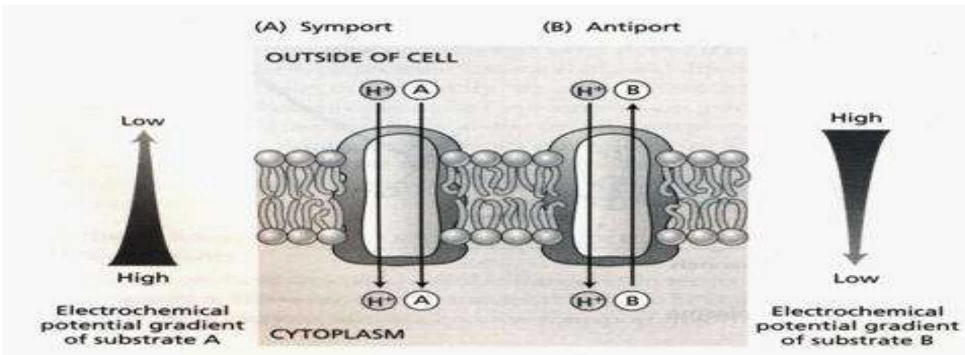
Three types of transporters have been identified.

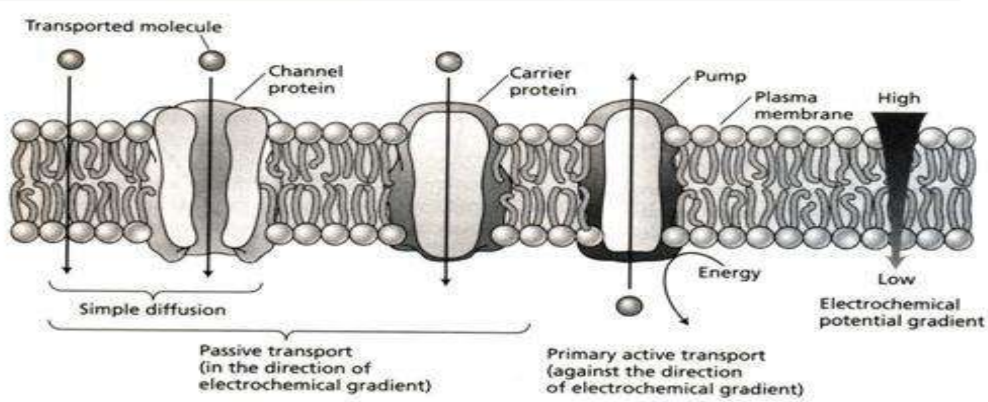
Uniporters: Transport one molecule (i.e. glucose, amino acids) at a time down a concentration gradient.

Antiproters: Catalyze movement of one type of ion or molecule against its concentration gradient. This is coupled with the movement of a different ion or molecule in the opposite direction. Examples of antiporter transport are H^+ - Na^+ and H^+ - Ca^{+2} transport into the vacuole.

Symporters: Catalyze movement of one type of ion or molecule against its concentration gradient coupled to movement of a different ion or molecule down its concentration gradient in the same direction. The high H^+ concentration in the apoplast provides the energy for symporter transport of NO_3 and the other anions.

Therefore, the energy for antiporter and symporter transport originates from the electric potential and/or chemical gradient of a secondary ion or molecule, which is often H^+.





2. Active Transport Mechanism:

Larger or more-charged molecules have great difficulty in moving across a membrane, requiring active transport mechanisms (i.e., sugars, amino acids, DNA, ATP, ions, phosphate, proteins, etc.) Active transport across a selectively permeable membrane occurs through ATP-powered pumps that transport ions against their concentration gradients. This mechanism utilizes energy released by hydrolysis of ATP. The Na^+ - K^+ ATP pump transports K^+ into the cell and Na^+ out of the cell, another example is the Ca^{+2} ATP pump.

Thus, it can be understood from the above discussion that the ion transport mechanisms operate both actively and passively. For some of the ions the uptake mechanism is active and for some others it is passive.

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MILLETS *VS* GLYCAEMIC INDEX

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Introduction

The glycaemindex is a measure used to assess how quickly carbohydrates in foods raise blood sugar levels after consumption. It ranks carbohydrate-containing foods on a scale from 0 to 100 based on how rapidly they cause blood sugar levels to raise compared to pure glucose (which has a GI of 100).

GI scale:

Low GI (55 or less):

Foods with a low GI are digested and absorbed slowly, causing a gradual and steady rise in blood sugar levels. These foods are often recommended for people with diabetes or those looking to manage their blood sugar levels more effectively.

Medium GI (56 to 69):

Medium glycemic index (GI) foods are those that fall in the middle range of the glycemic index scale. These foods are known to cause a moderate increase in blood sugar levels after consumption.

High GI (70 or more):

Foods with a high GI are quickly digested and cause a rapid increase in blood sugar levels. These foods are generally not recommended for people with diabetes or those trying to control their blood sugar levels.

Millets Vs Glycaemic index

Millets are a group of small-seeded grains that have been a staple food in various parts of the world for thousands of years. They are gaining popularity due to their nutritional benefits and relatively low glycaemic index (GI) compared to some other grains. Here's a comparison between millets and their glycaemic index:

Low GI:

Millets, such as pearl millet (bajra), foxtail millet, finger millet (ragi), and sorghum (jowar), generally have a lower glycaemic index compared to refined grains like white rice and wheat. This means millets cause a slower and more gradual increase in blood sugar levels when consumed. Millets typically have a GI ranging from around 50 to 70, depending on the type and preparation method, which is lower than white rice and many wheat products.

Nutrient-Rich Millets:

Millets are not only having low GI but also packed with nutrients. They are a good source of fiber, vitamins, minerals (such as magnesium and phosphorus), and antioxidants. These nutrients can contribute to better overall health and may help regulate blood sugar levels.

Filling and Satiety:

Millets are known for their satiating effect, which can help control appetite and reduce the likelihood of overeating. This can be particularly beneficial for those managing their weight and blood sugar.

Gluten-Free:

Most millets are naturally gluten-free, making them a suitable choice for people with gluten intolerance or celiac disease.

Diverse Culinary Uses:

Millets can be used in various culinary applications, including as whole grains, flour, flakes, or as ingredients in dishes like porridge, roti (flatbread), and even desserts.

Cultural and Regional Variations:

The popularity and types of millets vary by region and culture. For example, finger millet (ragi) is commonly consumed in South India, while pearl millet (bajra) is popular in North India.

Millets and their glycaemic index values

Type of millet	Average glycaemic index
Barnyard millet	42.3
Foxtail millet	54.5

Finger millet	61.1
Kodo millet	65.4
Little millet	64.2
Proso millet	57.4
Mixed millet	42.7
Pearl millet	56.6
Sorghum	61.2

(https://somiigbene.com/the-best-types-of-millet-for-blood-sugar-control/, 2023)

Crops having low Glycaemic index

Finger millet

Barnyard millet

Proso millet

Little millet

Foxtail millet

Kodo millet

Pearl millet

Sorghum

Factors affecting the glycaemic properties of millets

The glycaemic properties of millets, like any other food, are influenced by several factors. Millets are generally considered to have a lower glycaemic index compared to many other grains and cereals, which can make them a good choice for individuals looking to manage blood sugar levels. Here are some factors that can affect the glycaemic properties of millets:

Variety of Millet:

Different varieties of millets, such as finger millet, pearl millet, foxtail millet, and sorghum, have varying glycaemic indices. For instance, finger millet tends to have a lower glycaemic index compared to pearl millet.

Processing:

The way millets are processed can impact their glycaemic index. Whole grains tend to have a lower glycaemic index compared to polished grains. Millet flours and products made from whole millets are likely to have a lower glycaemic index than highly processed and refined flour millet products.

Cooking Method:

The cooking method used for millets can affect their glycaemic index. Boiled or steamed millets generally have a lower glycaemic index than fried or fluid millets

Ripeness:

The ripeness of millet grains can influence their glycaemic index. Fully mature grains tend to have a lower glycaemic index compared to immature grains.

Fiber Content:

Millets are generally high in dietary fiber, which can help to down the absorption of glucose in the blood stream, leading to a lower glycaemic response. The fiber content can vary among different millet varieties.

Particle Size:

Finely ground millet flours may have a higher glycaemic index than coarsely ground or whole millets because they are absorbed more quickly in the digestive system.

Presence of Anti-Nutrients:

Some millets contain anti-nutrients like phytates and tannins that can reduce the glycaemic response by inhibiting the absorption of carbohydrates.

Mixture with Other Foods:

Combining millets with other foods, especially those rich in protein, fiber, or healthy fats, can lower the overall glycaemic impact of a meal.

Cooking Time:

Longer cooking time can help break down complex carbohydrates in millets, making then easier to digest and potentially reducing theor glycaemic index.

Portion Size:

The quantity of millets consumed can affect blood sugar levels. Larger portions may lead to a higher glycaemic response.

Individual Variability:

Glycaemic responses can vary among individuals based on factors such as genetics, gut microbiota, and insulin sensitivity.

Conclusion

Millets offer a favorable option for individuals seeking to manage their blood sugar levels due to their generally lower glycaemic indices compared to many other grains and cereals. Their diverse varieties, processing methods, cooking techniques, and fiber content contribute to variations in glycaemic properties, allowing for flexibility in dietary choices.

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GENOME ENGINEERING FOR CROP IMPROVEMENT

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Introduction

Genetic diversity serves as the foundation for enhancing agriculture. The primary objective of plant breeding is to create and utilize this genetic diversity. Throughout the extensive history of plant breeding, encompassing both traditional and modern approaches, four significant methods have been employed: cross-breeding, mutation breeding, transgenic breeding, and genome editing-based breeding. Traditional plant breeding, also known as cross-breeding, entails deliberately crossing plants to amalgamate desirable traits through sexual recombination. This technique has played a pivotal role in enhancing agricultural productivity. One notable example is the initial Green Revolution, which began in the late 1950s. During this period, genetic mutations, particularly those associated with dwarfing traits, were introduced into major staple crops like wheat (*Triticum aestivum*) and rice (*Oryza sativa*), resulting in the development of high-yield varieties (Khush, 2001). However, cross-breeding has its limitations since it can only incorporate traits already present in the parent plants' genomes. The restricted genetic diversity in elite germplasms restricts the utility of this method.

In mutation breeding, mutations are induced randomly throughout the genome using chemical or radiation-based techniques, significantly increasing genetic variability (Holme *et al.*, 2019). However, the process of identifying rare individuals with the desired traits from a large population of mutagenized plants is labour-intensive and time-consuming (as shown in Figure 1). A pivotal advancement in plant breeding came with the development of transgenic breeding, which involves introducing genes or traits from other organisms into crop plants. This has led to improved yields, reduced pesticide usage, and enhanced nutritional qualities. Nevertheless, the adoption of transgenic crops has been limited to only a few, mainly due to the random integration of foreign DNA into plant genomes and the strict government regulations governing genetically modified organisms (GMOs). Moreover, concerns about the safety of these products among the public have also constrained their potential.

Genome editing techniques have been developed to enable precise and predictable modifications to plant genomes, facilitating the acquisition of desired traits. These techniques are ushering in a new era of precision breeding, which is shaping the future of plant breeding (Chen *et al.,* 2019). Among these technologies, CRISPR-Cas (Clustered Regularly Interspaced Short Palindromic Repeats and CRISPR Associated) has emerged as one of the most advanced systems for engineering crop genomes.

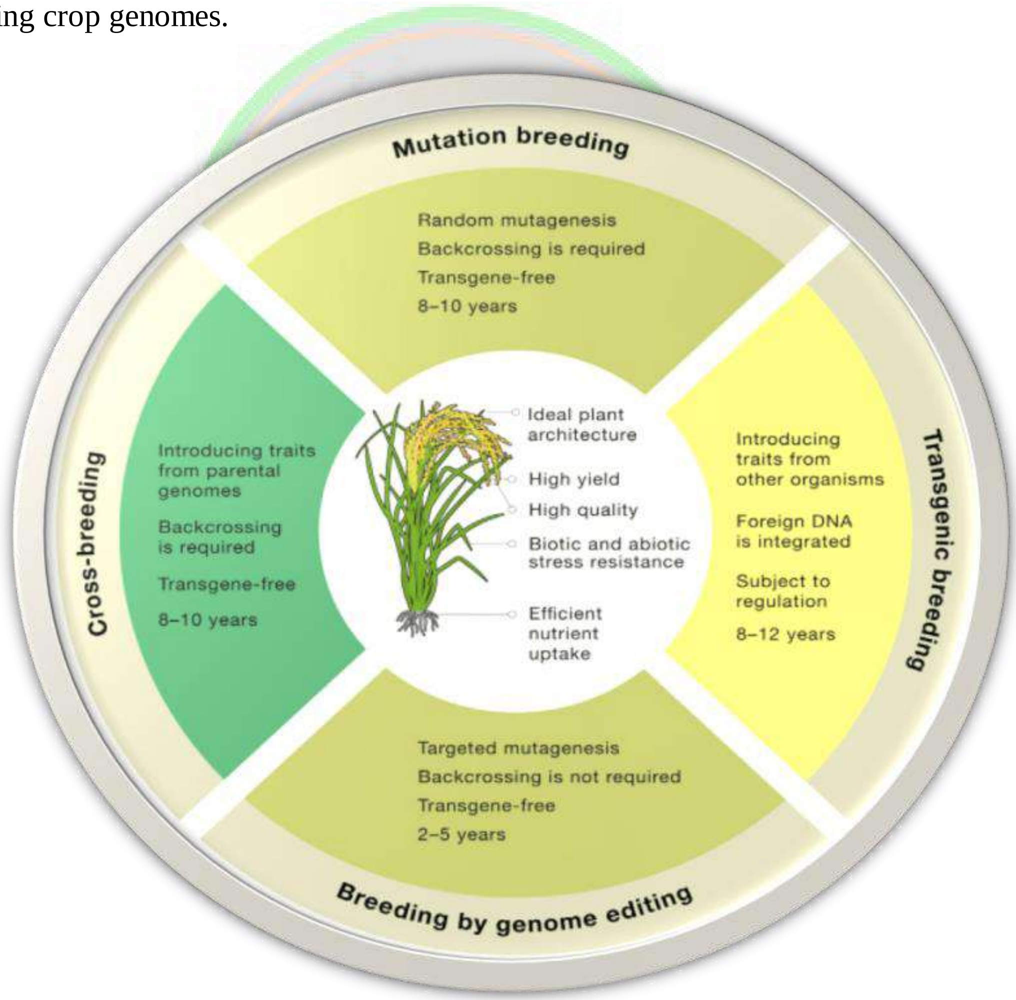


Figure 1. Plant breeding techniques commonly used to introduce new traits into an elite crop variety

This technology has seen rapid expansion and application in major cereal crops like rice, wheat, and maize (*Zea mays*), as well as in other vital food security crops such as potato (*Solanum tuberosum*) and cassava (*Manihot esculenta*) (Zhu *et al.*, 2020).

Procedure for genome editing

The general procedure for genome editing in plants can be divided into six steps:

(1) select the appropriate nuclease based on the target sequence;

(2) construct genome editing vectors;

(3) validate the activity of these vectors using protoplasts (wall-free plant cells released from enzyme-digested tissues; optional step);

(4) deliver genome editing reagents into plant cells;

(5) regenerate genome-edited cells into plantlets via tissue culture; and

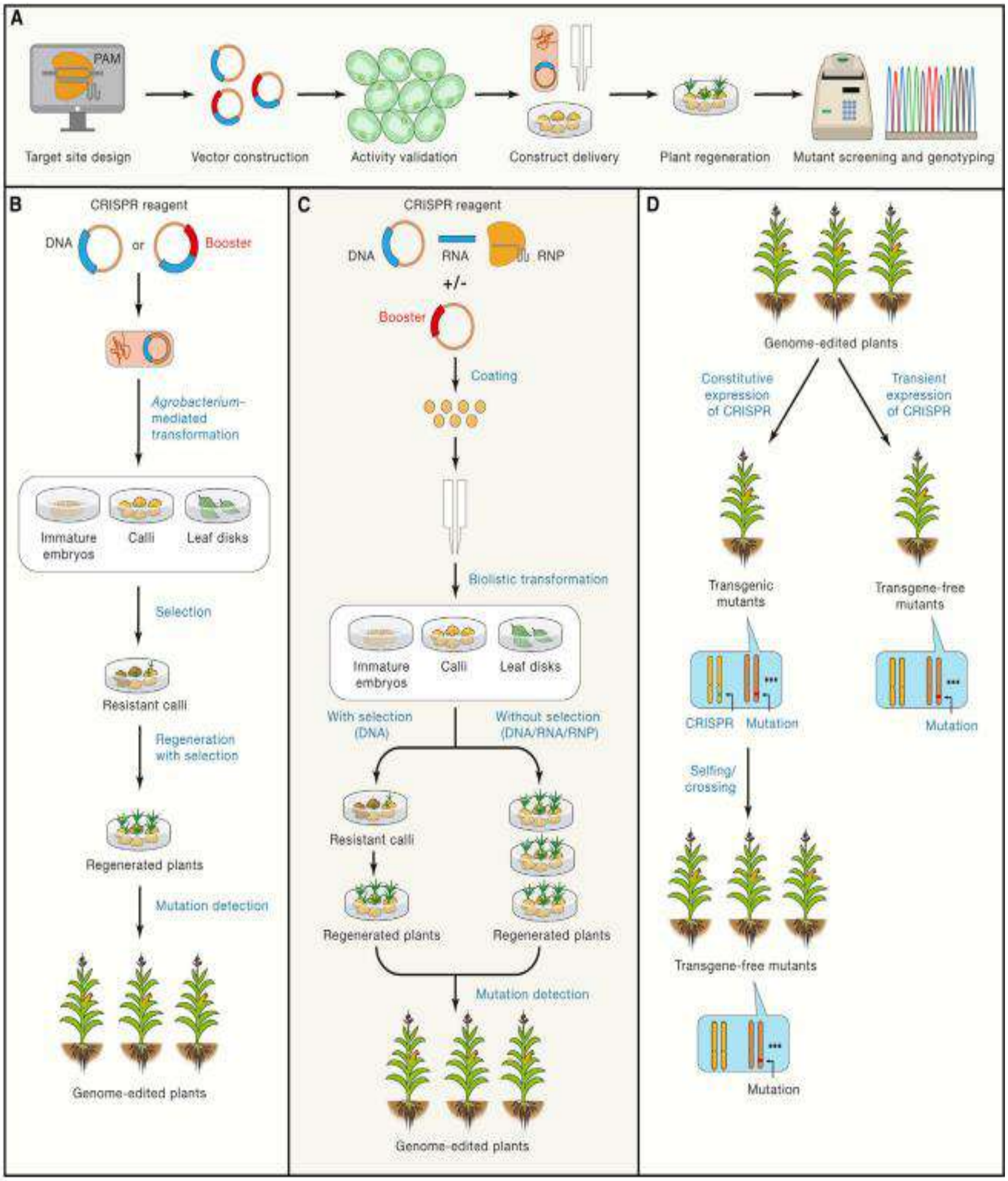
(6) screen and genotype the resulting genome-edited plants.

There are three common types of genome editing reagents: CRISPR-Cas9 DNA, RNA (which includes in vitro transcripts of Cas9 and single-guide RNA [sgRNA]), and RNP (ribonucleoprotein, comprising Cas9 protein and in vitro-transcribed sgRNA) (Ran *et al.*, 2017). While DNA can be introduced into plant cells using both particle bombardment and Agrobacterium-mediated transformation methods, RNA and RNP can only be delivered into plant cells through particle bombardment (Liang *et al*., 2017) as depicted in Figures 2B and 2C).

Genetic modifications generated by genome editing in plants

In addition to ZFNs and TALENs, the introduction of the CRISPR-Cas system has accelerated the development of plant genome editing. The most widely used CRISPR-Cas systems are the Cas9 and Cas12a complexes, both of which are single effector proteins that perform nucleic acid cleavage (Chen *et al*., 2019; Figure 3A). Recently, the Cas12b system was also developed for plant genome editing (Ming *et al.*, 2020). All of these systems rely upon crRNAs to guide the Cas protein to target sequences. The Cas9 protein requires an additional RNA molecule known as a trans-acting crRNA (tracr-RNA), which can be artificially fused with the corresponding crRNA to form a sgRNA. CRISPR-Cas systems can be programmed by simply designing the DNA target protospacer sequence into the crRNAs or sgRNAs.

The CRISPR-Cas system and newly developed tools such as base editors (Gaudelli et al., 2017; Komor *et al*., 2016; Figure 3B) and prime editors (Anzalone *et al.*, 2019; Figure 3C) have greatly expanded its potential applications. To date, genome editing has been used to generate a variety of heritable genome modifications in plants including (1) small random insertions/deletions (indels) (Figure 3D); (2) point mutations or nucleotide substitutions (Figure 3E); (3) DNA fragment insertions (Figure 3F); (4) DNA fragment deletions (Figure 3G); and (5) targeted chromosomal rearrangements (Figure 3H).



(*Source*:https://www.researchgate.net/publication/331538032_CRISPRCas_Genome_Editing_and_Precision_Plant_Breeding_in_Agriculture.)

Figure 2. (A) Schematic illustration of the six major steps in plant genome editing.

(B) Genome-edited plants generated by Agrobacterium-mediated delivery of CRISPR DNA.

(C) Conventional and transient expression methods for particle bombardment-mediated genome editing by delivery of CRISPR DNA or RNA.

(D) Two strategies used to obtain transgene-free mutants.

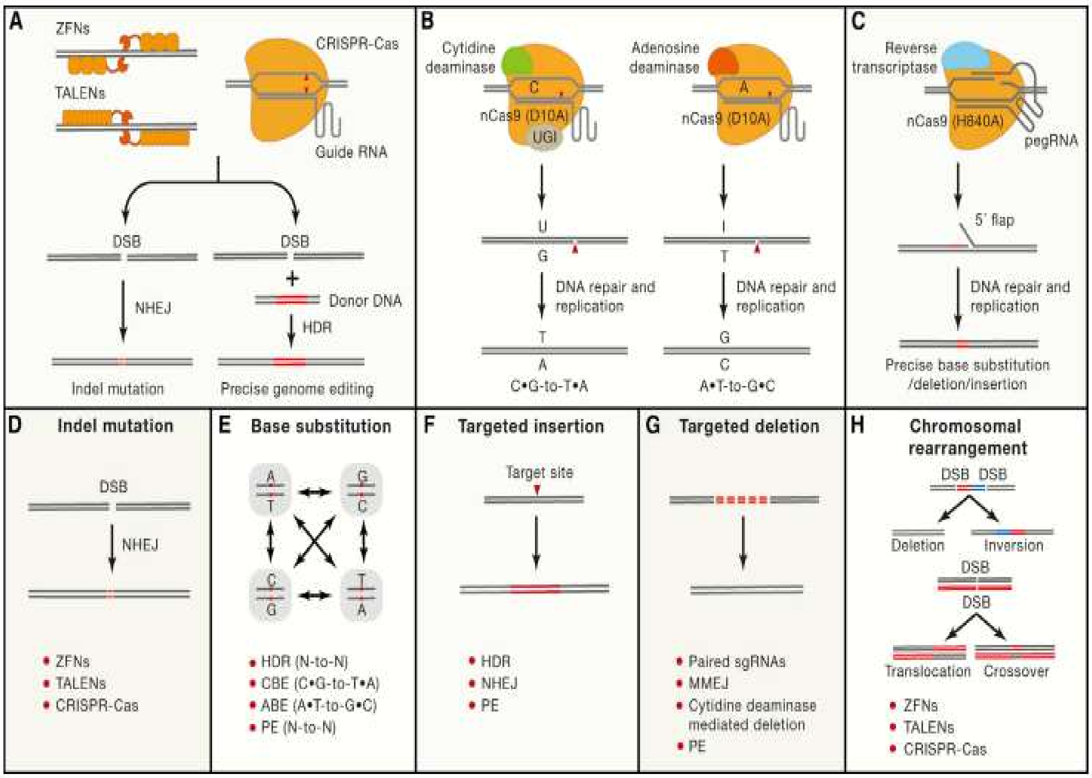


Figure 3. Genetic modifications generated by genome editing in plants

(A) Schematic diagram of the NHEJ and HDR DNA repair pathways when DNA double-strand breaks (DSBs) are produced by sequence-specific nucleases (SSNs).

(B) Base editing technology. Cytidine or adenosine deaminase is fused with Cas9 nickase (nCas9 (D10A)) to generate a cytosine base editor (CBE) or adenine base editor (ABE), respectively. The CBE generates C$G-to-T$A base substitutions, and the ABE generates AT-to-GC base substitutions. UGI, uracil DNA glycosylase inhibitor.

(C) Prime editing technology. The prime editor (PE) is composed of a fusion of nCas9 (H840A) with reverse transcriptase and a prime editing guide RNA (peg RNA).

(D) ZFNs, TALENs, and the CRISPR-Cas system induce small random indels mutation via the DNA non-homologous end joining (NHEJ) repair pathway.

(E) Base substitutions can be created by HDR, CBE, ABE, and PE.

(F) Targeted insertion editing by HDR, NHEJ, and PE.

(G) Targeted deletion editing by paired sgRNAs, cytidine deaminase-mediated deletion, MMEJ, and PE.

(H) Pairs of DSBs are introduced simultaneously into chromosomes, inducing chromosome deletions, inversions, translocations, and crossover.

The CRISPR system could be used to precisely edit the genomes of specific organisms within a complex microbial community (Rubin *et al.*, 2020). These edited organisms could then be returned to the laboratory environment to study whether a specific modification results in new characteristics in the host plant, such as improved nutrient absorption or pathogen resistance. Such information would reveal the exact function of a specific organism within a microbial community. The CRISPR system could first be transformed into a microbial community, followed by delivery into a natural plant growth environment, such as soil and leaves. The CRISPR system could also be transferred from modified microbes to other microbial community members via interactions and conjugation, leading to in situ genome editing of the plant microbiomes. Such precise genome editing of plant microbiomes would enable new approach for improving crop production

Conclusion

The development of genome editing technologies in plants enables a breadth of opportunities for plant breeding. Efficient, precise, and targeted mutagenesis via genome editing has laid the foundation for many next-generation breeding strategies that will revolutionize the future of agriculture. To exploit the full potential of plant genome editing, all approaches must be explored. Genome editing allows for a combination of genetic traits to be rationally designed into crops. These precise and efficient techniques when used for rapid plant breeding results in outcomes similar to those of classical breeding.

However, it is unlikely that genome editing-based next-generation breeding will completely displace conventional approaches; only when combined with other technologies, such as high-throughput phenotyping, genomic selection and speed breeding, can we guarantee the widespread implementation of genome editing in agriculture. This multidisciplinary approach will advance plant breeding to help secure a second Green Revolution in order to meet the increasing food demands of a rapidly growing global population under ever-changing climate conditions.

References

Anzalone, A.V., Koblan, L.W., and Liu, D.R. (2020). Genome editing with CRISPR-Cas nucleases, base editors, transposases and prime editor. *Nat. Biotechnol*. 38, 824–844.

Anzalone, A.V., Randolph, P.B., Davis, J.R., Sousa, A.A., Koblan, L.W., Levy, J.M., Chen, P.J., Wilson, C., Newby, G.A., Raguram, A., and Liu, D.R. (2019). Search-and-replace genome editing without double-strand breaks or donor DNA. *Nature* 576, 149–157.

Capdeville, N., Schindele, P., and Puchta, H. (2020). Application of CRISPR/ Cas-mediated base editing for directed protein evolution in plants. *Sci. China Life Sci*. 63, 613–616.

Chen, K., and Gao, C. (2020). Genome-edited crops: how to move them from laboratory to market. Front. Agric. Sci. Eng. 7, 181–187.

Chen, K., Wang, Y., Zhang, R., Zhang, H., and Gao, C. (2019). CRISPR/Cas Genome Editing and Precision Plant Breeding in Agriculture. *Annu. Rev. Plant Biol*. 70, 667–697.

Meng, X., Yu, H., Zhang, Y., Zhuang, F., Song, X., Gao, S., Gao, C., and Li, J. (2017). Construction of a Genome-Wide Mutant Library in Rice Using CRISPR/ Cas9. Mol. *Plant* 10, 1238–1241.

Rubin, B.E., Diamond, S., Cress, B.F., Crits-Christoph, A., He, C., Xu, M., Zhou, Z., Smock, D.C., Tang, K., Owens, T.K., *et al*. (2020). Targeted Genome Editing of Bacteria Within Microbial Communities. *bioRxiv*. *https://doi.org/10. 1101/2020.07.17.209189.*

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IMPORTANCE OF *Bacillus* spp. AS BIOAGENTS FOR SUSTAINABLE AGRICULTURE- A BRIEF ACCOUNT

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Abstract

Pesticides have been shown to be a promising agent for supplying the growing population's food needs. However, these hazardous pesticides have produced human health problems, pest resistance development, loss of biodiversity, and environmental challenges, raising anticipates about the pesticides' safety. As a result, it is critical to reduce the dependency on these synthetic pesticides. The use of PGPR is a promising alternative for environmentally friendly agriculture. *Bacillus spp*. has been identified as direct and indirect growth stimulants in sustainable agriculture. N_2-fixation, P and K Solubilization, phytohormone production by Bacillus strains, as well as antibiotic synthesis, production of lytic enzymes and ISR are all direct and indirect Bacillus action mechanisms that aid in plant growth promotion, pest resistance, and disease avoidance. Some Bacillus species have been identified as promising biocontrol agents. Food production and accessibility have long been a top goal in feeding the world's population. Considering the importance of sustainable agriculture, *Bacillus spp*.-based bioproducts could be a promising addition to the restricted product range available. There is an urgent need to investigate the potential of *Bacillus spp*. in conjunction with other suitable microbial agents to boost PGPR (Plant Growth Promoting Rhizobacteria) activity and food quality.

Introduction

A number of pathogenic bacteria produce a variety of plant diseases, which reduce agricultural production and cause significant yield losses. Various approaches have been used to control plant diseases; however, their effectiveness is often reduced due to pesticide resistance. Furthermore, the abuse of synthetic fertilizers not only has negative impacts on the biosphere but also harms ecosystems, operating, and reduces agricultural sustainability. *Bacillus* species, which inhibit plant diseases through competitive and antagonistic mechanisms, are among the best-studied biocontrol agents as biopesticides. *Bacillus* species' ability to produce antibiotics and durable, resistant endospores to control a wide range of phytopathogens has made them an essential biological control agent.

One well-known example is "*Bacillus thuringiensis*" (Bt), a naturally occurring soil bacterium that produces proteins toxic to certain insect pests. Bt has been used in organic farming and as a biological control agent to manage insect pests while minimizing environmental impact and preserving beneficial insects. Bt-based insecticides have been utilized as a component of integrated pest management (IPM) strategies. (Compant *et al*., 2005)

The major concern in the use of conventional pesticides:

The major concern in the use of conventional pesticides is the development of pesticide resistance in target pests. Over time, repeated exposure to the same pesticide can lead to the selection of individuals within the pest population that are naturally resistant to the chemical. These resistant individuals survive and reproduce, passing on their resistance genes to the next generation, which results in an increase in the resistant pest population.

As the resistance spreads, the effectiveness of the pesticide diminishes, making it less useful in controlling the pest infestations. Farmers may then resort to using higher doses or more potent pesticides, which can further exacerbate the problem and lead to other environmental and health issues. (Rajmohan *et al.*, 2020)

To address these concerns, integrated pest management (IPM) strategies have been developed, which focus on combining various pest control methods, including biological control (using natural predators or parasites), cultural practices, and the targeted use of pesticides, with the goal of reducing reliance on chemical pesticides and minimizing their negative impacts.

Types of Toxins produced by Bt:

Bacillus thuringiensis bacteria produce different insecticidal proteins known as Cry and Cyt toxins. Among them the Cyt toxins represent a special and interesting group of proteins. Cyt toxins are able to affect insect midgut cells but also are able to increase the insecticidal damage of certain Cry toxins.

1. **Crystal Toxins:** These are generated as parasporal crystalline inclusions during the stationary phase of development, and are also known as delta endotoxins. Poisons like Cry and Cyt are examples of this.
2. **Cry Toxins:** At the moment, cry proteins account for the vast bulk of insecticidal proteins produced by *Bacillus species*. The Bt toxin Nomenclature Committee has categorised 73 different types of Cry Proteins to yet. It is harmful to Lepidoptera, Coleoptera, Hemipterans, Dipterans, and Nematodes.
3. **Cyt Toxins:** Cyt (Cytotoxin) proteins are encoded by Cyt genes. • Unlike Cyt proteins, Cyt proteins have widespread cytolytic activity *in vitro* but are primarily dipteran specific *in vivo*.

Some of the key ways in which *Bacillus*-based products contribute to sustainable agriculture:

1. **Biofertilization:** Certain *Bacillus sp.* have the ability to fix atmospheric nitrogen into a plant-available form. When applied to the soil or on plant roots, these bacteria can enhance the nutrient content of the soil, thereby promoting plant growth without the need for synthetic fertilizers.
2. **Biocontrol of Plant Pathogens:** *Bacillus*-based biopesticides, particularly *Bacillus thuringiensis* (Bt), are widely used to combat various agricultural pests, including insects and nematodes. Bt produces crystal proteins that are toxic to specific groups of insects, making it an effective and environmentally friendly alternative to chemical insecticides.
3. **Disease Suppression:** *Bacillus* species like *Bacillus subtilis* and *Bacillus amyloliquefaciens* have been shown to produce antibiotics and other antimicrobial compounds that can suppress the growth of plant pathogens. By using these beneficial bacteria, farmers can reduce the reliance on chemical fungicides and bactericides.
4. **Inducing Systemic Resistance:** Some *Bacillus* strains can trigger the plant's immune system, inducing systemic resistance to diseases. This means that when the plant is

exposed to pathogens, it can mount a faster and stronger defense response, reducing the severity of the disease.

5. **Enhancing Crop Tolerance to Abiotic Stress:** *Bacillus*-based products have been found to enhance the ability of plants to withstand various abiotic stresses, such as drought, salinity, and extreme temperatures. This can be particularly beneficial in regions facing adverse climatic conditions.
6. **Biodegradability and Safety:** Unlike synthetic chemical inputs, *Bacillus*-based products are biodegradable and do not persist in the environment for extended periods. They have a favorable safety profile, with minimal risk to non-target organisms, including humans, wildlife, and beneficial insects.
7. **Reduced Environmental Impact:** By reducing the reliance on synthetic fertilizers, pesticides, and fungicides, *Bacillus*-based solutions contribute to minimizing the environmental impact of agriculture, including the pollution of water bodies and the disruption of beneficial ecosystems.

***Bacillus* spp. as PGPR (Plant Growth Promoting Rhizobacteria)**

Plant growth promoting rhizobacteria (PGPR) are bacteria that colonize the rhizosphere (the root zone of plants) and stimulate plant growth. *Bacillus* stimulates plant development via enhancing nutrient absorption from the soil or by activating the host's defence mechanism against numerous plant diseases. Other species can also suppress the population of plant harmful microbes. Zubair *et al.*, 2019 highlighted two *Bacillus* strains, CJCL2 and RJGP41, for their potential contribution to lowering cold stress and stimulating plant growth in wheat plants.

Mechanism of PGPR in plant growth and development

1. **Production of Phytohormones:** PGPR can synthesize and release plant growth-regulating hormones such as auxins, cytokinins, gibberellins, and ethylene. These hormones play vital roles in promoting root development, increasing nutrient uptake, and enhancing overall plant growth (Fan *et al.*, 2019).
2. **Nutrient Solubilization:** Some PGPR are capable of solubilizing and mobilizing essential nutrients, particularly phosphorus, from the soil. They produce organic acids and enzymes that break down complex nutrient compounds, making them more available and accessible to the plant.

3. **Nitrogen Fixation:** Certain PGPR, particularly species of nitrogen-fixing bacteria like *Rhizobium* and *Azospirillum*, have the ability to convert atmospheric nitrogen (N_2) into ammonia (NH_3) in a process called nitrogen fixation. This ammonia can then be used by the plant as a nitrogen source, promoting growth and development.
4. **Induced Systemic Resistance (ISR):** PGPR can stimulate the plant's natural defense mechanisms, triggering the production of secondary metabolites and pathogenesis-related proteins. This induced systemic resistance helps the plant better protect itself against various pathogens.
5. **Antagonism against Plant Pathogens:** Some PGPR produces antimicrobial compounds and compete with pathogenic microorganisms for space and nutrients in the rhizosphere. By doing so, they help suppress the growth of harmful pathogens, reducing the risk of plant diseases.
6. **Enhanced Water Use Efficiency:** Certain PGPR can improve a plant's ability to cope with drought stress by facilitating water uptake and retention, as well as by regulating the plant's water balance.
7. **Detoxification of Harmful Compounds:** PGPR can aid in the detoxification of pollutants and harmful substances in the soil, thus promoting phytoremediation and environmental cleanup.

***Bacillus* species exist in soil**

A wide range of microorganisms, including bacterial species, archaea, and fungi, coexist in soils and play important roles in ecosystem function. According to Mishra *et al.,* (2016), 1 g of soil contains 1010-1011 bacteria, 6,000-50,000 species of bacteria, and up to 200 m of micro-fungal hyphae, the majority of which are beneficial to plants and soil.

In recent years, an intensive agriculture system has become the primary source of nutrition for a growing population. These industrially produced chemicals pollute the ecosystem and limit the quantity of beneficial microorganisms in the soil.

Microbial inoculum or biofertilizers are microorganisms cultivated in synthetic culture. *Bacillus* species such as *B. subtilis*, *B. cereus*, *B. thuringiensis*, and *B. pumilus* promote plant development while inhibiting plant growth.

Table 1. *Bacillus* species are used as biocontrol agents against different kind of phyto-pathogens.

Name of Species	Target Pathogen(s)	Mode of Action
Bacillus subtilis	Fungal pathogens	Production of antifungal compounds, competition for nutrients and space
Bacillus thuringiensis	Lepidopteran insects	Production of insecticidal proteins (Bt toxins)
Bacillus amyloliquefaciens	Fungal pathogens	Production of antimicrobial compounds
	Bacterial pathogens	induced systemic resistance
Bacillus pumilus	Fungal pathogens	Production of antifungal compounds,
	Bacterial pathogens	Induced systemic resistance
Bacillus licheniformis	Fungal pathogens	Production of antifungal compounds,
	Bacterial pathogens	Induced systemic resistance
Bacillus cereus	Fungal pathogens	Production of antifungal compounds,
	Bacterial pathogens	Induced systemic resistance
Bacillus mycoides	Fungal pathogens	Production of antifungal compounds

Please note that the effectiveness of these biocontrol agents may vary depending on the specific strains, target pathogens, and environmental conditions. Additionally, there are many more *Bacillus* species and other beneficial microorganisms used in biocontrol practices, but the table above highlights some of the common ones and their general modes of action against pathogens.

Conclusion

Pesticides have showed promise in satisfying the food needs of an expanding population. However, these hazardous pesticides create human health problems, the development of pest resistance, the reduction of biodiversity, and a variety of environmental issues, generating questions about pesticide safety and use. As a result, it is critical that we limit our reliance on synthetic pesticides. The use of PGPR is the most promising green agriculture approach. *Bacillus* has been identified as a growth enhancer for sustainable agriculture via both direct and indirect methods. It was described as a potentially effective biocontrol agent. Biopesticides have long been popular because they are a safer alternative to traditional pesticides. Given the importance of sustainable agriculture, organic-based *Bacillus* spp. products could be a viable addition to sustainable agriculture.

References

Compant, S., Duffy, B., Nowak, J., Clément, C. and Barka, E. A. (2005). Use of plant growth-promoting bacteria for biocontrol of plant diseases: principles, mechanisms of action, and future prospects. *Applied and environmental microbiology*. **71**(9): 4951-4959.

Fan, B., Wang, C., Song, X., Ding, X., Wu, L., Wu, H. and Borriss, R. (2019). Corrigendum: Bacillus velezensis FZB42 in 2018: the gram-positive model strain for plant growth promotion and biocontrol. *Frontiers in Microbiology*. **10**: 1279.

Mishra, J., Prakash, J. and Arora, N. K. (2016). Role of beneficial soil microbes in sustainable agriculture and environmental management. *Climate Change and Environmental Sustainability*. **4**(2): 137-149.

Rajmohan, K. S., Chandrasekaran, R. and Varjani, S. (2020). A review on occurrence of pesticides in environment and current technologies for their remediation and management. *Indian journal of microbiology*. **60**: 125-138.

Zubair, M., Hanif, A., Farzand, A., Sheikh, T. M. M., Khan, A. R., Suleman, M. and Gao, X. (2019). Genetic screening and expression analysis of psychrophilic Bacillus spp. reveal their potential to alleviate cold stress and modulate phytohormones in wheat. *Microorganisms*. **7**(9): 337.

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THE DAMP AND SHADY GARDEN

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Introduction

The Victorians learnt how to make a virtue out of damp and shady places in the garden, so the revival of interest in popular plants of this period has included varieties suitable for such conditions. Many have flowers of delicate or unusual colouring such as the green hellebores, or leaves which are excellent for flower arrangements in the house. Our illustration shows a flight of steps leading up from a flag stoned basement path into a shady part of the garden. Self sown mosses and grasses are in the joints of the path, and a fern grows in the crevice of the wall. Lichens are a sign of pure air, as they do not tolerate atmospheric pollution.

Nurseries offer an exciting range of hardy ferns besides those which occur naturally. Most are ideal for damp shade.

The wild perennial ground covers shown are the yellow flowered creeping jenny (*Lysimachia nummularia*) and the bronze and blue spikes of Blue bugle – *Ajuga reptans.*

Creeping Jenny – *Lysimachia nummularia*

Blue bugle – *Ajuga reptans*

Spotted Dead nettle - *Lamium maculatum*

True London pride- *Saxifrage umbrosa*

Curled Plantain Lilly - *Hosta crispula*

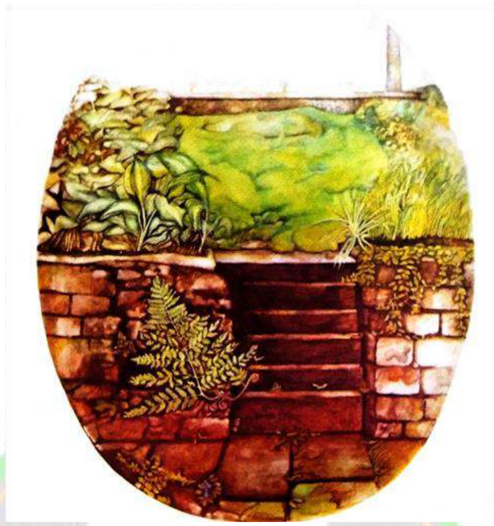
Christmas Rose- *Hellebores niger*

Japanese Sedge- *Carex morrowii*

Creeping Velvet Grass- *Holcus mollis*

Reed Canary Grass- *Phalaris arundinacea*

Introduce the Spotted Dead nettle - *Lamium maculatum*, or its varieties 'Album' and 'Aureum' and provided there is not too much traffic on the path – the dense, carpeting rosettes of True London pride- *Saxifrage umbrosa.*



Curled Plantain Lilly -*Hosta crispula* at the top of the wall represents the 20 odd varieties of this family, outstanding for plants that thrive in cool, shady places. The Christmas Rose- *Hellebores niger* or hellebores contrast well with the hosta, havng deeply divided leaves. In places where lawns will not grow properly, let grasses and sedges mature into their flowering and fruiting stages- they have a beauty of their own. Japanese Sedge- *Carex morrowii,* a sedge, and Creeping Velvet Grass- *Holcus mollis* are planted at the top of the wall. The best known vriegated grass is gardeners garter's Reed Canary Grass- *Phalaris arundinacea* but it spreads unduly if not checked.

Dig soil to 18 inches and lay perforated plastic pipes on a heavy quality plastic sheet. Leave vertical pipes at intervals, in order to feed the subterranean irrigation system in very dry weather. Collect rainwater from roofs in water butts/ barrels for watering (never make a damp bed if you have to rely all the time on tap water). Backfill first 3 inches with crocks, etc. then a peat soil mix. Drainage and aeration are essential, so see that excess water can seep away through 'weep' holes in any retaining wall. Laying paving on the damp bed cuts down water evaporation and gives plants a cool root-run.

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WEED MANAGEMENT BY RICE BRAN

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Introduction

Weeds are the most important biological constrain that interfere the growth and development of crop and cause 69 percent yield loss. A major pre-requisite to improve crop productivity and production is by weed control. In the crop field for the control of weeds repeated application of herbicides resulted in negative effects such as developing resistance in weeds towards herbicide, residual effects on the following crop due to persistence in the soil, brings up dormant weed seeds and stimulates weed seed germination, disappearance of some susceptible weeds and reduce the population of some bio-control agents. Allelopathy is the environmentally friendly weed management that reduces dependence on weeding, application of herbicide and simultaneously reduces cost of production and obtain higher yields.

The term allelopathy, was introduced by Molisch in 1937, and is derived from the Greek words allelon 'of each other' and pathos 'to suffer' and mean the injurious effect of one upon the other. Allelopathy is the detrimental effects of chemicals or exudates produced by one (living) plant species on the germination, growth or development of another plant species (or even microorganisms) sharing the same habitat. Allelopathy causes Crop-Weed interference but does not form crop-weed competition.

Allelochemicals in Weed Management

Chemicals released from plants and imposing allelopathic influences are termed allelochemicals or allelochemics. For weed management we are interested in the inhibition of one plant (the weed or weeds) by another (usually the crop) through the production of allelochemicals. These allelochemicals may be actively produced by a growing plant or arise from the residues after death. The effects of the allelochemicals may be reduced or enhanced by micro organisms. Allelo chemicals are produced by plants as end products, by-products and metabolites liberalised from the plants. They belong to phenolic acids, flavanoides and other aromatic compounds *viz.*, alkaloids, steroids, terpenoids and organic cyanides. Allelopathic results in poor germination, stunted shoot growth and impaired root growth. These symptoms can also have other causes apart from allelopathy and in practice it can often be difficult to distinguish true allelopathic effects.

WEED MANAGEMENT BY ALLELOPATHY

Allelopathy effect includes in different ways as

1. Superior weed suppressing crop varieties
2. Germplasm screening
3. Conventional breeding or genetic transfer
4. Cucumber, Oat, Sunflower, Soybean etc.,
5. High density monoculture crops (*i.e.*, legumes, grasses)
6. Rotational and cover or companion crops
7. Suppression from living mulches, residues
8. Herbicide discovery

ALLELOPATHIC EFFECT OF CROP PLANTS ON WEEDS

1. Root exudation of maize inhibits the growth of *Chenopodium album*
2. The cold water extracts of wheat straw when applied to weeds reduce germination and growth of *Abutilon* sp.

ALLELOPATHIC EFFECT CROP ON CROPS

1. Residues from allelopathic crops can hinder germination and growth of following crops as well as weeds.
2. A sufficient gap must be left before the following crop is sown.
3. Larger seeded crops are effected less and transplants are not effected.

WEEDS IN RICE FIELD RICE (*Oryza sativa*)

Rice is the staple food crop for more than half of the global population. A total of 90% rice is grown and consumed in Asia and the major problem that is dominating in the early stages of rice cultivation is weed. Weed spectrum depends upon the altitude, temperature, weather, efficiency of the control measures adopted and where the crop grown. *Echinochloa colona* and *E. crus-galli* are the most serious weeds affecting rice in all methods of rice establishment. Other weeds dominating in rice crop include *Ammannia baccifera*, *Cyperus difformis*, *Cyperus iria*, *Eclipta alba*, *Fimbristylis miliacea*, *Ischaemum rugosum*, *Leptochloa chinensis*, *Monochoria vaginalis*, *Paspalum distichum* and *Spaenoclea zeylanica*. They are the most important dominating weeds that interfere rice cultivation and heavy yield losses, to the extent of complete crop loss under extreme conditions. The application of rice bran in rice field as mulch upon decomposition it suppresses *Echinochloa colonum, E. crus-galli* and *Cyperus difformi* at early stage.

In recent years, extensive screening programmes have been carried out in the search for rice accessions with an enhanced allelopathic activity. In field tests, 412 rice accessions out of 12000 were allelopathic against *Hetherantera limosa* and 145 out of 5000 were allelopathic against purple ammannia when the allelopathic activity was evaluated as a weed free zone around rice plants. Sixteen rice accessions inhibited both weed species. In another field experiment, 1000 accessions were screened for allelopathic activity against the two weedy species, *Echinochloa crusgalli* and *Cyperus difformis*. Of these 45 accessions showed allelopathic, activity against one of the weeds and five accessions inhibited both species. These experiments showing selectivity in weed control among accessions of rice, indicate that several chemical compounds, with selective mode of action against particular weeds are involved in rice allelopathy.

USE OF RICE BRAN IN RICE FIELD

The traditional method of hand weeding is eco-friendly but it is time consuming, very costly and shortage of labour during the peak period which made to shift towards herbicide usage for control of weeds. The higher application and usage of herbicides has resulted in serious problem in the environmental degradation and public health concern. To overcome these problems, the present trend in weed control is to reduce the dependency on herbicides by using natural products, which possess natural herbicide. The weed control potential is higher in Rice bran and used as natural herbicides.

Rice bran, the post harvest by product left over during milling (processing) of rice grains. It is one of the major by-products which accounts for 5-8% of the weight of rough rice and has weed control potential and rich in microbes and minerals. In other countries, research has shown that the rice bran apply is beneficial to rice growth and yield as well as it reduced weed growth due to the negative effect of phenolic compounds produced during the decomposition process and Rice bran @ 2 t ha^{-1} applied on 3 DAT + hand weeding on 35 DAT is the viable technique for reduced weed density, weed dry weight and increased yield and net return of organic rice. Japanese organic farmers are now using rice bran (200 g m^{-2}) for weed control and fertilizer on transplanted rice.

Conclusion

Several researchers have suggested improvement of allelopathic properties of crop cultivars by traditional breeding or by genetic manipulation. Among them in rice field, Rice bran is weed free organic mulch that is readily available after harvest. As it solves the problems of food demand for ever increasing population, weed growth, environmental degradation, and economical aspects. Rice bran mulch is one of the successful weed management alternatives for sustaining the crop productivity and still research in this area is receiving attention.

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INTELLECTUAL PROPERTY & PLANT BREEDERS' RIGHT

Article ID: AG-VO3-I10-60

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Introduction

"It is an idea, design, an invention, a manuscript, etc., which can ultimately give rise to a product/application." The development of such property as a rule, requires intellectual inputs, ingenuity and innovativeness it also demands considerable monetary and other resources. Therefore, the innovator of an intellectual property would like to ensure at least a fair reward for his invention.

INTELLACTUAL PROPERTY RIGHTS (IPR)

The right of an inventor to derive economic benefit from his invention i.e., intellectual property. This right is called IPR.

The IPR, however, is recognized by the governments only so long as it is not to detriment of the society.

PROTECTION OF INTELLECTUAL PROPERTY RIGHTS:

The protection of IPR may take several forms depending mainly on the type of intellectual property and the type of protection sought.

The main forms of IPR protection are as follows:

(1) Trade Secrete

(2) Patents

(3) **Plant Breeders' Right (PBR)**, and

(4) Copyright.

PLANT BREEDERS' RIGHT (PBR):

HISTORY

1. The PVR was the world's first use of patent to establish rights of return for plant breeders.
2. The Netherlands in 1941 began to adopt different forms of PBR in legislation-the first time in the world.
3. In 1961, the eight west European countries met in Paris to negotiate a convention called the union for the protection of new varieties of plants (UPOV).
4. UPOV having head quarter in Geneva, Switzerland, seeks to make PBR legislation uniform through out the world. Today more than 30 nations conform PBR laws as suggested by UPOV.
5. This UPOV convention was revised in 1991 and most contracting countries are now on their way implementing the 1991 act into their national laws. The Indian PVR includes elements of both the revised act of 1991 and of the former act of 1978 and has introduced some new features like……

(a) **Scope of breeders' rights:** production, marketing, exporting and importing of propagating material.

(b) **Extent of coverage:** all species.

(c) **Time of protection:** 15 years.

(d) **Exception to rights:** farmers rights specifically recognized, if requires.

(e) **Compulsory licensing:** in case of public interest, defined as reasonable availability of seeds, and supply of export market.

What is PBR?

The Plant Breeders' Rights Act allows the developers of new varieties to recover their investment in research and development by giving them control over the multiplication and sale of the reproductive material of a new variety. Like a copyright, it protects the unique qualities of the varieties and generally takes the form of a royalty being collected at the time of seed is sold.

Plant breeding offers the single most cost-effective way to increase yield, market value and disease resistance. PBR will encourage the greater investment in plant breeding for dramatic increase in the development of new variety which can make their agriculture sector more efficient and profitable. The holder of the right may pursue legal action to claim damages for infringement of the right.

The need for PBR

The considerations that prompted the development of PBR systems in the developed world were as follows.

1. It encourages breeders by providing economic incentives.
2. It encourages private sector to invest in plant breeding activities.
3. The development of a variety is an innovation. Therefore, a plant variety protection is an intellectual property, which should be protected.

Initially, it was proposed to patent plant varieties. But this was not favoured, especially, in Europe due to the following considerations.

1. Industrial patents are applicable to inanimate objects.
2. Plant varieties are not absolutely stable.
3. An exact description of plant material is not possible.
4. There is a lack of repeatability in breeding plant varieties.
5. Plant varieties do not fulfil the criterion of inventiveness for patents since they contain only new combinations of preexisting alleles/genes.

Requirements for PBR:

Under the provisions of UPOV (1991) act, a variety must satisfy the following criteria for protection:

- **Novelty:** A variety should not have been commercially exploited for more than one year before grant of PBR protection.
- **Distinctiveness:** the new variety must be distinguishable from other varieties by one or more identifiable morphological, physiological or other characteristics.
- **Uniformity:** The new variety must be uniform in appearance under the specified environment of its adaptation.
- **Stability:** The new variety must be stable.

The extent of protection by PBR:

The UPOV Act (1991) offers the following protections to the concerned variety.

1. Production for commercial purposes, offering for sale and selling all material of the protected variety is the exclusive right of the holder of PBR title.

2. A grower may be allowed to use a part of his harvest for planting his next crop without any obligation to the holder of PBR title. This privilege is dependent on the provisions of the national laws.

Protection coverage	Plant varieties of nationally defined species	Plants varieties of all genera and species	Varieties of nationally specified genera and species
Requirements for protection	1. Distinctiveness 2. Uniformity 3. stability	1. novelty 2. distinctiveness 3. uniformity 4. stability	1.novelty 2.distinctiveness 3.uniformity 4.stability
Duration of protection	Minimum 15 yr	Minimum 20 yr	Maximum 15 yr for exatant varieties, 15 yr for new varieties of crops, and 18 yr for varieties of trees and vines
Scope of protection	Commercial use of the ***reproductive*** material of the protected varieties	Commercial use of ***all material*** of the protected varieties	Commercial use of all material of the protected varieties
Breeders' exemption	Yes	Yes, except for ***essentially derived varieties***	Yes, except essentially derived varieties, and use as parents of hybrid varieties
Farmer's privilege	Yes (in practice)	Optional; left to the national laws	Yes, as 'farmers' rights'; No more extensive than in UPOV Act (1978)

3. Exchange of propagating material of cultivars between farmers is not allowed.
4. The minimum period of protection is 20 years. Some UPOV member states provide protection for upto 25tears or even 30 years (maize inbred in France).

5. The protected variety can be freely used for scientific as well as breeding purposes (except for essentially-derived varieties).

An Indian PBR bill:

Indian agriculture stands at a crossroads today as the government prepares to bring fourth legislation on Plant Breeders' rights (PBR). By introducing PBR, India would fulfill commitments made under GATT and accommodate the demands of the private seed industry. India is the firth country that tries to give concept of farmers' rights (FR) a legal footing in PBR legislation.

Despite the attempt by the Indian legislation to strike a balance between interest of the farmers and the private breeders, the OBR bill is challenged by both.

The aim of the proposed Plant Varieties Act (PVA) is "To protect the right of the developers of new varieties to stimulate investment in plant breeding and to generate a competitiveness in the field of research and development both in the public and the private sector with the ultimate aim of facilitating access to newly developed varieties and maximizing agricultural production and productivity in the country". In short, PVA stands for the protection of the farmers and researchers rights to strive to balance the need for stimulation and incentives to R & D with welfare of the farmers.

Rights of Breeders and Researchers:

Breeders' Rights are fully protected by the legislation. On registration, the breeder has complete rights of commercialization for the registered variety. These include the right to produce, sell, market, distribute, import or export the registered variety.

Penalties for infringing Breeders' Rights:

Violation of a Breeders' Right can apply to the variety itself, as well as to its packaging. Penalties can range from Rs. 50,000 to ten lakh as well as a jail term ranging from three months to two years, depending on the severity of the damage caused. For repeated offence, fines can go upto Rs. 20 lakh and the jail term to three years. The new law has provisions for Researchers' Rights which allow scientists and breeders free access to registered varieties for research. The registered variety can also be used for the purpose of creating new varieties. This flexibility is curtailed only when the registered variety needs to be used repeatedly as a parental line for commercial production of another variety.

Farmer's privilege:

Generally, a PBR system allows a farmer to use a part of the material produced on his farm, from a protected variety, for planting his own fields without any obligation to the PBR title holder; this is called ***farmer's privilege.*** The UPOV Act (1978) has a provision for farmer's privilege, which was withdrawn from UPOV Act (1991). But due to a strong opposition from various corners, it has now been left to the member states of UPOV to make a provision for the farmer's privilege.

Farmer's privilege allows a farmer to use his own produce as seed (=propagule), but does not allow him to exchange seed with other farmer. farmer's privilege is a very important provision for countries like India where >90% of the land is planted with seed produced by the farmers themselves as the availability of new quality seed is limited to <10% of the total requirements. In addition, a majority of farmers are poor, and forcing them pay royalty of their own produce would be unjust and, even, cruel.

Farmer's rights:

Agriculture began some 10,000 years ago. During this period, the genetic resources of crops have been selected, developed and conserved by farmer families and farming communities, particularly in the developing countries. These resources have been collected and used as the basic raw material s to develop high yielding varieties by seed corporations of the developed countries. The seeds of these new varieties are earning huge profits to these corporations. It is only just those farmers/farming communities who provided the genetic resources for these varieties be allowed a share of these profits. These positions has been recognized by FAO as farmer's rights, which arise from past, present and future contributions of farmers in conserving, improving and making available plant genetic resources, particularly in the centres of origin/diversity.

The key question relating to farmer's rights remain as 'to whom to reward, to what extent and in what manner. It has been suggested that tribal people, rural communities and traditional farming families be rewarded. The quantum of, suggested reward is around 5% of the profits. However, farmer's rights are yet to be legalized in any countries; it will be a happy day when they are actually implemented.

The Protection of Plant Varieties and Farmer's Rights Act, 2001:

Most developed countries have a PBR system in force.

The situation in India differs from that in the developed countries in the following respect:

1. Plant breeding activity is mainly carried out by the public sector.
2. Private sector is not yet a major contributor.

There have been arguments that the situation is not ripe for a PBR system in India, but the arguments appear as artificial and are unconvincing. Some have suggested that Asian countries must evolve their own PBR systems with the following provisions.

1. Recognition of community interest, e.g., informal systems of open-pollinated varieties, etc.
2. Extension of the concept of 'essentially-derived' varieties to the unprotected varieties.

In any case, India is obligated, under TRIPs to adopt UPOV Act (1991), allow patents or enact a sui genesis PBR system that afford protection equivalent to UPOV Act (1991) or a patent. India had been trying to develop a sui generis system of PBR (Rana 1995). A sui generis system simply means 'a system of their own', e.g., designed by them, in this case, India. This efforts have culminated in the passage of "The Protection of Plant Varieties and Farmers' Rights Act 2001" (PPVFR Act, 2001) on august 9, 2001 by the Lok Sabha. The Act aims "to provide for the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants"

Benefits from PBR:

A PBR system offers the following benefits.

1. It encourages breeders in their efforts by offering the incentives of a share in the profits from the varieties developed by him.
2. It encourages investment from private companies in plant breeding activities.
3. It enables an access to varieties protected by PBR laws.
4. It increases competition among plant breeding organizations and, thereby, benefits farmers.

Disadvantages from PBR:

The various disadvantages from a PBR are as follows:

1. It encourages monopolies in genetic materials for specific traits.
2. It discourages free exchange of germplasm, and may encourage unhealthy practices.
3. PBR title holder may try to maximize profits by producing seed than the demand.
4. Farmer's privilege may become diluted/ eliminated.

5. It may increase seed cost, which will be against the interests of poor farmers.
6. It will delay the spread of new varieties in India, since exchange of seeds among farmers is the main instrument of their spread in the villages.

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TEA MOSQUITO BUG IN GUAVA

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Introduction

The tea mosquito bug (TMB), *Helopeltis theivora* is a serious pest on tea, cashew and cocoa. Of late, *H. theivora* expanded the host range attacking certain weeds, vegetables and medicinal plants. Mosquito bugs have a characteristic spine on the scutellum, which is a diagnostic feature. Classification in the field is based on morphological characteristics, with considerable variations in colouration between insects of the same species. (although for example, *H. theivora* is characteristically green and *H. antonii* red-brown).

Marks of Identification

The adult *H. theivora* is small bug measuring 6-8 mm in length. The body is slender and elongated with yellowish-brown or olive green head, dark red thorax and yellow and greenish-black abdomen. Appendages are long, dark and delicate. The thorax bears a characteristic dorsal knobbed process.

Nature of Damage

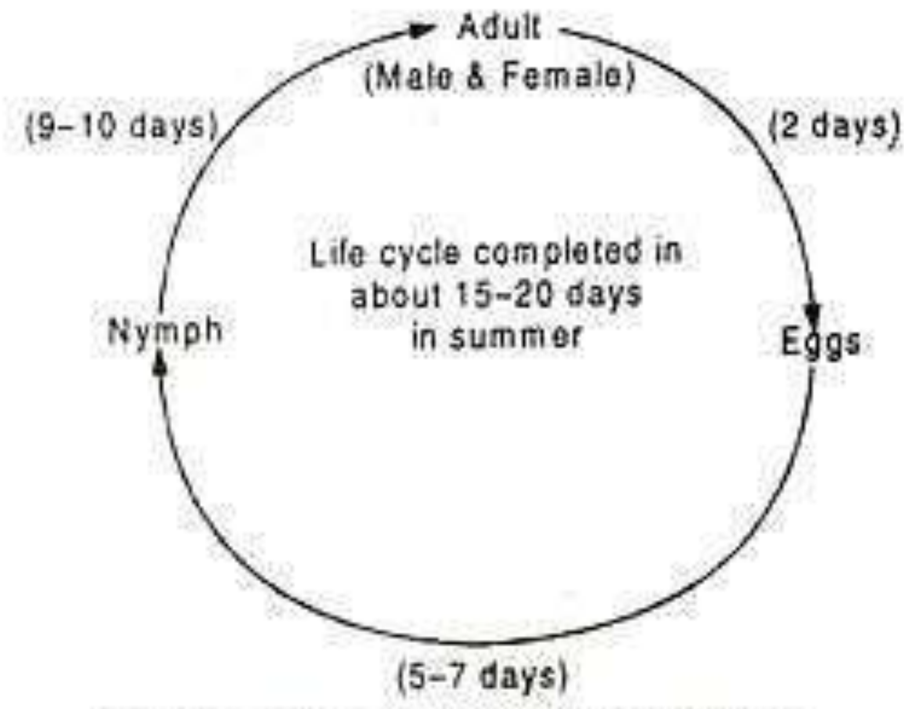
The adult and nymphal stage of *H. theivora* causes damage of serious nature to the tea plantation. The nymph and adult inserts their proboscis into the younge leaves, buds and tender shoots to suck the plant sap. The toxin injected through saliva of the pest causes the tissues around the punctured snot to dry and die. With typical Hemipteran sucking mouthparts, they pierce plant tissues and cause damage ranging from leaf tattering and fruit blemishes, to complete death of shoots, branches or whole plants. The affected portion becomes brown and later on becomes black. The leaves having many such black spots shrivel and eventually fall off.

The infected shoot also show such spots winch extends to almost whole plant. The bushes severely affected by this pest look as if they have been torched by fire.

Tea mosquito bug damage on guava fruit at MIT CAT Farm

Life Cycle

Mating occurs soon after the emergence of adults. Female start laying eggs within two days later copulation- A female is capable of laying about 500 eggs. The eggs are trust by the female into the surface tissues of the host plants, like leaves, tender shoots mid rib petioles of the leaves and buds.



Life cycle of Tea mosquito bug

The eggs are elongated and sausage shaped. Each egg bears two C filamentous processes which project out from the tissues in which the eggs have been inserted Hatching occurs within 5 to 7 days in summer and 20 to 27 days winter.

The nymph looks like spider in appearance because it bears delicate, elongated legs. The dirty-yellow nymphs suck the sap of the host plant and undergo five moults to attain maturity. The larval periods lasts for 9-10 days in summer and 25-29 days in winter. Life cycle is completed in about 15 - 20 day in summer and 45-60 days in winter in North-East Indian conditions. There may be several generations in a year. In extreme winter the adults undergoes hibernation.

Control

- Collect and destroy the damaged plant parts. Regular pruning and shade regulation facilitates proper penetration of sunlight inside the canopy which reduces the incidence of this pest.

- Bagging of fruits in high density planting system prevents infestation of tea mosquito bug as well as fruit fly.
- Raise yellow sticky traps at 40-50 nos/acre. Encouragement of the egg parasitoid viz. *Telenomus sp*. minimises the usage of pesticides.
- Bimonthly spray from the time of flowering with malathion 0.1 per cent, lambda cyhalothrin 0.005 per cent, neem formulation at 2ml/lit minimises damages.
- Plant growing in soil having high ratio of available potash to available phosphoric acid show less infestation of this pest. Therefore, cultivation of tea plants in appropriate soil is advisable to keep the pest population under control.
- It includes collection and destruction of the mosquito adult by using hand net.

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HARNESSING THE HEAVENLY DEW WITH TAL YA TRAYS

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Introduction

The Tal-Ya tray is a unique, patented, rigid polypropylene square, serrated tray that covers a plant's root system, on the ground, directing water and fertilizer directly to the roots. By influencing gravitation, reducing evaporation, and enhancing photosynthesis and insulation, Tal-Ya trays facilitates an ideal microclimate around the plant's foundation (roots) which serves as a personal green house for tree/ plant. It can sustain plant life upto 10 years and 100 % recyclable. This unique Tal Ya Mitra system was developed by an Israeli company Tal Ya Water Technologies Ltd.

(a) (b) (c)

Fig. 1 (a)Polypropylene square, serrated Tal Ya Tray, (b) water and fertilizer from Tal Ya trays directing to the root, (c) recyclable trays

Concept of Tal Ya trays

The ancient Israelites used stones to collect dew from the air, now the modern ones are taking the idea further. A Israeli company Tal-Ya Water Technologies, promises to squeeze dew from the air for watering crops where water resources are precious or scarce. This reusable tray is made from a special plastic composite sits directly on the ground with a hole in the center for a plant to grow. Using non-PET recycled and recyclable plastic with UV filters, and a limestone additive, Tal-Ya trays do not degrade in the sun or after the application of pesticides or fertilizers. An aluminium additive which is responsible for stabilization of temperature between night and day and promote dew formation. When a change of 12 ºC occurs, dew forms on both surfaces of the Tal Ya tray during the night which further channelled down to the plant's root system.

During day, evaporation is reduced, and the condensation that builds up beneath the product keeps the soil moist, and is also directed back down to water the plant roots. Irrigated water is directed straight to the plant's root system, reducing water consumption up to 50 %. Rainwater is more efficiently collected and directed to the plant's root system. Tal-Ya trays is easy to install, use, and maintain by farmers located in different areas of the globe dealing with different climate characteristics, and is applicable on various crops. The belief in the power of simplicity has led to the adoption of this technology by well-known global organizations, such as the Red Cross, **Tata Trusts**, and the Jewish National Fund (JNF).

Benefits of using Tal Ya trays in agricultural system

1. Saving of water

It saves irrigation water by at least 50% due to reduced soil water evaporation, reduced utilization of water by the weeds and due to collection of dew, thus it increase dramatically the productivity of irrigated farming and mainly rain fed farming and reduces the demand and expenses for irrigation water.

2. Saving of fertilizers

It saves fertilizers input by at least 30% due to reduced wash of nutrients below the root system and loss of nitrogen to the atmosphere.

3. Sanitation

Expenses for manual, mechanical and chemical weed control around the plants are reduced as weeds cannot grow below the trays. Expenses for pest control, especially soil borne diseases, are reduced as well as the conditions for their development under the trays are less favoured. It reduces hazards of soil borne diseases and contamination by soil particles. In drip irrigation the pipes are placed below the trays and when recycled water is used there is no contact between the fruits and the water.

4. Enhanced growth

Trees growth is enhanced tremendously as for favoured growth conditions under the trays and favoured micro climate conditions above it. It also maintains favourable conditions for beneficial microorganism's and fauna populations in the soil. The trays reflect sun light into the shadowed part of the trees and plants canopy that accelerate photosynthesis

5. Earlier ripening and yield quality

This technology brings accelerated ripening of trees fruits and better quality.

6. Winter hibernation in orchards

In area having harsh winters, it can reduce winter hibernation period and therefore enhance trees blooming as soil temperatures are little higher under the trays.

7. Frost and overheat damages

This technology was proved to reduce frost and overheat damages as it regulates soil temperature and micro climate conditions within the crops canopy.

8. Salinization hazards

Salinization hazards are reduced as evaporation of soil water is controlled and salts cannot reach the soil surface. As we use less irrigation water, less dissolved salts are accumulating in the soil cross section. This technology enables irrigation with brackish water as salts do not concentrate on the soil surface and due to effective collection of dew water that can assist in washing down salts below the root system. Even very short rains of few mm are effective in water supply and wash of salts.

9. Soil conservation

This technology is excellent for soil conservation as it prevents soil erosion and salinization under the trays and it increases soil fertility.

10. Farming of residual lands

Taking into consideration all the above-mentioned benefits of this technology, it is believed that residual lands can be cultivated with reasonable revenues.

11. Organic farming

All the above-mentioned benefits make Tal Ya technology excellent for organic farming.

12. Economical aspects

The benefits of this technology for the farming system and a specific farmer are impressive. The expenses for purchasing the trays and placing them (they can last for at least 6 years) can be covered within one or 2 years.

Fig. 2 Benefits of Tal Ya trays

Tal Ya trays manufacturing, supply and user guidelines

The size of the tray currently in production is 72 × 55 cm, and is relevant for a wide variety of crops including all forestry, fruits, vegetables, and planation crops. Tal-Ya trays have already been sold and are in use all over the world: Israel, U.S., Chile, Georgia, Sri Lanka and China

Installation instructions

1. Till and level the soil in the area in which you intend to plant.
2. Uproot any existing wild weeds from the soil.
3. Insert the tray through the slit opening, until the trunk of the tree is in the center.

Fig. 3 Installation of Tal Ya trays

4. Cover the flat border edge of the tray with soil from all sides to secure the positioning of the tray. Press the soil well to make sure the tray is securely positioned. Leave the remainder of the tray above the soil to enable free flow of water and fertilizer.

5. Make sure the two edges of the opening slid lay one on top of the other to prevent sunlight from penetrating the soil below the slit (to prevent weed growth in the slit).

6. For use with drip irrigation hoses (trickle lines), it is recommended to place them above the tray. If they are placed underneath, make sure no light reaches the soil at their entrance and exit points.

7. In the case of organically grown trees, add slow-release manure before placing the tray.

8. Place covers in a straight line in the field to easily allow tractors, etc. to pass through.





Fig. 4 The effectiveness of Tal-Ya trays in a very wide range of agricultural sectors including: forestry, fruit trees and vegetables crops.

Maintenance guideline

1. Make sure the opening on the drip irrigation hose (if used) irrigates only on the tray, to prevent weed growth around the tray.

2. Do not spray weed control (herbicide) on the surface of the tray or underneath it.

3. When the trunk diameter reach the border of the center opening, it is possible to cut the plastic in a circular way to allow further trunk enlargement.

Fig. 5 Farmers of Andhra Pradesh, India producing tomatoes, watermelon and citrus using Tal Ya trays (Source: http://www.tal-ya.com)

4. Don't over-irrigate, remember that trees using Tal-Ya trays require 50% less water. Adjust irrigation to the soil type and it's water holding capacity.
5. It is recommended to use a soil tensiometer and water suction to measure the nitrate in the soil solution at a depth of 10cm.
6. There is no need to remove leaves from the tray’s surface, they do not prevent the water and fertilizer from getting through, and provide additional temperature control.
7. With the end of use, store the trays, after they are cleaned, stacked one on top of the other.
8. It is possible to store trays for long periods and reuse, preferably on palettes.

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YIELD MAPPING IN HORTICULTURAL CROPS

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Introduction

Specialty crops like fruits and vegetables require more care and are sensitive to growth conditions, making them suitable targets for precision agriculture techniques. However, a lack of technology, particularly in yield monitoring and mapping, is a major problem. Yield information is crucial for successful implementation of precision agriculture, but few commercially available systems are available for specialty crops, making it a major limitation in applying precision agriculture to these crops.

Specialty crop producers face challenges in developing yield monitoring systems due to the diversity in harvesting methods and smaller market compared to row crops. Accurate yield estimates early in the season are crucial for better contract negotiations and budget adjustments. A yield map helps understand variability within a field, analyse reasons behind it, and improve management. A yield monitor system should be installed on combine harvesters, recording yield data automatically during harvesting.

Fig- combine harvester equipped with yield sensor and monitor, moisture sensor, yield monitor display data recording device and GPS system.

Yield Mapping

Yield mapping is a precision agriculture technique that uses GPS data to monitor and analyze crop yield in a field. It involves collecting georeferenced data on crop yield and characteristics during harvesting. Various methods, including yield monitors and sensors, provide precise yield information by time or distance. Developed in the 1990s, it uses GPS technology and physical sensors installed with harvesters to monitor and record yield data. This data is then processed by a computer-based software system, producing a yield map for comparison of yield distribution within the field.

This allows farmers to determine areas of the field that, for example, may need to be more heavily irrigated or are not yielding any crop at all. It also allows farmers to show the effects of a change in field-management techniques, to develop nutrient strategies for their fields, and as a record of crop yield to use in securing loans or renters.

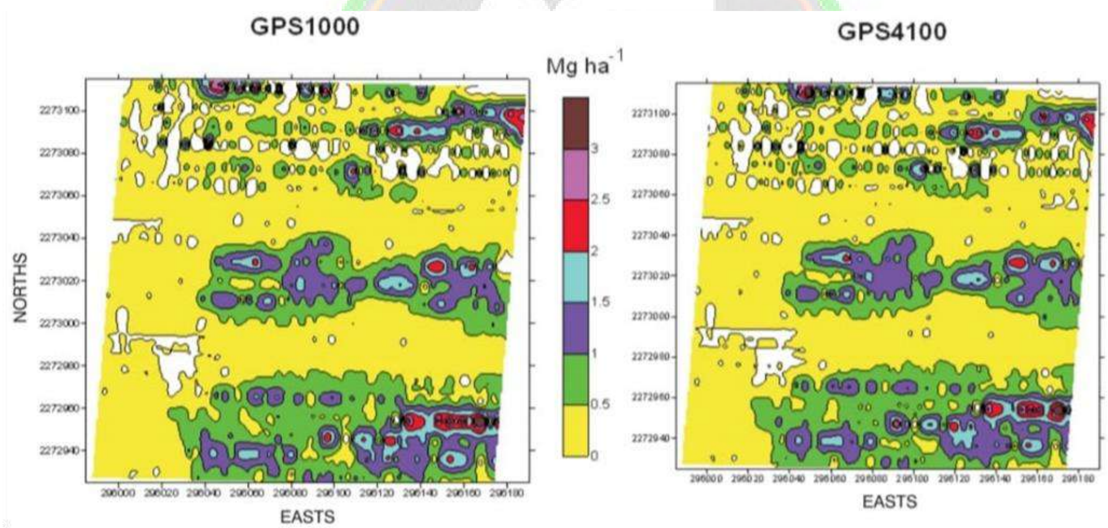


Fig- yield maps for one round trip through the field, elaborated using the same weight and area data and different position data obtained for each GPS systems in broccoli

Yield Mapping Sensors and Monitors

The main sensor used in horticultural crops is the mass or volumetric flow sensor. Depending on the type, this sensor measures the volume or the actual mass or weight of the fruit. The yield monitor uses information from ground speed sensors along with the actual operating width of the machine to calculate the area covered by the machine for a given time. Yield monitors calculate yield by dividing the crop mass/volume that passed through a mechanical harvesting machine for a given time by the covered area from which the crop was harvested during the sampling period. Finally, the latitude and longitude information that is obtained from a GPS receiver is indexed to the yield data. This information is usually collected and stored on a memory card at 1 Hz or more.

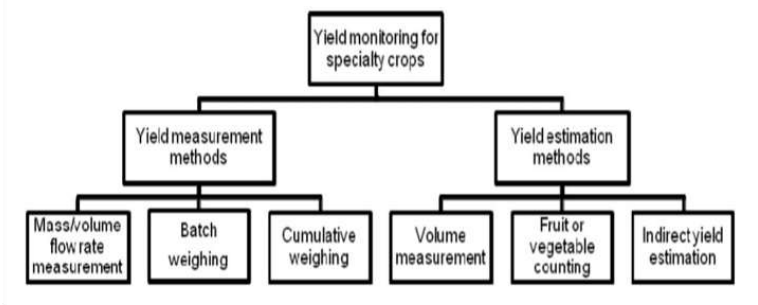


Fig- different methods used for yield estimation and yield monitoring and mapping in horticultural crops

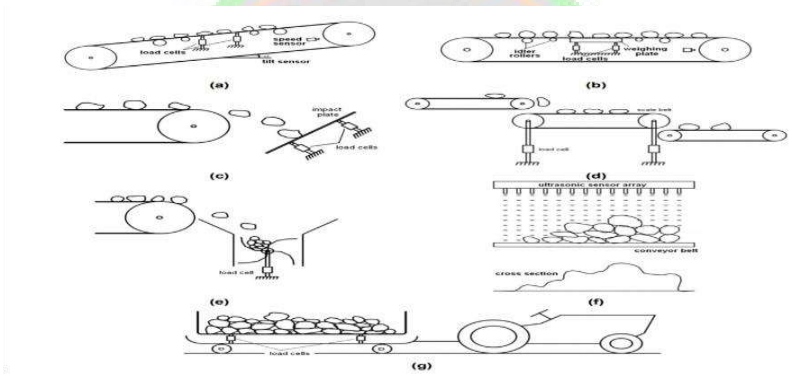


Fig- schematics of common yield monitoring system for horticultural crops

Processing of Yield Maps and Evaluation

The yield information stored on a memory card is processed and displayed on a map using Geographic Information System (GIS) software. These maps provide precise information about yield and related parameters in each location of the monitored field. Evaluating the temporal variation of yield distribution within the field using yield maps is crucial for identifying high and low yield areas. Several approaches can be used to evaluate temporal effects on yield, such as calculating the relative yield for each point or grid cell.

Fig- processing of yield data into yield maps using computer based software

Some Yield Mapping Systems in Horticultural Crops

1. AgLeader System- It is manufactured in Iowa, USA and is supplied to fit any harvester. It consists of a mass-flow yield monitor, a moisture sensor and a display-control panel. A PC card is supplied to record data. The unit comes with a mounting kit and detailed manual. It also developed a device to mark the location of weed a within a paddock.

Fig- AgLeader system

2. New Holland System– it is developed in North America, is completing field tests of its Precision Land Management System which includes an Accu-wave yield monitor sensor and display, DGPS and field mapping software. The system can be fitted to older model New Holland harvesters. The firm is also testing a GPS linked robotic windrower which may be a sign of things to come.

3. John Deere System- it is manufactured in the US. The yield mapping system collects positioning and correction data as well as information on yield and moisture. A mass-flow yield monitor is standard and position signals are corrected using a satellite DGPS. Buyers are provided with a yield monitoring system, computer software called JDMap, and a Windows '95 based program.

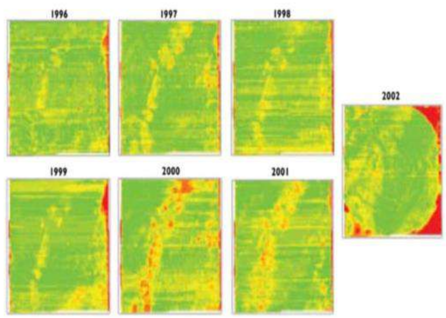

Fig- John Deere system

4. Satloc System- it is developed in USA. The system includes a yield monitor, moisture sensor, data logger and yield mapping software. The data logger can also be used to record weed information. A speed sensor is fitted and a switch is provided to stop the sensor when turning on headlands.

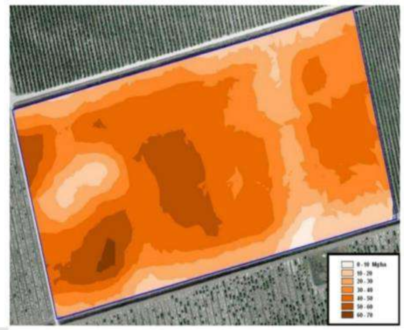

Fig-Satloc system

Yield Mapping and Monitoring System for Hand-Harvested Horticultural Crops

Yield monitoring and mapping systems for hand-harvested crops use a technique to record the weight of the fruit or vegetable in a container and geo-reference it before delivery to the hauling truck. For example, Whitney et al. (2001) developed a system for yield mapping of hand-harvested citrus, which used hydraulic cylinders for more accurate measurements than shear-beam load cell systems. Tumbo et al. (2002) used limit switches to detect when a tub was picked up by the hauling truck, which was 89% accurate. These systems were connected to a GPS unit to map the location of each tub in the field.



Yield maps in a period of few years



Contour yield map of a citrus orchard

Conclusion

Yield monitoring and yield mapping is a very essential component of precision agriculture. With the use of yield maps precisely we can go for different management activities as per requirement of the crop plants which ensures high output and healthy growth of the crop. But there is still very limited use of yield mapping system in case of horticultural crops which is a major matter of concern. So, we should encourage the use of yield mapping system among the farmers as far as possible in order boost the development in agricultural production including horticulture.

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TECHNIQUES TO ENHANCE COMPOSTING FASTER IN FOOD AND AGRICULTURAL WASTE

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Abstract

The recent increase in global population and several industrial activities produced a large amount of garbage. Even though the food and agricultural industries are some of the oldest human endeavors, they produce wastes just like any other industrial activity. The management of garbage must be done correctly. Composting is the process of breaking down food waste, agricultural waste, and other waste products into usable manures. It also creates humus-like organic compounds. The composting method is more widely used, but it takes a lot of time. To solve this problem, we can apply various techniques to make composting quicker and simpler, which will save time, labor, and money.

Introduction

The benefits of recycling agricultural waste (solid) include reducing greenhouse effects, using fossil fuels, animal feed, and the creation of organic fertilizers and manures. The backbone of India is agriculture, so the sector generates waste in large amounts and is the main sector for doing so (FAO 2017). [K, Kautto and Mc Cormick 2013]

Many plant parts that are economically valuable are added to the soil after harvesting but take longer to decompose, occasionally produce pathogens, affect beneficial organisms, and change the physical and chemical properties of the soil, necessitating the use of efficient composting techniques to turn waste into manures.

Composting can recover vital nutrients and increase soil fertility by converting agricultural wastes into sanitary, stable, and pollution-free products. But typically the time required is long, and the capacity to deliver nutrients is small, so in this case we can apply some current popular approaches to generate compost quickly and easily with great nutritional value.

Techniques to enhance composting faster

Cut up your waste

According to D. M. S. H. Dissanayaka et al. (2021), chopping up agricultural wastes or raw materials into smaller pieces will reduce generation time or duration by increasing the surface area, which will slow down the rate of decomposition. The increased surface area will allow microbes, such as bacteria and fungi, to access more of the organic material in the scraps and eventually break them down into finished compost.

Add carbon

Faster composting depends on having the proper carbon to nitrogen (C:N) ratio (K. Azim et al. 2018). Brown materials include things like leaf litter, twigs, sawdust, and paper that are high in carbon. Greater brown material gives your pile greater bulk and improves airflow within it. It's vital to remember that neither brown nor green materials are constantly those colors. Green material is wet with a high moisture content, as opposed to brown material, which is often dry, woody, and low in moisture.

Add high nitrogen

You could also add high nitrogen material to the pile for a quick composting process. Green materials, which can be utilized as a pre-composting substrate, include things like grass clippings, plant cuttings, and fruit and vegetable scraps that are nitrogen-rich. The nutrients and moisture that grass clippings provide to your pre-compost make them wonderful environmentally friendly additions. Fruit and vegetable peels and cores are great providers of moisture and nutrients.

Turn your pile:

Turning a compost pile is crucial because it promotes equal decomposition, complete composting for odor management, and composting's primary goal of heating up. Composting piles that are turned once a week or once every two weeks often decompose at a slower rate.

Thus, increased rotation causes the elimination of gaseous nutrients like ammonia and methane and decreases the compost pile's temperature. Regular turning will ensure that moisture is distributed evenly, stop your compost from compacting, and let oxygen permeate the entire pile.

Use insulation to heat up

Use insulation, such as hay or straw, if your compost pile is having trouble heating up. This will aid in retaining heat and hasten the composting process. As you uniformly sprinkle the insulation material on top of the pre-compost heap, layer it on. As the temperature drops or if you want the pile to be at a high temperature, you can raise the insulation's thickness.

Add old compost

Making sure there are plenty of helpful bacteria is a fantastic method to hasten the composting process because it depends on them. The simplest way to introduce those microbes into a new compost pile is to mix in some compost that has already been created.

Summer outdoor compost

As heat plays such a huge role in the composting process, doing whatever you can to increase and maintain the heat in your pre-compost heap will make it finish quicker. If at all possible, you should always compost outdoors in the summer, and place the pile somewhere that gets plenty of sun. We need to use natural resources properly. This will easily increase the temperature of your compost.

Winter indoor compost

Due to the significant role that heat plays in the composting process, doing everything you can to raise and sustain the temperature in your pre-compost heap will hasten its completion. In the summer, if at all feasible, you should always compost outside. Make sure the pile is located where it will receive lots of sunlight. Natural resources must be used wisely. This will quickly raise the compost's temperature.

References

K. Azim, B. Soudi, and S. Boukhari, composting parameters and compost quality: a literature review, org. Agr. 2018, 8:141-158.

D. M. S. H. Dissanayaka, V. P. T. Dhananjaya, E. J. Kosgollegedara, and S. Karthigayin, impact of improved aeration on decomposition rate of enriched compost, International Journal of Trend in Scientific Research and Development,2021,5(2):852-857

Mc Cormick and K, Kautto N. The bioeconomy in Europe: an overview. Sustainability. 2013:5:2589-2608.

Scarlat N, Dallemand JF, Monforti-Ferrario F, Nita V. The role of biomass and bioenergy in a future bioeconomy: Policies and facts. Environment and Development. 2015:15:3-34.

Food and Agriculture Organization of the United Nations (FAO 2017). The future of food and agriculture: trends and challenges.

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BIOCHAR: THE ANCIENT SOLUTION MODERN AGRICULTURE NEEDS

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Abstract

Biochar, a carbon-rich, charcoal-like substance has roots in ancient agricultural practices and is reemerging as a pivotal solution for today's modern agricultural challenges. Historically, indigenous communities incorporated biochar to enhance soil fertility and structure. In our contemporary setting, where the need for sustainable farming practices and effective carbon sequestration methods is paramount, biochar's potential is more relevant than ever. This substance, primarily derived from organic waste materials through pyrolysis, not only revitalizes soil health by improving water retention and nutrient availability but also acts as an efficient carbon sink, mitigating greenhouse gas emissions. Moreover, biochar offers a sustainable approach to waste management and presents a renewable alternative to synthetic fertilizers. This article delves into biochar's ancient origins, its myriad of benefits for modern-day agriculture, and how embracing this "black gold" can steer us towards a more sustainable and resilient agricultural future.

Introduction

In the annals of agricultural history, civilizations have continuously striven to harness the potential of the Earth to sustain and nourish ever-growing populations. One such practice, which dates back thousands of years, involves the use of biochar-a carbon-rich, charcoal-like substance. Ancient societies, particularly in the Amazon Basin, recognized the value of this "black gold," integrating it into their agricultural routines to enrich the soil and ensure bountiful harvests. The remnants of these practices can still be witnessed in the dark, fertile patches of the Amazon's Terra Preta soils, a testament to biochar's enduring legacy.

Fast forward to the 21st century, where modern agriculture grapples with challenges ranging from climate change to soil degradation. The resurgence of biochar in contemporary agricultural discourse stems not just from its prowess in enhancing soil fertility, but also from its potential as a tool against the escalating climate crisis. Biochar's innate ability to capture and store carbon dioxide offers a dual solution: revitalizing the very ground from which our food springs forth while simultaneously sequestering carbon to mitigate the impacts of global warming. In an era where sustainable solutions are paramount, biochar emerges, once again, as an ancient remedy addressing modern exigencies.

The Science Behind Biochar

Understanding the science behind biochar is crucial to grasp its significance in modern agriculture and its potential role in addressing environmental challenges.

What is Biochar?

Biochar is a stable, carbon-rich substance derived from the thermal decomposition of organic materials in an oxygen-limited environment. Structurally, it resembles charcoal, but its intended use is distinctively different. While charcoal is primarily used as a fuel, biochar is used as a soil amendment. Its porous nature provides an ideal habitat for beneficial soil microbes, which play a pivotal role in nutrient cycling. The high carbon content in biochar not only aids in sequestering carbon dioxide from the atmosphere but also enhances the overall carbon content of the soil. This improvement in soil carbon content can bolster soil fertility, increase water retention, and decrease soil acidity.

Pyrolysis - The Key Process

Pyrolysis is the cornerstone process for biochar production. It involves the thermal decomposition of organic matter, such as agricultural residues, wood chips, or manure, in the absence of oxygen. This oxygen-limited environment is what differentiates pyrolysis from combustion (burning). The process occurs in specialized equipment called pyrolysis reactors or kilns, and it can take place at various temperatures, ranging from 300°C to 700°C. The precise temperature and duration of the process determine the characteristics of the resulting biochar.

Pyrolysis yields three primary products:

1. Biochar: The solid, carbon-rich residue that can be integrated into soils.
2. Bio-oil or Pyrolysis Oil: A liquid that can potentially be refined and used as a biofuel.
3. Syngas (Synthesis Gas): A gaseous mixture containing hydrogen, carbon monoxide, carbon dioxide, and other gases. It can be harnessed for energy or further processed to produce other valuable chemicals.

In the context of sustainable agriculture and environmental protection, pyrolysis offers a win-win scenario. It transforms organic waste, which would otherwise decompose and release methane - a potent greenhouse gas into valuable products, including biochar, which can be used to improve soil health and combat climate change. Grasping the scientific principles behind biochar and pyrolysis allows us to combine age-old wisdom with contemporary techniques, forging a path towards a sustainable future in agriculture.

Benefits to Modern Agriculture

Biochar's application in modern agriculture extends far beyond its fundamental role as a soil conditioner. It touches upon the core of sustainable agriculture, addressing multiple facets of soil health, crop productivity, and environmental conservation.

Role in Soil Fertility Enhancement:

A. Nutrient Retention:

One of the standout qualities of biochar is its porous nature, which provides numerous sites for nutrient ion adsorption. This implies that when nutrients, such as nitrogen, potassium, and phosphorus, are introduced to a soil enhanced with biochar, they bind to the biochar particles. This reduces the likelihood of nutrient leaching, especially in areas that experience heavy rainfall. As a result, crops have a prolonged and more consistent access to essential nutrients, leading to better growth and yield.

B. Microbial Activity Boost:

Soil health is inextricably linked to the microbial life it hosts. Biochar creates a conducive habitat for beneficial soil microbes, fungi, and bacteria. Its porous structure offers shelter and a surface for these microorganisms to colonize. In return, these microbes play a pivotal role in breaking down organic matter, facilitating nutrient cycling and even suppressing soil-borne diseases.

C. Improved Soil Structure:

A soil's physical properties play a significant role in its overall health and productivity. Biochar, due to its texture and composition, can reduce soil compaction, improve aeration and promote better root penetration. This not only aids in root respiration but also ensures that plant roots can access nutrients from deeper soil layers.

D. Mitigating Water Stress:

Water scarcity is an increasing concern in many agricultural regions. Biochar's sponge-like structure enables soils to retain moisture more effectively. This means that in periods of reduced rainfall or in drought-prone areas, crops in biochar-amended soils can still access the water they need, reducing the adverse effects of water stress and ensuring better crop survival.

E. Carbon Sequestration:

Agriculture, in its conventional form, is a significant contributor to greenhouse gas emissions. Biochar presents an opportunity to reverse this trend. By converting organic waste into biochar, carbon that would otherwise be released into the atmosphere as CO_2 or methane gets "locked" in a stable form. When this biochar is integrated into the soil, it effectively sequesters this carbon for potentially centuries, acting as a sink for greenhouse gases.

While there are various methods and strategies proposed for carbon sequestration, biochar offers a unique advantage. Not only does it capture carbon effectively, but it also enhances soil health simultaneously. Other methods might capture carbon but don't offer the added agricultural benefits that biochar does, making it an integrative solution for both climate change mitigation and agricultural advancement.

Economic and Ecological Implications

Biochar's potential extends beyond mere agricultural enhancement. Its broader implications resonate strongly in the spheres of economics and ecology, addressing some of the most pressing issues that face in these domains.

A. Transforming Agricultural Waste into a Valuable Resource:

Annually, vast quantities of agricultural residues like straw, husks, and shells are generated. In many parts of the world, these are either burned, leading to air pollution, or left to decompose, contributing to greenhouse gas emissions. Biochar presents an innovative approach to this dilemma. Instead of viewing agricultural waste as a problem, it can be seen as a raw material for biochar production. Through pyrolysis, these residues can be converted into biochar, turning a waste disposal challenge into an economic opportunity. For farmers and agricultural industries, this represents a new revenue stream. They can sell their waste for biochar production or produce biochar themselves for sale or personal use. At the same time, the environment benefits from reduced pollution and greenhouse gas emissions.

B. Reduced Dependency on Synthetic Fertilizers:

The global reliance on synthetic fertilizers has been a double-edged sword. While they've undeniably boosted crop yields, their overuse has led to numerous environmental issues, such as soil degradation, water pollution from runoff, and destruction of beneficial soil microbes. Biochar's ability to enhance soil fertility naturally reduces the dependency on these chemical fertilizers. Its nutrient retention capability ensures that plants get prolonged access to essential nutrients. Additionally, by fostering a healthy microbial environment, biochar promotes the natural cycling of nutrients, reducing the need for external chemical inputs.

From an economic perspective, this means reduced costs for farmers, as they spend less on fertilizers. Ecologically, it leads to healthier soils, cleaner waterways, and a more balanced environment. Furthermore, as consumers become more aware of and concerned about the ecological footprint of their food, produce grown with reduced chemical inputs may fetch a premium in the market, further incentivizing the shift towards sustainable practices like biochar incorporation.

Challenges and Considerations

While the benefits of biochar are manifold and its potential transformative, it is essential to acknowledge the challenges and considerations that surround its production and application. Addressing these can pave the way for more effective and widespread use of biochar in agriculture and beyond.

A. The need for quality standardization in Biochar production:

Biochar's effectiveness as a soil amendment is closely linked to its quality, which can vary based on the raw materials used and the pyrolysis conditions applied. Different feedstocks, ranging from wood chips to animal manure, can produce biochar with varied characteristics. Similarly, the temperature, duration, and specific conditions of the pyrolysis process can influence the properties of the resulting biochar. This variability can lead to inconsistent results when applied to soils. A biochar that works wonders in one scenario might be less effective or even counterproductive in another. For farmers and end-users, this unpredictability can be a deterrent. The solution lies in standardizing biochar production processes. Establishing quality standards and best practices can ensure that the biochar produced, regardless of its source, meets specific criteria conducive to enhancing soil health and carbon sequestration.

B. Economic Constraints-Overcoming Initial Costs for Widespread Adoption:

Despite its long-term benefits, the initial costs associated with transitioning to biochar can be a significant hurdle for many, especially small-scale farmers. The investment required for pyrolysis equipment, acquiring biochar or even the training needed to effectively apply and integrate biochar into agricultural practices can be daunting. Moreover, the economic benefits, although substantial, are often realized over an extended period. For instance, while biochar can lead to better crop yields and reduced fertilizer costs, these advantages accumulate over multiple farming cycles. For farmers living on tight margins, fronting the initial costs without immediate returns can be challenging. Addressing this challenge requires a multi-faceted approach. Financial incentives, grants, or subsidies for farmers willing to adopt biochar can ease the transition. Public-private partnerships can facilitate the setup of communal biochar production units, benefiting a cluster of farmers. Furthermore, educating farmers about the long-term economic and ecological returns of biochar can motivate more to make the shift.

To sum it up, while the path to global embrace of biochar has its barriers, by harnessing knowledgeable strategies and collective action, it can overcome these impediments, tapping into the extensive benefits of biochar are realized on a global scale.

Future Prospects and Research

The evolution of biochar as a pivotal tool in agriculture is a journey that intertwines innovation, research, and adaptation. Navigating the complexities of modern farming and environmental challenges, biochar stands at the intersection, promising transformative solutions. The road ahead is paved with opportunities for refinement, innovation, and integration.

A. Innovations Making Biochar Production More Efficient:

As the demand for biochar grows, there is a pressing need to optimize its production, ensuring both quantity and quality. Several areas of innovation are emerging:

1. **Feedstock Optimization:** Research is delving into identifying the most efficient feedstocks, not just in terms of yield but also the quality of biochar produced.
2. **Energy Recovery:** Modern pyrolysis units are being designed to capture and utilize the energy released during biochar production, making the process not only environmentally friendly but also energy-efficient.
3. **Tailored Biochar Production:** Innovations are allowing the customization of biochar properties based on specific soil needs, ensuring maximum effectiveness when applied.
4. **Scalability:** Advances in reactor designs are aiming to make biochar production feasible at various scales, from small farm-level units to large industrial setups.

B. Integration with Modern Farming Techniques:

The potential of biochar is magnified when it is integrated with modern farming techniques. Some synergies being explored include:

1. **Precision Agriculture:** Using technology to determine the exact amount and location for biochar application, ensuring optimal soil health and crop yield.
2. **Drip Irrigation:** Combining biochar's water retention properties with drip irrigation systems can maximize water use efficiency.
3. **Integrated Pest Management (IPM):** Biochar's ability to boost soil microbial activity can be leveraged in IPM, enhancing the soil's natural defences against pests.
4. **Agroforestry:** In systems where trees and crops are grown together, biochar can play a role in enhancing below-ground biodiversity, benefiting both trees and crops.
5. **Cover Cropping:** When used with biochar, cover crops can further enhance soil structure, fertility, and organic matter content.

In essence, the future of biochar is not just about its standalone benefits but how it can be a part of a larger, holistic agricultural approach. By investing in research and innovation, and by understanding the synergies between biochar and other modern agricultural practices, which paves the way for a sustainable and productive agricultural landscape.

Conclusion

The annals of human civilization have always been punctuated by moments of rediscovery. In the realm of agriculture, the resurgence of biochar is a testament to this cyclical journey of knowledge. Biochar's origins trace back to ancient civilizations, where it was recognized not merely as a soil enhancer but as a keystone in harmonizing human existence with nature. Today, in an age characterized by rapid technological advancements and growing environmental concerns, this ancient wisdom offers a beacon of hope. Modern challenges like soil degradation, water scarcity, and climate change loom large, but biochar, with its multi-faceted benefits, presents viable solutions. The beauty of biochar lies not just in its inherent qualities but in its adaptability. By harnessing modern technology to refine and optimize biochar production which amplifies its ancient benefits. Drones and precision agriculture tools guide biochar application, advanced pyrolysis techniques improve its production and digital platforms facilitate global knowledge sharing about its best practices. The confluence of old-world wisdom with new-age technology sets the stage for a promising agricultural future. By embracing biochar, it is not just reviving a forgotten practice but are adapting it to fit contemporary needs. It's a call to action for stakeholders globally from farmers to policymakers to invest, research, and implement biochar-based solutions. In wrapping up, the story of biochar is a compelling reminder that sometimes, the solutions to tomorrow's challenges can be found in the lessons of the past. As we stand on the cusp of an agricultural revolution, it is this synergy of ancient wisdom and modern innovation that holds the promise of a sustainable and bountiful future. In conclusion, biochar's tale underscores that the fusion of age-old wisdom and contemporary innovation can guide towards a sustainable and prosperous agricultural future.

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GOAT FARMING: A PROFITABLE LIVESTOCK ENTERPRISE

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Introduction

Goats are called poor man's cow, because they give you the same benefit as the cow, and it is cheaper than the cow so that poor people can afford having them. Goat is a multi-functional animal and plays a significant role in the economy and nutrition of landless, small and marginal farmers in the country. Goat rearing is an enterprise which has been practiced by a large section of population in rural area. Goats are an important component of livestock industry and play a vital role in the socio - economic structure of our rural community. They have been reared as domestic animals across the world since ancient times. Goats are among the main meat-producing animals in India, whose meat (chevon) is one of the choicest meats and has huge domestic demand. Besides meat, goats provide other products like milk, skin, fiber and manure. Goat milk has traditionally been known for its medicinal properties and has recently gained importance in human health due to its proximity to human milk for easy digestibility and its all-round health promoting traits. Demand for goat milk and milk products for internal consumption and export is expected to rise in coming years. Goat milk production is a dynamic and growing industry that is fundamental to the wellbeing of hundreds of millions of people worldwide and is an important part of the economy in many countries. Goats are important part of rural economy, particularly in the arid, semi-arid and mountainous regions of the country Goat farming provides glimpses of future hope for employment generation, nutritional security and prosperity to the millions of small and marginal farmers in the country. Goat rearing under intensive and semi-intensive system for commercial production has been gaining momentum. A number of commercial goat farms have been established in different regions of the country.

Present Scenario

Goat is an important livestock species consisting of 27.79 percent of the total livestock population in India with 148.80 million population (20th livestock census, 2019). It supplements income to the 33.01 million households. Goat contributes 8.40 percent to the livestock GDP which predominantly supports livelihood of rural poor and contributing 3.0 percent to the total milk basket of the country (2021-22).

Traditionally goat has served as source of livelihood and financial security to large section of society, mainly comprising of resource-poor people. In the present scenario of changing agro-climatic conditions, this small ruminant farm animal has incredible potential to be projected as the “Future Animal” for rural and urban prosperity. The backyard goat rearing is gradually turning as the fastest growing livestock enterprise in the country. Goat farming in India is essentially an endeavor of millions of small holders who rear animals on “Crop Residues” and “Common Property Resources”. The small holders produce milk, meat, fiber, skin etc. for the community with no capital, resource, and formal training of Goat farming. More often goats are reared for production of meat, but they also serve as ready source for milk to meet the family requirement.

Status of Goat industry in India:

The goat industry in India has yet to be firmly laid down on scientific lines. Goat keepers are keeping goats in all kinds of situations depending upon the ecology and their situations. The minimum goat unit could consist of one goat and the maximum could go to a few hundred under range management system. Goat farming in the country is mainly based on *“zero input”*. The fear of mortality has perhaps been largely responsible for not starting many large-scale goat farms. However, largescale goat farms have successfully running since over last 30 years at the CSWRI Avikanagar, MPKVV Rahuri, and at Leh.

Goat Production Systems in India

In our country, goats are reared by men and women with varied working and professional background. The production systems are as numerous as the socioeconomic and diverse agricultural situations in the country. However, they can be broadly classified into the following;

1. Tethering:

This is common in the sub-humid and humid zones, where probably because of intensive cropping, it is a convenient means of rearing goats from the stand point of control, minimum labour input and utilization of feed in situ. A variation of this method is combining tethering with grazing up to 5 goats at a time, led by ropes detained by women and children.

2. Extensive production system:

This involves low carrying capacity in situations where land is marginal and is plentiful. It is characterized by low rainfall and various browse plants. The system is used by nomadic people, usually in very low rainfall areas or during winter months when crop resides are available.

3. Intensive production system:

The goats are fed in confinement with limited access to land. It involves high labour and cash inputs. Cultivated grasses and agro-industrial byproducts are fed in situ. This system also has the advantage of allowing control over the animals.

4. Semi-intensive production system:

This system is practiced to some degree in most of the situations, but the nature and extent of integration depend on the type of crops grown and their suitability to goats. The advantages of this system are increased fertility of land via the return of dung and urine, control of waste herbage growth, reduced fertilizer usage, easier crop management, increased crop yields, and greater economic returns.

Reasons to go for Goat Farming Enterprise

- Risks are very less in goat farming enterprise than any other livestock farming business.
- Starting a goat farming business requires low initial investment.
- Goats don't require huge area for housing because their body size is comparatively smaller than other livestock animals.
- Goats are very friendly in nature and very lovable.
- Goats are good breeders and they reach sexual maturity within their 8-12 months of age and give birth to kids within a short time and some goat breed produce 2 or more kids per kidding.
- Both male and female goats have almost equal value/price in the market.
- No religious taboo against goat farming and their meat consumption.

- There is no need of a specific housing system for goats. Even they can easily share their living place with their owners or his/her other livestock animals.
- Goats are less prone to diseases than other domestic animals.
- Goats are easily available, comparatively cheaper in price and easy to maintain even by poor farm families
- They are capable of adopting themselves with almost all types of agro-climatic environments or conditions.
- They can tolerate high and low temperature and they also can tolerate hot climate more than other animals.
- According to the investment per unit they produce more than other domestic animals.
- Goat meat has a huge demand and high price in the local and international markets. Goats can be milked as often as required.
- You can use the goat's manure as a high-quality natural fertilizer in crop field.
- Goat manure is 2.5 times richer than cow manure.
- Goat milk is easily digestible
- Storage of milk is easy
- In a day, goat can be milked several times
- Goat farming enterprise is a regular source of employment and income generation.

Role of Goat Farming as Livestock in the country

In Entrepreneurship Development: In last few years, goat production in the country gained momentum in the form of a commercially viable enterprise as evidenced by increasing interest of young entrepreneurs to develop knowledge and skill in this enterprise.

In Rural Economy: Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless laborers of rural India. Small ruminant rearing ensures self-employment and acts as a cushion in distress situations like drought and famine.

In Global scenario: India ranks on top in goat population. The demand for meat, milk and fiber is increasing progressively and expected to further rise in future in view of sizable increase in per capita income and health consciousness of people.

In Nutrition and Health: Goats possess distinct social, economical and biological advantages. Goat meat (chevon) is one of most preferred meat type by the consumers in several countries including India. The goat milk is easily digestible due to smaller size of fat globules and serves as a ready source of family nutrition. In India, both demand and production of goat meat have shown steady increase during the last decade and despite the rising production trend, country would need to double the number of goats to meet the projected requirement of goat meat for growing human population in the coming decades.

SWOT Analysis of Goat Farming Sector in India

Strength	**Weakness**
• India is having the second highest number of Sheep & Goat. (After China). • Extraordinary hardiness and ability to adapt to the harshest regions and facility of movement in rugged and harsher terrains. • Indigenous breeds with good production potential • Marketing potential for wool and meat. • Regulatory compliance. • Low production costs compared to other breeds and animal species	• Unorganized structure of goat farming sector. • Lack of marketing infrastructure facilities for Value addition such as meat processing, warehousing, Cold storage, refrigerated vehicles • Absence of Public Private Partnership in goat farming enterprise. • Lack of demand driven interventions • Scarcity of good breeding stock, • Inadequate doorstep veterinary and extension services
Opportunities	**Threats**
• The growing demand of goat milk, meat and its products • Low start-up cost • Importance of Goat in Integrated Systems Farming (IFS) module • Untapped potential for the export & value- added products. • Paradigm shift in Government policies. • Modern production technologies of goat production system	• Extreme climatic conditions and natural calamities. • Invasion of diseases • Depletion of natural resources (pastural land) • Urbanization. • Tax regulations for marketing and other transactions

Conclusion

Goat farming, which was the economic activity of rural resource-poor people has attracted large and progressive farmers, businessman and industrialists due to its economic viability under intensive as well as semi-intensive systems of management for commercial production. The entry of resource-rich people, who have better access to technical knowledge, resources and markets, into this activity would help in realizing the potential of this enterprise. It would also encourage the aspirant commercial goat farmers who do not have access to grazing resources. The goat farmers can earn best profit by producing and marketing pure breed goats and festive sale like; Eid. There is need of establishment of service centers for goat owners to provide technical knowledge, recommended inputs and market information. Small size modern slaughterhouses need to be established near the production centers to maintain commercialization of goat farming enterprise. The private sector may be encouraged to create such infrastructures through appropriate policy support and incentives. This would enable the farmers to enhance their productivity and reduce cost of their production

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POLLEN STORAGE -NOVEL GENETIC RESOURCES CONSERVATION

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Introduction

Pollen is a product of genetic recombination and can provide a reliable source of nuclear genetic diversity at the haploid stage. Systematic research on pollen storage started at the end of the 19th century. There is large number of crop species, including vegetables, fibre and fruit crops, forage and cereals, for which pollen storage strategies are desirable. Genetic conservation through pollen storage is desirable for a variety of horticultural plant species, since pollen is known to transmit important genetically heritable characters. Pollen is a product of genetic recombination and can provide a reliable source of nuclear genetic diversity at the haploid stage. Although genetic conservation through pollen storage does not accomplish the whole genome conservation, a plant breeder involved in genetic enhancement of a given horticultural crop could have access to a facility called 'Pollen Cryobank', from where he can draw pollen parents of his choice in the process of breeding a new cultivar.

Keeping the viability and vigour intact the pollen grains can be suitably stored in appropriate containers like, glass or plastic vials for an extended period of time. Such containers are stored in desiccators with dehydrating agents to control humidity. Saturated solutions of different salts are used to obtain the required humidity. Lycopodium spores are used as diluents before storage to increase the bulk of pollen and prevent wastage of pollen sample during artificial pollination. This diluent has all the property of a good diluent, like non sticky and nonhydrating and in addition it keeps the viability rate quite high. It also provides its own growth factors, which leads to higher percentage of germination.

Pollen collection

Pollen should be harvested soon after anthesis, usually in the morning hours. Shelf life is short for pollen collected from immature, aged, or weather-damaged anthers. It is usually more practical to collect anthers in the field and then separate the pollen grains from the anthers in a laboratory environment soon after collection. All pollen must be processed immediately (within hours) to ensure maximum potential longevity.

Collected pollen serves to maintain and preserve the alleles of an individual or population. Sampling strategies have often recommended collecting a set number of individuals per population to ensure that the common alleles are captured. The exact number of individuals that most effectively captures the genetic variation is dependent upon the genetic diversity and life-history traits of the specie. It is suggested that collecting pollen from a single tree easily captures the alleles for that genotype; however, it is recommended that a minimum of 68 trees be sampled to represent a wild population.

Pollen desiccation

Successful pollen gene banking is dependent upon achieving long-term survival of stored pollen. Water content, cooling rate and storage temperature all affect the longevity of stored pollen. Field conditions and relative humidity at the time of harvest affect the pollen moisture content, and germinability is impaired when pollen is kept for any length of time in wet or high-humidity conditions.

The Graminaceous pollen contains nearly 35 to 60% water when shed, thus immediate freezing would cause irreversible structural damage as a result of ice formation. Thus the water content of the pollen needs to be reduced before cryo storage, which is however, problematic, as there is rapid loss of viability with decreasing water content.

Secale cereale and Zea mays can tolerate higher degrees of desiccation than the grains of Triticale. *Triticum aestivum* is however, intolerant to any degree of dehydration.

Pollen ages quickly when held at 24°C and 75% relative humidity (RH). For desiccation-tolerant pollen, it is critical that the pollen be dried to a target moisture content soon after harvest. Depending on species, successful long-term storage requires that the moisture content be reduced to or below levels at which there is no free water. For many species, pollen can be dried to water contents of 0.05 g H2O g-1 dry weight (DW) without a loss in viability. This can be achieved by drying overnight in a low-humidity room environment or over salt chambers that are maintained at RH of about 30%. Anthers or pollen grains can also be dried over silica gel at room temperature. Also dehydrated at 20°C for 16–24 hours at RH of 15% or 32% prior to storage.

Rapid air-drying can also be achieved by using specialized pollen-dryers that blow air at 20% to 40% RH and 20°C, to quickly reduce moisture content in the pollen of Poaceae species, including *Avena, Pennisetum, Saccharum, Secale, Triticum, Tricosecale and Zea.*

Method of Pollen Storage:

I. Short Term Pollen Storage:

It includes the effect of temperature and humidity, and pollen storage in organic solvent.

i. Pollen Storage in Organic Solvent:

Pollen grains stored in non-polar organic solvents like benzene, diethyl ether and cyclohexane retained viability and showed very little leaching of phospholipids, sugars, and amino acids into the solvent.The Citrus pollens can be maintained in different organic solvents for three months. Plants like, *Armenica vulgaris, Camellia japonica, Ginkgo biloba, Juglans regia, Malus pumila, Prunus triloba, Prunus percia, Salix babylonica, and Zea mays* shows that the insect pollinated species stored in a suitable organic solvent at 4°C for 35-40 days exhibited the needed viability.

II. Long Term Pollen Storage:

Thus for a long term preservation cryogenic technique seems to be more promising. Some of the methods of long term preservation are stated below.

i. Storage at Sub-Zero Temperatures:

Using a storage temperature of -10° C and – 34° C the longevity of bicellular pollen (desiccation tolerant) and pollen with original low content of moisture has been successfully extended between 1 and 3 years.

ii. Freeze or Vacuum Drying (lyophilization):

Pollen of different taxa especially the desiccation-tolerant pollen can be successfully preserved for a long period of time by freeze or vacuum dying method. Freeze-drying involves the rapid freezing of pollen to sub-zero temperature of -60° C or -80° C using inert gas helium or nitrogen, and then the gradual removable of water under vacuum sublimation. In vacuum drying the pollens are directly exposed to a vacuum and simultaneous cooling. The moisture is later withdrawn by evaporative cooling. In number of taxa when freeze drying is combined with lyophilization then storage and viability of pollen has been found to be very effective.

iii. Cryopreservation by Deep-Freezing:

Long term preservation can also be done by ultra low temperature, ranging between -70° C and -196° C. Among the long term storage methods, cryopreservation is most promising and widely used method. stored in liquid nitrogen for many years without loss of its essential capabilities to pollinate, fertilize, and set normal fruit and seed.

Pollen stored at cryogenic temperature

S.No.	Species	Storage temperature °C	Storage time
1.	*Avena sativa*	-192	1 day
2.	*Saccharum spontaneum*	-80	30 to 140 days
3.	*Secale cereale*	-192	7 days
4.	*Triticum aestivum*	-196	Few weeks
		-196	10 years
		-192	1 day
		-196	Few weeks
5.	*Zea mays*	-196	180 days
		-76	363 days
		-196	10 years

SIGNIFICANCE OF POLLEN STORAGE

- For Plant breeders and the horticulturists-fruit tree improvement, it overcomes the seasonal limitations, geographical limitation and physiological limitation.
- Ensures constant supply of short-lived pollen.
- Facilitating hybrids between genera, species and genotypes.
- Maintain genetically diverse stocks of pollen collected from wild for future conservation and use.

- Pollen can be used for international exchange of germplasm, in a PGR management program.
- Eliminates the need for frequent sampling of pollen from wild.
- It provides the required male parent in a viable and fertile form for primary and supplementary pollination needs.
- Tree species- germplasm can be easily received and exchanged through pollen.

References

Ganeshan S, Rajashekaran RK. 2000. Current status of pollen cryopreservation research: relevance to tropical horticulture. In: Engelmann F, Takagi H, editors. Cryopreservation of Tropical Plant Germplasm. IPGRI, Rome. pp. 360–365.

Gayle M. Volk. 2014. Collecting pollen for genetic resources conservation, National Center for Genetic Resources Preservation.

Shripad N. Agashe. 2008. Pollen and Spores Applications with Special Emphasis on Aerobiology. Science Publishers.

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HERBICIDE RESISTANCE IN AGRICULTURE: MECHANISMS, IMPLICATIONS AND POSSIBLE STRATEGIES

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Abstract

Synthetic herbicides have been used to control weeds worldwide. Herbicide resistant weeds may become a more serious economic problem within 5 to 10 years than pest resistances to insecticides and fungicides due to the greater use of herbicides in agriculture. According to the WSSA (1998), herbicide resistance is "the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type". This article examines the multidimensional nature of herbicide resistance, the difficulties it creates for contemporary agriculture, and the innovative approaches that hold the promise of successfully combating this grave danger. By bringing this important topic to light, we hope to encourage cooperation and well-informed decision-making in order to protect the future of our agricultural landscapes and ensure the security of the world's food supply.

Keywords: Herbicide, Resistance, Tolerance, Susceptibility

Introduction

Herbicide resistance, which is the innate ability of some weed biotypes to tolerate herbicide treatments that ought to normally eradicate them, has grown to be a common and complicated problem. We examine the complexities of herbicide resistance in this essay, including its causes, definitions, and the urgent need for a multipronged strategy to address this agricultural threat. It is important to distinguish between instances of real resistance and situations where factors other than resistance may be at play. Herbicide resistance has undoubtedly increased as a result of the repeated and continuous use of herbicides with the same mechanism of action in intensive farming systems. Herbicide resistance frequently results from the selection of rare natural mutations seen in weed populations.

Development of resistance

Herbicide resistance was also defined by HRAC (2015) as "the naturally inherited capacity of some weed biotypes within a given weed population to survive a treatment with a herbicide that should, under normal use conditions, effectively control that weed population. "Herbicide resistance has been primarily caused by the continuous and repetitive application of a herbicide or herbicides with the same mode of action in intensive agriculture or horticulture systems involving crop monoculture and minimal tillage. However, it is crucial to honestly assess the causes of herbicide efficacy problems before referring to them as herbicide resistance. The term "herbicide resistance" might be used in a deceptive manner at times. Even if a herbicide is used consistently in the same place for a long time, resistance may not always emerge. Instead, resistance develops through the selection of rare, naturally occurring mutations in a population of resistant plants. It is thought that only a single plant or a small number of plants already existing in a population are the source of herbicide-resistant plant biotypes. Herbicide-resistant plant biotypes are believed to be emerging from only one or a few plants that are already present in a population. At this stage we say that the weed has developed resistance against a herbicide or in other words called selection pressure of herbicides reached to maximum (Duke *et al*. 1991).

Mechanism of Herbicide Resistance

A biotype: is a group of plants within a species that has distinct genetic variation not common to the population as a whole.

Herbicide susceptibility: It is the lack of capacity to withstand herbicide treatment with recommended dose so that the plant is damaged by the herbicide (Ashton and Crafts 1981).

Herbicide tolerance: It is the ability of a species to survive and reproduce after herbicide treatment. It is the ability to compensate the damaging effect of herbicides with No physiological mechanisms involved (Menalled and Dyer 2006).

Herbicide cross resistance: occurs when a plant is resistant to one class of herbicide within one group or several herbicide classes within one group. The resistant biotype has evolved by selection pressure from herbicides attacking acetolactate synthase (ALS) that will be resistant to all herbicides and act on a particular site. If evolution of resistance to one herbicide immediately endowed resistance to other herbicides, there is cross-resistance. It is metabolic cross resistance if the herbicides or their toxic products are degraded by the same mechanism.

Multiple resistance:

Multiple resistance is the phenomenon of resistance to herbicides from more than one chemical classes to which a population has been exposed (Holt *et al*. 1993). It refers to a weed or crop biotype that has evolved mechanisms of resistance to more than one herbicide and the resistance was brought about by separate selection processes. Ex: Multiple HR crops have been developed and commercialized in recent years, including glyphosate/dicamba- or 2,4-D–resistant soybean and cotton, glyphosate/glufosinate-resistant corn, and 2,4-D/ glufosinate /glyphosate-resistant corn primarily for control of GR weeds. (Beckie *et al*. 2019 Reference Beckie, Ashworth and Flower).

Basic difference between cross and multiple resistance: The term cross resistance should be used to describe cases in which a weed population is resistant to two or more herbicides by the presence of a single resistance mechanism. In contrast multiple resistance should be used in case where resistant plants possess two or more distinct resistance mechanisms.

Negative cross resistance: It refers to the phenomenon by which an individual resistant to one herbicide or a chemical family of herbicides shows higher or increased sensitivity or susceptibility to other herbicides than its natural wild type susceptible population (Gadamaski *et al*. 2000).

Target site resistance: Target-site resistance occurs when the target enzyme of a herbicide becomes less sensitive or insensitive to the herbicide. The loss of sensitivity is usually associated with a gene-coding mutation for a protein, which can lead to conformational changes in the structure of the protein. In short, target site resistance refers to a structural change to the binding site of herbicide molecule to confer resistance or when the target site is overexpressed through gene amplification.

Non target site resistance: Non target site resistance is associated with physiological mechanisms aimed at reducing the amount of herbicide reaching the target site. These mechanisms mainly consist of decreased rates of herbicide penetration and herbicide translocation, and also an increased rate of herbicide sequestration or metabolism. Enhanced metabolization of herbicidal compounds enables the majority of non-target site resistance cases. Cases of nontarget-site resistance by altered herbicide distribution have been reported for two important herbicides, paraquat and glyphosate. Among the various enzyme systems involved in metabolic herbicide detoxification, two are of particular importance in weeds and crops:

● **The cytochrome P450 monooxygenase system**: This system (several protein families) catalyzes oxidative transformations of the herbicide molecule (e.g. hydroxylation and oxidative dealkylations). In fact, the system is a member of a large enzyme family that consists of multiple cytochrome P450 monooxygenases with diverse substrate specificities.

● **Glutathione S-transferase:** This family of enzymes catalyzes conjugation reactions that result in the nucleophilic displacement of aryloxy moieties, chlorine, or other substituents by the tripeptide glutathione (GSH). The GSTs also occur in various isoforms that differ in their catalytic properties.

Herbicide Resistance Factors:

Herbicide resistance is caused by a number of reasons, including:

1. **Reliance on a Single Herbicide Too often**: Using a single herbicide continuously creates selective pressure on weed populations, favouring the survival of individuals with innate resistance features.

2. **Improper Herbicide Application**: Using the wrong rates, timing, or procedures for applying herbicides might make them less effective and make it more likely that resistance will emerge.

3. **Lack of Diversity in Weed Control**: Monoculture agricultural systems and limited weed control techniques might foster the emergence of resistance.

4. **Seed Dispersal:** Weeds that produce a large number of genetically diverse seeds are more likely to develop progeny that are resistant.

5. **Effect of climate change**: studies indicating that climatic change or rising CO_2 concentrations are likely to alter or negatively influence herbicide performance.

Herbicide Resistance future aspects:

Farmers and researchers are collaborating to address herbicide resistance using a variety of techniques:

1. **Diverse Weed Management:** Using several modes of treatment, cover crops, and crop rotation can all assist delay the emergence of resistance. Ex: In potato-based crop rotations, manual removal of P. minor plants at potato harvest reduced P. minor infestation by >90% in succeeding wheat (Walia and Brar, 2004).

2. **Precision Application:** By employing technology to apply herbicides more accurately, the quantity of chemicals required is decreased and the chance of resistance is decreased.
3. **Education and Training:** Farmers gain from continual training in the best ways to apply herbicides and manage resistance. Ex: Weed control is a serious challenge in non-puddled DSR because the initial flush of weeds is no longer controlled by flooding (Baltazar and De Datta, 1992; Olofsdotter et al., 2000). Training farmers for Adoption of herbicide-resistant (HR) rice may overcome the problem of weed management in DSR.
4. **Research and Innovation:** Creating new herbicide formulations and crop varieties that are herbicide-tolerant can provide weed control specialists more options at their disposal. Ex:

GM-Mustard

Dhara Mustard Hybrid-11 or DMH-11 is a genetically modified variety of mustard developed by the Delhi University's Centre for Genetic Manipulation of Crop Plants. The researchers at Delhi University have created hybridised mustard DMH-11 using "barnase / barstar" technology for genetic modification. It is Herbicide Tolerant (HT) crop. If approved by the Centre, this will be the second GM crop, after Bt Cotton, and the first transgenic food crop to be allowed for cultivation in the country. There has been strong opposition from various organisations and also from within government to the approval given to GM mustard (www. isaaa.org).

Conclusion

The arrival of genetically engineered crops that are herbicide-tolerant, providing new instruments in the fight against resistant weeds, is one notable development on the horizon. These improvements, however, present their own set of difficulties and conflicts, necessitating a careful and thoughtful approach to acceptance. Herbicide resistance is a critical issue in contemporary agriculture that calls for collaboration between farmers, researchers, and politicians. Our ability to strike a careful balance between efficient weed control and the judicious use of herbicides is essential to the agricultural landscapes we depend on and to the world's food security. We can guarantee a sustainable and secure future for the world's food supply and the health of our planet by tackling herbicide resistance head-on. We may work toward a more sustainable and fruitful agricultural future by diversifying weed management techniques, using herbicides sparingly, and investing in novel solutions.

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REVOLUTIONIZING AGRICULTURE IN INDIA

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Introduction

The increasing global population and economic growth are the major forces driving the demand for increased food production, crop production and fertilizer use. To overcome the demand, the agricultural soils must maintain adequate levels of quantity and quality to produce food, fiber, and energy, without falling victim to a negative impact on their balance of nutrients. The modern agricultural development is emphasizing on the environmental friendly agriculture. Fertilizer is one of the most important production elements in agricultural production activities and its application is believed to have been responsible for at least 50% increase in crop yield in the 20th century. The use of mineral fertilizers has been a key tool to offset nutrient outputs and thus achieve increased yields. As the main subject of fertilizer reduction in agricultural production activities, the fertilizer application behavior of farmers and motivating mechanism have been a heated topic of discussion in academics and politics. Fertilizer reduction as the key work to achieve sustainable agricultural development, as well as how to better promote farmers' fertilizer reduction behavior, is currently the main problems in agricultural production. There is an increased realization of the food insecurity situation by government policy makers. In the last few decades, the government has prioritized the development of agriculture. However, the trends shows that the total consumption of fertilizer products were 63.94 million MT during 2021-22 with a decline of 5.4% over 2020- 21.

Considering these factors, promoting sustainable agriculture practices that will not only uplift the economic status of the farmers but also lead to environmental rejuvenation has been a main agenda by the Government of India. The initiative, led by Prime Minister Narendra Modi's Cabinet Committee on Economic Affairs (CCEA), aims to boost farmers' income, fortify organic farming, and secure food availability for the nation. The CCEA has approved a **unique package of innovative schemes for farmers** with a total outlay of Rs.3,70,128.7 Crores during June 2023.

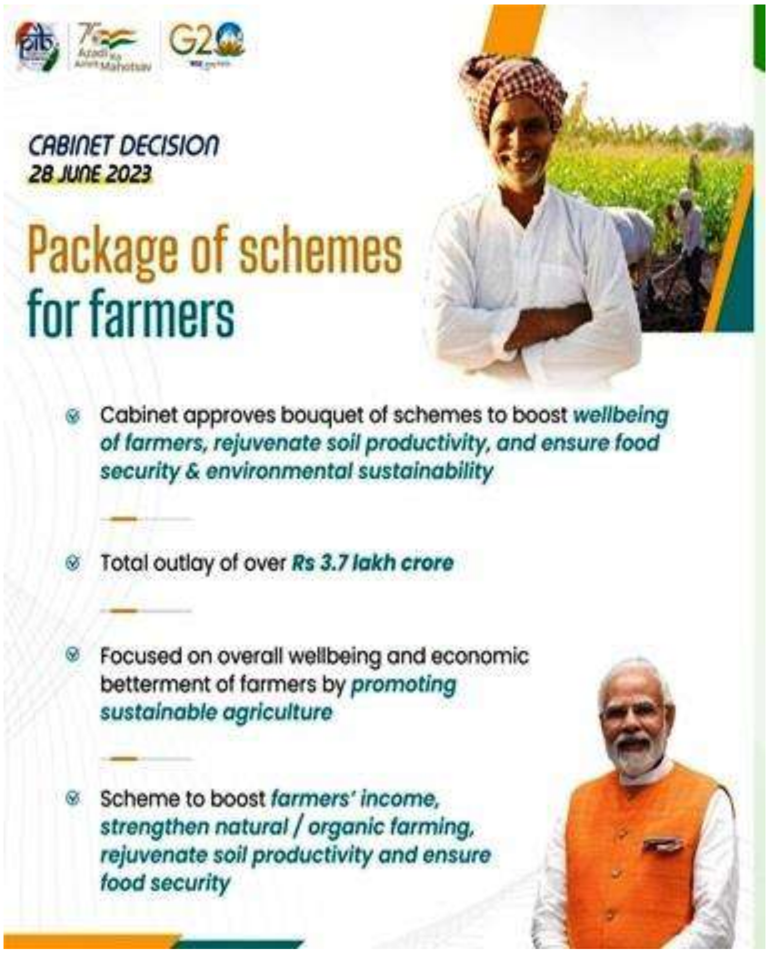

Photo Source: @PIB_India

OBJECTIVE OF THE SCHEME

To improve the overall well-being, enhancing the soil productivity, food security, providing eco-friendly environment and economic betterment of farmers by promoting sustainable agriculture.

SALIENT FEATURES

Continuation of the Urea Subsidy:

A major highlight of this economic package is the continuation of the Urea Subsidy Scheme. Within the allocated budget for the urea subsidy for three years (2022-23 to 2024-25), the scheme ensures that urea will remain accessible to farmers at an affordable price *i.e.,* Rs 242/- per 45 kg bag excluding taxes and neem coating charges. This move, combined with the recently approved Nutrient Based Subsidy, will help farmers control their input costs. Furthermore, the Indian government aims to promote the indigenous production of urea and achieve self-reliance in this sector thereby protecting farmers from the escalating global fertilizer prices.

Strengthening of Nano Urea eco-system

By 2025-26, eight Nano urea plants with production capacity of 44 Crore bottles equaling to 195 LMT of conventional urea will be commissioned. The plants established will offer an eco-friendly and cost-efficient alternative to traditional urea. Nano urea provides a controlled release of nutrients, improving crop yield, and promoting cost-effectiveness. This new approach is a part of the government’s broader mission to render India self-sufficient in urea production by 2025-26.

India to be Atmanirbhar in Urea by 2025-26

The scheme is to achieve self-reliance in urea production by 2025-26 by setting up and reviving 6 urea production units at Chambal Ferti ltd. - Kota Rajasthan, Matix ltd. Panagarh West Bengal, Ramagundam-Telangana, Gorakhpur-UP, Sindri-Jharkhand and Barauni-Bihar since 2018 to make the country atmanirbhar in terms of urea production and availability. Indigenous production of urea has increased from the level of 225 LMT during 2014-15, to 250 LMT during 2021-22. In 2022-23, production capacity has increased to 284 LMT.

PMPRANAM: Restoring fertility of Mother Earth

To promote natural and organic farming, and sustainable use of chemical fertilizers, the “PM Programme for Restoration, Awareness Generation, Nourishment, and Amelioration of Mother – Earth (PMPRANAM)” will be launched.

- It is an initiative that aims to protect and enhance the fertility of the soil
- It encourages and supports the adoption of natural/organic farming, alternate fertilizers, and innovations

- It creates awareness among farmers and consumers
- It provides incentives to States/ Union Territories based on their performance
- It is implemented in collaboration with various stakeholders, such as State Governments, research institutions, civil society organizations, the private sector, etc.

Market Development Assistance (MDA) through GOBARdhan:

The government has taken a major step towards promoting organic fertilizers from Gobardhan Plants by approving the Rs. 1451.84 crores for Market Development Assistance (MDA) scheme. This scheme will provide Rs 1500 per MT to the producers of Fermented Organic Manures (FOM), Liquid FOM and Phosphate Rich Organic Manures (PROM) that are derived from Bio-gas Plants or Compressed Biogas (CBG) Plants under the GOBARdhan initiative.

These organic fertilizers would be branded in the names of Bharat Brand FOM, LFOM, PROM and will offer multiple benefits to the farmers and the environment. The scheme includes setting up 500 new waste-to-wealth plants under the GOBARdhan scheme, which aims to promote a circular economy and reduce greenhouse gas emissions. They will help in managing crop residue, reducing Parali burning, enhancing soil health, and generating additional income for farmers. Farmers will get organic fertilizers (FOM/LFOM/ PROM) at affordable prices. 425 KVKs (Krishi Vigyan Kendras) have laid down demonstrations of natural farming practices and organized 6,777 awareness programs involving 6.80 lakh farmers. A course curriculum for Natural Farming has been developed for B.Sc. as well as M.Sc. programmes to be implemented.

Sulphur coated Urea as “Urea Gold”:

Sulphur coated Urea termed as “Urea Gold,” is being introduced as first of its kind in India. It is more economical, efficient and superior alternative to the Neem coated urea that is currently used. The scheme aims to address the sulphur deficiency of soil, save input costs and increases the income for farmers with enhanced production & productivity.

PMKSKs: A One Stops Solution

One of the key components of the package is the establishment of around one lakh Pradhan Mantri Kisan Samruddhi Kendras (PMKSKs). These centers will offer a one-stop solution for all farming needs, further simplifying farming processes for the country’s cultivators. It will also create awareness and educate farmers about the benefits of natural farming and soil conservation.

BENEFITS

- The packaged scheme helps the farmers in judicious use of chemical fertilizers, thereby reducing input cost of cultivation.
- They will help farmers save on input costs by providing them with affordable and effective fertilizers that can enhance crop growth and yield.
- Promoting natural/ organic farming, innovative and alternate fertilizers like Nano Fertilizers and organic fertilizers will help in restoring fertility of our Mother Earth.
- The availability of low-cost urea, the reduction in the use of chemical fertilizers, and the introduction of innovative alternatives like Nano urea and Urea Gold, promise to lower input costs for farmers and boost crop production.
- They will help protect the environment by reducing soil and water pollution, greenhouse gas emissions, and crop residue burning, which can adversely affect air quality and human health.
- Better utilization of crop residue like parali will help resolve the issue of air pollution and improve the cleanliness and betterment of living environment and also help to convert waste into wealth.

CONCLUSION

In spite of decades of government policies prioritizing fertilizer as the leading driver of increased agricultural output, India has yet to see the benefit in terms of higher yields. The development of effective and convenient policy with regard to the distribution and use of fertilizer has always been a challenge for the government. The government is committed to support farmers and ensure their welfare through these schemes. By using organic and alternative fertilizers, farmers can not only improve their income and livelihoods but also contribute to the noble cause of restoring and nourishing Mother Earth. The government will also provide training, awareness, and extension services to farmers to help them adopt these schemes effectively.

The schemes should target the small and marginal farmers and the appointed “Fertilizer Supply and Distribution Management Committee” in each district should ensure that the targeted groups are the ones who benefit. Based on the perceptions of farmers with regard to extension services, it would seem that access to these services is necessary if the benefits of modern farming techniques are to be demonstrated and their adoption encouraged. Therefore, the effective provision of extension services is essential.

Since agricultural extension services provide mechanisms for sharing information with farmers, there is a need for these services to be responsive and relevant. One of the ways to achieve this is to increase the institutional capacity of subject specialists and to introduce more interdisciplinary ways of involving farmers, research scientists and extension officers. An extension system that is capable of responding to farmers' needs and able to advice on the application of fertilizer according to plant needs is clearly required.

REFERENCES

FAI. (2022). Annual Review of Fertilizer Production and Consumption 2021-22 (Executive Summary). *Indian Journal of Fertilizers.* 18 (9): 893-895.

https://fertiliserindia.com. Retrieved on 26th September, 2023 at 6:00 PM.

https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1935896. The information was posted on 28th June, 2023 3:51PM by PIB, Delhi and retrieved on 24th September, 2023 at 2:00 PM.

https://www.iasgyan.in/daily-current-affairs. The information was retrieved on 22nd September, 2023 at10:00 AM.

Krasilnikov, P., Taboada, M. A and Amanullah. (2022). Fertilizer Use, Soil Health and Agricultural Sustainability. *Agriculture, 12* (4): 462-471.

Shiyao Zhou., Chen Qing., Jia He and Dingde Xu. (2023). Impact of Agricultural Division of Labor on Fertilizer Reduction Application: Evidence from Western China. *International Journal of Environmental Research and Public Health.* 20 (5): 3787-3795.

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SUCCESS STORY OF IMPLEMENTING THE INTEGRATED PESTS AND DISEASES MANAGEMENT PRACTICES IN GOURDS

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Problem assessment

Mr. R. Chandraprabu is a progressive farmer of Pangulathur village of Olakkur block, Villupuram district and he owns 7.0 acres of land. He is a dedicative agriculturist and actively involved in doing agriculture in an innovative way. The major crops cultivating are paddy, groundnut, pulses, snake gourd, bitter gourd, melons, bhendi and brinjal. To protect the crops from various pests and diseases he used to spray pesticides at weekly interval. This increase his cost of production and led to reduction in net income.

Mr. R. Chandraprabu approached KVK to improve his agricultural activities and gain more income. In Villuppuram district, area under cultivation of pandhal vegetables is more. But higher pest and disease incidence and indiscriminate use of agrochemicals are very common in cultivation of gourds. Moreover farmers are lacking knowledge on pest and disease monitoring and Integrated pest and disease management (IPDM) strategies. This increase his cost of production and led to reduction in net income.

Plan, Implement and Support

He advised to attend training programmes conducted by KVK, Villupuram to develop knowledge and skill. He attended various training programmes viz., improved production technologies, organic farming, ecofriendly management of pest and diseases, importance of soil health management. KVK, Villupuram conducted front line demonstration (FLD) and farmers field school on "IPDM in gourds". The integrated pest and disease management strategies includes summer ploughing, use of improved varieties/hybrids, setting up of yellow sticky trap, fruit fly traps, precision farming (portray nursery, drip irrigation and mulching), use of biocontrol agents, need based pesticides spray, intercropping/ border cropping with marigold. After that, he started adopting improved technologies.

Photo documentation

	
Protray nursery seedling production	Use of traps and intercropping with marigold to better pollination
	
Cultivation of snake gourd	FLD on IPDM in gourds

Outcome

He has earned as additional income of Rs. 1,87,450/- with BC ratio of 5.56 from cultivation of snake gourd when compared to the regular practices. The details are given below

Details	Cost of Cultivation / ha (in Rs)	
	Before	After
Seed	10000	24000
Land Preparation	5000	5000
Mulch sheet & spreading	-	22000
Sowing	1250	1500
Irrigation	7000	2500
Fertilizer	11250	12000
Weed management	7250	500
Plant Protection	13200	4000
Harvest	3000	4000
Total	57,950	75,500
Yield (tonnes)	21.5	42.0
Returns		
Gross returns	2,15,000	4,20,000
Net returns	1,57,050	3,44,500
BCR	3.71	5.56

Impact

Now, he is applying fertilizer based on soil test to enhance the production and reduction in cost of cultivation. In case of cultivation of gourd, he is practicing precision farming system *viz*., drip irrigation and mulching and Marigold under the pandhal which increases the pollination rate resulting high yield. He is doing agroforestry model of papaya and moringa around the field which acts as the wind barrier and gives addition income. He is using all the integrated approaches *viz*., traps, biocontrol agents to protect the crop from insect pests and diseases.

He is also served as a resource person for training programmes organized by KVK, Villupuram and Department of Agriculture and Horticulture, Villupuram. KVK, Villupuram documented his success story on IPDM in gourds with the help of Doordarshan Kendra, Podhigai, Chennai and telecasted for mass coverage.

Success story on IPDM in gourd telecasted in DD Podhigai, Chennai

Received **Krishi Yuva Samman** (Young Farmer of the Year) award at Regional level (South India) during Mahindra Samriddhi India Agri Awards 2019 held at New Delhi on 18.03.2019

He received **Krishi Yuva Samman Regional award for South India with cash prize of Rs. 51000/- (Rupees fifty one thousand only) under Youth farmer category** from Executive Chairman, Mahindra & Mahindra Ltd., during Mahindra Samriddhi India Agri awards 2019 held on 18.03.2019 at New Delhi for encouraging the youth farmers in agriculture and for disseminating the latest agricultural technologies in Villupuram District.

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DIRECT SEEDED RICE - SUSTAINABLE APPROACH TO RICE CULTIVATION

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Introduction

Rice is one of the most important food crops in the world, and staple for more than half of the global population. 40% of the world's irrigation water is used for rice production in cultivation of traditional transplanting of rice (TPR), but as urbanization and climate change make water scarcer, as well as labour shortages and shrinking arable land, new ideas and innovations in rice cultivation are urgently needed to meet growing demand and ensure food security. Direct seeded rice (DSR) is one potential alternative management strategy to these problems (Farooq et al, 2007). Instead of the conventional way of raising seedlings in a nursery before transplanting them into flooded fields, direct seeding is a crop establishment approach in which rice seeds are placed straight into the field.

Direct seeding of rice refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. There are three principal methods of direct seeding of rice in DSR, pre-germinated seeds can be sown in a puddled soil (wet seeding) or prepared seedbed (dry seeding) through broadcasting (scattering seeds) or through drum seeders. Dry seeding has been the principal method of rice establishment since the

1950s in developing countries (Pandey and Velasco, 2005). In TPR method seedlings from a nursery planted in puddled fields and it is labour and water intensive.

	
1. Drect seeded rice	**2. Traditional transplantation of rice**
	
3. Broadcasting of rice	**4. Drum seeder technique**

Why DSR needed?

- ✓ Increasing water scarcity
- ✓ Increasing demand and competition of water from non- agricultural sector
- ✓ The rising cost ans scarcity of labour at peak periods
- ✓ Increasing labour wages
- ✓ Adverse effect of puddling
- ✓ Rising interest in conservation agriculture
- ✓ Best fit in cropping systems
- ✓ Crop intensification
- ✓ Development in DSR techniques

In DSR a farmer can save Rs.8000 to Rs.10000 per acre and seeds required will be 8 to 12 kg while in case of TPR method needs 25 to 30 kg seeds (Hemanth Kumar, 2023). The method of transplanting and establishment is one of the important agronomic practices, which influences the cropgrowth and development (Gopi et al. 2006). It also helps the crop to maintain proper spacing, optimum population and supports in vigorous growth put forth more production. A specially labour drudgery in different operations (Sravanthi et al., 2022) One of the most significant hurdles is weed control. In flooded paddy fields, water serves as a natural barrier to weed growth. However, in DSR systems, weeds can grow side by side with rice, reducing yield. Thus, effective weed management strategies are critical for the successful application of DSR.

Advantages of direct seeding

- No significant reduction of yield under optimal conditions
- Savings on irrigation water by 12-35% under efficient water management practices
- Reduces labor and drudgery by eliminating seedling uprooting and transplanting
- Reduces cultivation time, energy, and cost
- No plant stress from transplanting
- Faster maturation of crops
- Lower GHG emissions
- Mechanized DSR provides employment opportunities for youth through service provision business model
- Increases total income by reducing cost of cultivation

Comparative yields in DSR can be obtained various cultural practices *viz.*,

- Selection of suitable cultivars
- Improved short duration
- High yielding varieties
- Proper sowing time
- Optimum seed rate
- Proper water management
- Nutrient and water management techniques to encouraged the farmer to shift from TPR to DSR culture.

Compared to transplanted crops, direct seeded crops take less effort and grow more quickly. With this technique, plants are not stressed out by having their roots plucked out of the ground and regrown as tiny rootlets. However, they have more competition from weeds. Direct seeding can be carried out in one of two ways depending on the technique chosen for land preparation.

A) **Dry Direct Seeding:** This method is usually practiced for rainfed and deep water ecosystems. Farmers then dry soil surface, then incorporates the seed either by ploughing or harrowing.

B) **Wet Direct Seeding:** Direct seeding in wet fields can be accomplished by either distributing pre-germinated seeds or using a drum seeder to drill seeds into the puddled soil.

All the field operations are carried out in dry field for dry rice cultivation, whereas, wet rice cultivation practiced in puddled field situations it is the usual practice to sow ungerminated seeds in dry soil and sprouted seeds in puddled soil.

In dry direct seeding there are 3 methods, which are generally used

Broadcasting

1) Broadcasting of 60-80 kg of seeds uniformly by hand or in furrows
2) Make shallow furrows along the prepared field
3) After broadcasting cover the seeds with harrow.

Drilling

1) Drilling seeds may be done using precise machinery like the **Turbo Happy Seeder**.
2) Drill the seed of 80–100 kg per hectare
3) The machine scatters seeds over both dry and wet soil before irrigating them. To make sure that seeds are not sown at depths larger than 10 to 15 mm, a smooth, flat seedbed is required.
4) This method allows for the simultaneous application of seeds and fertilisers.
5) With contrast to broadcasting, manual weeding is also simpler with machine-drilled crops.

Dibbling

Dibbling or hill planting is typically done on mountain slopes or in areas where harrowing and ploughing are challenging. To dig holes, use a long pole made of wood, bamboo, or with a metal scoop fastened to the end. Fill the holes with dirt after placing the seeds there. On mountain slopes or in difficult-to-plough terrain, dibbling or hill planting is frequently done. After planting the seeds there, fill the holes with soil.

How to use herbicides to effectively control weeds

The kind of weeds will determine which herbicide to use. All weeds in the rice crop cannot be controlled by a single herbicide. Apply a pre-emergence herbicide at 1-3 DAS and post-emergence at 15 and 25 DAS for effective weed control..

How to do stale seedbed technique

If the field has a significant weed seed bank, this strategy works well. Due to the two-month fallow time between harvest and sowing, which let weeds to sprout before they are destroyed, they may be controlled either with herbicides or by intercultivation operations. It can significantly reduce the weeds in DSR.

Manual and mechanical weeding

Weeds are practically impossible to control by **manual weeding by hand**. However, one or two hand weeding can be done to remove weeds that escape herbicide application, prevent weed seed production and the accumulation of weed seeds in the soil. Motorised cono weeders and other hand weeders can be used for mechanical weeding.

Current constraints

- Higher seed rates
- Seeds exposed to birds and pests
- Weed management
- Higher risk of lodging
- Risk of poor or non-uniform crop establishment

Conclusion

On the face of global water scarcity and escalating labour rates, when the future of rice production is under threat, DSR offers an attractive alternative. A successful transition of rice cultivation from transplanting system TPR to DSR culture demands breeding of special rice varieties and developing appropriate management strategies. If the extent and nature of weeds properly managed, comparable yield may be obtained from DSR compared with TPR. Another concern is the need for precision in seed placement. Unlike transplanting, where seedlings are carefully placed in fields, direct seeding requires accurate equipment to ensure optimal plant density and uniform growth. Technological advancements, such as laser-assisted land leveling and drill seeders, are paving the way for overcoming these challenges, making DSR an increasingly feasible option for farmers.

Because of the water, labor, and energy intensive nature of this system, and rising interest in conservation agriculture, dry-seeded rice (Dry-DSR) with zero tillage (ZT) or reduced tillage (RT) has emerged as a viable recent development in DSR. Projections and trends seem to suggest that Dry-DSR will likely be a major rice culture in many countries in the future.

Reference

D. Sravanthi, A.V. Ramanjaneyulu, P. Raghu Rami Reddy and P. Jagan Mohan Rao. 2022. Mechanized transplanting and harvesting in rice: An on-farm study. The Pharma Innovations Journal. 11(12): 3815-3820.

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DEVELOPMENT OF MAPPING POPULATIONS FOR MOLECULAR BREEDING

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Introduction

In the realm of genetics and plant breeding, the development of mapping populations plays a crucial role in understanding the inheritance of traits and identifying molecular markers associated with specific genes of interest. This article delves into the various types of mapping populations and their significance in genetic research. Mapping populations are central to genetic studies, tracing their roots back to the pioneering work of Gregor Mendel, who laid the foundation for modern genetics. Mendel's experiments with pea plants revealed that the development of phenotypic characteristics is governed by factors known as genes, and these genes segregate independently in offspring. In 1902, Sutton and Boveri proposed the chromosomal theory of inheritance, suggesting that genes are located on chromosomes. This theory laid the groundwork for understanding the physical location of genes within an organism's genome.

Significance of Mapping Populations

Mapping populations are developed from highly homozygous parents, making them ideal for genetic studies. They offer several key advantages:

- **Mapping of Monogenic and Polygenic Traits**: Mapping populations allow researchers to study both monogenic (controlled by a single gene) and polygenic (controlled by multiple genes) traits. This versatility is invaluable in genetic research.

- **Identification of Molecular Markers**: Mapping populations are instrumental in identifying molecular markers linked to genes of interest. These markers serve as signposts for locating specific genes within an organism's genome.
- **Basic Tools for Genomic Analysis**: Mapping populations serve as fundamental tools for identifying genomic regions associated with traits, a critical step in understanding an organism's genetic makeup.

Historical Milestones in developing mapping populations

One of the key milestones in the field of gene mapping was Thomas Hunt Morgan's genetic linkage map of Drosophila melanogaster, published in 1913. This pioneering work provided crucial evidence for the chromosomal theory of inheritance.

Morphological markers were the initial tools used to construct linkage maps in many species. These markers represented the first molecular variations employed in gene mapping. One such marker, RFLP (Restriction Fragment Length Polymorphism), was widely used in linkage mapping.

The use of DNA markers revolutionized gene mapping, enabling the construction of linkage maps for various plants and the mapping of qualitative traits at specific loci. Constructing a linkage map requires a suitable marker system, appropriate mapping populations, and specialized software for data analysis.

Mapping and Mapping Populations

Mapping is the process of determining the relative location of markers, DNA sequences, and genes of interest within a chromosome or a genome. Mapping populations are essential for this process, and they are typically obtained through controlled crosses.

The selection of parents is the critical first step in developing a mapping population. These parents should exhibit sufficient genetic variation for the traits of interest at both the DNA sequence and phenotypic levels. Genetic variation at the DNA sequence level is essential for tracing recombination events accurately.

Mapping Population Size

The size of a mapping population depends on various factors, including the type of mapping population, the genetic nature of the target traits, the objectives of the experiment, and the available resources. Generally, for most quantitative traits, a mapping population size of 500 or more is recommended. A population of at least 200 individuals is suitable for mapping QTLs (Quantitative Trait Loci). However, when the goal is positional cloning of genes, a population of several thousand plants may be necessary (Singh *et al.*, 2015).

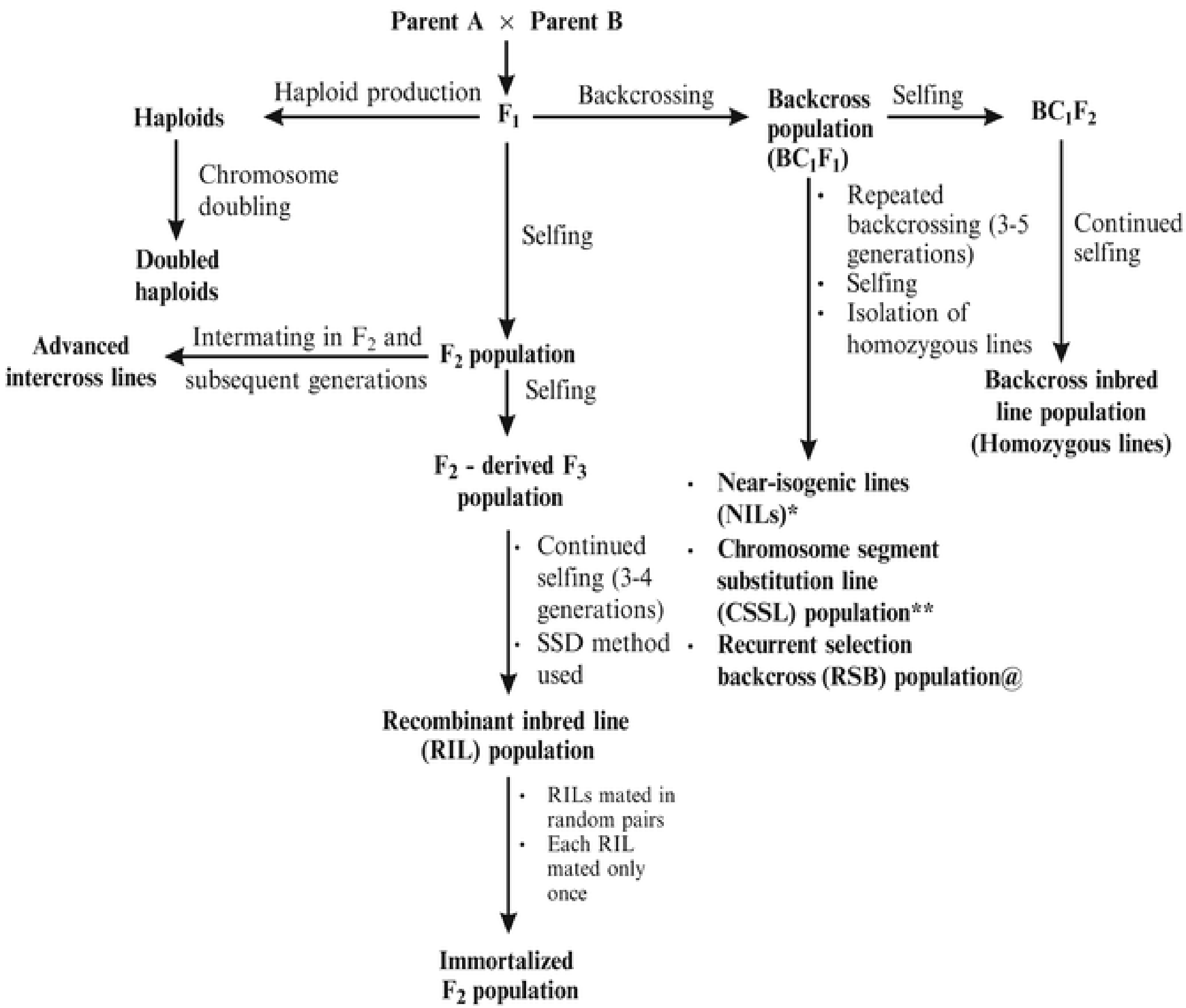

Fig.1. Different types of mapping populations that are created by crossing two parents and manipulating their offspring.

Types of Mapping Populations

Mapping populations can be broadly categorized into two types: primary mapping populations and secondary mapping populations.

1. F_2 Population: The F_2 population is a fundamental and rapid method in genetic mapping. Typically, it involves the selection of two pure lines as parents. The F_2 population is generated by selfing or sibling mating of the F_1 individuals resulting from a cross between the selected parents. The F_2 generation represents the outcome of a single meiotic cycle in F_1 plants. In the F_2 population, the expected segregation ratio for dominant and co-dominant markers is 3:1 and 1:2:1, respectively. This population is particularly useful for the preliminary mapping of markers and oligogenic traits. It's advantageous because it requires only two generations to develop, making it the minimum for biparental population development. Moreover, F_2 populations provide estimates of additive, dominant, and epistatic components of genetic variance. However, F_2 populations have limitations. They are not ideal for fine mapping and mapping of Quantitative Trait Loci (QTLs). Additionally, preserving F2 populations can be challenging because F_2 plants are often immortal.

2. F_2-derived F_3 Population: The F_2-derived F_3 or $F_{2:3}$ population is obtained by selfing the F_2 individuals for a single generation. Seeds are harvested from each F_2 plant separately, with each F_2 plant representing an individual plant progeny. This population is suitable for mapping oligogenic traits controlled by recessive genes and QTLs since data can be recorded on multiple plants in each $F_{2:3}$ family. While $F_{2:3}$ populations offer advantages in reconstructing the genotype of respective F_2 plants, they require an extra season for construction. Many F_3 families are heterogeneous due to the segregation of one or more genes. Moreover, it's not possible to use multiple genotypically identical plants from an $F_{2:3}$ family as replicates, and the data may underestimate certain gene actions due to increased inbreeding.

3. Backcross Population: Backcross populations are generated by crossing F_1 plants with either of the two parents of the F_1 hybrid. Genetic analysis is typically limited to phenotypic segregation for the target trait in the backcross generation. Backcrossing to the recessive parent, known as a testcross, is common. While backcross populations can preserve elite combinations and require less time for development, they are primarily used for qualitative traits. Developing a new cultivar through this method can take several seasons.

4. Doubled Haploids (DH): Doubled Haploid plants are obtained by doubling the chromosome number of haploid plants usually derived through anther or pollen culture from F_1 plants. DH populations can be evaluated in replicated trials and are suitable for mapping both qualitative and quantitative traits. However, they are limited in estimating certain genetic variances due to the homozygous nature of DH plants.

5. Recombinant Inbred Lines (RILs): RILs are sets of homozygous lines produced by continuous inbreeding/selfing of individual F_2 plants. They are used for developing molecular marker linkage maps and identifying markers associated with QTLs. While they offer advantages in QTL mapping and represent an immortal population, developing RILs can be time-consuming.

6. Near-isogenic Lines (NILs): NILs are pairs of homozygous lines differing in genotype at a single gene/locus. They are produced by backcrossing a donor parent with a recurrent parent. NILs are used for fine mapping, map-based cloning of QTLs, and functional genomics work. However, they may suffer from linkage drag and involve increased costs (Arrones *et al.*, 2020).

7. Interconnected Mapping Population: Interconnected populations are generated by crossing a set of homozygous parental lines, with some parents being common between different crosses. These populations are useful for specific genetic studies but can be complex to manage.

8. Backcross Inbred Lines (BILs): BILs are developed through backcrossing F1 hybrids to one of the parents and selfing to obtain homozygous lines. They can have an increased frequency of alleles contributed by the parent used for backcrossing. BILs are used for genetic analysis but are not suitable for QTL mapping.

9. MAGIC Populations: MAGIC populations involve RILs produced from a complex cross of several parental lines. They are used for high-density maps, modelling cytoplasmic effects, and genomic selection. However, they require extensive resources and time (Huynh *et al.*, 2018).

10. Nested Association Mapping Population: Nested association mapping combines the advantages of linkage and association mapping strategies by crossing diverse founders to common parents and generating RILs. It enables efficient genetic dissection of complex traits (Scott *et al.*, 2020).

11. Advanced Inter-cross Lines: Advanced inter-cross lines are developed by intermating F_2 and subsequent generations from a suitable cross. They maintain heterozygosity and allow for precise QTL location.

Choice of Mapping Populations

The choice of mapping populations depends on the specific research goals. Short-term populations like F_2, backcross, and conceptual NILs are suitable for initial mapping. Long-term populations like RILs, NILs, and DHs are preferred for more extensive studies. The combination of markers and populations is essential, as the genetic segregation ratio is influenced by marker nature and mapping population type.

Characterization of Mapping Populations

Characterizing mapping populations involves genotyping and phenotyping individuals or lines. This step is vital for the success of mapping projects. Molecular marker genotypes are independent of the environment, making them reliable for genetic studies. Perpetual mapping populations like RILs, DHs, and BILs are ideal for this purpose.

Challenges in Mapping Studies

Mapping studies encounter challenges related to limited DNA sequence variation detectable as alleles in the elite germplasm of some crops. Additionally, segregation distortion for specific markers can complicate mapping efforts.

Software for Mapping Populations

Several software tools are available for constructing genetic linkage maps and conducting QTL mapping, including MAPMAKER, R package, and R-based GAPIT software packages.

Advantages of Developing Mapping Populations for Molecular Mapping:

1. **Precision**: Molecular mapping offers high precision in pinpointing the location of genes or markers.
2. **Quantitative Trait Locus (QTL) Identification**: It is an effective method for identifying regions that control quantitative traits.
3. **Marker-Assisted Selection**: Molecular mapping expedites breeding efforts by assisting in selecting specific traits.
4. **Efficiency**: Compared to traditional methods, it requires fewer plants and less time.
5. **Population Immortality**: Some mapping populations can be maintained over multiple generations.
6. **Exploring Genetic Diversity**: This approach provides insights into the genetic diversity within a species.

Limitations of Developing Mapping Populations for Molecular Mapping:

1. **Time-Consuming**: The process of creating mapping populations can be time-intensive, often spanning several years.
2. **Labor-Intensive**: Molecular mapping involves substantial labour and can be costly due to the need for specialized laboratory work.
3. **Resource-Intensive**: It demands expensive equipment and reagents, increasing the overall cost.

4. **Segregation Distortion**: Mapping populations may not always follow expected Mendelian ratios, affecting accuracy.
5. **Limited Applicability**: Molecular mapping is most suitable for traits controlled by major genes.
6. **Field Validation Required**: Markers identified in the lab must be validated under real-world field conditions to ensure accuracy.
7. **Genetic Fixation**: The process can inadvertently reduce genetic diversity through inbreeding practices.

Conclusion:

Mapping populations are indispensable tools in genetics and plant breeding research. They enable the identification of genes, QTLs, and molecular markers associated with various traits, paving the way for improved crop breeding and understanding of genetic mechanisms. Researchers should carefully select mapping populations and use appropriate software to achieve their research objectives.

References

Singh, B. D., & Singh, A. K. (2015). Mapping populations. In *Marker-assisted plant breeding: principles and practices* (pp. 125-150). Springer, New Delhi.

Arrones, A., Vilanova, S., Plazas, M., Mangino, G., Pascual, L., Díez, M.J., Prohens, J., & Gramazio, P. (2020). The Dawn of the Age of Multi-Parent MAGIC Populations in Plant Breeding: Novel Powerful Next-Generation Resources for Genetic Analysis and Selection of Recombinant Elite Material. *Biology, 9*.

Huynh, B. L., Ehlers, J. D., Huang, B. E., Muñoz-Amatriaín, M., Lonardi, S., Santos, J. R., ... & Roberts, P. A. (2018). A multi-parent advanced generation inter-cross (MAGIC) population for genetic analysis and improvement of cowpea (Vigna unguiculata L. Walp.). *The Plant Journal*, *93*(6), 1129-1142.

Scott, M. F., Ladejobi, O., Amer, S., Bentley, A. R., Biernaskie, J., Boden, S. A., ... & Mott, R. (2020). Multi-parent populations in crops: a toolbox integrating genomics and genetic mapping with breeding. *Heredity*, *125*(6), 396-416.

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SOIL HEALTH MANAGEMENT IN ORGANIC FARMING

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Introduction

Organic farming is a form of farming that focuses on cultivating the land and growing crops in a way that maintains the life and health of the soil. By eliminating the use of synthetic fertilizers and pesticides, organic farming maintains soil life by reducing chemical soil disturbance. Since the start of the movement, organic farmers have followed the adage "feed the soil and the soil will feed the plant." The foundation of an organic farming system is the management of soil organic matter, which in turn maintains the soil's physicochemical and biological characteristics. In organic farming, soil organic carbon and nitrogen are the main measures of soil health. The United States Department of Agriculture (USDA) defines organic farming as a system that relies as much as possible on crop rotation, crop residues, animal manures, off-farm organic waste, mineral grade rock additives, and biological systems of nutrient mobilization and plant protection while avoiding or largely excluding the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives, etc.).

According to Doran and Zeiss (2000; also known as soil quality), soil health is "the capacity of soil to function within ecosystem boundaries to sustain biological activity, maintain environmental quality, and promote plant and animal health" (Doran and Zeiss). Implementing procedures that either preserve or enhance the soil's physical, chemical, and biological characteristics in order to enhance soil functions is known as soil health management.To provide specialized soil services and to improve ecosystem functions like nutrient availability, erosion prevention, and water infiltration, these qualities work in concert and interact intricately.The main principles of soil health management in organic farming are preserving soil fertility over the long term, promoting soil biological activity, and sustaining levels of organic matter. The foundation of organic farming is the use of soil-building techniques such crop rotation, intercropping, symbiotic relationships, cover crops, organic fertilizers, and minimal tillage. These procedures promote soil formation, soil structure, and the development of more reliable systems.A healthy soil would guarantee high levels of organic matter, appropriate soil tilth and structure, proper water and nutrient retention and release, root growth promotion and support, maintenance of soil biotic habitat, responsiveness to management, and resistance to degradation. Building and enhancing soil health will assure ongoing productivity, increase farmer incomes, and advance food security in organic farming.

Fig 1. Components of soil health management under organic production system

Strategies to Improve Soil Health in Organic Farming

A requirement for improving soil health is raising yields and factor productivity. By enhancing soil structure and biodiversity, conservation measures such as zero tillage, inter- and cover crops, moisture conservation, etc. place a high value on enhancing soil health. With the use of conservation tillage, India's soils with low levels of carbon dioxide have a significant potential for carbon storage. Through conservation methods such as zero tillage, inter- and cover crops, moisture conservation, etc., soil carbon lost during tillage can be accumulated (Conant et al., 2007). The beating heart of the soil is its organic content. This is demonstrated by its impact on the chemical, physical, and general health of the soil. Organic techniques that increase soil organic matter generally also improve soil life. The diversity and activity of soil organisms, nutrient availability, moisture-holding capacity, and soil structure are the fundamental soil qualities that are influenced by organic matter.The main elements of soil health management in organic farming must be organic matter additions as crop residues and/or green manure crops in rotation or as intercrops. Compared to conventional systems, a vegetative cover on the soil's surface increases soil humidity and retains the soil at a significantly lower temperature. This encourages soil organisms to be active. N fixation is encouraged by legume-rich cover crops and crop rotations. The soil system will be able to hold and release nutrients in the most suitable forms that are easily absorbed by the plant roots because to an increased population of beneficial organisms like nutrient mobilizers and PGPRs.

Organic manures

Organic manures are the excellent and balanced source of nutrients as it improves the soil health, quality of produce and safe environment. Organic manures are any material of plant or animal origin that can be added to the soil to improve soil health and stimulate biodiversity. Examples of organic manures includefarmyard manure (FYM), farm compost, night soil, sludge and green manure which are bulky in nature and supply large quantities of organic matter but small quantities of plant nutrients. Presently, FYM is a major source of organic matter and nutrients of conventional and some of the organic farms. Therefore, higher amounts of FYM ranging from 15 to 35 tones ha-1 are usually required to fulfil the nutrient demands of different crops and to maintain soil health.

Enrichment of FYM with Trichoderma and Bio-fertilizers: Well decomposed FYM is thoroughly mixed with *Trichoderma harzianum or T viride* , *Azatobacter* or *Azospirillum* and

Phosphate Solubilizing bacteria (PSB) (all (@ 1 kg/tof FYM), moistened with sprinkling water and covered with wet gunny cloth and kept to incubate for 21 days under partial shade. This enriched FYM should be mixed with remaining FYM before applying to the field. About 35 to 40 tof well decomposed FYM, 1.5 - 2.0 t of vermicompost and 250 kg neem cake having 8 -10 % oil content is found to be good for most of the agricultural crops.

Using composted manure, which may improve soil health overall, organic N, and active and stable soil organic matter more than raw manure.The abundance of carbon in composting material increases the number of heterotrophic bacteria and fungi, as well as the activity of soil enzymes that transform unavailable forms of nutrients into available forms. Vermicompost is organic manure or compost that is made by earthworms, which typically reside in soil, consume organic waste, then expel it after being digested. These are abundant in vitamins, growth hormones, macro- and micronutrients, as well as immobilized microflora that is crucial for plant growth. Compared to bulky organic manures, concentrated manures are those that are organic in nature and include a higher percentage of vital plant nutrients including nitrogen, phosphorus, and potash. The raw materials used to create the concentrated manures are either from plants or animals. Oil cakes, blood meals, fish meals, meat meals, and horn and hoof meals are examples of the concentrated organic manure that is frequently employed. Rock phosphate or bone meal can be utilized as a source of P when combined with Phosphate solubilizing Bacteria. Both have a P2O5 content of 20–22%. Wood ash (2.5 to 3% K2O) and sheep manure (3-4% K2O) can also be used as sources of K.Good quality manure and compost improve the fertility and long-term soil health, according to numerous research. However, depending on soil tests, compost and manure must be used sparingly to prevent nutrient excesses.

Biofertilizers

Biofertilizers contains living microorganism which, when applied to seed, plant surfaces, or soil, it promotes growth by increasing the supply or availability of nutrients. It enhance soil fertility and also crop productivity by fixing atmosphere N, mobilising sparingly soluble P and by facilitating the release of nutrients through decomposition of crop residues. Azotobactor, a free-living heterotrophic N fixing bacteria not only provides N but also produces a variety of growth promoting substances. The ICAR-Indian Institute of Horticultural Research, Bengaluru, has developed the “Arka Microbial Consortium” for sustainable soil health and crop production. It is a combination of N fixing, P and Zn solubilizing and plant growth promoting microbes in single carrier. This technology exploits the synergistic effects of the individual microbial strains and does away with the need for applying individual microbial inoculants.

Green manures

Green manures form an imperative part of soil heath management in organic farming systems. Green manuring is a practice of ploughing or turning undecomposed green plant materials into the soil either *in-situ* or *ex-situ*. The main advantage of green manuring is to add organic matter to the soil which improves the structure of soil and other physical properties, facilitates penetration of rain water, thus decreasing run-off and erosion, hold plant nutrients that would otherwise be lost by leaching, leguminous plants add nitrogen to the soil and increases the availability of certain plant nutrients like phosphorus, calcium, potassium, magnesium and iron etc. Leguminous crops such as *Peuraria javanica, Calopogonium mucunoides, Sesbania, Sunhemp* and *Centrosema pubescens* and *Glyricidia maculata* are common green manuring crops. Research has shown that green manures used regularly in the rotation for short periods of less than six months between cash crops can be as effective at maintaining soil N concentrations and yields.

Green manure crop and it incorporation in soil

Crop rotation

On the same plot of land, crops should be rotated every two years or more to maintain or improve soil fertility and control pests, weeds, and diseases. Consistently growing the same crop in the same soil results in the accumulation of pathogens, which are microorganisms that cause disease. By cultivating a plant from a different family, this can be prevented. The pathogen cycle is disrupted since the new crop from a different family cannot act as a host for the pathogen. Rotational planting of legumes enhances soil fertility.Crop rotation is linked to the promotion of healthy and vibrant soils, which reduces the need for pesticides and herbicides, environmental pollution, and enhances natural biodiversity.

Cover cropping

Growing a cover crop is one way to increase the soil organic matter through the addition of biomass to the soil. A cover crop may be any crop grown within the system to provide soil cover, irrespective of whether it is later incorporated into the soil. Such cover crops may be an 19 Economically important crop like food legumes or *Mucuna* or sweet potato etc., or a green manure crop that produces huge biomass along with nitrogen fixation. These cover crops may be an annual or a biennial or even some perennial herbaceous plants grown in a pure or mixed stand mainly during monsoon period or may be throughout the year. Cover crop biomass must be returned to the soil after the desired growing period for the soil health benefit to be fully realized. However growing legume cover crops is still the best practice for improving organic matter levels and, hence, soil quality.Cover crops improve soil tilth and drainage. Deep-rooted cover crops penetrate subsurface hardpan and thereby, improve soil aeration.Some cover crops deliver other benefits to the soil. For example, legumes have the capacity to fix nitrogen in the soil by associating with a type of bacteria called rhizobium. The mainpurpose of such cover crops is to prevent soil erosion but they also reduce water losses, keepssoil surface cool, stimulate soil life, suppress weeds, promote an increased biodiversity in theorganic farming system and eventually add organic matter to the soil. Farmers can select such cover crops that have market value or as livestock fodder.

Crop residues management

Permanent crop cover with recycling of crop residues is a prerequisite and integral part of conservation agriculture, which is promoted as alternative to the conventional farming system for improving and sustaining soil health in organic farming.Incorporation of crop residues in soil or retention on surface has several positive influences on soil health. Crop residues in turn adds soil organic matter and facilitates availability of nutrients, prevent leaching of nutrients, increase cation exchange capacity, provide congenial environment for biological N fixation, increase microbial biomass and enhance activities of enzymes such as dehydrogenase and alkaline phosphatase. Increased microbial biomass can enhance nutrients availability in soil as well as act as sink and source of plant nutrients. It increases hydraulic conductivity and reduce bulk density of soil by modifying soil structure and aggregate stability. Mulching with plant residues increases the minimum soil temperature in winter and decreases soil temperature during summer due to shading effect. Retention of crop residues on soil surface slows runoff and thereby enhances infiltration. Combined with reduced water evaporation from the top few inches of soil and with improved soil characteristics, higher level of soil moisture can contribute to higher productivity and sustainability.

References

Conant, R.T., Easter, M., Paustian, and Williams, S. (2007). Impacts of periodic tillage on soil C stocks: Asynthesis. *Soil and Tillage Res.*, *95*, 1-10. http://dx.doi.org/10.1016/j.still.2006.12.006

Doran, J.W., and Zeiss, M.R. (2000). Soil Health and Sustainability: Managing the Biotic Component of Soil Quality. *Applied Soil Ecology* 15: 3–11.

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BIOLOGICAL CONTROL OF PLANT DISEASES: AN EVOLUTIONARY AND ECONOMIC CONSIDERATION

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Introduction

Plant diseases caused by infectious pathogens have seriously affected human society and nature through their damages to food production, economic development, ecological resilience, and natural landscapes over human history. Hunger and malnutrition of the Irish famine caused by the potato late blight pathogen *Phytophthora infestans* (Mont.) and the Bengali famine, caused by the rice brown spot pathogen *Bipolaris oryzae* (Breda de Haan) led to millions of deaths and uprooted families and social structures. In addition, many plant pathogens produce mycotoxins that directly or indirectly threaten the health of humans and animals. Plant diseases can occur in the entire crop production chain and remain as one of the greatest threats to the sustainable development of society, resulting in a 13%–22% annual yield loss, or billions of US dollar economic costs in staples of rice, wheat, maize, and potato along with additional costs spent on education and the development of management strategies. These biological and economic losses at least partially account for the recent estimates of ~800 million people in the world experiencing starvation or undernourishment.

Approaches of Plant Disease Control

Plant diseases result from complex interactions among plants, pathogens, and the environment. In the long history of agriculture, humans have developed a variety of approaches to manipulate the interaction to create a system in favor of the growth and development of host plants but suboptimum to the establishment, reproduction, and transmission of pathogens. Depending on circumstances of crop, pathogen, geographic location, technology availability, regulation policy, and other factors, these control approaches can be agronomic (e.g., crop diversification and field hygiene), regulative (e.g., quarantine and eradication), genetic (e.g., disease resistance and tolerance), physical (e.g., soil solarization and flooding), and chemical (e.g., pesticides and host-immunity inducer) and can be used individually or in combination (integrated disease management, IDM) to suppress causal pathogen, promote host immunity, or change the biotic and abiotic environment where host–pathogen interaction occurs.

Biological control is a method of plant disease management by inhibiting plant pathogens, improving plant immunity, and/or modifying the environment through the effects of beneficial microorganisms, compounds, or healthy cropping systems. Biological control offers several advantages over other approaches of plant disease management by taking into consideration the following: (1) biological control agents (BCAs) usually target a specific group of pathogens and therefore have fewer negative impacts on the ecosystem as opposed to fungicides, even though some risks of ecological issues should be considered, particularly with the introduction of non-native species; (2) many BCAs can sustain themselves and keep in place for a longer time without additional efforts to keep the system running. For example, long-term effects of BCAs *Trichoderma harzianum* Rifai, *Pochonia chlamydosporia* Zare and Gams, and *Paecilomyces lilacinus* (Thom) Samson to suppress soybean root diseases have been reported in Northeast China]; and (3) a documented tradeoff exists between host resistance and agronomic traits. BCAs prevent the consistent expression of the host immune system, allowing plants to allocate more energy and resource for agronomic traits important to farmers. To date, despite the well-known documentation of biological control as an important component of IDM, its commercial value is less than 5% of the total crop protection market. The low commercial contribution is highly associated with low technology transfer such that its economic value is not yet realized by the agricultural community, particularly in developing countries. The efficacy of many BCAs is usually strongly affected by biotic and abiotic factors, and its durability under continuous pathogen evolution is concerned, further constraining the application of the approach. Addressing this dilemma requires a better understanding of the interaction of BCAs with plants, pathogens, and the environment in the context of economics, ecology, and evolution.

Types and Mechanisms of Biological Control

As a promising approach to plant disease management, the concept of biological control is dated to 4000 years ago in Egypt. However, the advanced study of biological control did not start until the nineteenth century. The discovery that the severity of some soil-borne diseases was mitigated by *Bacillus subtilis* (Ehrenberg) Cohn, *Ampelomyces quisqualis* Ces, and other antagonistic microorganisms stimulated the exploration of using BCAs to manage plant diseases. Since then, research in biological control has been revolutionized. A great number of BCAs have been developed, including the utilization of beneficial microorganisms, plant inducers, microbial metabolites, and plant extracts in-crop diversification. According to their modes of action, these BCAs can be divided into three categories, as discussed below.

1. Suppressing Pathogens

Some microbes are hyperparasites that produce antibiosis to directly kill pathogens or rely on pathogens for energy supply or living environments, while others may serve as competitors for niche and nutrients by releasing compounds or antimicrobials. Some fungi, mycoviruses, and bacteriophages have these properties. They can potentially be BCAs augmented against plant pathogens and applied in fields once or several times depending on their biological features and environments. The secondary metabolites and compounds released by microbial or non-microbial species can also be used as pathogen inhibitors to control plant diseases. Plants can defend themselves by producing compounds to kill pathogens or promote the growth of beneficial microbes. These compounds can be extracted from plants and used in combination with antimicrobials or metabolism produced by beneficial microbes such as BCAs. For example, many bacterial and fungal endophytes produce myriad secondary metabolites that have antagonistic, inhibitory, and deterrent properties that defer plant pathogens. The antibiosis of endophytic BCAs is triggered by different types of secondary metabolites they produce. *Pseudozyma flocculosa* produces a compound that induces a rapid formation of cell collapse in the pathogen and is an effective BCA to control powdery mildew. *Pseudomonas chlororaphis* (Guignard and Sauvageau) Bergey produces phenazines, pyrrolnitrine, 2-hexyl, 5-propyl resorcinol and hydrogen cyanide, siderophores, and a complex blend of volatile organic compounds that effectively contribute to the control of several plant pathogens and nematodes. *Fluorescent pseudomonads* has been used to compete with several pathogenic fungi and bacteria. Some strains of *Bacillus* sp. deliver antagonizing metabolites into the root system, where they directly suppress the growth of pathogenic bacteria.

2. Compounds Priming, Inducing, or Strengthening Plant Defense Responses

Some beneficial microbes interact with plants to induce host resistance or prime host immunity responses without direct contact with pathogens. These agents include the natural products and chemical compounds produced by different sources, such as plant extracts, microbial metabolites, synthetic chemicals, and gene product. Many secondary metabolites involved in signal transduction, catalytic activities, and compounds such as salicylic acid, acetylsalicylic acid, and nitric oxide have properties that induce host plant immunity and enhance host resistance. These compounds are responsible for the observed systemic acquired resistance after host plants are infected by pathogens and can be produced by many other non-pathogenic microbes, such as rhizobacteria. They are also commonly found in plant tissues but vary widely in extent among species, even genotypes within the same species. It is evident that some of these inducer compounds not only suppress plant diseases but also improve plant vigor, possibly due to the enhanced production of hormones. For example, *T. harzianum* produces a butenolide metabolite called harzianolide that stimulates growth and defense mechanisms of tomato plants, resulting in a 16–30% reduction of disease caused by *S. sclerotiorum* . Attempts to induce an immune response against *P. infestans* by treating potatoes with various fatty acids have achieved 39–82% protection. Similarly, root rot diseases of green beans caused by *Fusarium solani* Marti and *Rhizoctonia solani* Kühn were substantially suppressed (60–80%) after field treatments of chitosan salicylic acid and humic acid. However, the exploitation and utilization of the active substances for BCAs for commercial use is usually costly and low efficient partially due to the time lag of inducing plant resistance.

3. Regulating the Ecosystem to Protect and Promote Natural Enemies or Competitors of Pathogens

Plant disease often results from a disordered ecosystem. The success of biological control relies on a healthy ecosystem provided by predators, competitors, promoters, and other species. These beneficial organisms have spatiotemporal dynamics in crop fields as the function of genetics, composition, and structure of local plant and microbial communities. The beneficial interplay of the microbiome with other organisms in soil communities is particularly important in maintaining a functional ecosystem for the growth and immunity development of plants. Methanol can suppress the growth of methanotrophs that can survive by coexisting with *Hyphomicrobium* spp. to build a rhizospheric microbial association, in which *H.* spp. is capable of improving effective nutrient utilization and removing harmful methanol in the rhizosphere. One attempt in biological control is to improve environmental quality by increasing the amount and diversity of beneficial microorganisms in farmlands to suppress the occurrence and development of pathogens, which can be achieved through crop diversification such as crop rotation, intercropping, and cultivar mixture. There is increasing evidence showing that crop diversification can suppress plant diseases. Disease suppression by crop diversification involves multiple mechanisms, including inoculum dilution, the creation of physical barriers constraining pathogen transmission, and amelioration of pathogen pathogenicity, fungicide resistance, and evolution. Crop diversification also improves soil fertility and microbial diversity, which in turn enhances nutrient availability for rigorous crop growth and microbial complexity to compete with pathogens. In wheat, the take-all disease caused by *Gaeumannomyces graminis* (Sacc) Arx and Olivier var. *tritici* is observed to be more severe in monoculture than in fields with diversified crops. Similar patterns were found in Huanglongbing caused by *Candidatus* Liberibacter asiaticus and brown patch caused by *R. solani* in citrus and turfgrass.

4. The Natural and Economic Considerations of Plant Disease Management with Biological Control Agents

Biological control can generate multiple effects in food production, nutrient supply, and environmental health, thereby affecting economic development and ecological sustainability (Figure 1). The BCAs must be effective to give high crop yields and good crop quality and provide an economic incentive to the end-users compared to other disease management approaches. Ideally, BCAs should positively contribute to ecosystem services, such as improving soil fertility and biodiversity for succeeding agricultural production.

1. Effectiveness

Effectiveness is the primary consideration of biological control. BCAs must have a visual impact on disease epidemics either by suppressing pathogen growth or promoting host immunity to ensure crop yield and quality with a good economic return. The commercial BCAs of *Fusarium* wilt in lentils reduced disease incidence up to 50.0% and increased yield up to 58.7%. *B. myloliquefaciens* significantly suppressed *Fusarium equiseti* (Corda) Sacc. disease in *Vicia faba* plants, reducing disease up to 100% and increasing plant growth up to 82%. The effectiveness of BCAs is highly associated with their modes of action and often has tradeoffs with other natural properties of the agents, such as their specificity as well as persistence in environments [43,95]. For BCA *Candida oleophila* Montrocher strains against *Penicillium expansum* Link of apple disease, a significant difference in enzymatic activity existed between in vivo and in vitro application. Therefore, it is important to select the agents that have stable effectiveness under various environmental conditions, such as soil texture, moisture, temperature extremes, or competition.

2. Durability

Pathogens empower the ability to evolve in response to environmental changes. Continual applications of the same BCAs on a commercial scale could pose a strong selection of pathogens, which may eventually lead to the emergence of new pathogen populations able to escape or mitigate the adverse effects of the BCAs. This adaptability of pathogens is developed in an eco-evolutionary process involving many biotic and abiotic factors in the ecosystems, including the genetics and the biology of target pathogens, and BCAs, as well as community structure and ongoing climate changes, may complicate the interaction further, which is favorable to the evolution of pathogens to evade the BCAs currently used. Although rarely reported in practice, erosion of BCAs against plant pathogens has been documented in laboratory and greenhouse conditions. The BCA effects against *B. cinerea* disease of *Astilbe hybrida* significantly reduced after eight successive treatments and were totally lost after ten treatments. The sensitivity of *B. cinerea* to pyrrolnitrin, an antibiotic derived from many BCAs, was rapidly reduced after 10 generations of passage.

The durability of BCAs is negatively associated with the evolvability of target pathogens. Shorter durability is expected in the BCAs targeting pathogens with higher genetic variation from sexual reproduction, large effective population size, and long dispersal ability compared to those with lower genetic variation, clonal reproduction, small effective population size, and limited dispersal ability. The durability of BCAs also depends on their modes of action and how they are applied in agriculture.

3. Ecological Sustainability

An ecosystem is linked by the interaction of species with their physical environment through nutrient cycles and energy flows. It undergoes consistent dynamics spatially and temporally in response to the change of any individual biotic and abiotic components. An introduction of BCAs to the interactions either through the applications of living organisms or compounds to farmlands inevitably modify the compositions and functions of the entire ecosystem temporarily or permanently. Good BCAs should not only be effective to suppress disease epidemics for high crop yield and quality in the current production but also do not have deleterious impacts on ecosystems supporting future agriculture and socioeconomics. This could be achieved by enhancing natural enemy/competitors, beneficial species, and ecological efficiency by nurturing functional biota This concern of ecological safety has led to a heated debate between conservationists and practitioners, particularly in western countries, and a clouded approach to control plant diseases. Ecological philosophers argue that biological control may lead to species extinction in extreme cases, threatening ecological function and resilience, but agricultural pragmatists claim there is no evidence of such impacts.

4. Economic and Practical Incentives

Farmers decide what technologies they use to control plant diseases, and their attitude to biological control is powered by economic, technological, and practical factors such as effectiveness, profit, availability, and convenience. To attract farmers' adaptation of biological control, technology should be easy to assess, ready to use, and lead to economic advantages relative to others in terms of the supply and demand relationship and cost efficiency. For example, formulations in granules that can be stored at room temperatures and applied by simple machines are generally favored by farmers in developing countries as opposed to those requiring more expensive equipment or refrigerator storage. The lack of understanding of the technology features and fewer choices of successful technologies discourage farmers from adopting the biological control approach. In this case, information exchange between technology developers and end-users through training and field demonstration is important. Farmers' attitudes to biological control can be promoted by the internalization of positive externalities through governmental and public incentives of financial supports.

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SYNGAS FOR SUSTAINABLE PRODUCTION OF FUELS AND CHEMICALS

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Introduction

Currently, petroleum-based fossil fuels are the most critical energy sources, contributing significant share utilized for vehicle fuels. The global liquid fuel consumption is predicted as 102.33 million barrels per day for the year 2024 (EIA, 2023). Even though, these fuels are known as polluting substances that create various environmental problems/issues. Hence, significant efforts have been made to find alternate fuels *via* a cleaner and sustainable process. Moreover, synthesis of fuels and chemicals from lignocellulosic biomass feedstocks has been investigated widely to facilitate a sustainable way to produce cleaner fuels that can substitute fossil derivatives. Among the biofuels, the syngas derived from biomass has more potential to produce various liquid biofuels and platform chemicals. The composition of syngas is primarily hydrogen and carbon monoxide, which is produced by gasification using different biomass.

Syngas production through biomass gasification

Biomass gasification is an eco-friendly method employed for converting the dried biomass feedstocks (mostly lignocellulosic biomass) into energy in the form of gaseous fuel (*ie.*, syngas or producer gas). Gasification is uses heat energy with limited air supply that alters the biomass chemical structure at the temperature range of 500-900°C using a gasifying agent. Generally, various gasifying agents such as instance air, steam, oxygen, carbon dioxide (CO_2), and a combination of these compounds have been utilized in syngas generation. The gasification process mainly depends on the reaction temperature, gasifying agent, pressure, heat supply, and gas composition. The gasification technique involves drying, pyrolysis, oxidation, and reduction. It is a complex method that involves a sequence of simultaneous parallel thermochemical reactions that result from chemical breaking in biomass molecules. A series of endothermal and exothermal reactions (oxidation, boudouard, water gas, and water shift reactions) occurred during the gasification.

Gasifiers are used for the gasification process, which is categorized by factors such as gasification blow, gasifier temperature, and pressure. Also, gasifiers can be classified based on the reactor configurations, fluid dynamics, and solid and gas contacting named as fixed bed (updraft, downdraft, and crossdraft), fluidized bed, and entrained bed. The downdraft and fluidized bed gasifiers have been preferred for power generation, whereas updraft gasifiers are used for heat production.

The syngas derived from biomass gasification consist of carbon monoxide, hydrogen, carbon dioxide, methane, and trace amounts of sulfur dioxides. Like coal syngas, biosyngas generally have measurable quantities of hydrocarbons, sulfur oxides, and nitrogen oxides. Then, a cleaning system must be equipped with a gasifier to remove the impurities in syngas. The impurities include tar, particulates, ammonia, hydrogen sulfide, hydrogen chloride, hydrogen cyanide, and trace metals. Alkali metals are responsible for the corrosion and bed defluidization. Sulfur, nitrogen, and chloride contaminants can create potential hazardous pollutants. The particulates are inorganic materials, including alkaline metals, carbonaceous materials, and iron. Tar is the fraction of an aromatic hydrocarbon consisting of condensable organic compounds. Hydrogen sulfide in the syngas generates sulfur dioxide during the combustion of syngas, making carrion and acid rain. Nitrogen contaminants like ammonia and volatile amides are generated through pyrolysis in biomass gasification. Also, nitrogen gas is produced from a significant quantity of ammonia due to the gasification temperature elevation.

Since, it is chemically analog, the syngas derived from biomass could replace fossil fuel based syngas, making it feasible to utilize in similar applications. Furthermore, it has a positive impact on carbon footprint and reduces the emissions of greenhouse gases (Boerrigter and Rauch, 2005). Emissions include methane, carbon dioxide, nitrous oxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride, which are principally associated with climate change.

Fuels and chemicals synthesis from syngas

Syngas is a combustible gas that can be used in turbines and fuel cells to generate electrical energy. However, the current fuel demand needs to cover the syngas potential like conventional fossil fuels. Various chemicals such as ammonia, alcohol, natural gas, olefins, and several other aromatic compounds (Molino *et al*., 2016) have been produced from syngas. The Fischer-Tropsch (FT) synthesis process is a primary method to produce hydrocarbons from syngas. Another option, the diesel synthesis from the FT process can include high quality, better octane number, shallow sulfur content, nitrogen compounds, and aromaticity. This process also produces fewer emissions than conventional diesel fuels. Ammonia synthesis and methanol production are two other significant routes to convert syngas into fuels. Generally, ammonia can be synthesized by shift reactions. Whereas, methanol is produced through an exothermic hydrogenation process, in which carbon monoxide and carbon dioxide can hydrogenated using a cu-based catalyst. There is a wide possibility to produce many useful products from methanol for various industrial applications (Brachi *et. al*., 2014). Besides, biomethane can be synthesized from syngas by combining the thermochemical and biochemical routes (Chandel *et al*., 2018). In addition, bioethanol can be produced from syngas using syngas fermentation technology at a meager cost compared to ethanol derived by hydrolysis (Neubauer, 2011). Biohydrogen from biomass is also possible by separating hydrogen from syngas. Apart from this, the syngas can be converted into chemicals such as light olefins, C_{2+} oxygenates and aromatics. Most of them are used as feedstocks in the chemical industry to produce a variety of fine chemicals.

References

Boerrigter, H. and Rauch, R., 2005. Syngas production and utilisation. In *Handbook biomass gasification*. BTG.

Brachi, P., Chirone, R., Miccio, F., Miccio, M., Picarelli, A. and Ruoppolo, G., 2014. Fluidized bed co-gasification of biomass and polymeric wastes for a flexible end-use of the syngas: focus on bio-methanol. *Fuel*, *128*, pp.88-98.

Chandel, A.K., Garlapati, V.K., Singh, A.K., Antunes, F.A.F. and da Silva, S.S., 2018. The path forward for lignocellulose biorefineries: bottlenecks, solutions, and perspective on commercialization. *Bioresource technology*, *264*, pp.370-381.

https://www.eia.gov/outlooks/steo/report/global_oil.php (accessed on 25.09.2023)

Molino, A., Chianese, S. and Musmarra, D., 2016. Biomass gasification technology: The state of the art overview. *Journal of Energy Chemistry*, *25*(1), pp.10-25.

Neubauer, Y., 2011. Strategies for tar reduction in fuel-gases and synthesis-gases from biomass gasification. *Journal of Sustainable Energy & Environment Special Issue*, *67*, p.71.

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AGARWOOD: CULTIVATION PRACTICES, ARTIFICIAL INDUCTION METHODS AND SUITABILITY IN INTERCROPPING

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Introduction

Agar trees are members of the Thymelaeaceae family's Aquilaria genus. A total of 21 plants from the genus Aquilaria have been identified, with 13 of them found to agar so far (Lee and Mohamed, 2016). The species *A. malaccensis* is native to Assam, Manipur, Meghalaya, Arunachal Pradesh, Sikkim, Mizoram, Tripura and Nagaland, as well as West Bengal. The evergreen rain forest of India's north eastern states is dominated by *A. malaccensis* Lam. and *A. khasiana* Hall. and *A. macrophylla* Miq. is found in the Nicobar Islands.

Aquilaria is a medium-sized, fast-growing evergreen tree with an average diameter of 40 cm that is extensively distributed in the Indo-Malaysia region. Agar trees (Aquilaria spp.) thrive well in acidic, aerated soil with a light to medium texture with a mean annual temperature of 22–28°C and 1500–6500 mm of rainfall. Even sloppy and forests lands are congenial for its growth. Agarwood, a resinous and fragrant heartwood produced by agar trees, is extremely valued. Agarwood is unique in that it is only formed in ill or wounded trees, rather than healthy and lush ones. Agarwood is created as a result of the plant's defence mechanisms against injury (natural or artificial), fungal infection, insect attack, and animal grazing. Agarwood is a popular aromatic product all over the world today and depending upon the quality agarwood prices globally might range from US$ 20-6000 per kg (Akter *et al*., 2013). Natural agar resources are fast depleting due to high market prices and demand. As a result of the rapid decline of the species in the wild, the genus is now recognised as an endangered species and protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) legislation (Lee and Mohamed, 2016).

Agarwood is the most revered perfumery and aroma raw material, obtained from the afflicted wood of an agarwood tree due to the infection of a borer insect (such as *Zeuzera conferta* Walker) on agarwood development (Kalita *et al*., 2015). In addition to their perfumery and aroma value, agar and agar oil are frequently employed in the creation of numerous cosmetic items and in Ayurvedic treatments. Northeast India is particularly rich in this valuable resource, known locally as "agar" or "xasi" (and 'aguru' in Sanskrit), and is regarded as the cradle of agarwood aromatics, with strong and developing agarwood production traditions. It has been utilised for medical, aromatic, and religious purposes for over 2000 years. In the Middle East and India, Aquilaria malaccensis is the principal source of agarwood for fragrance and religious traditions. Agar is primarily found in Assam and Tripura in Northeast India. Agartala, Tripura's state capital, is thought to have gotten its name from agarwood. This severely endangered tree is very adapted to the environment in Tripura.

Climatic requirement of Agar:

Aquilaria species grows naturally in almost all ecological zones and on a variety of soils in a wide range of weather conditions, making it ideal for evergreen forests in North-East India (Table 1). Agarwood trees are predominantly found in the North Tripura district's Kadamtala block, the Khowai subdivision of the Khowai district, and a few pockets in the South Tripura and Gomati districts. It can, however, thrive in any section of Tripura, as the edaphic elements necessary for tree growth can be found throughout the state.

Table 1: Climatic variables and soil factors range for agar cultivation.

Climatic variables and soil factors	**Range of values suitable for Agar tree**	**Range of values in Tripura**
Altitude range	29-1000 m	15-750 m
Mean annual rainfall	1500-6500 mm	2100 mm
Mean annual temperature	22-28°C	10-33°C
Mean maximum temperature of hottest month	22-40°C	32-33°C

Mean minimum temperature of coldest	14-22°C	10°C
Absolute minimum temperature	5°C	-
Soil texture	Light, medium	Mostly red loam and sandy loam
Soil drainage	Free	-
Soil reaction	acid; neutral	Acidic

Source: Adopted from Talucder *et al.,* 2016 and IMD Agartala (https://agartala.imd.gov.in/Tripura-Climatology/)

Propagation:

Agar is propagated using seeds, which are available in June and July. The rainy season is the best time for sowing. As the seed germination is epigeal, additional care is essential during nursery management. They are germinated in sand beds before being moved to poly bags. Because seeds have a short viability span (7-10 days), storage is challenging because viability is lost fast once they are exposed to the environment. Seeds that are germinated on time have a high rate of germination, up to 90%, and take 16-63 days to germinate (Ali and Kashem, 2019).

The seedlings are carefully transplanted to poly bags set under temporary shade after 25 days, when the cotyledons have just dropped down. Young seedlings are planted in poly bags and then put in a bed supported by bamboo poles all around. Shifting of bags should be done at least once a month to prevent roots from penetrating the soil. To avoid wilting due to root system disruptions, seedling shifting should be followed by light watering. Root trainer is a tool that can be utilised effectively (Anonymous, 2004). Agar trees can also be propagated using tissue culture techniques.

Plantation:

Agar is a plantation crop that takes a long time to grow. A productive plantation might have a cycle of 15 years or more. The shorter plantation cycles yield only low-quality essential oil, or 'agar attar' (Boyaoil). In a commercial plantation, agar plants should be spaced at 2.75 m x 2.75 m, however in home gardens, spacing can range from 1 m x 1 m to 1.5 m x 1.5 m. There are two strategies for plantation: (a)Planting at wider spacing with some acceptable intercrops and harvesting at the end of the crop cycle and (b) Planting at a close spacing and harvesting in two or three phases. In the second strategy, after about 8-10 years of planting, roughly 40% of selected trees may be harvested in order to thin out the plantation for better growth and development of the remaining trees, as well as to generate a significant profit (Anonymous, 2004).

Manuring and fertilizer application:

Prior to planting, well-decomposed cowdung/FYM @ 10-15 kg/pit of size 50 cm^3 can be applied in the pit and thoroughly mixed with the soil. Inorganic fertilisers are not required at the time of planting. However, from the second year onwards, nitrogen (N), phosphorus (P2O5), and potassium (K2O) in a 10:10:4 ratio may be applied in two splits, afterwards 200 g/tree in the second year, 300 g/tree in the third year, and 500 g/tree in the fourth year onwards, along with decomposed cow dung/compost @10-15 kg/tree. Nitrogenous fertiliser @ 400-500 g/tree per year may be administered in two splits during the pre- and post-monsoon period after 6-7 years of growth. This may aid to maintain tree wood flexible by allowing easy insect boring followed by fungal infection and dissemination of infected region over a wider wood volume, resulting in a higher rate of bioconversion (Ali and Kashem, 2019).

Cultural Operation:

Once every 3-4 months, a 50-cm radius of soil around the tree should be worked. From the second year onwards, fertiliser application should be followed by these activities, preferably twice a year, before and after monsoon. Goats or cattle feed upon agar seedlings, hence fencing is required to preserve the plantation. During the first 4-5 years, farm animals should be kept at bay. Trenching surrounding the plantation has also yielded positive results. All casualty replacements should be completed during the same planting season, and if necessary, a second replacement can be completed the following year using large seedlings (Anonymous, 2004).

Agarwood Induction:

Thunderstorms, animal grazing, insect and disease infestations are all known to cause physical injury or damage to Aquilaria trees, which leads to the creation of agarwood (Wu *et al*., 2017). The insect borer *Zeuzera conferta* Walker infests the agar plant (*Aquilaria malaccensis*) (Kalita *et al*., 2015). Their infestation exposes the inner parts of the trees to pathogenic bacteria, triggering *Aquilaria's* defensive mechanism to begin resin production. The development of various artificial induction methods has been substantially influenced by the natural production process of agarwood. One of the compounds responsible for the scent in Agarwood is agarospirol. In a study, various microbes related to infested agar trees were tested, among them inducing the infection with bacteria *Pantoea dispersa* (3.77 percent) and fungi *Penicillium* *polonicum* (3.33 percent) yielded successful Agarospirol production in healthy trees in Assam within 3 months (Chhipa and Kaushik, 2017). New induction techniques have been created which include injecting signalling molecules directly and specifically into *Aquilaria* trees to activate agarwood resin production pathways, rather than depending on external stimuli to induce plant responses, such as mechanical wounding or biological inoculum (Wu *et al*., 2017). Table 2 lists the many artificial induction methods now in use.

Table 2: Various artificial induction techniques in Agar trees.

Artificial Induction Technique	Name of the Technique	Method
Conventional	Nailing method	Hundreds or even thousands nails are hammered into the trunks of each agarwood tree (Fig 1c).
	Drilling method	Drilling 3 to 5 cm apart on stems, roots, and thick brunches, then rewounded every 2 to 3 months. (Fig 1a)
	Partly-Trunk-Pruning method (PTP)	The tree's main trunk was sawed down on one side with cuts 2-4 cm broad and 3 - 5 cm deep. (Fig 1b)
Non-Convenional	Fungi-Inoculation method (FI)	*Melanotus flavolivens* Sing culture media is inserted into 8cm deep holes, which is subsequently covered with rubberized textiles. *Aspergillus* sp., *Chaetomium* sp., *Fusarium* sp., *Lasiodiplodia* sp., *Penicillium* sp., and Xylaria sp. are among the other fungal strains employed for induction. (Fig 1d)
Modern	Aeration Method	An aeration device (made of plastic, bamboo, wood, or other materials, with a diameter of 2 cm) is put into the wound to prevent the pores from healing and helps establish a long-term infection. (Fig 2)
	Whole-tree agarwood inducing technique	Simple and inexpensive transfusion sets are used to inject agarwood inducers into the xylem section of the tree. Agarwood production is 4-28 times higher and of better quality than prior approaches.

	(Agar-Wit)	
	Cultivated agarwood kits (CA-Kits)	Tubes are inserted into the tree trunk to deliver microbes and stimulate the tree's natural synthesis of defensive chemicals. (Fig 3)

Source: Modified from (Talucder *et al., 2016*)

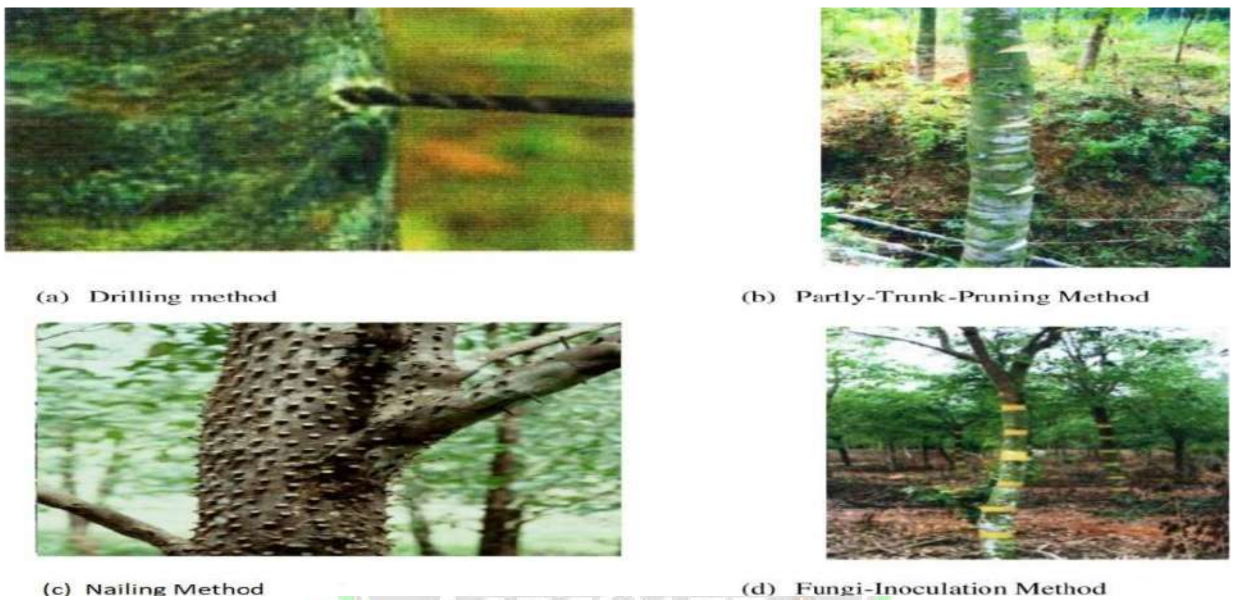

Figure 1 Conventional and non-conventional methods of agarwood induction

Figure 3 Aeration method (Agar-Wit) (Liu *et al*., 2013)

Figure 2 CA- Kit (Blanchette *et al*., 2015)

Natural induction yields the highest-grade agarwood, but the rate of infection is extremely low (only 10-15%), unsustainable, and unpredictable. Farmers prefer conventional techniques because they are cost-effective and simple, but they are time-consuming, illness is localised, and quality is unpredictable. Although introducing microbial cultures into the tree to mimic pathological infection in Aquilaria is a better option (Tan *et al*., 2019), it has several drawbacks, including a long incubation time, intensive labour use, and inconsistency in the availability of quality strains, all of which cumulatively result in inferior quality agarwood. Modern technologies, particularly chemical inducers (Agar-wit, CA-kits, and so forth), are the better solutions till date because they guarantee quick results with consistent high and quality produce. However, their inaccessibility and lack of awareness among farmers produces a gap in induction methods that must be filled through more research and development.

Agar plant in Agroforestry:

Agar has been commonly intercropped with cassava, sweetpotato, and oil palm in Vietnam. Acacia, upland rice, and pineapple can also be intercropped with agar. Saikia and Khan (2012) depicted agar as a favoured cash crop in upper Assam's home gardens due to its cheap input requirements, flexibility in site requirements, and adaptability for intercropping. The agar tree can be grown along the boundaries of a field. Agar trees are also grown on the borders of gardens, school grounds, office grounds, parks, and residential areas.

Agar plant in tea garden:

Due to the rising demand for agarwood, it is being successfully introduced as a shade tree in tea plantations, particularly in Upper Assam, and can be replicated in other north eastern states, especially Tripura.

Conclusion

Agar is a long duration plantation crop and yields benefit after 10-15 years of planting. The plant is hardy and well adapted to various climatic conditions, therefore it is easy to cultivate making it highly remunerative. Farmers income and livelihood security can be boosted adding agar as a component. However, the chance of infection occurring naturally in agar is meagre, and therefore modern methods of induction should be promoted.

References

Akter, S., Islam, M.T., Zulkefeli, M. and Khan, S., (2013). Agarwood production- a multidisciplinary field to be explored in Bangladesh. *Int. J. Pharm. Life Sci.* 2: 22–32.

Ali, S., and Kashem, M. A. (2019). An overview on Growth and Development of Agar Plant (Aquilaria malaccensis Roxb) Through Management Practices in Bangladesh. *International Journal of Research in Agriculture and Forestry*, *6*(7): 6-11.

Anonymous.(2004). Agar Plantation In: M. Ahmed (Editor), Hand Book on Medicinal and Aromatic Plants. North Eastern Development Finance Corporation Limited, Guwahati, Assam. Pp.39-48.

Blanchette, R. A., Jurgens, J. A. and Beek, H. H. V. (2015). Growing Aquilaria and Production of Agarwood in Hill Agroecosystems. In: Integrated Land Use Management in the Eastern Himalayas. Edited by: Eckman K and Ralte L. Akansha Publishing House Delhi. 66-82.

Chhipa, H., and Kaushik, N. (2017). Fungal and Bacterial Diversity Isolated from *Aquilaria malaccensis* Tree and Soil, Induces Agarospirol Formation within 3 Months after Artificial Infection. *Frontiers in microbiology*. *8*: 1286. https://doi.org/10.3389/fmicb.2017.01286.

Kalita, J., Bhattacharyya, P.R., Deka, H.P., Unni, B.G., Lekhak, H. and Nath, S.C. (2015). Association of Zeuzera conferta Walker on agarwood formation in Aquilaria malaccensis Lam.. Asian Journal of Plant Science and Research, 5(1): 4-9.

Lee, S.Y. and Mohamed, R. (2016). The origin and domestication of Aquilaria, an important agarwood-producing genus. In: Mohamed, R. (Ed.), Agarwood Tropical Forestry. Springer, Singapore, pp. 1–20. https://doi.org/10.1007/978-981-10-0833-7_1.

Liu, Y., Chen, H., Yang, Y., Zhang, Z., Wei, J., Meng, H., Chen, W., Feng, J., Gan, B., Chen, X., Gao, Z., Huang, J., Chen, B. and Chen, H. (2013). Whole-tree agarwood-inducing technique: an efficient novel technique for producing highquality agarwood in cultivated Aquilaria sinensis trees. Molecules. 18(3):3086-106.

Saikia, P. and Khan, M. L. (2012). Agar (Aquilaria malaccensis): a promising crop in the homegardens of Upper Assam, northeastern India. J. Trop. Agri. 50(1-2): 8-14.

Talucder, M. S. A., Haque, M. M., and Saha, D. (2016). Development of agar (Aquilaria malaccensis) cultivation, propagation technique and its potentiality as agroforestry component in bangladesh: a review. *A review, Journal of Sylhet Agriculture University*, *3*(2): 149-157.

Tan, C. S., Isa, N. M., Ismail, I., and Zainal, Z. (2019). Agarwood induction: current developments and future perspectives. *Frontiers in plant science*. *10*: 122.

Wu, Z. Q., Liu, S., Li, J. F., Li, M. C., Du, H. F., Qi, L. K., *et al*. (2017). Analysis of gene expression and quality of agarwood using Agar-bit in Aquilaria sinensis. *J. Trop. For. Sci*. 29: 380–388. doi: 10.26525/jtfs2017.29.3.38 0388.

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SANITARY PUMP AND ITS APPLICATION IN DAIRY INDUSTRIES

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Introduction

Pumps convert mechanical energy into hydraulic energy. Pumping is the technique of adding kinetic and potential energy to a powdered solid or fluid in order to move it from one location to another. Fluid flow is influenced by friction, pipe size, liquid viscosity and tiny losses caused by pipe fittings. Pumps are utilized in several industrial applications. There are several types of pumps available. Positive displacement pumps and dynamic pumps, or non-positive displacement pumps, are the two primary groups of pumps. Positive displacement pumps typically generate a modest, steady flow rate at high pressures. The volume of fluid supplied is not affected by the discharge pressure. The volume of fluid supplied is not affected by the discharge pressure. Dynamic pumps often provide high flow rates at low pressures, and the discharge pressure has a direct effect on the amount of supplied fluid.

Full of life and goodness, milk is synonymous with good health and nutrition. Hygienic pump design and gentle handling keep your fresh milk and dairy products just the way you want them. In operations where cleanliness is desirable or enforced, sanitary pumps are used to convey and meter solutions, slurries and colloids of milk and food ingredients. Many food processing industries, for example, employ sanitary pumps. Because there are so many different types and kinds of sanitary pumps, identifying and selecting the right one can be challenging.

Classification of Sanitary Pumps:

Sanitary pumps are classified as Centrifugal, Positive displacement and Jet and Airlift types. The decision tree includes only centrifugal and positive displacement pumps.

Centrifugal pump:

The revolving impeller and stationary casing are the two basic components of a centrifugal pump. The high-speed impeller generates liquid velocity, and the casing drives the liquid out of the pump, converting velocity to pressure. Because of their basic design, these pumps are suited for a wide range of hygienic applications. Centrifugal pumps are ideal for applications requiring varied flow rates. Throttling and altering impeller speed can be used to control their flow capacity. Throttling, which needs an adjustable valve in the discharge pipe, is one of the most cost-effective methods of flow control. Throttling has the disadvantage of increasing system pressure and wasting energy. Milk products typically handled by sanitary centrifugal pumps are low viscosity product like whey, cream, milk, buttermilk, evaporated milk and sweetened condensed milk.

Characteristic curves of centrifugal pumps are defined as those curves which are plotted from the results of a number of tests on the centrifugal pump. These curves are necessary to predict the behavior and performance of the pump is working under different flow rate, head and speed. The characteristic curves for pumps are Main characteristic curves or System curves, Operating characteristic curves or Pump curves and Constant efficiency or Muschel curves.

Positive Displacement:

Positive displacement pumps have expanding cavities on the suction side and contracting cavities on the discharge side. As the cavity on the suction side expands, liquid flows into the pump and is driven out of the discharge side as the cavity closes. Positive displacement pumps come in a variety of configurations, including hose, rotary piston, rotary lobe, internal gear, diaphragm, and piston.

A piston pump is made out of a piston that reciprocates in a cylinder. The flow is controlled by inlet and output valves, which ensure that it flows in the correct direction. In dairies, piston pumps are mostly utilised as metering pumps. A homogenizer is a form of piston pump as well. Raw materials transfer, drum emptying, recirculation, filling machines, mixing and dosing, processing and sampling are all applications for diaphragm pumps in the dairy industry. They can handle viscous liquids as well as fluids containing soft and hard materials, such as fruit puree with seeds and pips. Because of their flexibility, they are ideally suited to pumping a wide range of fluids, including yoghurts, cream, ice cream mix, syrups and toppings, chocolate coatings, and margarine and fats.

Each version follows the same operating concept. Unlike a centrifugal pump, a positive displacement pump produces the same flow at any speed, regardless of discharge pressure. Because it operates against a closed valve on the discharge side, a positive displacement pump cannot be entirely throttled. If complete throttling is attempted, it will continue to produce flow, increasing the pressure in the discharge line until either the line bursts, the pump is severely damaged, or both. The most practical means to control flow rate is to adjust component speed with a variable-speed drive. Products typically handled by positive displacement pumps likes fluid milk, cream, ice cream, cheese, yogurt, butter, juice, cleaning solutions

Jet and airlift Pump:

In hygienic applications, jet and airlift pumps are less prevalent than centrifugal and positive displacement pumps. The fluid is pushed via a jet or nozzle, converting all or virtually all of its energy to velocity energy. The energy is directed and directed towards the fluid to be moved. Jet pumps are widely utilised to move solid matter or chemically active compounds from sumps or process leftovers. When a recirculated stream produces the jet, the centrifugal pump must be shielded against damage caused by solid particles in the fluid stream (Henderson et al. 1997). At the bottom of the lift pipe, air or another gas is introduced and mixed with the liquid. The air-liquid mixture, with lower specific weight than the liquid, rises in the pipe and is discharged at the point above the level of the liquid. This device can be used for elevating liquids that contain foreign materials or are corrosive. 20 to 40% of the energy used to compress the gas is effective in elevating the liquid.

Sanitary Pump Selection Criteria:

Main area are identified to properly select a sanitary pump i.e. process requirements, product properties, operational requirements and cost.

Process requirements define the information required to pick a pump that satisfies the production demands. A flow rate or range must be determined based on the process's current and future demands. A design flow rate meets the process's requirements. Maximum flow rate is assessed for future expansion demands or specific processing requirements such as quick product transfers. The pump's pressure rating is critical. Consider the rated pressure of the pump and pipe, the product sensitivity, and the energy required. For disassembly, cleaning, and connection to the pump, sanitary pipe systems are often made of "schedule 5" tubing that is either welded together or utilizes clamp type connections. The upper pressure limit for the tubing and connectors ranges from 75 to 3,000 psi, depending on the connector style, product temperature, and installation and service conditions. In many systems, the pressure must be calculated for the given product, process conditions and piping arrangement. Assistance with this task can be obtained from the equipment supplier or vendor. Provide an excellent resource for pipeline design for dairy and food products (Steffe and Singh, 1997) Line size can be increased or decreased to control line pressure. It is customary to limit product flow rate to five feet per second or less.

Product attributes offer the information required to pick the pump depending on the pumped product's qualities. The temperature of the product is crucial since physical attributes change with temperature. Viscosity is a measure of flow resistance and hence a significant concern in pumping applications. If particle integrity must be maintained or if the particles potentially interfere with pump performance, product particle size information is essential. For specifying building materials for wetted pump components, information on the product's chemical activity is required. To prevent corrosion while handling extremely acidic or caustic materials and wash solutions, stainless steel with a low carbon content (e.g., 316L) or another particular material may be required. Shear sensitivity refers to the influence of the pump's impeller on the product induced by the impeller's "cutting" action. Some goods' physical properties will alter after being subjected to extreme shear. The product modification may or may not be desired. At equilibrium circumstances, vapour pressure is the pressure in an enclosed space above the liquid product. "Flashing" will occur if the pressure in the pumping system falls below the vapour pressure of the liquid. The vaporization of a liquid substance into gas is known as flashing. When the system pressure rises, the gas bubbles may finally burst. Cavitation is the phenomena of bubble collapse. Cavitation is most common around the pump impeller and can seriously harm the pump. Properties of the fluid handled like’s density, viscosity, oxidation sensitivity, abrasiveness, flow properties (Newtonian or non- Newtonian), foaming and shear damage.

The pump's installation and operation in the plant are determined by operational needs. Concerning the operation of the pump, the following questions must be answered:

- ✓ What are the plant's environmental conditions?
- ✓ How many hours (in hours) will the pump run per year?
- ✓ Is the pump going to be cleaned manually or automatically?

- ✓ What is the cleaning schedule?
- ✓ Should the pump be operated automatically or manually?
- ✓ What is the ideal speed range for the pump?

Pumps are often driven by electricity, hydraulic fluid, or compressed air. Pumps driven by compressed air and hydraulic fluids are often less expensive to acquire, but take more energy to operate than pumps powered by electricity. It is critical to understand equipment cleanup processes as well as if hot, high-pressure water and harsh chemicals will be employed. A variable speed electric drive will adjust the pump speed across a certain range. Piping and valves are used to regulate the speed of air and hydraulically powered pumps. Some pumps are resistant to various sorts of pollutants in the product stream due to the nature of their design or the type of contamination predicted and may not require protection. Metal particles, for example, may not harm diaphragm pumps. Sanitary pumps can be mounted with drives on fixed or portable bases. Portable pumps optimize process flexibility and are ideal for situations where a pump or pumps are used on multiple lines that are not operated simultaneously. Portable pumps facilitate maintenance and cleanup. Whether fixed or portable, the pump base should be rugged and sanitary. Sanitary designation indicates that the pump base is easily cleaned and is free from ledges, cracks, and crevices that collect debris.

The cost of sanitary pumps is an important consideration in their choosing. Because of unique construction materials and severe cleaning standards, sanitary pumps are intrinsically costly. For product contact regions, expensive corrosion-resistant materials (such as stainless steel AISI 304 or AISI 316) are selected. Surfaces that come into touch with the product must be cleanable and neatly polished. To enable disassembly for cleaning, quick-change fasteners, flanges, and gaskets are used. Components are often basic and engineered to be exceptionally durable in order to survive regular disassembly for cleaning. Finally, sanitary pumps must be dependable since pump failure means costly production downtime. A pump powered by air, for example, is more expensive to run than a pump powered directly by an electric motor. Compressed air is expensive to provide both in terms of maintenance and energy requirements.

Conclusions

Pump is a mechanical device to increase the pressure energy. Pump is used for raising fluids from a lower to higher level. Typical dairy pumps are centrifugal, liquid-ring and positive displacement pumps. The three types have different applications. The centrifugal pump is the type most widely used in dairies. The centrifugal pump is mainly used for low-viscosity products, but it cannot handle heavily aerated liquids. The liquid-ring pump is used when the air content is high. The positive displacement pump is used for gentle treatment and high viscosities.

References

Henderson, S.M., R.L. Perry and J.H. Young. (1997). Principles ofProcess Engineering. American Society of Agricultural Engi-neers, St Joseph, MI.

Steffe, J.F. and R.P. Singh (1997). Pipeline Design Calculations forNewtonian and Non-Newtonian Fluids. In Handbook of FoodEngineering Practice, K.J. Valentas, E. Rotstein, and R. Singh,editors. CRC Press, NY.

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AGRICULTURAL WASTES: A POTENTIAL SOURCE FOR BIOETHANOL PRODUCTION

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Introduction

Mechanization of all industrial sectors has led to the increase in energy consumption which in turn increased the intensity of reliance on fossil fuels. As the fossil fuels are main drivers of climate change, renewable energy sources are picking up to satisfy the energy demand to a considerable extent. Renewable energy sources are preferred instead of fossil fuels for the following reasons; i) It is renewable and available in plenty, ii) Low cost, iii) Creates employment and iv) Highly economic & makes the industry self-reliable. Bioethanol is one of the main renewable energy sources and Brazil & United States serves as the leading producers in the world. Agricultural wastes from sugarcane, maize, sugar beet, wheat, woody materials, etc., serve as major raw materials for bioethanol production. Bioethanol is a potential alternative to the petroleum based fossil fuels. Ethanol is produced from biodegradable wastes like agro residues under controlled conditions by the action of microorganisms: sugars converted to ethanol with the evolution of carbon dioxide (CO_2). Ethanol production industry majorly relies on yeasts especially *Saccharomyces cerevisiae* and to some extent bacteria – *Zymomonas mobilis.* Raw materials used for ethanol production falls into three categories *viz.*, sugar rich crop residues, starchy residues and lignocellulosic biomass. Production of bioethanol from lignocellulosic biomass is gaining importance as the availability of lignocellulosic biomass is abundant in the agricultural sector. Bioethanol production from lignocellulosic biomass mandates the pre-treatment processes for delignification.

This paper discusses on different agricultural wastes that are potentially used as a source of bioethanol production.

1. Ethanol from sugarcane biomass

Sugarcane is one of the important agricultural crops and serves as the main source for sugar manufacturing. Sugarcane biomass produced in large quantum is rich in sugar (sucrose) and hence remains as a potential source for bioethanol production. Sugarcane bagasse and molasses are the residues of sugarcane that remains after sugar recovery. Ethanol is normally produced from molasses which is the liquid waste generated during sugar recovery.

Ethanol production from sugar industry waste is a form of revenue generation which holds the advantage of effective waste management. Disposal of untreated molasses directly into the environment causes serious problems such as pollution, health hazards to the local residents, etc., Molasses contains 40 to 50% of sugar and produced in large quantum from sugar processing industry and hence remains as a potential raw material for bioethanol production. Brazil is the leading country followed by India in sugarcane production

2. Ethanol from sago industry waste

Tapioca is a starch rich crop and is one of the industrially important crops cultivated in many nations. Sago processing industries utilizes tapioca for extraction of starch called as sago. Sago is used in food industries, chemical industries, etc., Sago pith waste (SPW) is a fibrous starchy lignocellulosic byproduct generated after extraction of starch. In India tapioca is cultivated in southern part *viz.*, Kerala, Tamil Nadu and Andhra Pradesh. In Tamil Nadu it is cultivated in six districts including Salem, Namakkal, Dharmapuri, Erode, Perambalur and Viluppuram. More than 150 sago industries are located in Salem. Sago pith waste (SPW) serves as a potential substrate for bioethanol production with the contents of 58% starch, 23% cellulose, 9% hemicellulose and 4% lignin. Bioethanol production from lignocellulosic biomass involves different steps such as pretreatment, hydrolysis, fermentation and ethanol recovery.

3. Ethanol from woody biomass

Woody biomass is a rich source of lignocelluloses. Lignocellulosic materials are used as a potential renewable energy alternative for fossil fuels. It has wide scope as raw material for production of ethanol and sugars. The main consideration in using this woody biomass as raw material is the pretreatment process which is done to separate cellulose, hemicellulose and lignin. Enzymatic hydrolysis is essentially important as it reduces cellulose crystallinity and breaks down lignin linkages thus making it susceptible for further process. Sugar and ethanol production are two main applications of lignocellulosic biomass.

Due to industrialization, the demand for energy is increasing and on the other side the fossil fuel sources are depleting. To meet out the demand of growing energy sector, finding out suitable and easily available renewable energy source is highly important. Woody biomass is one such promising alternative which is available in plenty and cheaper in cost.

4. Ethanol from POME

Palm Oil Mill Effluent (POME) is serving as another renewable energy source available in plenty and cheaper cost. It is a thick brown liquid waste of palm oil industry which is highly viscous and colloidal in nature. Indonesia is the largest producer of palm oil in the world. India is a lead producer of palm oil but to a considerable level it processes the palm oil. POME is an organic residue which contains lignin and phenolic compounds. Due to this content, it is difficult to dispose the POME directly into the environment without any pretreatment which will lead to severe environmental issues. For every ton of fresh fruit, 0.5-0.75 t of POME is discarded into the environment. POME contains 95–96% water, 0.7–0.7% oil, and 2–4% total suspended solids and serves as a good source of biofuels production. Many researchers have reported that upon blending with other agro industrial residues such as sugarcane bagasse, corn steep liquor, etc.. it is possible to produce ethanol from POME.

Conclusion

Agro residues serve as a potential source of renewable energy feedstock and has many advantages such as i) available in large quantum, ii) cheaper in cost, iii) higher nutrient composition, iv) amenable for fermentation and v) effective disposal. Paper mill effluent, dairy industry wastes, etc are also potential sources for ethanol production. An array of other agro residues have the potential to be used as an alternative raw material for ethanol production *viz.*, rice straw, corn cob, wheat straw, fruit wastes, etc., Ethanol serves as a potential alternative for petroleum fuels and hence in future the demand for ethanol will rise to newer heights. The research in future should focus on i) developing new technologies to enhance the conversion ratio of biomass to ethanol, ii) improve the fermenting ability of ethanol producing microbes and iii) standardize suitable pre-treatment methods to enhance ethanol production from agro residues.

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BIOFUMIGATION: INNOVATIVE STRATEGIES FOR CROP PROTECTION

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Introduction

Now a days agriculture production faces a challenge with the management of phytopathogens. Under intensive conventional cultivation systems, volatile chemical compounds of nonspecific action are used frequently. A well-known example of a substance used for this purpose before it was outlawed is methyl bromide (CH_3Br). Due to its ban, various manufacturing areas were restricted, which sparked a scramble to find alternatives. However, regardless of the product used, fumigation aims at sterilization, which is incompatible with the philosophy and principles of production systems that value the biological activity of the soil, such as organic or agro ecological systems. Studies have been looking into potential alternatives to using synthetic chemical compounds as a fumigant since the 1990s. The most crucial of these techniques is biofumigation.

What is biofumigation?

- It relates to the control of diseases and pests using plants and fungi that produce inhibitory compounds, also referred to as secondary metabolites. The procedure can lower nematode, fungus, and bacterial infections by releasing volatile molecules called isothiocyanate compounds (ITCs) by the hydrolysis of glucosinolate (GSL) compounds.
- It is the beneficial use of *Brassica* green manures that release isothiocyanates chemically similar to methyl isothiocyanate, the active agent from the synthetic fumigant metam sodium, which is used as a substitute for methyl bromide in some systems (Matthiessen and Kirkegaard, 2006)

- Metam sodium generates the compound methyl isothiocyanate upon contact with moist soil (Turner and Corden, 1963; Munnecke, 1967; Smelt and Leistra, 1974) and it is methyl isothiocyanate that possesses broad-spectrum biological activity against nematodes, fungal pathogens, insects, and weeds (Munnecke *et al*., 1962; Richardson and Thorn, 1969).
- There are a range of different biofumigant crop species available, with the most commonly grown being Indian mustard (*Brassica juncea*), rocket (*Eruca sativa*) and oil radish (*Raphanus sativus*), although most of the research to date has focused on Indian mustard.

Steps Involved in Incorporation of Biofumigants.

- When the enriched biomass is at its highest peak of glucosinolate concentration, the flowering plants(60-80 % blossom) should be chopped into finely and immediately introduced into the soil at the depth of 15-20 cm.
- Optimum Irrigating should be done at its field capacity.
- Covering the soil surface tightly with a transparent plastic film.
- In order to escape the gases from soil the film should be removed after 3-4 weeks.
- Main cropplant can be planted after 24 hours.

Biofumigants and their effect on pathogen

1. Sorghum :

Cynogenic plants have some potential as biological green manure crops in limiting several soilborne pests and pathogens. Sorghum (sorghum bicolor L. Moench) contain the Cyanogenic glucoside p-hydroxy-(S)-mandelonitrile-β- D-glucoside compound called Dhurrin as a substrate of its secondary defensive system able to release hydrogen cyanide following tissue lesions due to biotic or abiotic factors. Given that dhurin content is correlated with the biofumigant efficacy of the plants.(Nicola *et al*., 2011)

2. Brassica Sp.:

The most often employed plant species as biofumigants are brassicas.

Pest	**Brassica spp.**	**reference**
nematodes		
Meloidogyne javanica	*B. napus* *B. juncea*	Stirling and Stirling (2003)
Tylenchus semipenetrans	*B. juncea*	Daugovish *et al*. (2004)

Meloidogyne javanica	*B. juncea*	Rahman and Somers (2005)
fungus		
Sclerotinia minor	*B. juncea* *S. alba*	Daugovish *et al*. (2004)
Rhizoctonia solani	*B. juncea*	Van Os *et al*. (2004)
Pyrenochaeta lycopersici	*B. rapa* *B. oleracea*	Amenduni *et al*. (2004)
Bacteria		
Streptomyces scabiei	*B. oleracea*	Gouws and Wehner (2004)

The profile, concentration, and distribution of various glucosinolates vary within and between *Brassica* species as well as in various plant tissues; as a result, the concentration and nature of the chemicals produced by biocidal hydrolysis also vary (Mithen, 1992).

Mexican Marigold:

It works well in the management of root-knot nematodes. It is also employed as a trap crop; in response to mechanical and biotic stress, the root cells produce terthiophenes that prevent the growth and metabolism of plant diseases (Hooks *et al*., 2010)

3. *Ceratocystisfimbriata*:

Soil-borne ascomycete fungus. Recently, it is found that a variety of volatile organic compounds (VOCs) produced by *C. fimbriata* have strong bioactivity against a wide range of fungi, bacteria and oomycetes (Li *et al*., 2015). It a potential player in control of post harvest diseases of fruits through biofumigation. Butylacetate, ethylacetate and ethanol were identified as volatile organic compounds isolated from this fungus

4. *Muscodoralbus*:

An endophytic fungus, *M. albus* is also used as a biofumigant for the management of post harvest diseases of fruits and vegetable. It is effective against a wide range of storage pathogens and controlling fungal decay. Biofumigation for 24 h or longer with rye grain culture of *M. albus* controlled brown rot of peaches, caused by *Monilinia fructicola*, and gray mold and blue mold of apple, caused by *Botrytis cinerea* and *Penicilliumexpansum*, respectively and postharvest lemon diseases (Mercier and Smilanick, 2005).

5. Trichoderma:

Trichoderma is a biocontrol agent which also emits volatile compounds such as 3-methly-1-butanol, 6-pentyl-2-pyrone, 2-methyl-1-propanol and acetoin. Volatile compunds emitted from the fungus decreases the growth of phytophthora infestans. It is a potential agent in control of the post harvest potato tuber diseases through biofumigation. (elsherbiny *et al*., 2020)

Advantages

Soil biology

Biofumigation crops act as break crops, disrupting the lifecycle of pests and diseases. Suppression may result from direct biocidal toxicity as well as indirectly through changes in the soil fauna and microbial community. Populations of beneficial microorganisms, including mycorrhizal fungi, have been found to increase after biofumigant crops

Weed suppression

Early vigorous growth and improved plant vigour help to outcompete weeds. When incorporated correctly, the release of isothiocyanates (ITCs) from the biofumigant crop leads to the biocidal burning of weed seedlings.

Soil organic matter

Organic matter is replenished in the soil after incorporation of the biofumigant. As microorganisms break down organic matter they produce sticky substances that bind soil particles together into soil aggregates. This, in turn improves:

- Water infiltration, water and air holding capacity.
- Structural stability, reducing the risk of compaction.
- Soil friability, making the soil easier to work.
- The soil's resilience to wind and water erosion.
- Nutrient holding capacity.
- Overall biological activity.
- Root growth. Organic matter also buffers against changes in ρH, salinity or sodicity and it inactivates or filters toxic elements.

Nutrient cycling

Deep-rooted break crops can access nutrients stored deeper within the soil profile that are unavailable to shallow-rooted crops. Better biological activity can lead to improved nutrient cycling and crop nutrient uptake. The nutrients become available to the next cash crop. Increased rates of nitrogen mineralisation following *Brassica* and other break crops have been recorded(Anonymous 2015).

Conclusion

Biofumigation with plant residues and fungi can be an important strategy in the integrated management of pests and diseases. Therefore, this technique represents a comprehensive management system involving chemical, physical, and biological soil changes with multiple effects on phytopathogenic agents, pests, weed species, the soil environment, and plants of economic interest. This technique may be of particular interest for organic production systems and can be integrated with other alternative strategies such as soil solarization with projections of improved effects. But there is still a need to fill knowledge gaps and understand the processes and mechanisms involved, the specifics of each material used and the effects on different groups of phytopathogens, pests and on the soil microbiota and microfauna

References

Amenduni, M.; D'Amico, M.; Colella, C. and Cirulli, M. (2004). Effect of Brassicaceae green manures and soil-solarisation on corky root of tomato. *Agroindustria*,**3:** 303–307.

Anynomous(2015).https://www.soilwealth.com.au/imagesDB/news/SW-ICP-biofumigation-factsheet-150216-FINAL.pdf

Daugovish, O.; Downer, J.; Becker, O.; Browne, G. and Dunniway, J. (2004). Mustard-derived biofumigation for vegetable crops and strawberries. *Agroindustria*,**3**: 335–338.

De Nicola G. R.; Leoni, O.; Malaguti, L.; Bernardi, R. and Lazzeri, L. (2011). A simple analytical method for dhurrin content evaluation in cyanogenic plants for their utilization in fodder and biofumigation. *Journal of Agricultural and Food Chemistry*, **59**(15): 8065-8069.

Elsherbiny, E. A.; Amin, B. H.; Aleem, B.; Kingsley, K. L. and Bennett, J. W. (2020). Trichoderma volatile organic compounds as a biofumigation tool against late blight pathogen *Phytophthora infestans* in postharvest potato tubers. *Journal of agricultural and food chemistry*, **68**(31): 8163-8171.

Hooks, C. R.; Wang, K. H.; Ploeg, A. and McSorley, R. (2010). Using marigold (*Tagetes* spp.) as a cover crop to protect crops from plant-parasitic nematodes. *Applied Soil Ecology*, **46**(3): 307-320.

John N. Matthiessen and John A. Kirkegaard (2006). Biofumigation and Enhanced Biodegradation: Opportunity and Challenge in Soilborne Pest and Disease Management. *Critical Reviews in Plant Sciences*, **25**(3): 235-265.

Mithen, R. (1992). Leaf glucosinolate profiles and their relationship to pest and disease resistance in oilseed rape. *Breeding for Disease Resistance*, 71-83.

Munnecke, D. E. (1967). Fungicides in the soil environment. In: Fungicides I. Torgeson, D. C., Ed., Academic Press, New York.**pp**. 509–559.

Munnecke, D. E.; Domsch, K. H. and Eckert, J. W. (1962). Fungicidal activity of air passed through columns of soil treated with fungicides. *Phytopathology*, **52:** 1298–1306.

Rahman, L. and Somers, T. (2005). Suppression of root knot nematode (*Meloidogyne javanica*) after incorporation of Indian mustard cv. Nemfix as green manure and seed meal in vineyards. *Australasian Plant Pathology*, **34:** 77–83.

Richardson, L. T. and Thorn, G. D. (1969). Comparative fungitoxicity and phytotoxicity of sodium N-methyldithiocarbamate and its n-alkyl homologues. *Canadian Journal of Botany*, **47:** 241–245.

Smelt, J. H. and Leistra, M. (1974). Conversion of metham-sodium to methyl isothiocyanate and basic data on the behaviour of methyl isothiocyanate in soil. *Journal of pest science*, **5**: 401–407.

Stirling, G. R. and Stirling, A. M. (2003). The potential of *Brassica* green manure crops for controlling root-knot nematode (*Meloidogyne javanica*) on horticultural crops in a subtropical environment. *Australian journal of experimental agriculture*, **43**: 623–630.

Turner, N. J. and Corden, M. E. (1963). Decomposition of N_methyldithiocarbamate in soil. *Phytopathology*, **53**: 1388-13.

Van Os, G. J.; Bijman, V.; Van Bruggen, A. S.; de Boer, F. A.; Breeuwsma, S.; van der Bent, J.; de Boer, M. and Lazzeri, L. (2004). Biofumigation against soil borne diseases in flower bulb culture. *Agroindustria*, **3:** 295– 301.

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IOT AND ELECTRONIC IN AGRICULTURE

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Abstract

IoT (Internet of Things) and electronics are increasingly being used in agriculture to improve efficiency, productivity, and sustainability. In agriculture, IoT sensors and devices can provide real-time data on soil moisture, temperature, humidity, and other factors, allowing farmers to optimize planting, irrigation, and fertilization. IoT devices can also monitor the health and well-being of livestock and automate irrigation systems to reduce water usage. Drones can be used to monitor crops, identify pests and diseases, and assess crop health. IoT and electronics can be used to control temperature, humidity, and other environmental factors in greenhouses, ensuring optimal growing conditions for plants. IoT and electronics can also be used to track and monitor the movement of agricultural products from farm to market, ensuring food safety, quality, and traceability.

Keywords: IoT, Electronic, Sensor.

Introduction:

IoT and electronics-enabled smart agriculture is an emerging area of research that involves the use of modern technologies to improve the efficiency and productivity of agriculture. In this review, we will explore the various aspects of smart agriculture and how it is transforming the way farmers work. The Internet of Things (IoT) has the potential to revolutionize many industries, and agriculture is no exception. IoT devices can be used to monitor and control various aspects of agriculture, from soil conditions to irrigation systems to crop health. By leveraging IoT technology, farmers can improve their efficiency, reduce waste, and ultimately increase their yields.

Smart agriculture involves the use of IoT (Internet of Things) devices, sensors, and other electronic technologies to monitor and control the agricultural environment. By collecting and analyzing data from the environment, farmers can make informed decisions about when to plant, irrigate, fertilize, and harvest crops.

One of the primary ways IoT is being used in agriculture is through sensors. These sensors can be placed in the soil to measure factors such as temperature, moisture, and nutrient levels. Farmers can use this data to make informed decisions about when to plant, water, and fertilize their crops. They can also use the data to monitor soil erosion and track the impact of climate change on their land.

Finally, IoT can be used to improve supply chain management in agriculture. By tracking the movement of crops from the field to the grocery store, farmers can ensure that their products are handled properly and reach their destination in a timely manner. They can also use IoT to monitor inventory levels and predict demand, helping them to make informed decisions about when to plant and harvest their crops.

IoT in Agriculture

IoT devices are playing an increasingly important role in agriculture. Farmers can use sensors to monitor soil moisture, temperature, and other environmental factors. They can also use drones and other autonomous vehicles to survey their fields and identify areas that need attention. IoT devices can also help farmers track livestock and monitor their health.

Precision Agriculture

Precision agriculture is a subset of smart agriculture that uses precision technology to optimize the use of resources. Farmers can use precision agriculture techniques to apply fertilizers, pesticides, and water only where and when they are needed. This can reduce waste and increase efficiency, leading to higher yields and better profits.

Smart Irrigation

Smart irrigation is a key component of smart agriculture. Farmers can use sensors to monitor soil moisture levels and adjust irrigation systems accordingly. This can help reduce water waste and increase the efficiency of the irrigation system.

To monitor crop health:

Farmers can use sensors to detect diseases and pests in their crops, allowing them to act before the problem spreads. They can also use drones equipped with cameras and sensors to take aerial photos of their fields and identify areas where crops may be struggling.

To track and manage farm equipment:

By installing sensors on tractors and other machinery, farmers can monitor their usage and performance in real-time. This allows them to schedule maintenance and repairs before a breakdown occurs, reducing downtime and increasing productivity.

Challenges of Smart Agriculture

Despite the benefits of smart agriculture, there are also several challenges that farmers may face. The cost of implementing IoT devices and other electronics can be prohibitive for some farmers. Additionally, the data collected by these devices must be analyzed and acted upon in a timely manner, which may require specialized knowledge or skills.

Smart agriculture, also known as precision agriculture, is the use of advanced technology to optimize and automate agricultural processes. While this approach offers many benefits, there are also several challenges that must be addressed in order to fully realize the potential of smart agriculture. Here are some of the key challenges facing smart agriculture:

High cost: Smart agriculture technologies can be expensive, particularly for small-scale farmers who may not have the resources to invest in them. While the long-term benefits of these technologies can outweigh the costs, many farmers may not be able to afford the upfront expenses.

Technical skills: Smart agriculture technologies require a certain level of technical expertise to install and operate. This can be a challenge for farmers who may not have experience with these types of systems. Training and education programs are needed to help farmers learn how to use these technologies effectively.

Data management: Smart agriculture technologies generate large amounts of data, and managing this data can be a challenge. Farmers need to have the tools and expertise to store, analyze, and make decisions based on this data. In addition, privacy and security concerns need to be addressed to protect the sensitive information collected by these systems.

Connectivity: Many smart agriculture technologies rely on connectivity to the internet, which can be a challenge in rural areas where internet access may be limited or unreliable. This can impact the ability of farmers to use these technologies effectively.

Adaptability: Smart agriculture technologies need to be adaptable to different crops, growing conditions, and geographic regions. One-size-fits-all solutions may not be effective for all farmers or all types of agriculture.

Environmental concerns: Smart agriculture technologies can have environmental impacts, particularly if they rely on the use of chemicals or intensive irrigation. These impacts need to be carefully considered and managed to ensure that smart agriculture practices are sustainable in the long term.

Advantages of IoT and Electronics in Agriculture:

Increased Efficiency: IoT and electronics can increase efficiency in agriculture by automating tasks, optimizing resources, and providing real-time monitoring and control.

Improved Productivity: By providing real-time data and insights, IoT and electronics can help farmers make better decisions about planting, irrigation, fertilization, and pest management, leading to increased productivity.

Reduced Costs: IoT and electronics can reduce costs in agriculture by optimizing resource usage, minimizing waste, and reducing the need for manual labor.

Enhanced Quality: By providing real-time data and monitoring, IoT and electronics can help ensure that crops are grown under optimal conditions, leading to higher quality yields.

Increased Profitability: By increasing efficiency, productivity, and quality, IoT and electronics can help farmers increase their profitability.

Disadvantages of IoT and Electronics in Agriculture:

High Initial Cost: The high cost of IoT and electronics can be a barrier for many farmers, particularly those in developing countries or with limited resources.

Technical Complexity: IoT and electronics can be complex and require specialized knowledge and skills to implement and maintain, which can be a challenge for some farmers.

Dependence on Technology: Farmers may become overly reliant on technology and may not have the skills or knowledge to manage their farms without it.

Security Risks: IoT and electronics can be vulnerable to cyber-attacks, which can compromise the privacy and security of sensitive data.

Environmental Concerns: The use of electronics and IoT devices in agriculture can have environmental impacts, particularly if they rely on the use of chemicals or intensive irrigation.

IoT (Internet of Things) and electronics are increasingly being used in agriculture to improve efficiency, productivity, and sustainability. Here are some of the key applications of IoT and electronics in agriculture:

Precision Agriculture: IoT sensors and devices can provide real-time data on soil moisture, temperature, humidity, and other factors, allowing farmers to optimize planting, irrigation, and fertilization. This approach, known as precision agriculture, can improve crop yields and reduce waste.

Livestock Monitoring: IoT devices can monitor the health and well-being of livestock, including tracking their location, activity, and vital signs. This information can help farmers identify and address health issues early on, improving the overall health and productivity of their animals.

Automated Irrigation Systems: IoT and electronics can be used to automate irrigation systems, adjusting the amount and timing of water based on real-time data on soil moisture, weather conditions, and plant needs. This approach can conserve water and reduce waste while improving crop yields.

Drone Technology: Drones equipped with sensors and cameras can be used to monitor crops, identify pests and diseases, and assess crop health. This approach can provide farmers with valuable data and insights to make better decisions about crop management.

Smart Greenhouses: IoT and electronics can be used to control temperature, humidity, and other environmental factors in greenhouses, ensuring optimal growing conditions for plants. This approach can improve crop yields and quality while reducing energy consumption and costs.

Supply Chain Management: IoT and electronics can be used to track and monitor the movement of agricultural products from farm to market, ensuring food safety, quality, and traceability.

Conclusion

The use of IoT in agriculture has the potential to transform the way we grow and produce food. By using sensors, drones, and other IoT devices, farmers can monitor and control various aspects of their operations in real-time. This not only improves efficiency and reduces waste but also helps farmers to produce more food with fewer resources. As technology continues to evolve, we can expect to see even more innovative uses of IoT in agriculture in the years to come. The challenges faced by IoT and electronic in agriculture ranges from cost and technical skills to data management, connectivity, adaptability, and environmental concerns. Addressing these challenges will require collaboration between farmers, technology providers, policymakers, and other stakeholders to ensure that smart agriculture practices are effective, sustainable, and accessible to all. IoT and electronics are transforming agriculture, providing farmers with valuable data and insights to optimize crop yields, reduce waste, and improve sustainability. As these technologies continue to evolve, they have the potential to revolutionize agriculture and help address some of the world's most pressing food security and sustainability challenges.

Summary:

IoT (Internet of Things) and electronics are increasingly being used in agriculture to improve efficiency, productivity, and sustainability. In agriculture, IoT sensors and devices can provide real-time data on soil moisture, temperature, humidity, and other factors, allowing farmers to optimize planting, irrigation, and fertilization. This approach, known as precision agriculture, can improve crop yields and reduce waste. IoT devices can also monitor the health and well-being of livestock and automate irrigation systems to reduce water usage. Drones can be used to monitor crops, identify pests and diseases, and assess crop health. IoT and electronics can be used to control temperature, humidity, and other environmental factors in greenhouses, ensuring optimal growing conditions for plants. IoT and electronics can also be used to track and monitor the movement of agricultural products from farm to market, ensuring food safety, quality, and traceability.

However, the challenges of using IoT and electronics in agriculture include the high initial cost, technical complexity, dependence on technology, security risks, and environmental concerns. Therefore, farmers and other stakeholders need to weigh the advantages and disadvantages of these technologies carefully and make informed decisions about how to best leverage them to improve agricultural practices and outcomes.

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CRACKING IN FRUIT CROPS AND THEIR MANAGEMENT

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Inroduction

India is second largest producer of fruit crops next to China in the world. The nutritional security is only achieved through horticulture especially by fruits and vegetables. The production and quality of fruit crops is affected by various factors faced by the farmers which intern influence the market price both in domestic and export markets. Cracking in fruit crops is one the most damaging physiological phenomena that happens to the crop during fruit development and affect the quality of the crop and decrease market value. The fruits of many cultivars in tropical, sub –tropical and temperate trees will split open. The damaged fruit is unmarketable and provides a habitat for fungal and insect pests that can reproduce and then damage currently marketable fruit. Losses of 30 to over 50 percent of the crop are possible with some cultivars. This is a physiological disorder that starts with nutrient imbalances at flowering that result in mechanically weak areas in the rind. These rupture if interior parts of the fruit expand faster than the peel can stretch. This is also a problem for growers because they can only see the problem after it is too late to correct.

Causes of fruit cracking

1. Water imbalance in fruits

Maintaining the water balance in fruits is extremely important achieving quality fruits without cracks in fruit cultivation in any region. Water imbalance could result from irregular irrigation, prolonged period of dry condition followed by sudden rain fall or irrigation, and increase in the environmental temperature that leads to increases the temperature of fruit skin. To prevent the negative effect of water imbalance in the crop, proper irrigation should be given at regular intervals according to soil moisture and temperature in prevailing region

2.Nutrition's

Maintenance of leaf nutrient levels within "norms" is standard practice affecting a wide range of physiological processes in all fruit plants. However, the following nutrients have been shown to be important in fruit crops.

Secondary and micro nutrients play a major role in growth and development of fruits and its deficiencies causes fruit cracking. A balanced nutrition of calcium and boron is very important for the strength, integrity and flexibility of the cell walls and membrane in fruit crops. Better Calcium supply, through soil and foliar applications during summer, also minimizes risks and sprays a month before and then when spiliting is seen, helped reduce the number of split fruit. Deficiencies of any of two nutrition increase the risk of cracking. An early season spray of potassium can help reduce this disorder.

Boron

B was suggested to be involved in promotion of cell division, synthesis of cell walls, and possibly cell wall integrity and "toughness". Boron application reduced cracking in lemon from a 2-year average of 33% in the control to 23.7%, and in mandarin the 0.8% foliar boric acid spray reduced splitting from 52% in the control to 8.89%. Boron may play a synergistic effect where calcium applications.

Calcium

Assuming that calcium incorporation into cell walls "strengthened" them or increased their plasticity, the best strategy to improve Ca content of fruit was to optimize root uptake and transport via the transpiration stream, as Ca was not readily absorbed from foliar applications nor from fruit surfaces. Any factor hampering Ca transport (e.g., lowered vapor pressure deficit), especially during the critical stages of cell division and growth may lead to reduced Ca levels in the fruit. Such a shortfall could lead to physiological disorders of the rind, including cracking

However, $Ca(NO_3)_2$ foliar sprays (1% concentration) were applied at the start of the cell enlargement stag in citrus. In contrast, a single application of $Ca(NO_3)_2$ applied (2% concentration) as a foliar spray at "70% petal fall" on 'Nova' resulted in reduced spiliting. Peels of cracked fruits had higher levels of malonaldehyde, polygalacturonase, cellulase, soluble pectin, peroxidase, and polyphenol oxidase, but lowered concentrations of protopectin, superoxide dismutase, and catalase. Calcium fertilization decreased the concentration of soluble pectin, polygalacturonase, cellulase peroxidase, and polyphenol oxidase, but increased the concentration of protopectin, superoxide dismutase, and catalase in the peel. Normal fruits had higher N and Ca. Levels of P were higher in normal fruit in the leaf, peel, and pulp but the difference was not significant.

Phosphorus

The effects of relatively high leaf phosphorus levels in inducing thinner, smoother rinds are well documented. To reduce PFS, nutritional programs must balance peel thickening and/or strengthening elements (e.g., K, Ca), with peel-thinning phosphorus. There is a strong negative correlation between rind thickness. There is also a correlation between phosphorus and rind thickness where both low and high P produce thin peels.

Potassium

The number of split fruits decreased sharply where leaf K levels exceeded 1.25%. In 'Valencia' orange (Malelane, South Africa), leaf K levels gave inconsistent results for pre-harvest splitting severity although indications were that leaf K levels <0.8%. KNO_3 at 6% application at full bloom reduced splitting from 7% in the controls to 2% and was as effective as an application later (fruit 1.5 to 2 cm) or an application at both times. However, the later application was more effective than an earlier application at 4%, and at 2%, fruit split was 5.5 to 6% .

Zinc

Zn was suggested to play a role in increasing cell enlargement and accelerating fruit growth. The possibility existed that fruit rind-cracking-related gene Cs-cdc48 and cell wall-related gene Ct-Exp1 which were both specifically expressed in "normal" fruit peels, were not expressed in cracked fruit peels. Zn fertilizer application during the cell enlargement stage promoted the upregulation of Cs-cdc48 expression .

3.Hormonal control:

Different hormones like Auxin, Gibberellin, Cytokinin, Abssicsic Acid and Ethylene play major role in during growth and development of fruits. The concentration, time of application, mode of action is also an important factors. It helps to grow and increase fruit size but the excessive use causes cracking in fruit crops. This cracking is due to the abnormal increase in size of the fruit due to cell division by excess application of gibberellic acid and use of approximate concentration of GA_3 could significantly reduce the occurrence of cracking in different fruit crops. Because it adjusts the water balance of the cell wall and durability and elasticity of the outer shell of the fruit.

Figure: 1 cracking symptom in different fruit crops and their cultivar

1.		
	Cracking in Mango Var. Imampasand	Cracking in Banana Var. Nendran
2.		
	Cracking in Passion Fruit	Cracking in Mandarin orange
3.		
	Cracking in Peach Var. Shan-e-Punjab	Cracking in Peach Var. Nectarine

4.		
	Cracking in Pomegranate Var. Bhagwa	Cracking in Litchi var. Bombay Green

4.Cultivation of cultivars with resistant to cracking

Most of the fruit varities in Pomegranate, Litchi are highly susceptible to cracking due to their inability to withstand the extreme environmental and biological condition surrounding the plant. Therefore, during cultivation of any fruit crops especially Pomegranate, Citrus, Litchi choose a resistant varieties which with stand stress.

Pomegranate

Pomegranate (*Punica granatum*) belonging to the family Punicaceae is one of the favourite table fruits of tropical and subtropical regions. The fruit is native of Iran and is extensively cultivated in the Mediterranean countries like Sapin, Morocco, Egypt, Iran, Afghanistan and Baluchistan

Cracking of pomegranate fruits is a serious problem in pomegranate which occurs more frequently in dry atmosphere of the arid regions. The cracked fruits though sweeter, lose keeping quality and are unfit for shipment and are liable to rot. The cracking of pomegranate is believed to occur due to sundden change in soil moisture content. At the time of fruit ripening, if the soil becomes too dry and then irrigated heavily cracking will appear. It also due to deficiencies of calcium and boron and cultivars. Adequate and regular irrigation and intercultural throughout the bearing period may reduce cracking. Application of 5% pinolene as vapour guard (an anti-transpirant) 4-5 weeks before harvest reduces fruit splitting. Humic acid through foliar application could also reduce cracking in Pomegranate fruit.

Passion Fruit

Peel splitting is often caused by extreme fluctuations in soil moisture as well as temperature and humidity. period the peel will turn fairly inelastic. When this is followed by irrigation or rain, a large amount of water is taken up into the fruit, forcing the rind to burst at its weakest point. Fruit splitting also occurs when long, wet periods are followed by dry spells. Minimizing stress by correct irrigation and reducing crop load can reduce physiological stress and splitting in susceptible cultivars. Trees that are deficient or low in potassium and calcium can result in fruit skins that are either too thin or which are structurally weak and more prone to these stresses. Therefore, improved potassium and calcium supply can minimize splitting.

Citrus

Pre-harvest fruit splitting (PFS) is a global problem of physiological origin that affects most citrus cultivars to some degree. Also known as “fruit splitting” , “side-splits” or “navel-end splits” , “fruit cracking” , “fruit burst” , and “flavedo splitting” . “Cracking” was defined as a physical failure of the fruit skin, with “splitting” being an extreme form. This physiological disorder is relatively common in many citrus growing areas of the world.

Pre-harvest fruit splitting is not related to fruit creasing (albedo splitting, albedo breakdown) which appears as narrow sunken grooves on the fruit. Pre-harvest fruit splitting affects all cultivars, but is a critical problem in some cultivars and the variability in the problem for different scion and rootstock combinations. Factors Affecting Severity is Crop Load, Fruit Shape, Fluctuating Water Status, Humidity and Light, Peel Quality.

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MICROARRAY TECHNOLOGY IN CROP GENETICS

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Introduction

A microarray is a small slide made of glass or silicon onto which huge number of probes are immobilised for hybridising with unknown DNA samples. It is a high-throughput transcriptome profiling technology to understand patterns of transcription during different stages of plant growth. It had been used for the preparation of transcription atlas in several plant species *viz.*, *Arabidopsis thaliana* (Schmid et al 2005), rice (Fugita et al 2010), maize (Sekhon et al 2011), barley (Druka et al 2006) and soybean (Libault et al 2010). Probe represents the known sequence of biomolecules probably obtained from the genomic or cDNA libraries. The most widely used microarray is expression chip, which utilises cDNA as probe. Apart from this, there are other applications of microarray technology *viz.*, genomic hybridisation, mutation analysis, protein microarrays and tissue microarrays (Lesk 2017).

Types of microarrays (Singh and Singh, 2015)

***1.*DNA microarrays**

This is the most common type of microarray, where the hybridisation in the array is based on DNA-DNA hybridisation. The probe which is immobilised onto the array may be small cDNA, in case of expression chip or may be a larger known chromosomal location, for genomic hybridisation technique (Lesk 2017). These DNA microarrays may be classified into two maincategories: Spotted and Oligonucleotide microarrays (Kohane et al 2003).

1.1.Spotted microarrays

The DNA molecules to be used as probe are obtained from genomic or cDNA librariesof the concerned species. These probes of equal quantity may be immobilised onto a knowngrid of the microarray plates.

1.2.Oligonucleotide microarrays

The probe DNA molecules are artificially synthesised at very high density directly onto the array. Since, the DNA probes are present at high density, large number of test samples may be screened as compared to spotted microarray. These microarrays are commercially constructed based on our purpose *viz.*, disease specific oligochips or species specific genomic oligochips.

2.Antibody microarrays

This refers to microarrays for the analysis of protein-protein interactions. The probe used here is usually antibodies for the detection of specific proteins (Lesk 2017).

Methodology

Arraying

First, the PCR amplified cDNA are labelled and subsequently purified using 96-well multi-screen filter plates for removing contaminants like unincorporated nucleotides, primers, *etc* (Hegde et al. 2000). The slide used for array preparation is poly-L-lysine- or aminosilane-coated to improve the adherence of DNA and prevent spreading of the spots. Equal volume of DNA is added along with DMSO to prepare the slides. The DNA is spotted onto the slides at 22.2ºC and 45% relative humidity. The slide is allowed to dry and exposed to UV for crosslinking. Slides are stored in a light-tight box at room temperature for using it for hybridisation.

Pre-hybridisation

Then chemicals like BSA, SSC and SDS are added to the slide to prevent the non-specific binding of the DNA. It blocks the free amino groups on the slide. Subsequently, hybridisation buffer containing formamide, SDS and SSC are added and incubated at 42ºC. After washing, it is treated with isopropanol and air dried. Then it is immediately used for hybridisation.

Hybridisation

For hybridisation, equal volume of DNA samples are taken and denatured using heat or alkali. Then, it is mixed with hybridisation buffer heated to 42ºC. Subsequently, labelled DNA is added to the slide, covered with coverslip and incubated. After incubation period, wash buffers containing SSC and SDS is used for washing the slide. Finally the slide is washed using sterile distilled water and allowed to dry for analysis.

Analysis of microarray data

The data obtained after the hybridisation of microarray plates is a typical image with different colours based on the fluorophores used. The data obtained is basically qualitative. For instance, for the comparison of two test samples, the samples are labelled with different flourophores viz., red and green. After hybridisation, if only one sample was hybridised with the probe, the colour would be either red or green. If both the sample hybridises with the probe, it produces both colours making it yellow.

The intensity of fluorescence denotes the amount of hybridisation that had occurred in the array. Hence, for quantitative analysis of data, the intensity of the colour produced may be analysed. It is to be noted that the intensity of the colour does not usually denote the quantity of hybridisation. This is because the mRNAs are usually unstable and they revert back to cDNA. Hence, the microarray technique is often referred to as semi-quantitative (Lesk 2017).

The data analysis, however, is based on two main approaches based on our purpose: comparison of expression pattern of different genes and comparison of expression pattern of different samples.

Applications of microarrays in plant analysis

1.Analysis of gene expression pattern during various stages of plant development. An atlas of transcription pattern in several plants were created using microarrays. For instance, a database of rice gene expression atlas has been prepared by Cao et al (2012) using publicly available microarray data, Rice Oligonucleotide Array Database (ROAD).

2.Analysis of genes that are co-regulated for identification of common regulatory elements. Tamahsebi et al (2021) reported various differentially expressed genes during single and combined infection of Cucumber mosaic virus, Turnip mosaic virus and Turnip crinkle virus in *Arabidopsis*. These findings help in identification of common virus responsive genes, which may be utilised in crop improvement for virus resistance.

3.Analysis of known SNPs. Morales et al (2020) developed new SNP array in rice, that combines good SNPs from previous array reports. The new SNP array was reported to detect genome wide polymorphism between *O. sativa*, *O. glaberrima*, *O. rufipogon* and *O. nivara*.

4.Detection of diseases. Boonham et al. (2003) have reported the use of microarray technology for identification of different potato viruses in a single assay. They found that the sensitivity of this method was very high and comparable to common ELISA technique.

5.Analysis of some molecular markers like DArT. The diversity array technology involves the use of microarrays, usually called discovery array, for hybridisation with genomic DNA of test samples.

6.Detection of mRNA isoforms that are produced by alternative splicing. Shai et al (2006) have proposed an algorithm for identification of levels of alternative splicing in the samples. The prediction of this algorithm was based on the microarray analysis.

7.Transcribed genomic regions can be mapped with high resolution. Liu et al (2013) used SSR markers for mapping of QTLs for cold stress tolerance in rice. Further, they used microarray technology for fine mapping of the identified QTLs and candidate gene identification.

References

Boonham, N., Walsh, K., Smith, P., Madagan, K., Graham, I., & Barker, I. (2003). Detection of potato viruses using microarray technology: towards a generic method for plant viral disease diagnosis. *Journal of Virological Methods*, *108*(2), 181-187.

Cao, P., Jung, K. H., Choi, D., Hwang, D., Zhu, J., & Ronald, P. C. (2012). The Rice Oligonucleotide Array Database: an atlas of rice gene expression. *Rice*, *5*(1), 1-9.

Druka, A., Muehlbauer, G., Druka, I., Caldo, R., Baumann, U., Rostoks, N., ... & Waugh, R. (2006). An atlas of gene expression from seed to seed through barley development. *Functional & integrative genomics*, *6*(3), 202-211.

Fujita, M., Horiuchi, Y., Ueda, Y., Mizuta, Y., Kubo, T., Yano, K., ... & Kurata, N. (2010). Rice expression atlas in reproductive development. *Plant and Cell Physiology*, *51*(12), 2060-2081.

Hegde, P., Qi, R., Abernathy, K., Gay, C., Dharap, S., Gaspard, R., ... & Quackenbush, J. (2000). A concise guide to cDNA microarray analysis. Biotechniques, 29(3), 548-562.

Kohane, I. S., Kho, A. T., Butte, A. J., Pevzner, P. A., & Kho, A. (2003). *Microarrays for an integrative genomics* (Vol. 36). Cambridge, MA: MIT press.

Lesk, A. M. (2017). *Introduction to genomics*. Oxford University Press.

Libault, M., Farmer, A., Joshi, T., Takahashi, K., Langley, R. J., Franklin, L. D., ... & Stacey, G. (2010). An integrated transcriptome atlas of the crop model Glycine max, and its use in comparative analyses in plants. *The Plant Journal*, *63*(1), 86-99.

Liu, F., Xu, W., Song, Q., Tan, L., Liu, J., Zhu, Z., ... & Sun, C. (2013). Microarray-assisted fine-mapping of quantitative trait loci for cold tolerance in rice. *Molecular Plant*, *6*(3), 757-767.

Morales, K. Y., Singh, N., Perez, F. A., Ignacio, J. C., Thapa, R., Arbelaez, J. D., ... & Thomson, M. J. (2020). An improved 7K SNP array, the C7AIR, provides a wealth of validated SNP markers for rice breeding and genetics studies. *PloS one*, *15*(5), e0232479

Schmid, M., Davison, T. S., Henz, S. R., Pape, U. J., Demar, M., Vingron, M., ... & Lohmann, J. U. (2005). A gene expression map of Arabidopsis thaliana development. *Nature genetics*, *37*(5), 501-506.

Sekhon, R. S., Lin, H., Childs, K. L., Hansey, C. N., Buell, C. R., De Leon, N., & Kaeppler, S. M. (2011). Genome-wide atlas of transcription during maize development. *The Plant Journal*, *66*(4), 553-563.

Shai, O., Morris, Q. D., Blencowe, B. J., & Frey, B. J. (2006). Inferring global levels of alternative splicing isoforms using a generative model of microarray data. *Bioinformatics*, *22*(5), 606-613.

Singh, B. D., & Singh, A. K. (2015). *Marker-assisted plant breeding: principles and practices*. New Delhi: Springer India.

Tahmasebi, A., Khahani, B., Tavakol, E., Afsharifar, A., & Shahid, M. S. (2021). Microarray analysis of Arabidopsis thaliana exposed to single and mixed infections with Cucumber mosaic virus and turnip viruses. *Physiology and Molecular Biology of Plants*, 1-17.

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PHYSICAL CONSTRAINTS OF SOIL PRODUCTIVITY AND MANAGEMENT TECHNIQUES

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Introduction

Enhanced soil productivity and assured sustainability are the two major concerns to feed the increasing population of the modernized world. Scientific planning and management practices for further enhancement and sustaining of the productive potential of soils, however, require a proper understanding of the factors which limiting its crop productivity. A constraint free soil environment is very important for achieving higher food production. In India about 85.65 mha of land produce low yield of crops due to unfavourable soil physical conditions and affected by various soil problems. A number of soil physical constraints results into unfavourable soil environment for nutrient availability and utilization by crops. The physical fertility describes state of soil in respect of flow of water and air, thermal regimes and mechanical resistance to growing seedlings and roots. The adverse physical soil environment limits root growth and its activity and results in reduced nutrient absorption and growth of plants. Such physical degradation of soils had affected significant chunk of fertile tracts, particularly in the Indo-Gangetic plains and caused significant loss to crop productivity (Dhaneshwar Padhan *et al.*, 2016).

Causes of soil physical degradation in rainfed regions

The various predominant causes of soil degradation include: (i) water erosion which swings away the topsoil along with organic matter and exposes the subsurface horizons; (ii) repetitive cultivation, (iii) intensive deep tillage and inversion tillage with mouldboard and disc plough resulting in breaking of stable soil aggregates; (iv) nutrient imbalance; (v) mono cropping without following any suitable rotation; (vi) uncontrolled and excessive grazing; (vii) removal of vegetation; (viii) low use of organic manure; (ix) unprotected fields, etc. These are known to cause soil physical deterioration by enhancing erosion in rainfed regions *(Indoria et al., 2017).*

Highly permeable soils

These soils cover large areas (10.77 m ha) in Rajasthan and Haryana. In Tamil Nadu, a total area of about 15 lakh ha was affected by excessively permeable soils. Highly permeable coarse textured soils usually sand (>70%) and loamy sand textures, which are characterized by low water retention, but very high hydraulic conductivity and high basic infiltration rates (36.5 cm/h) and poor inherent fertility, are also prone to wind erosion because devoid of structural development. The structure of soil is loose to very weakly developed depending upon clay content and lack of cohesion, adhesion and plasticity in soil. In these soils, the fertilizer use efficiency is very low and the nutrient losses are very high discouraging the use of high levels of inputs that leads to very low in organic carbon, nitrogen and medium in P and K. So, whatever the nutrients and water added to these soils are not utilized by the crops and subjected to loss (Anonymous, 2009).

Remedial measures:

To correct the textural weakness of these sandy soils and to make them suitable for sound farming, various ameliorative measures have been devised. Introduction of artificial barriers in the subsoil zone using asphalt, bitumen and cement have been found to arrest the higher rate of nutrient and water losses in sandy soils. This technology is costly. To reduce deep percolation losses and enhance soil moisture storage capacity of highly permeable sandy soils, application of bentonite clay, fine textured soils or pond sediments.

Compaction technology:

The soils should be ploughed uniformly. About 24 hours after a good rainfall (or) artificial irrigation, the soil should be rolled 10 times with 400 kg stone roller of 1 m long (or) an empty tar drum filled with 400 kg sand. This practice increases the bulk density of 0-30 cm layer to optimum range (1.5-1.7 Mg/m^3). Then, shallow ploughing should be given and crops can be raised. By mixing of a fine textured soil having 50% clay would reduce the hydraulic conductivity and infiltration rate and also increases the N use efficiency (Anonymous, 2009). Application of mulches is an effective to conserve soil water and moderate soil temperature.

Form small plots and apply minimum and frequent irrigations. Adopt more number of splits of N and K fertilizers. Application of organic materials like FYM, compost, press mud, sugar factory slurry, composted coir pith, sewage sludge etc., or crop rotation with green manure crops like sunhemp, sesbania, daincha, kolinchi *etc*., or application of tank silt or black soil at 25 t ha^{-1} per year along with FYM , composted coir pith/ pressmud at 25 t ha^{-1} decreases bigger pores and increases smaller pores and which reduces HC and increases water retention.

Slowly permeable soils

The slow permeable soil is mainly due to very high clay content and poor drainage conditions which results in poor aeration and water stagnation and ultimately leads to poor crop growth and in certain case leads to complete death of crops. The slow permeability of the soil is mainly associated with black clay soils. These soils cover an area of 9.43 m ha in the Central India comprising Madhya Pradesh, Maharashtra, Andhra Pradesh, Gujarat and in Tamil Nadu, about 7.55 lakh ha of land affected by these soils.

Characteristics:

Slow preamble soils are those having very high clay content and bulk density, poor drainage, hydraulic conductivity and infiltration rate (6 cm/ day) due to higher proportion of pores. Temporary water logging of the soil develops oxygen stress in root zone. Development of salinity with poor drainage, high soil pH and calcareousness may promote ammonia volatilization and these kinds of soil are low in organic carbon N, P, Zn and Fe. It also induce nutrient fixation in the clay complex thereby nutrients become unavailable to crops, eventually causing deficiency of those fixed nutrients.

Remedial measures:

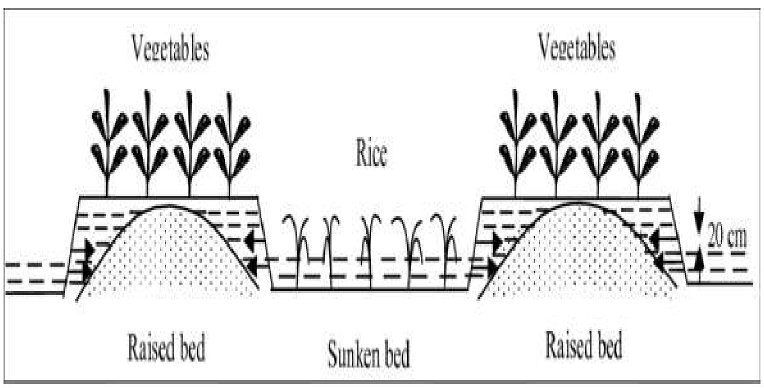
Addition of organics namely FYM/composted coir pith/press mud/urban compost at 12.5 t/ha found to be optimum for the improvement of the physical properties. Application of soil conditioners like H-concentrate, Vermiculite to reduce run-off and soil erosion and application of 100 cart loads of red loam soil which facilitates water movement to the roots.

Formation of ridges and furrows:

For rain fed crops, ridges are formed along the slopes for providing adequate aeration to the root zone. Interception of drainage channels of about 50 cm wide and 15 cm deep provides effective surface drainage.

Raised and sunken beds formation in between adjacent raised beds:

The bulk density was found to be reduced due to increase in non-capillary pores in upper 10 cm layer of raised bed besides increase in yield of crops by forming raised and sunken beds. The 6–12 m wide and 20 cm high raised bed alternating with 6 m wide sunken beds provides in situ drainage. The raised beds are constructed by removing the soil from the sunken beds. Furrow irrigated raised bed planting system (FIRBS) for improving soil physical environment and resource use efficiency has been found to be a useful technology.



Formation of broad beds:

To reduce the amount of water retained in black clay soils during first 8 days of rainfall, broad beds of 3–9 m wide should be formed either along the slope (or) across the slope with drainage furrows in between broad beds. The productivity of sodic clay soils can be increased to a significant extent through use of gypsum and agricultural grade iron pyrites. Long term application of organic manures along with chemical fertilizer under well aerated condition improves the available status of nutrients.

Subsoil hard pans

The reasons for the formation of subsurface hard pan in red soils is due to the illuviation of clay to the subsoil horizons coupled with cementing action of iron, aluminium and calcium carbonate. In Tamil Nadu, the area under subsoil hardpan is around 10, 54,661 ha (10.48% TGA). The occurrence of hard pan at shallow depths is the major prevalent soil physical constraints in these soils are prevalent in Coimbatore, Erode, Dharmapuri, Trichy, Cuddalore, Villupuram, Pudukottai, Sivagangai, Madurai and Salem districts.

Characteristics:

The subsoil hard pan is characterized by high bulk density (more than 1.8 Mg/m^3), which in turn lowers infiltration, water holding capacity, available water and movement of air and nutrients with concomitant adverse effect on the yield of crops.

The high bulk density in sub surface soil results in water stagnation on the soil surface after heavy rainfall (or) irrigation and the crops turn yellow due to oxygen stress. In high rainfall areas, sub surface layers at shallow depth reduce water storage capacity of the soil and run off starts even after a short shower, which cause floods in low-lying areas.

Remedial measures:

To eradicate the problem of subsoil impervious layer, chisel plough is recommended. Chisel plough is a heavy iron plough which goes up to 45 cm depth, thereby shatters the hard pan in the subsoil. The field is to be ploughed with chisel plough at 50 cm interval in both the directions, chiseling helps to break the hard pan in the subsoil and farm yard manure (or) press mud (or) coir pith at 12.5 t/ha is to be spread uniformly on the surface. The field should be ploughed with country plough twice for incorporating the added manures. The broken hard pan and incorporation of manures make the soil to conserve more moisture.

Soil Surface Crusting:

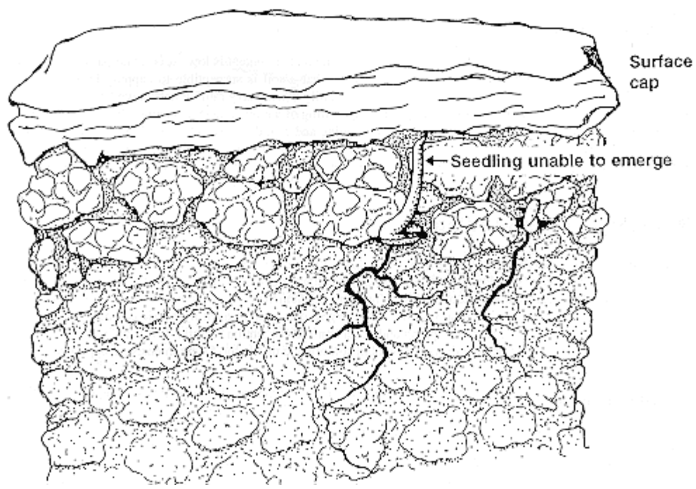
Surface crusting is due to the presence of colloidal oxides of iron and aluminium in Alfisols, which binds the soil particles under wet regimes. On drying it forms a hard mass on the surface. The alluvial sandy loam soils in Haryana, Punjab, Rajasthan, Uttar Pradesh, Bihar and West Bengal form a crust on the soil surface, which interferes with germination and growth of crops. The red sandy loam soils 'Chalkas' which cover a large area of Andhra Pradesh become very hard on drying with the result that the crop growth is adversely affected. The emergence of seedling in crops like pearl millet, cotton, sorghum, mustard etc. is reduced drastically when rain showers occurs within one or two days of seeding.

In Tamil Nadu, the area under soil crusting is around 4,51,584 ha (4.49% TGA) and this problem is prevalent mostly in red soil areas (Alfisols) and is of greater magnitude in districts like Trichy, Pudukottai, Ramnad and Tirunelveli.

The crusting of soils is directly related with aggregate stability, rainfall characteristics and its chemical composition. The poorly aggregated soil particles in alluvial, red and lateritic soils disintegrate easily under the impact of rain drops. The quantity of dispersed soil increases with the increase in drop size, drop velocity and rainfall intensity. The hydration of aggregates causes a disruption through the process of swelling and explosion of entrapped air. The fine fractions go into the suspension, which may either enters into the soil and clog the macropores or resettles on the surface to form a crust.

(a) Impact on soil properties

- Prevents germination of seeds
- Retards/inhibits roots growth
- Results in poor infiltration
- Acceleration of surface runoff
- Creates poor aeration in the rhizosphere
- Affects nodule formation in leguminous crops.



(b) Properties and effect of soil crust formation

The thickness of the crust also depends upon the amount and type of clay and silt present in the soil. Small amount of kaolinite type of clay tends to form a thin crust which curls up and breaks on drying, but montmorillonite type of clay tends to form a thick and hard crust. Soils having low organic matter, high silt content and high exchangeable sodium percentage more susceptible to formation of soil crust. Soil crusts have high BD, low non-capillary porosity and high soil strength. Soil crusting generally found in laterite group of soils, which have high amounts of soluble iron and alumina.

(c) Evaluation of Soil Crust Strength

- It can be evaluated by using Penetrometer, balloon pressure technique or modulus of rupture test.

(d) Remedial measures

Ploughing to be given when the soil moisture regime at optimum condition, followed by lime at 2 t ha^{-1} may be uniformly spread and another ploughing given for blending of the amendment with the surface soil. FYM 10 to 12.5 t ha^{-1} (or) composted coir pith at 12.5 t ha-1 (or) other organics may be applied to improve the physical properties of the soils after preparation of land to optimum tilth. Combined application of lime and FYM enhanced the yield of crops besides improving the physical properties of the soil. Scarping surface soil by tooth harrow will be useful. Bold grained seeds may be suited for sowing on the crusted soils; more number of seeds/hill may be adopted for small seeded crops. Sprinkling water at periodical intervals may be done wherever possible. Resistant crops like cowpea can be grown. Most of the red and laterite soils are poor in organic matter and therefore deficient in nitrogen. Organic manures and use of bio-fertilizers holds promise. These soils having high activity of Fe and Al in soil solution fix a good amount of soluble P. Application of rock phosphate will increase the available P and crop yield. Application of FYM on seed lines as mulch is very helpful in reducing the ill-effects of surface crust on seedling emergence and crop establishment in crust prone sandy loam and loamy sand soils. Upon mulching, the yield of pearl millet and cotton increases. Thus, FYM seed line mulch reduces the impact of rain drops and prevents the formation of the crust, improves the seedling emergence and yield of crops.

Fluffy paddy soils

The traditional method of preparing the soil for transplanting rice consists of puddling. This results in substantial break down of soil aggregates into a structure less mass. Intensive puddling deteriorates the soil structure and creates problem for subsequent crops say for wheat crops in rice-wheat cropping system in north India. The solid and liquid phases of the soil are thus changed. Under continuous flooding and submergence in rice-rice-rice sequence, the soil particles are always in a stage of flux and the mechanical strength is lost leading to the fluffiness of the soils. This is further aggravated by in situ incorporation of rice stubbles and weeds during pudding. In Tamil Nadu fluffy rice soils are prevalent in Cauvery deltaic zone and in many parts of the state due to the continuous rice-rice cropping sequence, which occupied 25,919 ha of land area (0.26% of TGA).

Impact:

Impact of fluffiness is sinking of drought animals and labourers during puddling in rice fields which is an invisible drain of finance for farmers due to high pulling power needed for bullocks and slow movement of labourers during puddling operations. Further fluffiness of the soil lead to very low bulk density and thereby leading to very rapid hydraulic conductivity and in turn the soil does not provide a good anchorage to the roots and the potential yield of crops is also adversely affected.

Management options:

Irrigation should be stopped 10 days before the harvest of rice crop. After the harvest of rice, when the soil is under semi-dry condition proctor moisture level, compact the field by passing 400 kg stone roller or an empty tar drum filled with 400 kg sand 8 times along with addition of lime @ 2 t ha^{-1} once in three years. Usual preparatory cultivation is carried out after compaction. For sustain the productivity of rice soils by application of organic amendments and crop residue management suggested that the organic amendments significantly increases the yield of rice and wheat due to enhanced nutrients supply and improvement in soil physical conditions. Leguminous green manures during puddling for growing paddy have been found successful.

References

Anonymous, 2009. *Fundametals of Soil Science.* By Indian Society of Soil Science, NASC Complex. Printed at Cambridge Printing Works, B-85, New Delhi- 110 028, pp.106-113.

Dhaneshwar Padhan, Arbind Kumar Gupta, A. Krishna Chaitanya and Shyam Prasad Majumder. 2016. Soil physical constraints for sustainable crop production and their management options. Source from: www.krishisewa.com

Indoria, A. K., K. L. Sharma, K. Sammi Reddy and Ch. Srinivasa Rao 2017. Role of soil physical properties in soil health management and crop productivity in rainfed systems-I: Soil physical constraints and scope. *Current Science*, Vol. 112 (12): 2405-2414.

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UTILIZATION OF RICE LANDRACES FOR SALINITY TOLERANCE BREEDING

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Introduction

For more than 60 per cent of the world's population, rice (*Oryza sativa* L.) is the most significant staple food crop and the least expensive source of both food and energy. Abiotic and biotic stresses, which prevent a crop from yielding more than what is theoretically possible based on genetics, are the main factors limiting rice output globally. Overcoming these limitations and producing high-yielding rice cultivars with a variety of abiotic and biotic stress resistances represents the main challenge for plant breeders. (Singh *et al.*, 2016).

Landraces, "it is a dynamic population(s) of a cultivated plant that has a historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems". (Dwivedi *et al.*, 2016). Salinity is the second most common soil issue in nations where rice is grown, behind drought, and it is thought to be a significant global constraint on rice production. (Gregorio, 1997). Traditional rice cultivars have several stress-resistant qualities. Despite growing propaganda on supporting the growth of high-yielding rice varieties, these qualities help keep rice landraces alive (Das *et al.*, 2013).

Thus, the landraces which are capable of being resistant to saline conditions can be used for breeding programmes for developing saline-tolerant varieties. The genetic diversity found in landraces can be used to identify and introduce salinity tolerance genes and traits into breeding lines, which can enhance the productivity and resilience of crops grown in salt-affected soils. Landraces also provide an opportunity to develop region-specific varieties that are adapted to local environmental conditions, including soil salinity. However, landraces are threatened by modern agricultural practices, urbanization, and climate change, which can lead to their loss and erosion of genetic diversity. Therefore, the conservation and use of landraces are crucial for sustainable agriculture and food security, particularly in areas affected by soil salinization. The integration of landraces into modern breeding programs can facilitate the development of more productive and resilient crops that can thrive in salt-affected environments.

Use of landraces in Breeding programmes:

The first step in using these traditional lines in breeding programmes is a thorough physio-biochemical screening as well as molecular marker-based profiling in connection to various abiotic stress tolerance to establish the traditional information that is currently available from farmers. While molecular profiling uses several stress tolerance-associated associated markers to genotype the researched lines, physiological characterization is most frequently accomplished by studying various physiological parameters under various experimental osmotic stresses. (Karmakar *et al.*2012).

In addition to using landraces, other breeding techniques, such as mutagenesis, gene editing, and transgenic approaches, can also be used to develop crops with improved salinity tolerance. However, using landraces in breeding programs can offer several advantages, such as preserving genetic diversity, adapting crops to the local environment, and avoiding some potential risks associated with genetic engineering.

Table 1. Rice landraces of different states having salinity tolerance at different growth stages

Salinity Tolerance	**State**	**Landraces**	**Reference**
Salinity Tolerant	Kolkata	Gheus, Ghunsi, Kuthiahara and Sholerpona	Ali *et al.*,2014
Salinity Stress	Himalayan	Saunji, Anjani, Bauran,	Agnihotri *et al.*, 2006

Resistance During Germination and Early Seedling Growth	region of Kumaun, Uttaranchal	Bindudhan, Dalbadal, Dudhikapkoti, Kaun-kaun, Tilansi	
Salinity tolerant at the seedling stage	Assam	Kolajoha	Mazumder *et al.*, 2020
Salt tolerant	Bangladesh	Vusieri, Nonabokra, Ghunsi, Hogla, Holdegotal, Kanchon	Rasel *et al.*, 2020
Salt tolerant	Bangladesh	Morishal	Bhowmik *et al.*, 2021
Osmotic stress tolerant	West Bengal	Kelas and Bhut Moori	Karmakar *et al.*, 2012
Salinity tolerance	Sundarbans	Balam, Lal Joyari, Patnai, Chamarmoni, Baskati, Sita sal, Agni Shikha, Nageswari, Gheus, Alta Pati, Pnathua, Harma Nona, Harina Khuri, Meghna Dumuru, Tal mugur, Mugi, Asfal, Khejur Chhori, Mach Kantha, Kute Patnai,	Aich *et al.*, 2022

Genetics and Physiology responsible for salt-tolerance

In numerous breeding efforts and investigations about salt tolerance, pokkali is frequently employed as a donor. On chromosome 1, a major Quantitative Trait Loci (QTL) called Saltol has been identified in one of the Recombinant Inbred Lines (RILs). It was in charge of preserving the low Na+, high K+, and Na+/K+ equilibrium in rice shoots. Salinity stress is a multigenic characteristic that includes the coordinated action of numerous genes. Plant breeders have used marker-assisted backcrossing and selection to transfer the entire Saltol QTL to order to confer salinity tolerance on some elite rice varieties, while molecular biologists have looked for candidate genes within the Saltol QTL that is essential for achieving salinity tolerance. (Waziri *et al.*, 2016).

There are several physiological metabolisms carried out in plants during saline stress one is they can compartmentalize salt within their cells, preventing it from accumulating in sensitive organelles. This is achieved through synthesising and accumulating compatible solutes, such as proline, glycine betaine, and trehalose, which are osmoprotectants and maintain cellular turgor in the essence of high salt concentrations. Furthermore, salt-tolerant plants can activate antioxidant defence systems to scavenge ROS.

Salt tolerant Landraces and Varieties of India

Landraces are traditional cultivars that evolved through farmers' selection in a confined region. These are pure lines or homogenous populations which have specific adaptations and are more genetically diverse than the commercial varieties. These contribute valuable alleles in breeding programmes. Salt tolerant landraces or genotypes can be used as a cultivar or indirectly in the varietal development programme.

Table 2. Salt-tolerant landraces of rice utilized in varietal selection (Sing *et al.*, 2010)

Landrace used	Selected variety	Attributes
Jhona	Jhona 349	Sodic soils of Punjab and Haryana
Chaul Local	T 21	Sodic soils of Uttar Pradesh
Kashi	Lakra or T 22A	
Bhanslot	Type 100	
Kalambank	SR 26B	Coastal saline soils of the East Coast
Local collections	SR 8	Coastal saline soils of Odissa
Local collections	Raspanjore	
BuddaMologolakulu	MCM 2	Coastal saline soils of Andhra Pradesh
Local collections	Kalar Samba	Coastal saline and sodic soils of Tamil Nadu
Local collections	Kallimadyan	
Local Rata	Kala Rata 1-24	Coastal saline soils of Maharashtra
Local Rata	Bhura Rata 4-10	
Patnai	Patnai 23	Coastal saline soils of West Bengal

Patnai	Patnai 298	
Damodar	CSR 1	
Dasal	CSR 2	
Getu	CSR 3	
Benisail	Matla	
Nona Bokra	Hamilton	
Local collections	VelkiBhaluki	Coastal saline soils of West Bengal and Odissa
Local collections	Rupsal	
Nonasail	CSR 6	
Arya	Arya 33	Saline and sodic soils of Karnataka
Karekagga	Ankola	
Local collections	Pokkali	Coastal saline soils of Kerala
Cheltivirippu	Mo 1	
Kalladachampavu	Mo 2	
Kunjathikkara	Mo 3	
Chottupokkali	VTL 1	
Cheruvirippu	VTL 2	
Orumundakan	Sagara	Saline track of Karthikappally taluk, Kerala
Local collections	Korgut	Coastal saline soils of Goa
Local collections	A 280	

Rice accessions developed through recombination breeding using landraces at IRRI

A vast number of rice accessions developed through recombination breeding have been tested at IRRI, Philippines. The hybridization-derived lines may be tolerant or moderately salt tolerant in affected soil conditions (Islam *et al.*, 2012). These salt-tolerant IRRI lines have been derived through hybridization with some of the most salt-tolerant rice accessions or traditional cultivars. The traditional cultivars may include Pokkali, Wagwag, ZawaBonday, Nam, KhaoSeetha, Cheriviruppu, Annapurna, Nona Bokra, Hamilton, Daeyabyeo, Giza 177 and Suweon. These salt-tolerant lines were hybridized with IR 20, IR 24, IR 28, IR 29, IR 36, IR 64, IR 68 and IR 72.

Table 3. Salt-tolerant rice accessions developed through recombination breeding at IRRI, Philippines (Islam *et al.*, 2012)

Variety	Parentage
FLT 378	IR 29/Pokkali B
NSIC 106	IR 32429/Wagwag
MS 13	IR 72/ ZawaBonday
NPT 1	IR 64/Nam
IR66404-4B-20-1-2	IR 52952/KhaoSeetha
IR65775-4B-19-1-3	IR 36/KhaoSeetha
IR55182-3B-14-3-2-3	IR9884/Cheriviruppu
IR 58430-6B-14-1-2	Annapurna/Pokkali
IR58427-5B-15	Annapurna/IR10206
IR63731-1-1-1-4-3	IR 28/Nona Bokra
IR64195-3B-9-2	IR39537/Hamilton
IR74099-3R-2-2	Daeyabyeo/Giza 177
IR68652-3B-16-2	IR 20/Pokkali B
IR69587-3R-P-4-1	IR 24//IR 20/Pokkali B
PSBR$_C$48	Nona Bokra/IR2070-414-3-9-6//IR 34
IR73104-B-8-2-2-1	Pokkali B/Suweon 290
IR70869-B-P-16-2	Pokkali B/IR 20/IR 24
IR70869-B-P-25-3	Pokkali B/IR 20/IR 24

Rice accessions identified for cultivation in salt-affected soils of different countries (Sankar *et al.*, 2011)

Rice accessions that have been identified for cultivation in salt-affected soils of different countries have unique genetic and physiological traits that enable them to tolerate high levels of salinity in the soil while still producing good yields of rice grains. These accessions are critical for ensuring food security in regions where salinity is a significant problem for rice cultivation.

Table 4. Rice accessions identified in different countries for salt tolerance (Sankar *et al.*, 2011)

Country	Rice accessions
India	CSR 30 (Yamini), CSR 36 (Naine), Lunishree, Vytilla 1, VTL 2, VTL 3, VTL 4, VTL 5, VTL 6, Panvel 1, Panvel 2, Panvel 3, Sumati, Sindewahi 1, Jarava, Butnath, Usardhan 1, Usardhan 2, Usardhan 3, CO 43, IET 1444 (Rasi), Kalarata, Nana Bokra (IRGC 22710), Pokkali (IRGC 108921), Cheriviruppu, Basmati 217, Damodar, FR13A, ARC 18567, AD 85002, IET 8113, and TRY 1; CORH 2, DRRH 1, PSD 1, KRRH 1, CNRH 3, NarendraUsar, Sankardhan 3 (Saline tolerant rice hybrids)
China	Ching-Tai-Chan, Zihui 100, Haoannong, Y134,Jingnuo, Linyitangdao, Xigu, Bairizao, Xiaojingdao, Cun-an lengshuibai, 80-85, Zhuxi 26, Sunuo 1, Zhengxian 139, Nanjing 570, Haoanxie, Zhuguang 23, Zhuguang 29, Taihuzao, Aijiaoloolaiquing, Jiucaiging, Maxiangu, Maodao,Erzaobaiguo,Hongmangxiangjingnuo, Hongkenuo, Meimanggui, Longjianghong, , Dahonggu, Huangjingnuo, Dayanggu, Yingyang 1, Shengshuilian, Xianzhan, Damangdao, Goaliangdao, Changbai 7 Liaoyan 2, and Wanmanzao
Philippines	IR 6, IR 24, IR 42, Hagonoy (IRRI 112), Bicol (IRRI 113), Sipocot (IRRI 124), Matnog (IRRI 125), Naga (IRRI 126), NSICR$_C$ 106 (IRRI 128), Gundang , Jumbo-Jet, Azucenaand NSICR$_C$ 182 (IRRI 147)
Bangladesh	BRRI dhan 40, BRRI dhan 41, BRRI dhan 47, BRRI dhan53, BRRI dhan 54, BRRI dhan55, Dular, Panbira, Siral, Gota, Minikit, Ashrafuli, Swarnapajan, Capsule, Kutipatnai, Bora DudhKalam, Hoglapata, Urichadra, Gurdoi, Demshi, GiaDhan, Dharga Sail, Gachia, Horkocha, Chola Mora, Rayada, Bora Dhan, Rajasai, ChiniSakkorl, BR 203-26-2, Kalimekri, Bhirpalaand Ghunshi
Pakistan	Basmati 198, Super Basmati, Basmati 385, Sathra 278, SRI-12, SHP, Jajai-77, KSK 133, KSK 282, Fakhre-Malakhand, Pakhal, Khushboo, Shahkar, Mushkan 41 and Shua-92
Egypt	Giza 117, Giza 178, Sakha 104 and Sakha 111

Vietnam	Lay, Chiu Han, LuaHuong, Trung Dung, Mot Bui Co Don, Co To, Bong Lu Tim, Ro Dinh Vo Den, Nang Sen Ran, Nep Mua, Nanh Chon, Goi 2, Lua F 5, Chet Xanh, Nho Thom, Tien Nu, Trang Cut, Nep Lem, Ca Dung Ket and AS 996
Guinea-Bissau	Sam
Senegal	Eratio, Walimbo
Thailand	Daw Hawn
Iran	Mulai, Anbarloo Sadri, Hassan Tareme, Dom Sofid, Larome, MassanMulat
Combodia	Mua So 43, Mua So 53, TrangQuang and Mua So 58
Japan	Mantaro rice, Guandong 51, Binren, Zhuziqing and Lansheng
Myanmar	Taangteikpan, Shwethweyin, Shwewatun and Yezin 3
Kenya	MsalimJaro
USA	Carolina Gold, Cypress

Conservation of Landraces:

For the preservation of grain genetic resources, two techniques are used: "in-situ" and "ex-situ." Both conservation techniques have advantages and drawbacks. In contrast to ex-situ conservation, which takes place "outside of their natural habitats" in designated gene banks or other national or regional conservation centres, in situ conservation is carried out on farms in "the natural habitats and includes the maintenance and recovery of viable populations of species in their natural surroundings." (Pinheiro *et al.*, 2013).

Conclusion

Landraces are traditional, locally adapted varieties of crops that have evolved over generations in response to various environmental stresses, including salinity. As such, they represent an important source of genetic diversity that can be harnessed to improve salinity tolerance in modern crop varieties through breeding programs. The genetic diversity found in landraces can be used to identify and introduce salinity tolerance genes and traits into breeding lines, which can enhance the productivity and resilience of crops grown in salt-affected soils. Therefore, the conservation and use of landraces are crucial for sustainable agriculture and food security, particularly in areas affected by soil salinization.

References

Aich, A., & Dey, D. (2022). Performance of Selective Indigenous Rice Landraces in Rain Fed Agro Ecological System of Indian Sundarbans [Preprint]. *Open Science Framework*. https://doi.org/10.31219/osf.io/c4gdp

Ali, A. J., Xu, J. L., Ismail, A. M., Fu, B. Y., Vijaykumar, C. H. M., Gao, Y. M., Domingo, J., Maghirang, R., Yu, S. B., Gregorio, G., Yanaghihara, S., Cohen, M., Carmen, B., Mackill, D., & Li, Z. K. (2006). Hidden diversity for abiotic and biotic stress tolerances in the primary gene pool of rice revealed by a large backcross breeding program.*Field Crops Research*, *97*(1), 66–76. https://doi.org/10.1016/j.fcr.2005.08.016

Ali, Md. N., Yeasmin, L., Gantait, S., Goswami, R., & Chakraborty, S. (2014). Screening of rice landraces for salinity tolerance at seedling stage through morphological and molecular markers. *Physiology and Molecular Biology of Plants*, *20*(4), 411–423. https://doi.org/10.1007/s12298-014-0250-6.

Bernstein L and Hayward H E (1958), Physiology of Salt Tolerance, *Annual Review of Plant Physiology*, 1958 9:1, 25-46.

Bhowmik, U., Kibria, M. G., Rhaman, M. S., Murata, Y., & Hoque, Md. A. (2021). Screening of rice genotypes for salt tolerance by physiological and biochemical characters. *Plant Science Today*, *8*(3). https://doi.org/10.14719/pst.2021.8.3.1098

Das, T., & Das, A. K. (2014). Inventory of the traditional rice varieties in the farming system of southern Assam: A case study. *Indian Journal of Traditional Knowledge* Vol. 13 (1), January 2014, pp. 157-163.

Dwivedi, S.L.; Ceccarelli, S.; Blair, M.W.; Upadhyaya, H.D.; Are, A.K.; Ortiz, R. Landrace germplasm for improving yield and abiotic stress adaptation. Trends Plant Sci. 2016, 21, 31–42.

Gregorio GB, Senadhira D, Mendoza RD (1997) Screening rice for salinity tolerance, vol 22, IRRI Discussion Paper Series. International Rice Research Institute, Laguna Philippines, pp 1–30

Islam, Md. R., G.B. Gregorio, Md.A. Salam, B.C.Y. Collard, R.K. Sing and L. Hassan, 2012. Validation of SalTol linked markers and haplotype diversity on chromosome 1 of rice. *Molecular Plant Breeding*, 3(10):103-114.

Karmakar, J., Roychowdhury, R., Kar, R. K., Deb, D., & Dey, N. (2012). Profiling of selected indigenous rice (Oryza sativa L.) landraces of Rarh Bengal about osmotic stress tolerance. *Physiology and Molecular Biology of Plants*, *18*(2), 125–132. https://doi.org/10.1007/s12298-012-0110-1

Karmakar, J., Roychowdhury, R., Kar, R. K., Deb, D., & Dey, N. (2012). Profiling of selected indigenous rice (Oryza sativa L.) landraces of Rarh Bengal in relation to osmotic stress tolerance. *Physiology and Molecular Biology of Plants*, *18*(2), 125–132. https://doi.org/10.1007/s12298-012-0110-1

Mazumder, A., Rohilla, M., Bisht, D. S., Krishnamurthy, S. L., Barman, M., Sarma, R. N., Sharma, T. R., & Mondal, T. K. (2020). Identification and mapping of quantitative trait loci (QTL) and epistatic QTL for salinity tolerance at seedling stage in traditional aromatic short grain rice landrace Kolajoha (Oryza sativa L.) of Assam, India. *Euphytica*, *216*(5), 75. https://doi.org/10.1007/s10681-020-02602-0

Pinheiro de Carvalho, M.A.A.; Bebeli, P.J.; Bettencourt, E.; Costa, G.; Dias, S.; Dos Santos, T.M.M.; Slaski, J.J. Cereal landraces genetic resources in worldwide GeneBanks. A review. *Agron. Sustain. Dev*. 2013, 33, 177–203.

Rasel, Md., Tahjib-Ul-Arif, Md., Hossain, M. A., Hassan, L., Farzana, S., & Brestic, M. (2021). Screening of Salt-Tolerant Rice Landraces by Seedling Stage Phenotyping and Dissecting Biochemical Determinants of Tolerance Mechanism. *Journal of Plant Growth Regulation*, *40*(5), 1853–1868. https://doi.org/10.1007/s00344-020-10235-9

Sankar, P.D., M.A.A.M. Saleh and C.I. Selvaraj, 2011. Rice breeding for salt tolerance. **Research in Biotechnology**, 2(2):1-10.

Sing, R. K., E. Redone, L. Refuerzo, 2010. Breeding efforts in rice for salinity tolerance. In Abiotic stress adaptation in plants. Editors. Ashwani P., S.K.Sopory, H.J. Bphnert and Govindjee. Springer Publ.

Singh R, Singh Y, Xalaxo S, Verulkar S. et al. From QTL to variety- harnessing the benefits of QTLs for drought, flood and salt tolerance in mega rice varieties of India through a multi-institutional network. Plant Science, 2016; 242: 278-287.

Waziri A, Kumar P and Purty RS (2016), Saltol QTL and Their Role in Salinity Tolerance in Rice. *Austin J. Biotech. & Bioengineering*, 3(3): 1067.

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YELLOW MOSAIC DISEASE: A SERIOUS THREAT TO BLACKGRAM CULTIVATION

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Introduction

Yellow mosaic disease (YMD) is the major limiting factor for the low productivity of the blackgram. The disease causes overall yield loss ranging between 10 and 100%, depending on the stage of crop and the genotype infected; an annual yield loss of about US $ 300 million in a year (Varma *et al*., 1992) is predicted. Nariani (1960) first reported the yellow mosaic disease in greengram in the experimental fields at Indian Agricultural Research Institute, Pusa, New Delhi.

The yellow mosaic disease is caused by a geminivirus belonging to the genus *Begomovirus* (family *Geminiviridae*) and these totally seven begomovirus species are, mungbean yellow mosaic virus (MYMV), mungbean yellow mosaic India virus (MYMIV), Dolichos yellow mosaic virus (DoYMV), horsegram yellow mosaic virus (HgYMV), Velvetbean severe mosaic virus (VBSMV), Kudzu mosaic virus (KuMV) and Rhynchosia yellow mosaic virus (RhYMV) in South and South East Asia. Among these, MYMV and MYMIV are important species infecting grain legumes in India. MYMV is the most prominent in Southern India.

Begomovirus

The begomoviruses are characterized by quasi-icosahedral twinned particles of 18×30 nm size encapsidating circular single stranded DNA and its genome contains two DNA components. The DNA A component contains six open reading frames (ORFs), two in the viral sense strand and four in the complementary sense strand and encodes for coat protein (CP, V1/AV1) and Pre-coat protein (AV2/V2) in viral strand and replication initiation protein (Rep, C1/AC1), transcription activator protein (TrAP, C2/AC2), replication enhancer protein (REn, C3/ AC3) and PTGS suppressor (C4/AC4) on complementary strand (Rojas *et al*., 2005; Seal *et al*., 2006). The product of an additional complementary-sense gene (AC5), which is only conserved amongst legume YMVs, has been shown to have a possible role in viral genome replication (Raghavan *et al*., 2004). DNA-B has two ORFs encoding movement proteins: BV1 (nuclear shuttle protein, NSP) on the virus-sense strand and BC1 (movement protein, MP) on the complementary-sense strand (Rojas *et al*., 2005; Seal *et al*., 2006). The DNA A and DNA B components of a virus have a highly conserved non-coding intergenic region referred to as common region (CR), which contains a stem-loop structure with the loop containing the invariant nanonucleotide sequence TAATATTAC that represent the origin of viral strand replication (Hanley-Bowdoin *et al*., 1999).

History and distribution of yellow mosaic disease

Yellow mosaic disease (YMD) was first reported from western India in the late 1940s in Lima bean (Capoor and Varma, 1948) and later Nariani (1960) reported in greengram in the experimental fields at Indian Agricultural Research Institute, Pusa, New Delhi. Since then the YMD was observed subsequently throughout India in almost all major legume crops. Similarly, in the regions of the subcontinent now forming part of Pakistan, YMD was first reported in cowpea in Faisalabad (Vasudeva, 1942). Across the subcontinent, including India, Bangladesh, Pakistan and Sri Lanka, YMD is a major constraint to the production of most of the major legume crops. A severe outbreak of YMD in greengram occurred in northern Thailand in 1997. This caused major losses to production and initiated a shift in cropping practices. Several variants of these viruses causing YMDs in grain legumes in different geographical regions of India have been detected (Varma *et al*., 1998; Ilyas *et al*., 2010; Satya *et al*., 2015).

Symptoms

Symptoms caused by YMV are largely dependent on host species and susceptibility. In blackgram, greengram and soybean, YMV causes irregular yellow and green patches on older leaves and complete yellowing of young leaves of susceptible varieties. Affected plants produce fewer flowers and pods; pods often develop mottling, remain small and contain fewer and smaller seeds. In blackgram two types of symptoms viz., yellow mottle and necrotic mottle can be distinguished (Nair and Nene, 1974; Nene, 1973). The necrotic mottle is usually associated with resistance. In pigeon pea, initially the symptoms appeared as yellow specks on the newly developed leaves. The specks coalesced and formed yellow patches against the green background of the lamina. In cowpea, affected plants showed a yellow mosaic with downward leaf curling, vein swelling, vein enations and severe leaf distortion (Rouhibakhsh and Malathi, 2005). Infections of french bean usually did not produce a mosaic but instead induced a downward leaf curling (Qazi *et al*., 2007a).

Host range

Yellow mosaic virus species mostly infect dicotyledonous plants especially leguminous crops and weeds. The crop species affected include; lima bean (Capoor and Varma, 1948), dolichos (Capoor and Verma, 1950), greengram, blackgram and soybean (Nariani, 1960; Nene, 1972), pigeon pea (Williams *et al*., 1968), horsegram and french bean (Muniyappa *et al*., 1976), groundnut (Sudhakar Rao *et al*., 1979), moth bean (Satyavir, 1980), cluster bean (Rao *et al*., 1982) and cowpea (Varma and Reddy, 1984). The host range of YMV in Thailand appears to be restricted to plants in the family *Leguminosae* (Honda *et al*., 1983). Differences in the host range of YMV isolates have been studied by various workers, but the results continued to be ambiguous (Varma and Malathi, 2003). The difficulty was mainly due to vector feeding behaviour, the host genotypes used and the environmental conditions provided. The difficulty in vector transmission of the virus from cowpea was also experienced by Thottapilly *et al*. (1998) when they attempted to transmit the cowpea golden mosaic virus from cowpea to lima bean. Pigeon pea isolate of MYMV (MVMV-Pp) could be transmitted by whitefly to greengram, blackgram, french bean, soybean, lima bean, horsegram and cowpea (Mandal *et al*., 1998). Soybean isolate of *Mungbean yellow mosaic India virus* (MYMIV-Sb) has the ability to infect cowpea, blackgram and greengram. MYMIV-Sb characteristically differed from MYMIV-Bg and MYMIV-Mg isolates in being infectious on cowpea and produce typical golden mosaic symptoms (Usharani *et al*., 2005). Cowpea isolate of MYMIV was transmissible by whitefly to cowpea, yard long bean and french bean and not to any other legumes (Malathi *et al*., 2005).

Epidemiology

The maximum incidence of YMV was recorded in greengram sown from March-May while low disease incidence was observed in the crop raised from August-December under South Indian conditions (Murugesan and Chelliah, 1977b). High temperature has been found to be positively correlated with *B. tabaci* population in 20-30 days old crop and with disease incidence in 45 days old crop. Multiple regression technique indicated that partial regression coefficient on maximum temperature alone was important in predicting the whitefly population one week in advance, whereas partial regression coefficient on maximum temperature, rainfall and vector population were important to predict the disease outbreak (Murugesan *et al*., 1977). Singh and Gurha (1994) also observed the highest disease incidence in summer sown greengram (March-April) compared to the crop grown in kharif and spring season at Kanpur, under North Indian conditions. Livinder *et al*. (2009) reported that the highest yellow mosaic disease incidence was observed when the temperature was maximum (34-35ºC), whereas no disease incidence was observed when there was heavy and wide spread rain during August. Khan *et al*. (2012) studied the correlation of environmental factors (maximum and minimum temperature, relative humidity and rainfall) with yellow mosaic disease and found significant correlation of environmental variables with yellow mosaic disease incidence.

Transmission

The YMV isolates of Indian subcontinent are not sap transmissible (Nariani, 1960), however a *Mungbean yellow mosaic virus* isolate from Thailand is sap transmissible (Honda *et al*., 1983). Yellow mosaic viruses are transmitted by whitefly, *B. tabaci* Genn. in a persistent circulatory manner. Even a single whitefly can transmit the virus and cause 25 per cent infection. Female whiteflies are better transmitters and also retain the virus for a longer period (10 days) than the male (3 days). The yellow discoloration of pods and seeds of infected plants and symptom emergence in the very first trifoliate leaf of the plants in the field were suggestive that MYMV may be seed borne, which was investigated by Kothandaraman *et al*. (2016). The distribution of the virus in various parts of the seeds of blackgram plants naturally infected in the field was determined by polymerase chain reaction (PCR). Southern blot analysis and nucleotide sequencing of the PCR amplicons from the seed parts from groups of ten seeds revealed the presence of MYMV in the seed coat, cotyledon, and embryonic axes.

Management

- Growing resistant varieties such as VBN 4, VBN 6, VBN 8, VBN 9, VBN 10 and VBN11 (Blackgram)
- Seed treatment with imidacloprid 600FS @ 5 ml/kg of seeds
- Remove the weed hosts periodically.

- Increase the seed rate (25 kg/ha).
- Installation of yellow sticky traps @ 12 numbers / ha
- Rogue out the virus infected plants up to 45 days
- Foliar spray of 10% notchi leaf extract at 30 DAS or neem formulation @ 3 ml/l
- Spray methyl demeton 25 EC 500 ml/ha or dimethoate 30 EC 500 ml/ha or thiamethoxam 75WG @ 100 g/ha or imidacloprid 17.8 SL @ 250 ml/ha or thiamethoxam 75 WS 1 g /3 lit and repeat after 15 days, if necessary

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UNLOCKING THE GENETIC POTENTIALS FOR DIFFERENT SPECIAL PURPOSE SORGHUMS

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Introduction:

Sorghum, a versatile and genetically diverse cereal, offers a treasure trove of untapped potential. This article delves into the surprising array of uses and benefits that sorghum can provide, from popping sorghums that rival popcorn to vegetable sorghums that offer a new twist on sweet corn. We explore how yellow-grained sorghums can combat vitamin A deficiency, quick-cooking sorghums that save time and energy, and aromatic sorghums that rival the fragrance of basmati rice. Additionally, we uncover the world of sweet sorghum, a renewable source of energy and food. The article also introduces the little-known "shallu" sorghum, which can be boiled like rice, and free-thrashing sorghums that simplify harvesting. Lastly, we touch upon broom sorghum, an essential resource for broom and brush production.

Sorghum, often overshadowed by other cereal crops, possesses an astonishing range of genetic diversity and untapped potential. This article will take you on a journey through the remarkable world of sorghum, showcasing its unexpected uses and the promising resources it offers. From popping sorghums that resemble popcorn to vegetable sorghums that rival sweet corn, sorghum's versatility knows no bounds. It holds the key to addressing vitamin A deficiency, offers quick-cooking solutions, and even boasts aromatic varieties reminiscent of fragrant basmati rice. Additionally, sweet sorghum emerges as a renewable energy source and food, while unique types like "shallu" sorghum, free-thrashing sorghums, and broom sorghum offer intriguing possibilities.

Breeding for special purpose Sorghum (NASEM, 1996)

Sorghum's range of genetic diversity is truly amazing. Many of the unusual types are promising resources in their own right. Some have properties and uses quite unexpectedly of a cereal. A few hold out the possibility of producing far better grains than those of today's major sorghums. Others could provide entirely new types of sorghum foods. Yet others can yield feed, forage, fertilizer, fibre, fuel, sugar, and raw materials for factories of many kinds. In this array of plant types, the vast potential of this remarkable species can be seen.

1. Popping Sorghums:

In parts of Africa and Asia, sorghums that pop like popcorn can be found. These have seldom received much scientific or entrepreneurial recognition. There is probably, however, a huge latent market for them. They make tasty foods, and they may have worldwide promise. Popping boosts the flavour of sorghum, and it is energy efficient and nutritionally desirable. Popping is so rapid that it takes little fuel and it denatures or hydrolyses the proteins and vitamins only slightly. Popped sorghum is already a favourite in central India, and it is starting to find favour in several other countries as well.

Fig.1. Popping Sorghum

A world collection of sorghums is maintained at ICRISAT. Of 3,682 accessions tested, 36 have shown good popping qualities that mostly originated in India. These could be the starting point for breeding popping sorghums on a scientific basis. As with popcorn, the best-popping types usually have small grains with a dense, "glassy" (corneous) endosperm that traps steam until the pressure builds to explosive levels. (Vázquez-Sosa et al., 2023).

2. Vegetable Sorghums:

In certain countries, sorghum is eaten like sweet corn. The whole panicle is harvested while the grain is still soft (dough stage). It is roasted over open coals, and the soft, sweet seeds make a very pleasant food. These strains are found notably in Maharashtra, India. Like sweet corn, they have sugary endosperms containing 30 per cent glycogen as well as grains that shrivel when dry. Vegetable Sorghum could be a powerful way to capitalize on the plant's ability to produce food in sites where most crops fail (Anbazhagan et al., 2022).

The types that perform this way should be collected, compared, and cultivated in trials. The traditional processes by which they are used should be analyzed, as should the nutritional value. Panicles in the dough stage may have a better-than-expected food value.

Fig.2 Vegetable sorghum

3. Vitamin-A Sorghum:

In some developing countries a lack of vitamin A in the daily diet blinds many children. However, certain sorghums with yellow grains may solve the problem, at least among sorghum-eating societies. The colour comes from xanthophyll and from the carotene pigments that are vitamin-A precursors.

People eating them have a better-than-normal production of vitamin A. Yellow sorghums are especially well known in Nigeria but probably can be found elsewhere, too. The carotene levels are typically only a fraction of those normally found in yellow maize. However, because of poverty or locality, sorghum eaters often have no chance to vary their diets. Yellow varieties may be the most practical way to protect their eyesight (Burgos *et al.*, 2023).

4. Quick-Cooking Sorghums:

The starches in the grains of most Sorghums have gelatinization temperatures around 70°C. They must reach that temperature to become cooked and edible. However, research has shown that some Sorghums have starches whose gelatinization temperature is only about 55°C. This can reduce the cooking time required.

These sorghums have waxy kernels (endosperm) rather than hard vitreous ones. Thus, they cannot always be used in the normal manner. Nonetheless, there is a good possibility that they will make non-traditional quick-cooking products that will appeal to many. These unusual types are found especially in East Asia. The starch in their grains is entirely amylopectin, rather than amylose and other normal forms.

5. Aromatic Sorghums:

Some Sorghums in Sri Lanka and northeastern India are said to have the aroma of basmati, the fragrant rice preferred by millions of Asians. Although bland-tasting rice has dominated international markets, the basmati type has always been tropical Asia's favourite, and it is now increasingly sold worldwide (even in the United States) as a high-priced speciality. The discovery of sorghum counterparts opens up similar opportunities. They, too, might become speciality foods of high value. Also, they might help boost the acceptance of Sorghum normally the blandest of grains, even where it is a staple. All in all, flavourful types like these present good opportunities for improving markets and increasing consumption, not to mention boosting the returns to farmers.

6. Sweet Sorghum:

Sorghum and sugarcane are fairly closely related, and certain sorghums (often termed "sorghos") have stems that are just as rich in sugar as sugarcane's. These sweet sorghums are surprisingly poorly known compared with sugarcane and sugar beet. Nonetheless, they have a big potential in a world increasingly in need of renewable sources of energy. Also, as food crops, they deserve more attention.

Unlike sugarcane, sweet sorghum grows in a wide geographic range. It can be considered "the sugarcane of the drier and temperate zones." It has a production capacity equal to or superior to sugarcane's, at least when considered every month. Sweet Sorghum is of two types *viz*., Syrup sorghums, which contain enough fructose to prevent crystallization; and Sugar sorghums, which contain mostly sucrose and crystallize readily (Vinutha et al*.*, 2014).

Fig.3. Sweet sorghum

7. Rice-like Sorghum:

The shallu type of sorghum (the *margaritifera* subrace of the *guinea* race) has small, white, vitreous seeds, which are boiled like rice. As of today, little or nothing is known about this interesting form of sorghum, but it could have a good future and deserves exploratory research.

8. Transplanted Sorghum:

In certain regions of semiarid West Africa, various special sorghums are transplanted like rice. These are used particularly by people living in the bend of the Niger, including parts of Cameroon, Chad, Niger, and Nigeria. However, transplanted sorghums are produced in the dry season, growing and maturing entirely on subsoil moisture. They are ephemerals that must get through their life cycle before the soil dries back to powder or pavement.

They must mature quickly to survive. Some can produce a crop in 90 days, merely half the time the rain-fed types require in that area. One fascinating example has been identified at Gao in northern Mali. It is cultivated by ex-nomad Tuareg and yields more than 1,000 kg per hectare on residual moisture from the runoff water remaining after light rains. Two other transplanted Sorghum varieties are Masakwa and Moskwaris. The yields from transplant sorghums depend on the amount of moisture stored in the soil but are relatively high by the standards of the very difficult sites where they are grown. These transplant types are uniquely adapted to the unusual conditions of inundated clays and perhaps are unsuited to dry

Fig.4. Transplanted Sorghum

9. Free-thrashing Sorghum:

Free-thrashing sorghum varieties, exemplified by "Rio" and SC599, introduce a game-changing dynamic into sorghum farming. Their innate ability to effortlessly separate seeds from the heads revolutionizes the entire cultivation process. This advantage extends from the initial harvest, where farmers can efficiently collect ripe sorghum panicles, to the subsequent stages of drying and transportation. The reduction in labour-intensive tasks not only alleviates the physical strain on farmers but also enhances overall productivity. In regions where these free-thrashing sorghum varieties are cultivated, they are heralded for their capacity to save time and resources. Their low threshing effort requirement, akin to threshing wheat or rice, minimizes the need for specialized machinery or excessive manual labour. Consequently, these varieties are particularly appealing to both small-scale and large-scale farmers alike.

10. Broom Sorghum or Broomcorn:

The sorghum known as "broomcorn" was supposedly first cultivated in the United States by Benjamin Franklin. He is said to have started the industry in 1797 with seeds he picked off an imported broom. The stiff bristles that rise from the plant's flower head have produced many of America's brooms and brushes ever since. By the 1930s, for example, American farmers were cultivating 160,000 hectares of broomcorn. Broomcorn is also used for industrial uses in paper making (Zhu *et al.*, 2020).

Fig. 5. Broom Sorghum

Conclusion

Sorghum, with its remarkable genetic diversity and adaptability, is a hidden gem in the realm of agriculture. Its diverse applications, coupled with innovative breeding techniques, promise to unlock its full potential and contribute significantly to global food security and sustainable agriculture. Sorghum, once overshadowed, is now emerging as a crop with immense value and promise. As we continue to explore and harness its capabilities, sorghum may well play a pivotal role in addressing the world's evolving agricultural challenges and nutritional needs.

References

Anbazhagan, K., Voorhaar, M., Kholová, J., Chadalavada, K., Choudhary, S., Mallayee, S., and Selvaraj, A. 2022. Dual-Purpose Sorghum: A Targeted Sustainable Crop-Livestock Intervention for the Smallholder Subsistence Farming Communities of Adilabad, India. *Frontiers in Sustainable Food Systems*, *6*, 742909.

Cruet-Burgos, C., Morris, G. P., and Rhodes, D. H. 2023. Characterization of grain carotenoids in global sorghum germplasm to guide genomics-assisted breeding strategies. *BMC Plant Biology*, *23*(1), 1-17.

NASEM (National Academies of Sciences, Engineering, and Medicine). 1996. Lost Crops of Africa: Volume I: Grains. Washington, DC: The National Academies Press. https://doi.org/10.17226/2305

Vázquez-Sosa, GG., Cabrera-Ramírez, AH., Reyes-Vega, ML., Morales-Sánchez, E., Gaytán-Martínez, M., and Vega-Vázquez, L. B. 2023. Alternative technologies for the production of popped sorghum: a comparative study. *Journal of Food Science and Technology*, *60*(1): 103-113.

Vinutha, K. S., Rayaprolu, L., Yadagiri, K., Umakanth, A. V., Patil, J. V., & Srinivasa Rao, P. 2014. Sweet sorghum research and development in India: status and prospects. *Sugar Tech*, 16: 133-143.

Zhu, M., Chen, J., Yuyama, N., Luo, L., Xiao, X., Lv, Y. and Cai, H. 2020. Genetic diversity and population structure of broomcorn sorghum investigated with simple sequence repeat markers. Tropical Plant Biology, 13, 62-72.

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ECO-LABELLING FOR AGRI PRODUCTS: NURTURING SUSTAINABILITY FROM FARM TO TABLE

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Introduction

In today's rapidly evolving world, where environmental concerns and sustainable practices have taken center stage, consumers are increasingly seeking products that align with their values. In the realm of agriculture, where practices can have profound impacts on ecosystems and communities, the concept of eco-labelling has emerged as a powerful tool to foster sustainability, empower consumers, and drive positive change from farm to table.

Understanding Eco-labelling: A Green Stamp of Approval

Eco-labelling can be thought of as a green stamp of approval on products, indicating that they have been produced in a manner that adheres to environmentally friendly and socially responsible practices. This label serves as a bridge between producers and consumers, conveying valuable information about the origin, production methods, and environmental impact of agri products.

Why Eco-labelling Matters in Agriculture

Agriculture is intimately connected with the environment, making it a crucial sector in the pursuit of sustainability. Traditional farming practices, such as excessive pesticide use, deforestation, and overuse of resources, can lead to soil degradation, water pollution, and loss of biodiversity. Eco-labelling aims to combat these issues by encouraging producers to adopt sustainable practices.

1. **Transparency and Accountability**: Eco-labelling brings transparency to the forefront by compelling producers to disclose their production processes.

This transparency fosters accountability, prompting producers to adopt practices that minimize negative impacts.

2. **Consumer Empowerment**: Eco-labelling empowers consumers by offering them insight into the products they are purchasing. Armed with information about a product's environmental footprint, consumers can make informed decisions that align with their values and preferences.
3. **Incentives for Sustainable Practices**: By awarding eco-labels to products that meet specific sustainability criteria, producers are incentivized to adopt greener practices. This creates a positive feedback loop where sustainable methods become not only a moral imperative but also a competitive advantage.
4. **Market Access and Differentiation**: Eco-labelled products often gain access to niche markets that prioritize sustainability. Moreover, they stand out on the shelves, differentiating themselves from conventional products and appealing to eco-conscious consumers.

Challenges and Considerations

While the concept of eco-labelling holds great promise, its implementation is not without challenges:

1. **Standardization**: Developing standardized criteria for eco-labelling is complex due to the diversity of agricultural practices, ecosystems, and cultural contexts. Striking a balance between stringent requirements and practical feasibility is essential.

2. **Verification and Enforcement**: Ensuring that the claims made by producers on their eco-labelled products are accurate requires robust verification mechanisms. Effective enforcement is necessary to prevent "greenwashing" – a practice where products are inaccurately marketed as environmentally friendly.
3. **Education**: Both producers and consumers need education about the importance of eco-labelling. Producers must understand the benefits of sustainable practices, while consumers need to comprehend the significance of the labels and how to interpret them.
4. **Costs and Accessibility**: For small-scale farmers or producers in developing countries, obtaining eco-certifications can be financially burdensome. Efforts should be made to make the certification process more accessible and affordable.

Advantages:

1. **Sustainability Promotion:** Eco-labelling encourages producers to adopt sustainable practices, such as reduced pesticide use, efficient resource management, and conservation of biodiversity. This shift towards more eco-friendly methods contributes to the long-term health of ecosystems and agricultural lands.
2. **Consumer Empowerment:** Eco-labelling provides consumers with essential information about a product's origin, production process, and environmental impact. This transparency empowers consumers to make informed choices aligned with their values, fostering a demand for more sustainable products.
3. **Market Differentiation:** Eco-labelled products stand out in the market, appealing to eco-conscious consumers who prioritize sustainability. This differentiation can lead to increased market share and access to niche markets that value ethical and environmental considerations.
4. **Incentives for Producers:** By adhering to the criteria necessary for eco-labelling, producers gain a competitive edge. The eco-label acts as a mark of credibility, potentially opening doors to new partnerships, export opportunities, and premium pricing.
5. **Positive Environmental Impact:** The widespread adoption of eco-labelling practices contributes to reduced pollution, improved soil health, enhanced water quality, and protection of natural habitats. This collective effort can mitigate the negative impacts of conventional agriculture on the environment.

Disadvantages:

1. **Complex Certification Process:** The process of obtaining an eco-label can be complex and resource-intensive. Small-scale farmers or producers with limited financial resources might find it challenging to meet the requirements, leading to potential exclusion from the benefits of eco-labelling.
2. **Standardization Challenges:** Developing standardized criteria that accommodate diverse agricultural practices, ecosystems, and cultural contexts can be difficult. Striking a balance between setting ambitious sustainability goals and ensuring feasibility for all producers is a significant challenge.
3. **Verification and Greenwashing:** Ensuring the accuracy of eco-label claims requires rigorous verification mechanisms. Without proper oversight, there is a risk of "greenwashing," where products are misleadingly marketed as more sustainable than they actually are, eroding consumer trust.
4. **Costs and Affordability:** Certification fees, inspections, and compliance with eco-labelling standards can be costly. This financial burden might deter some producers, especially those in developing countries, from seeking certification, perpetuating an uneven playing field.
5. **Limited Consumer Understanding:** Despite efforts to educate consumers, not all buyers fully understand the nuances of eco-labels. Misinterpretation or confusion regarding the significance of different labels can undermine the effectiveness of the system.

Balancing the Equation:

While the advantages of eco-labelling hold great promise for transforming agriculture into a more sustainable industry, the disadvantages underscore the need for careful consideration and proactive solutions. Collaboration among governments, producers, consumers, and certifying bodies is essential to address challenges and optimize the benefits. Efforts to streamline certification processes, offer financial assistance to smaller producers, and enhance consumer education can help mitigate some of the drawbacks. As eco-labelling evolves, continuous refinement and adaptation will be necessary to create a system that truly promotes sustainability while remaining accessible and equitable for all stakeholders.

The Path Forward: Collaboration and Innovation

Creating an effective eco-labelling system for agricultural products requires collaboration among stakeholders – governments, producers, consumers, and non-governmental organizations. Innovation in technology can play a vital role, such as blockchain to ensure transparency and traceability throughout the supply chain.

Moreover, governments can encourage the adoption of eco-labelling by offering incentives to producers who meet sustainability standards. Financial incentives, tax breaks, or grants can motivate producers to transition toward more sustainable practices.

Conclusion

Eco-labelling for agricultural products represents a pivotal stride towards a more sustainable future. It provides a conduit for consumers to support environmentally conscious practices while pushing producers to adopt methods that are kinder to the planet. As this movement gains momentum, it has the potential to transform agriculture into a force for good, nurturing the delicate balance between feeding the world and safeguarding its ecosystems.

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MYCOTOXINS: A CAUSE OF CONCERN FOR ANIMAL HEALTH

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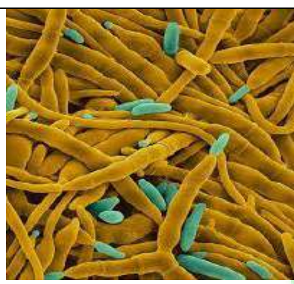
Abstract

Mycotoxins are fungal toxins produced by certain species of fungi which impart hazardous impacts by contaminating foods and beverages, animal feeds, cereal crops, dairy products, meat products etc., leading to be more significant from food safety, public health, and economic point of view. India is primarily an agricultural country and almost two third Indian population is dependent on agriculture and related businesses for their income. In such conditions malicious contaminants like mycotoxins hamper the quality of agricultural produce and leading to heavy losses for farmers as well as rural economy. Diseases caused by fungal toxins are called as mycotoxicosis and these are deadly diseases producing short term as well as long term health conditions in human as well as in livestock. The purpose of following article is to provide information about mycotoxins, their health hazards to humans and harmful effects on livestock, general treatment protocol of mycotoxicosis and prevention and control of mycotoxins

Introduction

Mycotoxins are one of the major food contaminants that degrade quality of agricultural produce, animal feeds and other food stuffs like meat, dairy, fruits, and vegetables etc. making these products unsafe for human as well as animal consumption. Mycotoxins contamination is one of the major concerns in agriculture as well as food industry as it is the major reason of economic losses of this industry. The term 'Mycotoxin' comes from two different Greek words which are 'myco' meaning fungi and 'toxins' meaning poisons; thus, mycotoxins are the poisonous substances produced by microscopic fungi which are harmful for human as well as animal health. There are different species of fungi which produce different types of mycotoxins causing various hazardous health effects. Some important fungal species which produce mycotoxins are *Penicillium, Fusarium, Trichoderma* etc. fungi mainly grow in moist, damp, and warm weather. Optimum temperature conditions along with moist food as well as moist environment promote fungal growth and contamination of stored grains and other food materials. Poor hygienic conditions, improper shipping and storage, moisture retention in storable feeds, rains, high temperature etc. are the major reasons for feed contamination with fungi and their mycotoxins. Health hazards caused by fungal toxins are known as Mycotoxicosis. Different species of fungi grow on specific grain or material and produce mycotoxins. List of fungi, their toxins and specific grain or associated food material to which they grow is as following.

Sr. No.	Fungus	Mycotoxin	Associated food with mycotoxin production
1.	 *Aspergillus flavus or Aspergillus parasiticus*	Aflatoxins	Corn, peanuts, tree nuts, milk 
2.	 *Fusarium*	Trichothecenes	Cereals and other food 

3.	 *Penicillium Verrucous or A. Ochraceous*	Ochratoxin A	Wheat, barley, corn 
4.	 *Claviceps purpurea*	Ergot alkaloids	Rye, barley, wheat 
5.	 *Fusarium moniliform*	Fumonisins	Corn 
6.	 *Fusarium spp.*	Zearalenone	Cereals, oil, starch 
7.	 *penicillium expansum*	patulin	Apple, pear 

General symptoms of mycotoxin exposure:

General symptoms of mycotoxin toxicity include abdominal pain along with nausea and vomiting. Symptoms may also manifest in form of jaundice due to direct effects of mycotoxins on liver. Respiratory effects include pulmonary oedema causing chest pain and breathing problems. Some mycotoxins can also lead to convulsions and may more deadly situations like coma and even death. In long run, mycotoxins impart effects on genetic materials leading to genotoxicity and thus damages the genetic materials. Mycotoxins exposure causes suppression of immune system causing weaker immune response to the affected animal. Other symptoms include heart diseases, agitation and aggression, paralysis. Mycotoxins can hamper the good gut bacteria thus causing disturbance of abdominal microflora. Skin exposure of mycotoxins can cause allergies and skin irritations. Some mycotoxins may also cause abortion or premature parturition in pregnant animals.

Types of mycotoxins

1) **Aflatoxin:** These are poisonous class of mycotoxins formed by poisonous Molds, particularly Aspergillus parasiticus and Aspergillus flavus, which may contaminate food and feed badly. There are several types of aflatoxins which are B1, G1, B2, G2, M1 and M2. Optimum environment for aflatoxin growth is 33 °C. Aflatoxin growth in food and feed was observed in stressful growing stage, e.g., drought growth conditions. The examples of crops susceptible to this mycotoxin are maize, wheat, rice, oilseeds, sunflower, peanut, cotton, almond, pistachio, walnut, coconut and spices like black pepper, red chilli, turmeric, and coriander. vegetables and fruits and in meat, animal tissues and animal products can also get affected. Toxic effects include nausea, vomiting, abdominal pain, convulsions, immunity suppression, liver damage and even liver cancer.

2) **Ochratoxins**: The fungal metabolites formed by species Aspergillus ochraceous and Aspergillus penicillamine are termed as Ochratoxins. Ochratoxin A is common toxin of this group. Ochratoxin A contaminates agricultural products and due to its growth in food, it is dangerous for human and animal health. Optimum conditions for ochratoxin growth are at 25-30 °C. food or grain associated with ochratoxin poisoning include Cereals, barley, nuts, dried fruits, porcine kidney, beer, coffee beans, wines, and mouldy bread. This mycotoxin mainly damages kidney.

3) **Ergot toxins:** these are toxins produced by parasitic fungi species *Claviceps purpurea* and mainly grows on cereal crops and grasses like rye, oats, barley, wheat, jowar etc. during humid conditions. Ergot infested jowar looks black in colour. Diseases accrue due to ingestion of ergot infested food are called as ergotism and it is seen in animals, poultry, and humans. Symptoms includes respiratory depression, aggressiveness, rise in body temperature, recumbency and even gangrene of extremities like muzzle, hooves ears and tail in animals. Fescue toxins which are type of ergot toxins cause fescue lameness/ fescue foot in animals.

Figure: Fescue lameness in cattle (source Google image)

4) **Trichothecenes:** This mycotoxin can be produced by many moulds including fusarium, trichothecium, Myrothecium, cephalosporium etc. The major trichothecenes are T2 toxins. These mycotoxins cause gastro intestinal irritation, reproductive abnormalities, decrease in immunity, blood clotting defects.

5) **Zearalenone:** Zearalenone is mainly formed from Fusarium graminearum and F. culmorum fungal species in different cereals including wheat, maize, oats, rye, and barley. Zearalenone has been demonstrated to induce infertility, mammary hypertrophy, and vulva oedema in various animal females. Pigs are most sensitive to this mycotoxin. Hyper oestrogenic syndrome/ porcine vulvovaginitis in females and feminization in males (testicular atrophy) can be observed. Structurally zearalenone is not like oestrogen but imparts oestrogenic activity by acting through oestrogen receptors.

Figure: Porcine vulvovaginitis in sow due to Zearalenone (source Google image)

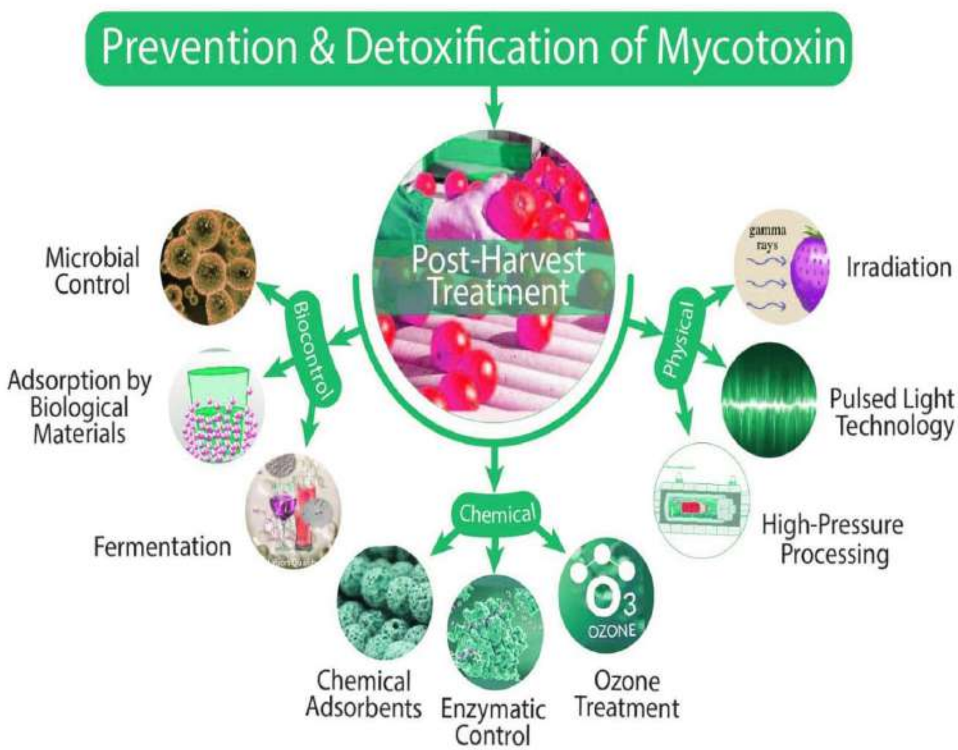
General treatment protocol for mycotoxicosis

Withdrawal of contaminated feed causing mycotoxicosis should be done immediately. Affected animal should be provided with low fat and high protein diets. Multivitamin supplements along with vitamin E and selenium should be given. Anabolic steroids like stanozolol at the rate of 2mg/ kg for 4 to 5 days interval can be given. Activated charcoal slurry with 30% w/v of phosphate buffer should be given at rate of 6.5 mg/kg. Antibiotics like oxytetracycline can be given at rate of 10 mg/kg intramuscularly once a day. Intravenous fluids like 5% dextrose can be given. Liver tonics can be given for better function of liver of affected animals. Other respective systematic treatments can be given by physician to treat the disease.

Prevention and control of mycotoxins

Prevention and control of mycotoxins contaminating crops, food material, fruits, vegetables etc. is an essential step as Mycotoxins impart many public health hazards as well as it leads to economic losses for agricultural industry, food and beverage industry, meat industry and dairy industry. India being predominately agrarian country, three fourth of Indian population dependant on agriculture and rural economy. Thus, awareness about such hazards like mycotoxin contamination must be spread so that agricultural and rural economical losses can be prevented. Public health hazards related to mycotoxicosis are severe and fatal in nature, so preventive measures must be taken against mycotoxin contaminations. Following measures can be implemented by the farmers to control fungal growth and mycotoxin contamination of agricultural produce and other food items.

1) **Pre harvest control**
   a) Using proper methods of cultivation including adequate watering and proper harvesting methods.
   b) Using fungicides on crops
   c) Removal and proper disposal of contaminated or fungal infected crops or food materials
2) **post-harvest control**
   a) Sun drying of grains
   b) Controlled atmospheric storage (air tight or cold storage)
   c) Chemical treatment using "Grain treat mixture" which is mixture of propionic acid, acetic acid, and benzoic acid)
   d) Separation and segregation of infected and non-infected grains, fruits, vegetables etc.
   e) Detoxification by cooking, dry roasting, and oil roasting
   f) Using genetically modified mycotoxin resistant varieties of crops.
   g) Biological control using Probiotic microorganisms (Saccharomyces cerevisiae and Lactobacillus).



Toxin binders

Mycotoxin binders or adsorbents are the substances that can be used as feed additives in animal feed to prevent them from harmful effects of mycotoxins. Binders are the substances that bind to mycotoxins and prevent their absorption from gut. It is advised to the farmers to check their stored grains and animal feeds on regular basis for mycotoxin detection but it also may be the instances when feedstuff cannot get checked regularly. In that case toxin binders play essential role. Most used mycotoxin binders are aluminosilicates- clays and zeolites. These are natural adsorbents that include hydrated sodium calcium aluminosilicates i.e., HSCAS binder.

References:

Synopsis of veterinary pharmacology and toxicology by Dr. V. Vani prasad

A review of mycotoxin types, occurrence, toxicity detection methods and control by Kalim et al (2019).

https://www.fao.org/3/X5036E/x5036E00.htm .

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SPECIAL PURPOSES TRADITIONAL RICE LANDRACES

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INTRODUCTION

Rice is the most important stable food crop consumed by more than half of the world's population. India is the world's second-largest producer of rice (Sivakumar *et al.*, 2021). The spread of high-yielding rice varieties implies a possible narrowing of the gene pool. Thus the need for the use of landraces came into force. Landraces are heterogeneous, locally adapted and domesticated varieties of a crop (Savitha *et al.*, 2016). Traditional paddy varieties refer to rice cultivars that have been traditionally grown by farmers and communities for many generations. The widespread cultivation and use of diverse rice landraces have helped to conserve an impressive genetic diversity interwoven with specific festivals, ceremonies, and social practices. Traditional paddy varieties have unique nutritional properties that are specific to children, women's health, pregnant and lactating women and workers from different sectors. Traditional paddy varieties can provide economic benefits to farmers through the preservation and marketing of high-quality rice products that are unique in taste, texture, and nutritional value. They can also be milled to produce brown rice, which retains the bran and germ layer, making it more nutritious than white rice.

SPECIAL PURPOSES OF RICE LANDRACES

The sampling strategy followed for the collection of rice landraces was bulking of seed samples either in the farmer's field or store. The information gathered from the farmers and tribal people during various exploration missions on land races of rice was recorded together with germplasm and compiled.

Rice landraces used in ceremonies and festivals:

The cultivation of traditional rice varieties represents an important aspect of local culture. The different landraces used for different ceremonies are mentioned below.

Ceremony/Festival	Name of the landraces
Marriages and Annaprasan,	Tulaipanji, Binni dhan, Chini Sakkar, Kalonunia
Sakti puja (Dussera) **Chaita Parab** (Worship seeds of various crops) **Bihanabuna** (Sowing of seeds) **Baisakha** (Full moon day), **Nuakhia** (first ceremonial eating of the harvest),	Osagathiali, Bodikaveri, Ladiari, Gathia, Umuriachudi, Machhakanta, Matidhan, Kalajeera, Sapuri, Para Dhan, Assamchudi, Sunaseri
Religious ceremonies	Sela, Sawa, Barpasso, Tilkakchandan, Lalchandan
Festivals and social ceremonies	Chakhao
Worshipping Goddess Kali	Binni dhan
Religious ceremonies and Special occasions	Karthika Mayamatti and Kaalijira

Rice landraces used in weed control:

Rice landraces with purple foliage and purple-coloured bases help in the identification of weeds. These varieties are grown in alternate years to facilitate rouging off types, wild rice etc. The landraces used for this purpose are Dambersali, Nyaremind, Antarsali, and Navalisali (Rajagopalan *et al.*, 2022)**;** Bodikaveri, Para dhan; Vaigunda, Singinikaar are some landraces that are used in controlling the weeds.

Figure 4: Singini Kaar

Rice landraces having fodder value:

Landraces such as Lal Kartika, Moinahaal, Terabali, Kaala mekuri, Kaalijira, Baigon bichi, and Berapua (Das *et al.*, 2014) have an increased fodder value. Some landraces provide good quality straw, they are Jedho budho, Pahele, Thulo gurdi, Suno gurdi; Arikirathi, Vellai Ponni, Kichili Samba and Arcot Kichili Samba.

Fig. 5. Ottadaiyan

Rice landraces for intercropping:

The landraces such as Laxhmi Kajal and Ottadaiyan are the best landraces that can be cultivated as an intercrop in coconut and other horticulture crops. **Laxhmi kajal** (black coloured) when cultivated along with yellow grain varieties will make it easier for its identification during the time of harvest. **Ottadaiyan** a 200 days duration crop is grown along with Poongar or Soorakuruvai a 150 days duration crop, the latter crop is harvested first and the next is harvested after 50 days.

Fig. 3: Kalajeera

Rice landraces having high commercial values:

Rice landraces namely Terabali, Kaalijra, Kaala birian, Lal birian, Puthi birian, Pakhi birian, Khoibaruah, Badaal, Saada Kartika (Das *et al.*, 2014) are commercially cultivated.

Rice landraces with good aroma:

Landraces with good aroma are used for making many special dishes to provide an enhancement to the dish's nature. Such landraces are Gujinina, Kalonunia, Red hira sail, Kanakchur, Radhuni tilak, Dangi, basful, Kala mogha (Semwal *et al.*, 2014); Gujanonia, Kalajeera, Haldichudi, Machakanta, Donger Basmati; Tulsibhog, Lilabati, Dar sal, Tulsi mukul, Karpurtal, Kanakchur; Ambemohr, Kagisali, Beeraga, Kumud, Yalakkisali, Huggi Bhatta, Karigajavile, Belguam basmati; Jeeragasala, Gandagasala, Briyaniari, Mullanchenna; Gobindobhog 1, Gobindobhog 2, Kalojeera, Taraori Basmati (Das *et al.*, 2014); Hansraj, Mushkbudgi, Basmati, Larbeoul, Qudirbeigh, Shahie, Barpasso, Katyoor, Thapachini.

Figure 6: Aanaikomban

Rice landraces with good keeping and cooking qualities:

Hallaga, Kanwa (Jakkeral *et al.*, 2018); Aden Kelte, Alur sanna, Bangar Kaddi, Karigajavili, Padmarekha, Raj kamal, Putta bhatta Local, Rajkhaima, Karigajavili, Padmarekha, Raj kamal (Khera *et al.*, 2012); Ratanasagar, Padmarekha, Rajkhaima, Mysore sanna, Gowri sanna, Shankar Poonam, Wari sanna, Sampige, Alur sanna, Bangar kaddi, Adnenkelte, Mala Bangarkaddi, Motte Bangarkaddi (Rajagopalan *et al.*, 2022) are the landraces that has excellent keeping and cooking quality. Aanaikomban, Seethavalli kuruvai, and Thirprasatham are some landraces that can keep the food without spoiling for weeks.

Rice landraces with different nutrient content:

Rice landraces have essential nutrients that are rich in different nutritional qualities. The nutrients present in the landraces are mentioned below.

Nutrients	Names of the landrace
Total protein	Kalanamak, Kuzhiyadichan
	Kattu vanipam, Poongar, Palkichadi, Karuppu Kavuni, Kaivara samba, Barma Kavuni, Lalmati, Sivappu malli
Total fat	Kuzhiyadichan, Neelan samba
Potassium	Kaivara samba, Kaatuyanam, Navara, Poovan samba
Iron	Sivappukuruvaikar, Sanna Samba
Calcium	Kullakar, Kalian Samba, Sivappukuruvaikar, Kaatuyanam
Zinc	Kalarpalaikarunkuruvai
Phosphorous	Poovan Samba,

Rice landraces for different categories of people:

Rice landraces have a wide range of uses for people of different work bases and sectors. Some of the landraces used are mentioned below.

Purpose	Name of the landraces
Farm work and other heavy work (energy)	Kalajeera, Umuriachudi
	Chhatoki, Chhoeamara, Mayamati, Koibaruah
	Parmai-sal, Kabiraj – Sal
Long-time stay in the stomach	Sunaseri, Umariachudi

Men	Mappillai Samba
Women	Poongar - overcome overall health problems
	Yedurubelthige, – Lactating mothers
	Athikaraya and Kayame – Pregnant women
Diabetic patients	Kattuyanam
	Karungkuruvai, Mappilai samba, Kudhaivazhai, Kalanamak, Perungkar, Kovuni, kullakar, Neelam samba.
	Sivappukudaivazhai, Paalkudaivazhai, Milagu Samba, Kuzhiyadichan, Kothamalli Samba, Singinikar, Kaar, Navarai, Naatu Samba
Anaemic patients	Arupatham Kuruvai, Kaalanamak, Vaalan Samba, Illupaipoo Samba,
Cancer patients	Seeraga Samba, Kaatuyanam
Cure for Filariasis	Karungkuruvai

Rice landraces for different amylose content:

The amylose content of the milled rice is the major determinant of rice texture – how soft or firm the cooked rice will be. After cooking, the high-amylose and intermediate-amylose rice is firm and fluffy; while the low-amylose and waxy rice are soft, moist, and sticky in texture.

Amylose content	Name of the landrace	Dishes prepared
High	Mahsuri, Parbol, Paizam, Raghusail, Sadashankar, Talmari, kalopahar	Puttu, Poha, Rice flakes, Kichadi
Intermediate	Laljhini, Achoo, Madhumalti, Mushkan, Qudirbeigh, Bhabri, Patari, Mehwan, Preneibar	Idly, Kozhukattai, Pongal, Paniyaaram
Low	Jaldhara, Jattoo, Jhangai, Jhumaria, Jawari, Roda, Chuartu, Sukhdwas, Thapachini, Danye, Zager	

Rice Landraces for various dishes:

A variety of dishes can be prepared with rice landraces. The dishes have their uniqueness in taste, aroma, colour *etc*. The different dishes prepared with rice landraces are mentioned below.

Purpose	Name of the landrace
Popped/puffed rice	Assamchudi, Bodikaveri, Umuriachudi, Ratnachuda, Nizamshait, Honnekattu, Kalanamak, Chakhao, Mappilai samba, Binni Dhan Thengaipoo Samba, Sembaalai, Poombaalai, Vaigunda, Salem Sanna, Soorukuruvai, Varakunnanellu, Njavara, Nagari
Kheer/Payasam	Navara, Mullan Kaima, Rajamudi, Magur sail, Erra mallelu, Garo joha, Kola joha, Tulsi joha, Rambhog, Til kasturi, Dhundhuni, Kalamdani, Kashiphul, Lakhan-sal, Rani kajal, Raschora, Deepika rani, Dodda baira, nellu, Jolaga, Mullu kayame, Sharbati, Dubraj, Garam masala, Hiranakhi, Kali kamod, Tivshya Tulsa Velchi, Chak haw, Poireithon, Kajji jaya
Rice Pudding	Nilabati, Meghamala, Machakanta, Mahalaxmi
Rice Flakes	Donger Gathia, Mati dhan, Para dhan, Udarsali, Valya, Sanna Mullare, Dodda Valya, Bilinellu, Kaala Birain, Pakhi Birain
Flattened rice	Sanara, Rajmalli, Meghananda, Pakhiasali, Kaivara Samba, Sivappukudaivazhai, Kaar, Sivappu Kavuni, Mozhikaruppu Samba
Fried rice	Gudumatia
Kesari	Mysore malli, Sanna Bhatta, Vasane Sanna Bhatta
Idiyappam	Raamakurikar, Rajamudi, Karupu Nel, Kaivara Samba, Madumuzhungi, Tulasi vaasanai samba, Vaasanai seeraga samba
Kozhukottai	Vallarakan
Puttu	Karuppu Nel, Sornavari, Muttan Kuruvai, Karudan Samba, SivappuKavuni, Kothamalli Samba, Tulasi vaasanai samba
Rice soup	Sela, Lalnakanda, Fulpatash, Mushqbudji, Nunbeoul, Qudirbeigh, Zager
Kichadi	Kichilli samba
Parboiled rice	Dodiga, Halaga, Honasu, Dhikinasali, Ghusuritinka, Harimuti, Laxmikajala, Motougiri, Mugudi, Raspanjari

Figure 5: Mysore malli

Figure 8: Kajji Jaya

Figure 7: Sivappu kavuni

Conclusion

Traditional paddy varieties continue to play a vital role in meeting the specialized needs of different regions and communities around the world. In addition, traditional varieties are often more sustainable and resilient than their modern counterparts, as they require fewer inputs and can better withstand climatic fluctuations. By supporting the conservation and promotion of traditional paddy varieties, we can not only preserve cultural heritage and diversity but also contribute to food security, environmental sustainability, and local livelihoods. Governments, farmers, consumers, and researchers all have a role to play in this effort, by investing in seed banks, farmer networks, education, marketing, and research to enhance the productivity, quality, and value of traditional paddy varieties. In summary, traditional paddy varieties are not just relics of the past, but dynamic resources for the present and future, capable of providing multiple benefits for different stakeholders. By recognizing and utilizing their potential, we can promote a more inclusive, healthy, and resilient agriculture, that honours the wisdom and creativity of our ancestors and meets the needs of our diverse and changing world.

REFERENCES

Das, T., and Das, A. K. 2014. Inventory of the traditional rice varieties in farming system of southern Assam: A case study.

Jakkeral, S. A., Patil, S. U., Hanumantappa, M., Shashikala, K., & Dhanlaxmi, T. N. 2018. Medicinal uses of red rice in coastal Karnataka. *Journal of Pharmacognosy and Phytochemistry*, *7*(3S), 436-439.

Rajagopalan, V. R., Manickam, S., & Muthurajan, R. 2022. A comparative metabolomic analysis reveals the nutritional and therapeutic potential of grains of the traditional rice variety Mappillai Samba. *Plants*, *11*(4), 543.

Savitha, P., & Kumari, R. U. 2016. Indigenous knowledge of traditional landraces in rice (Oryza sativa L.) in situ conservation of Tamil Nadu, India.

Semwal, D. P., Pandey, A., Bhandari, D. C., Dhariwal, O. P., & Sharma, K. 2014. Variability study in seed morphology and uses of indigenous rice landraces (*'Oryza sativa*' L.) collected from West Bengal, India. *Australian journal of crop science*, *8*(3), 460-467.

Sivakumar, P., Chitra, M., Gatta, VV., Harshavardini, K., and Velayutham, KV. 2021. Exploration of traditional rice (Oryza sativa L.) landraces: Scope for the future sustainable food production. *The Pharma Innovation*, *10*(10), 1039-1043.

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MILLETS FOR NUTRITIONAL SECURITY

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Introduction

Millet refers to a group of small grain cereal grasses. It is classified into major millets, such as sorghum (cholam), pearl millet (cumbu) and finger millet (ragi) and small millets, such as barnyard millet (kudhiraivali), foxtail millet (thenai), kodo millet (varagu), proso millet (panivaragu) and small millet (samai). They are also known as nutritive grains because they are rich in micronutrients, minerals, and B-complex vitamins. They are believed to be able to treat diabetes, aging, cancer, celiac disease and cardiovascular disease.

It contains many healthy phytochemicals and can be eaten as a dietary supplement. It can work well even in mixed crops with vegetables and legumes. Although India is the largest producer and consumer of millet, contributing more than 40% of global millet consumption, the country has never been at the forefront of national food and agricultural policies.

They hold promise not only for food security but also for nutritional security in India due to their tolerance and ability to grow in rainy regions. In India, 60% of lands farming is irrigated with rainwater. It has unique molecular, biochemical and morphological properties that enable it to tolerate extreme environmental factors, such as drought and unfavourable soil conditions.

They may also have advantages due to their short lifespan, limited leaf area, and small size. Millet is more efficient than common cereal crops in terms of tolerance to strong light, high temperatures, and dry weather, C_4 photosynthetic potential, efficient use of water and energy, and nitrogen. Although millet has a multitude of benefits, the area under which it is grown is limited. As a result, the current agricultural system has focused on revitalizing millet in India. In light of this concern, 2023 was declared the International Millennium Year.

COMPARING NUTRITIONAL VALUE IN MILLETS

Among millets, pearl millet has the highest content of macronutrients, proteins, lipids and micronutrients such as iron, zinc, magnesium, phosphorus, folic acid and riboflavin. Finger millet is a good source of energy, calcium, phosphorus, magnesium, potassium and thiamin. Both have a high fiber content of over 10g/100g.

Finger millet, although low in fat, is rich in polyunsaturated fatty acids. Finger millet contains 44.7% essential amino acids. It contains relatively high levels of the essential amino acids lysine, threonine, valine, sulfur-containing amino acids. The in vitro digestibility and amino acid profile of pearl millet and other cereals have shown that the amino acid profile of pearl millet is more favorable than that of normal sorghum and normal maize and can be compared with small grains, wheat, barley and rice.

Millet is a good source of energy (307-361 kcal/100g) equivalent to rice (345 kcal/100g) and wheat (341kcal/100g). The protein content of millet ranges from 6.2 to 12.5 g/100 g, higher than rice (6.8 g) and close to wheat (12.1 g). The fat content of millet ranges from 1.1 to 8.3 g/100 g, which is higher than that of rice (0.5 g) and wheat (1.7 g). The carbohydrate content of millet is similar to that of wheat (69.4 g) but lower than rice (78.2 g) and the fiber content is higher than rice but lower than wheat. The phytic acid content of millet ranges from 57 to 198 mg/100 g, which is lower than that of wheat (238 mg).

Millet compares well and even out performs many grains in terms of mineral and micronutrient content. Millet is a good source of thiamin, riboflavin, pyridoxine compared to wheat and rice. Millet contains a large amount of folic acid, iron, zinc, calcium, magnesium, sodium and potassium compared to rice and wheat. The phosphorus content of millet is lower than wheat (355mg/100g) but higher than rice (160mg).

BIOFORTIFICTION

Biological fortification means enriching/adding value to plants through genetic manipulation. This seed-based approach is empowering farmers and can go a long way in reducing micronutrient deficiencies, especially iron, zinc and vitamin A (beta-carotene) in the diet. Preference should be given to bio enhanced research, preferably using conventional and molecular breeding methods. A good example is the ongoing research on biofortification of pearl millet at ICRISAT, Hyderabad and participating NARS centres. A big push is being made to reinforce biology under a research program funded by CGIAR by ICRISAT. The goal of biofortification of pearl millet is to develop varieties/hybrids with high iron and zinc content.

A SUSTAINABLE AND HEALTHY FOOD APPROACH OF MILLET

Millet has long been a traditional food crop for millions of farmers, especially in India, China and Nigeria. Millet is equal with or superior to other major grains in terms of nutrients. The added benefits of millet are its high fiber content, low glycemic index and rich bio active phytochemicals, making it an ideal health food. The average protein content of millet is 10-11% and finger millet contains from 4.76 to 11.70 g/100 g.

Millet is rich in -carotene and B vitamins, including riboflavin, niacin and folic acid on par with rice and wheat. It has antioxidant properties that allow them to provide balanced and very nutritious nutrition. Mink tail has the highest thiamine content with 0.6 mg/100 g. The riboflavin level of millet was several times higher than that of the staple grains, with barn millet having the highest riboflavin content at 4.20 mg/100 g, followed by foxtail millet (1.65 mg/g). 100 g) and pearl millet (1.48 mg/100 g). Finger millet protein is rich in essential amino acids such as methionine, valine and lysine, and 44.7% amino acids.

India is the world's largest producer of small millet, but awareness of its nutritional importance and value is less. Small millet has the potential to play an important role in promoting immunity, providing forage, enhancing biodiversity and protecting farmers' livelihoods, in addition to securing food and nutrition. In addition to its nutritional value, it also has great therapeutic uses for the treatment of diseases such as cancer, leprosy, pneumonia, and dietary modification. Small millet is an excellent source of many essential elements that improve health.

MEDICINAL BENIFITS

S. No	Name of the Minor Millet	Biological Activity
1.	Finger millet (*Eleusine coracana*)	Diabetes Cardiovascular disease, Colon cancer, constipation, diverticulosis, wound healing, maintain body temperature during rainy season.
2.	Pearl millet (*Pennisetum glaucum*)	Neuro – degenerative disorder Diabetes mellitus Nephritis, Rheumatism, Alzhiemer disease, Cataracts,

		Cardiovascular disease, Acute liver toxicity and DNA damage Cancer, cardio vascular disease, reducing tumor incidence, lowering blood pressure
3.	Banyard millet (*Echinochola frumentacea*)	Diabetes mellitus, obesity, hyperlipidemia, Tumor necrosis
4.	Foxtail millet (*Setaria italica*)	Type 2 diabetes
5.	Kodo millet (*Paspalum scrobiculatum*)	Severity of asthuma, migraine attacks, reduce high blood pressure, diabetic, heart disease, atherosclerosis and heart attack
6.	Proso millet (*Panicum miliare*)	Liver disease

CONTRIBUTING TO ENSURING NUTRITIONAL SECURITY THROUGH MILLET

India's food security depends on only two crops: wheat and rice. Millions of hectares of dry land have been abandoned by farmers, which has resulted in a decline in millet production and consumption, which is the foundation of India's food and agricultural systems. If this land could be cultivated, it could generate livelihoods in the poorest parts of India. Likewise, not only food security is ensured, but food sovereignty is also ensured. Many plans are being worked on by the Indian government, which provides grain at subsidized prices to the poorest households, but the food security bill is believed to be the first to introduce millet into the Public Distribution System (PDS). As stated earlier, the mineral content of millet is higher than that of other grains, but its bioavailability is inhibited due to anti-nutritional factors.

There is scientific evidence that the mineral availability of millet can be improved by following simple and cost-effective home preparation methods such as soaking, malting, blowing, sprouting, sprouting. Yeast has been shown to improve the nutritional availability of millet. In view of this, if the beneficiaries of the food security bill were aware of these simple techniques, then nutrition security would also be addressed alongside food security.

Conclusion

Millet can thrive in extreme environmental conditions such as drought and some wild varieties can still survive in flooded fields and swamp environments. Here concluded that millet has been shown to have the potential to significantly contribute to India's food and nutrition security. To overcome deficiencies in nutrients such as protein, calcium and iron, millet foods should be included in international, national and state dietary programs that will help address current nutrient deficiencies in the developing countries.

References

Louhar, G, RS Bana, V Kumar, & H Kumar. 2020. Nutrient management technologies of millets for higher productivity and nutritional security. *Indian J. Agric. Sci*, *90*, 2243-2250.

Sarita, ES, & E, Singh. 2016. Potential of millets: nutrients composition and health benefits. Journal of Scientific and Innovative Research, 5(2), 46-50.

Brahmachari, K, S, Sarkar, DK, Santra, & S, Maitra. 2019. Millet for food and nutritional security in drought prone and red laterite region of Eastern India. International Journal of Plant & Soil Science, 26(5), 1-7.

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HYDROPONIC FODDER PRODUCTION

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Introduction

Green fodder is essential to feed livestock, but the reduced availability of land and lack of water. It is become difficult to produce the required quantity of green fodder throughout the year. Also, the lack of quality fodder hampers the growth production, and Reproduction of livestock. Fodder production cannot easily be increased due mainly to ever increasing human pressure on land for production of cereal grains, oil seeds and pulses. To meet this increasing demand for green fodder, one of the alternatives is hydroponic fodder to supplement the meager pasture resources. The word hydroponics is derived from two Greek words: 'hydro' meaning water and 'ponos' meaning labour *i.e.* water working. Hydroponic fodder is produced by growing seeds without soil, and with very little water; within six-seven days, the seeds are sprouted, the seedlings will be up to 30-35 cm tall and provide highly nutritious fodder (Bakshi *et al*., 2017). Fodders including maize, barley, oats, sorghum, rye, alfalfa and triticale can be produced by hydroponics. Others, including cowpea, horse gram, sun hemp, ragi, bajra, foxtail millet and Jowar have also been grown successfully by the use of hydroponics.

Hydroponic innovative technology

- To grow green fodder at wider temperature (15º - 32 ºC) and humidity (70 -80 %) range without fungal growth
- Environmental friendly

- Contamination free fodder
- Saves water and labour
- Fodder grown is highly palatable and nutritious
- Fodder improves animal health and reproductive efficiency.

Hydroponic fodder and Conventional fodder

Hydroponic fodder	Conventional fodder
Very little area required, and fertility of land is not an applicable factor	Requires large area with good fertility conditions
Grown under controlled condition	Fodder yield depends upon climatic conditions
Reduction of wastage and complete utilization of fodder	Partial utilization due to wastage during harvesting
Skillful but less labour requirement	More labour requirement
Chopping is not required	Feeding required chopping of fodder
Fertilization is not need	Fertilization is required for raising of green biomass
There is saving of power and energy	More energy requirement
Short grown duration generally 6 to 7 days after sowing	Long growth period generally 60 to 70 days after sowing

Hydroponic fodder

The hydroponics green fodder looks like a mat of 20-30 cm height consisting of roots, seeds and plants. To produce one kg of fresh hydroponics maize fodder (7-days), about 1.50-3.0 liters of water is required. Yields of 5-6 folds on fresh basis and dry matter content of 11-14% are common for hydroponics maize fodder, however, dry matter content up to 18% has also been observed. The hydroponics fodder is more palatable, digestible and nutritious while imparting other health benefits to the animals. The cost of seed contributes about 90% of the total cost of production of hydroponics maize fodder. It is recommended to supplement about 5-10 kg fresh hydroponics maize fodder per cow per day. However, sprouting a part of the maize of the concentrate mixture for hydroponics fodder production does not require extra maize. Feeding of hydroponics fodder increases the digestibility of the nutrients of the ration which could contribute towards increase in milk production (8-13%) (Rajesh Singh, 2019).

Process of hydroponic fodder production

Use only good qualities of seed for hydroponic fodder production. Never use broken or unhealthy seeds as these will not germinate and grow properly. Mostly farmer uses Maize seeds to produce hydroponic fodder. In cold climatic conditions, wheat and oats seeds are good, while in hot climatic conditions, maize seeds are suitable for hydroponic fodder production.

Process

- Add 5-7 liters of warm water in a plastic bucket and seed
- Remove seeds are float on the water because they will not sprout also remove other impurities

- After that, add 50 -100 gm salt in water; it helps minimize fungus production on the sprouted seed
- Allow this seed to soak water for around 12 hours
- After 12 hours, drain the water and then wash the seeds with clean water
- Transfer this washed seed to a gunny bag and allow them to sprout. In a cold climate, they will take more than 24 hours to germinate, while in a hot climate, the seed will take about 24 hours
- Before using the tray, wash them properly and check all holes if they are blocked or not. If there is a blockage, remove the blockage
- Transfer sprouted seeds from the gunny bags to trays and evenly spread them, and place them on the rack
- Every day sprinkle water to sprouted seeds by using watering cans or a sprinkler system
- In hot weather conditions, give water after every two hours, and in cold weather conditions, after 4 hours, it helps maintain moisture

- Always maintain cleanness in the shed; it helps to reduce fungus
- Please do not disturb the trays, sprouted seeds until they are harvesting, which influences the fodder's growth.
- Within seven days from one tray containing one kilogram of maize seed, you can produce about eight kilograms of fodder.
- When preparing hydroponic fodder to make the rack according to your fodder need, if you required every day five trays of fodder so for seven days, a prepared shade accommodates 35 trays (Amar Sawant, 2021).

Nutritional value of hydroponics fodder

Nutrients	Hydroponics fodder (Maize)
Protein	13.57
Ether extract	3.49
Crude fiber	14.07
Nitrogen free extract	66.72
Total ash	3.84
Acid insoluble ash	0.33

(Gebremedhin, 2015)

Advantages of hydroponic fodder

1) Nutrient Value

Hydroponics fodder has more nutrients than traditional fodder dry food or grain. It contains high carbohydrates, minerals, and vitamins. The crude protein, neutral detergent fiber, acid detergent fiber and Ca content increased, but organic matter and non-fibrous carbohydrates content decreased in the hydroponic green fodder (Mehta and Sharma, 2016).

2) Time to grow

Compared to traditional fodder, which often needs up to two months to grow, you can grow hydroponic fodder in just one week

3) Less water requirement

Compared to conventional fodder production, it required less water for hydroponic fodder production. Only 3 to 4 liters of water is necessary to grow one kilogram of hydroponic fodder. on the other, for traditional fodder, approximately 70- 100liter water is required. Hydroponic systems minimize water wastage since it is applied directly to the roots and is often recycled and used several times. However, the water should be clean because bacteria and fungi proliferate during recycling during the growth cycle. It is, therefore, suggested to go for infrared filtering of the water before recycling (FAO, 2015).

4) Easy daily production

Hydroponic fodder can be produced regularly throughout the year, even when low water problems. Fodder production is accelerated by as much as 25% by bringing the nutrients directly to the plants, without developing large root systems to seek out food. Plants mature faster and more evenly under a hydroponic system than a conventional soil based system. One kg of un-sprouted seed yields 8-10 kg green forage in 7-8 days (Anonymous, 2015). The hydroponics maize fodder yield on fresh basis is 5-6 times higher than that obtained in a traditional farm production, and is more nutritious.

5) Chemicals or pesticides

It does not require any chemicals or pesticides to grow. Traditional outdoor farming must rely on herbicides, fungicides and insecticides for optimum production. Hydroponic fodder is grown in a controlled environment without soil and therefore, is not susceptible to soil-borne diseases, pests or fungi, there by minimizing use of pesticides, insecticides and herbicides. An outbreak of pests or infections in hydroponically grown fodder can be quickly controlled by spraying the crops with appropriate pesticides or fungicides. Fresh and clean water should be used for irrigation as water-borne plant diseases spread quickly.

6) Less workforce and Transport cost

It needed less workforce and transport cost. Most of the farmers grow hydroponic green fodder near the livestock shade

Disadvantages of hydroponic fodder

- A high initial cost for the system
- Labor costs to process, maintain, harvest, and feed the fodder, which can be substantial for large operations
- A typical Hydroponic environment must be maintained (moderate temperatures and humidity); however, the hydroponic solution is not necessary, only clean water is required
- Loss in total dry matter

Conclusion

In developed countries where there is no dearth of quality feed and fodder, the hydroponic production of fodder is less competitive than traditional fodder production when compared on per kg dry matter basis. High initial investment on fully automated commercial hydroponic systems and high labour and energy costs in maintaining the desired environment in the system adds substantially to the net cost of hydroponic fodder production. Such systems are not successful in developing countries. Conversely, low cost hydroponic systems have been developed by utilizing locally available infrastructure where there is an acute shortage of fodder and water; local irrigation systems are not well established; transportation and fuel costs are high and seasonal variations of fodder prices are extreme. Typical lean periods of fodder production are the norm, investment in controlling temperature and humidity are low, and so is the cost of labour. Under such situations the cost structure is often shifted in favour of hydroponic fodder production, and it may find a niche in increasing livestock production.

References

Amar Sawant. (2021). Growing hydroponic fodder step by step guide. Agriculture Guruji.

Anonymous. (2015). What is alfaculture or hydroponic green fodder. https://alfaculture.wordpress.com/category/hydroponic-green-fodder/

Bakshi M.P.S., Wadhwa M., Harinder P.S. and Makkar. (2017). Hydroponic fodder production: A critical assessment. *Broadening Horizons*. 48:1-10.

FAO. (2015). Alternative fodder production for vulnerable herders in the West Bank. Resilience promising practice. www.fao.org/3/a-i4759e.pdf

Gebremedhin WK. (2015). Nutritional benefit and economic value of feeding hydroponically grown maize and barley fodder for Konkan Kanyal goats. *Journal of Agriculture and Veterinary Science*. 8(7):2319-2380.

Mehta M.P. and Sharma A. (2016). Hydroponic fodder production technology. Think Grain Think Feed, 2:12-13. https://issuu.com/thinkgrainthinkfeed

Rajesh Singh. (2016). Method of hydroponics green fodder production. *Pashudhan praharee.* ISSN: 2319-6971.

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SUCCESS OF CHICKPEA VARIETAL DEVELOPMENT AT REGIONAL AGRICULTURAL RESEARCH STATION (RARS), NANDYAL, ACHARYA N G RANGA AGRICULTURAL UNIVERSITY, ANDHRA PRADESH

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Introduction

AICRP on Chickpea Main Centre: Regional Agricultural Research Station (RARS), Nandyal, Acharya N G Ranga Agricultural University, Andhra Pradesh is adjudged as '**Best chickpea Research centre'** by ICAR –IIPR, Kanpur during Annual Group Meet on Rabi Pulses held at MPKV, Rahuri during 1 -3 September 2023. In the group meeting, two new chickpea varieties were also identified for cultivation in two zones of India *i.e.* Nandyal Gram 924 and Nandyal Gram 1267 from RARS, Nandyal. Till today total 10 chickpea varieties (including 8 desi and two kabuli) are released from Nandyal for cultivation throughout India.

The major chickpea growing districts in Andhra Pradesh are Kurnool, Prakasam , Anantapur and Cuddapah and nearly 80% of the chickpea growing area of the state is in the four districts. RARS, Nandyal is the lead centre responsible for location specific research on chickpea in scarce rain fall zone of Andhra Pradesh.

The scarce rainfall zone of Rayala seema region occupies an area of 49131 sq.km, constituting 17.9% of the geographical area. The zone lies in the south west part of Andhra Pradesh extending approximately from 13^0 to 16^0 north latitude and $76^0 54'$ to $79^0 40'$ east longitude. This zone is characterized by frequent drought with the lowest rainfall in the state. The rainfall is also uncertain and erratic. Agriculture in this zone is mainly dependent on the south west monsoon. Greater portion of annual precipitation (60-70%) is received in this monsoon period. Only about 20-30% is received in the northeast monsoon, which is characterized by cyclonic weather of variable interest. Chickpea crop is grown as rainfed crop in vertisols under receding soil moisture conditions. Crop is mostly sown from middle of October to middle of November. The growing season of chickpea is usually short (90-110 days).

With rapid expansion of area of chickpea in Andhra Pradesh, in particular in Kurnool district chickpea research was initiated under state plan project during 2004-05. During 2009-10, AICRP on chickpea sub centre was allotted to RARS, Nandyal the centre was upgraded to main centre during 2015.

Main moto

To make chickpea cultivation profitable to farming community through development of high yielding chickpea varieties with tolerance to biotic and abiotic stresses with matching agronomic practices and plant protection strategies.

Varieties released so far.,

Though the centre has released ten chickpea varieties, five chickpea varieties are released for Andhra Pradesh and five chickpea varieties are released at all India level, not only for South Indian states but also for Madhya Pradesh, Chhattisgarh and parts of Odisha, Punjab, Haryana, western UP, Delhi, north Rajasthan, Jammu and Kashmir and plains of Uttarakhand and Gujarat, Maharashtra, western Madhya Pradesh and Bundelkhand region of Uttar Pradesh.

S.No	Variety	Year of release	Type	Specific features	Recommended states
1	Nandyala Sanaga – 1 (N BeG 3)	2012	*Desi*	Tolerant to drought, resistant to wilt and bold seeded	Andhra Pradesh
2	Dheera (N BeG 47)	2015	*Desi*	Suitable for mechanical harvesting	Andhra Pradesh
3	Nandyal Gram 119 (N BeG 119)	2015	*Kabuli*	Early, large seeded *Kabuli* released for South Zone.	Andhra Pradesh Telangana, Karnataka and Tamil Nadu

4	Nandyal Gram 49 (N BeG 49)	2016	*Desi*	High yielding, tolerant to wilt with attractive seeds	Andhra Pradesh
5	Nandyal Gram 452 (N BeG 452)	2020	*Desi*	High yielding, tolerant to wilt	Andhra Pradesh
6	Nandyal Gram 810 (N BeG 810)	2020	*Kabuli*	Large seeded kabuli released for WCZ and NWPZ	North West Plain Zone comprising of Punjab, Haryana, western UP, Delhi, North Rajasthan, Jammu and Kashmir and plains of Uttarakhand and West Central Zone comprising of Gujarat, Maharashtra, western Madhya Pradesh and Budelkhand region of Uttar Pradesh.
7	Nandyal Gram 857 (NBeG 857)	2021	*Desi*	High yielding *desi* with tolerance wilt, suitable for irrigated conditions. Released for South Zone.	Andhra Pradesh Telangana, Karnataka and Tamil Nadu
8	Nandyal Gram 776 (NBeG 776)	2022	*Desi*	High yielding *desi* with tolerance wilt, suitable for mechanical harvest	Andhra Pradesh
9	Nandyal Gram 924 (NBeG 924)	2023	*Desi*	High yielding *desi* with tolerance wilt,	Madhya Pradesh, Chhattisgarh and parts

				released for ECZ	of Odisha
10	Nandyal Gram 1267 (NBeG 1267)	2023	*Desi*	High yielding *desi* with tolerance wilt, suitable for mechanical harvest, released for South Zone	Andhra Pradesh Telangana, Karnataka and Tamil Nadu

The recognition of new chickpea varieties is clearly evident from increase in seed demand as evidenced from breeder seed indents for chickpea varieties released from RARS, Nandyal. The genetic gains due to new chickpea varieties are also demonstrated in famers fields. (Demonstrating genetic gains of new chickpea varieties in Andhra Pradesh state of India. In National webinar on biotechnological interventions for improvement of pulse crops. Aug 07, 2020. Bihar Agricultural University, Sabour P.No. 37-38).

Salient features of new varieties of seeds available to farmers during current crop season

1. Nandyal Gram 776 (NBeG 776)

1. Year of release: 2022
2. NBeG 776 is a semi erect high yielding *desi* chickpea genotype tolerant to wilt and suitable for **machine harvest.**
3. It has duration of 90-105 days.
4. Yield potential up to 22-25 q kg/ha.
5. It is suitable for cultivation in all chickpea growing districts in Andhra Pradesh during *rabi* season under rainfed conditions. It also responds well to one or two supplemental irrigations.
6. NBeG 776 produces pods towards top portion of the branches. Pod bearing nodes are above 22-25 cm from the soil. The plant grows to height of 45-48 cm and hence like paddy or wheat, it is amenable to mechanical harvesting with existing combiners in the market.
7. NBeG 776 has attractive light brown coloured seeds with a 100 seed weight of 25.0 g and protein content of 20.9%.

8. Owing to its high yield and suitability to machine harvesting, it is recommended as a better alternative to JG11 and other *desi* varieties grown by farmers in Andhra Pradesh.

2. Nandyal Gram 452 (NBeG 452)

Year of release: 2020

Crop duration: 90-105 days.

Reaction to pests/ diseases/ abiotic stresses: Tolerant to wilt.

Average Yield (**q**/ha): Rainfed : 17.5-20 With one or two irrigations: 20-25

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Field view of NBeG 452

Salient features: It is a better alternative to JG11 and other popular *desi* varieties grown by farmers in Andhra Pradesh. NBeG 452 has semi spreading plant type with small leaflets, pink flowers, and attractive seeds with 100 seed weight of 23-25g

3. Nandyal Gram 857 (NBeG 857)

Year of Release : 2020

Recommended area : South Zone of India

Suitability : It is recommended for cultivation in Andhra Pradesh, Telangana , Karnataka and Tamil Nadu states.

Salient features :

- High yielding desi chickpea, tolerant to wilt
- crop duration : 90-105 days
- Attractive light brown coloured seeds
- 100 seed weight of 23.4g
- Protein content of 21.7%.
- Better alternative to JG11, JAKI 9218 and Super Annigeri.

Field view of NBeG 857

4. Nandyal Gram 119 (NBeG 119)

- Year of release: 2016
- N BeG 119 is high yielding bold seeded **kabuli** line with early duration of 90- 95 days.
- It has a yield potential of 18-20 q/ha.

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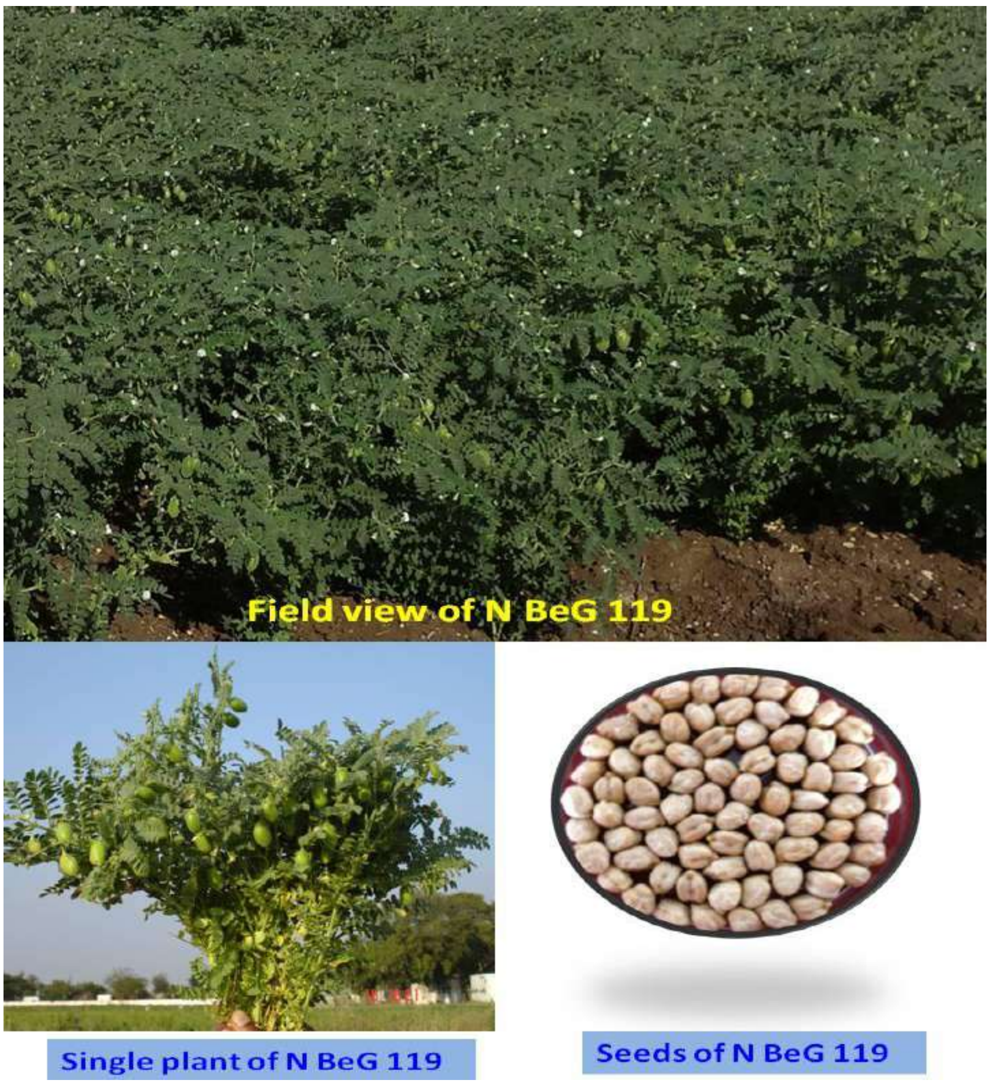

Salient features : A bold seeded kabuli variety (100 seed weight of 38 - 40g) with beige colour attractive seeds with a protein content of 19.25%. Suitable for cultivation in South Zone comprising of Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions as well as with one or two protective irrigations. A better alternative to KAK2

5. Nandyala Gram 810 (NBeG 810):

Year of release : 2020

Recommended area : North West Plain Zone and West Central Zone

Field view of NBeG 810

Suitability : Recommended for cultivation in Punjab, Haryana, western UP, Delhi, North Rajasthan, Jammu and Kashmir and plains of Uttarakhand, Gujarat, Maharashtra, western Madhya Pradesh and Budelkhand region of Uttar Pradesh.

Salient features :

High yielding extra large seeded

Crop duration of 110-115 days in West Central Zone and 145-150 days in North West Plain Zone.

Large attractive beige colour seeds

100 seed weight is 41g

Protein content of 20.67%.

Better alternative to extra large seeded *kabuli* varieties like PG 0517 and PKV 4

Volume: 03 Issue No: 10

RECENT ADVANCES IN NUTRIENT MANAGEMENT

Article ID: AG-VO3-I10-93

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Introduction

Plant nutrient management improve the problem for food security and rural development is to enhance the amount of plant nutrients in farming systems and hence crop productivity. It is therefore a complex challenge to increase agricultural production by better managing plant nutrition and making greater use of other production parameters. All nutrient sources must be managed, including organic manures, waste products, and fertilizer-recyclable trash. The entire amount of nitrogen fertilizer consumed worldwide in 2015 was 112.5 million tonnes, 118.2 million tonnes in 2019, and is anticipated to reach 7.9-10.5 billion tonnes by 2050. Farmers are quite concerned about the enormous demand for N fertilizers since it drives up cultivation costs and reduces the soil's natural fertility. As a result, excessive N fertilizer use results in the issue of N pollution, which is now seen as a new danger to the sustainability of the environment. This information may also be useful in lowering N pollution. Nitrogen is necessary for the healthy growth and development of plants. Crop productivity is significantly impacted by nitrogen deficit, but too much N could harm the plant.

Nutrient Management Challenges

a. Declining fertilizer response and crop productivity

b. Stagnation in fertilizer production

c. Stagnating food grain productivity

d. Macronutrient Deficiency
e. Micronutrient Deficiency
f. Multi micro- nutrient deficiency
g. Imbalances in fertilizers use
h. Gap in nutrient supply and nutrient removal

Nutrient Management: Options

Promoting

- ✓ Fortified and coated fertilizer
- ✓ Customized and water -soluble fertilizer
- ✓ Nanotechnology slow- release fertilizers
- ✓ Utilizing indigenously available nutrient sources
- ✓ Enhancing availability of organic manure
- ✓ Use of Bio-fertilizers
- ✓ Use of vermicompost
- ✓ Legumes in crop rotation
- ✓ Conservation Agriculture
- ✓ Managing problem soils through soil Amendments

Fortified and Coated Fertilizer

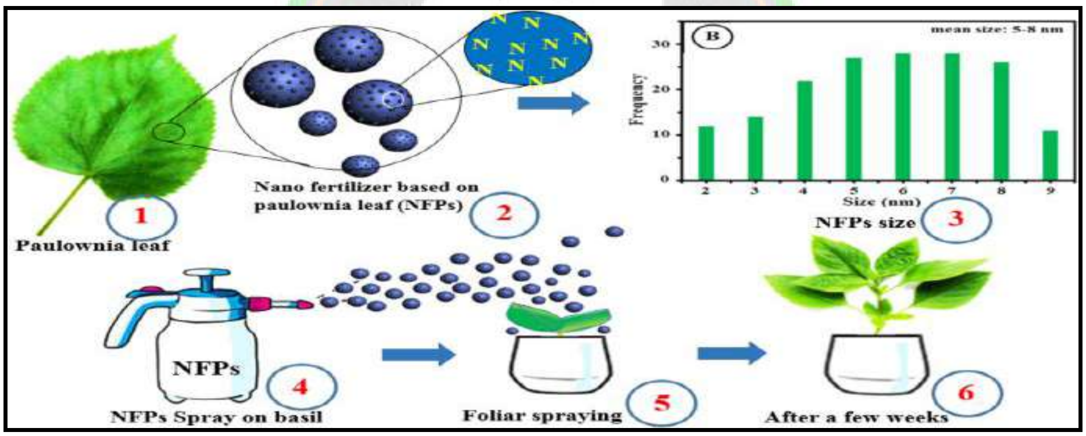
To rectify their widespread deficiencies in Indian soils, fertilizers should be strengthened and covered with micro and secondary nutrients.

Customized and Water-Soluble Fertilizer

For precise nutrient applications, it is necessary to promote a variety of specialized fertilizers suitable for various soil and crop conditions. The multi-nutrient carrier known as Customized Fertilizers (CF) comprises both macro and micronutrient versions. The "Paras Formula" was the first CF created in India and contains 10% N, 18% P_2O_5, 25% K_2O, 3% S, and 0.5% Zn. It includes all of the macro-and micronutrients needed by particular crops in particular areas. By using these fertilizers, NUE—which is currently 40% for nitrogen, 20% for phosphorus, 50% for potassium, and 2% to 5% for other micronutrients would be improved.

Nanotechnology Slow-Release Fertilizers

By providing slow- release Fertilizers (nano porous geolites) and soil quality and plant health monitoring systems (nano sensors), nanotechnology opens up a world of possibilities for better nutrient Management. The bulk of nutrients' still-low nutrient utilization efficiency could be improved by new products and tools. The availability of P was modified by the use of tailored nanoparticles formed of amorphous pyrogenic hydrophilic SiO_2, which increased its mobility. Wheat crop nano-Zn-chitosan increased Zn accumulation in plants cultivated in Zn-deficient soil. Sorghum's nano-ZnO increased productivity, uptake, and NUE. Application of $nCeO_2$ to the barley crop increased the uptake of macro- and micronutrients as well as the Ce content in grain. The delayed and continuous release of nutrients to plant roots and resulting increase in NUE caused by the application of NFs increased agricultural productivity. Similar to this, soil application of nano-titanium oxide ($nTiO_2$) to tomato plants enhanced plant nutrient growth, absorption, and accumulation.



Biochar

Biochar, a charcoal-like substance made from partially pyrolyzing agriculturally produced organic material, improves soil fertility and NUE by increasing the amount of available nutrients. Because of its large surface area, porosity, and many functional groups, biochar has the ability to keep more nutrients in the soil. It also has the potential to raise the pH of the soil. Additionally, it raises the soil's porosity, microbiological density, and ability to retain moisture and aerate it. The soil's available N and pH were raised by using wheat residue, charcoal, and nutrients in doses of 1 and 2%. Because of the oxidation of certain functional groups on the surface of the biochar, the usage of biochar made from woody components dramatically increased the cation exchange capacity of soil. The recalcitrant quality of rice husk biochar increased the soil's organic carbon concentration. In addition to improving crop output, biochar application increased the diversity and density of beneficial microorganisms in soil. Additionally, it has been noted that applying compost and biochar together improved the urease, dehydrogenase, and -glucosidase activities in the soil.

Zeolites

Zeolite surface application has the ability to reduce nitrogen losses to the environment by reducing NH_3 losses. Zeolites that are ammonium-charged have demonstrated the capacity to improve the solubilization of phosphate minerals, encourage rock phosphate dissolution in all types of soils, and lower soil fixation.

Remote Sensing Technologies

While moving, the GPS provide location data in real-time. After obtaining precise position information, it was possible to acquire soil and crop location information quickly. The ability to return to specific spots for managing certain regions is made possible by the use of GPS receivers, which can be kept with farm implements. A non-exhaustive N band that serves as a control or reference is kept in the field in a sensor-oriented method. Sensors may determine whether a crop needs more nitrogen by delaying the application of some of the nitrogen that is typically applied. Data from a distance can be collected using remote sensing techniques. For the purpose of to analyze the moisture, nutrients, and health stress that are visible in aerial images, remote sensing data are used. According to reports, the normalized difference vegetation index (NDVI) and plant N levels are strongly correlated. Since the NDVI rises when leaf greenness does as well, remote sensing could be utilized as a tool for applying nitrogen. VRAs are made up of three parts: a computer, a locator, and an actuator. The computer alters the quantity of input to be applied in the field by using the application map and GPS to send a signal to the input controller.

Leaf Color Chart

Based on the chlorophyll content of the leaves, a leaf colour chart (LCC) is employed to determine the leaf N concentration. It is a diagnostic tool for maximizing the N demand and nutrient control in the rice-wheat cropping system. LCC readings are taken 10 days after seeding or 20 days after transplanting/ For hybrid and basmati rice, an LCC value of 3 or 4 is required. According to N fertilizer was applied to hybrid rice using an LCC-based method, which resulted in a 25% fertilizer savings without lowering crop output. The LCC is the most practical and accurate nutrient management instrument, having several shades of green that can be compared to leaf colour and used to administer the necessary quantities of fertilizer.

4R Nutrient Stewardship

The use of the right source, right rate, right time, and right place is known as the "4R" approach to nutrient management. To achieve balanced fertilization and improved NUE in the cropping system, 4R nutrient stewardship is necessary.

Crop Modeling

Crop models are a set of mathematical equations created for accurate prediction of plant growth and development. A variety of models have been created for the evaluation of NUE in crops. De Nitrification De Composition (DNDC) and Decision Support System for Agrotechnology Transfer (DSSAT), for instance, were created in northeast China to explore management strategies to increase yield and NUE in maize crops. This crop model describes the soil water, organic matter, and N dynamics in relation to crop demand and weather conditions. This model implied that applying combination inorganic and organic fertilizers would increase agricultural output and NUE. Under climate change, the SPACSYS model was utilized to boost crop production and NUE in wheat and maize, which can be offset by cutting-edge soil management techniques and increased applications of N, P, K, and manure.

Conclusion

In modern times several new problems such as climate change, abiotic stresses, and problematic soils cause the loss of natural resources, and together amplify our food security target. There is an emergency need to reduce the cost of cultivation and degradation of natural resources. Therefore, increasing the NUE in economically important crops is a great challenge to secure environmental sustainability. However, the advancement in agronomical approaches for nutrient management has achieved some milestones in the last decades such as INM, SSNM, Nano-fertilizers and low-Release fertilizers approaches.

References

Sameer Mohapatro, Tanmoy Shankar, GVNS Swami and Sailasuta Sahu.2020. A Review on Precision Nutrient Management. Agro Economist - An International Journal, AE: 7(2): 77-83

Singh, A.L. and Anita Mann. 2012. Recent advances in plant nutrition "Physiological and molecular approaches for development of climatic resilient crops" ANGRAU, Hyderabad, India. pp. 6-22.

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VALUE ADDITION OF FLOWER CROPS

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Abstract

Value addition of flower crops is a method that increases employment, economic value, reduces post-harvest losses, and provides higher quality for individuals who have experienced hardship and who are living below the poverty line. The floriculture sector includes decorative plants, cut and loose flowers, as well as items with additional value made from flowers and flower components that are very profitable on the market. Several industries are also contributing economic value and jobs. The process of generating genetic and processing alterations, as well as employing novel techniques, to raise the economic worth and attractiveness of all floricultural products is known as flower value creation.

Introduction

Floriculture industry is presently considered as one of the most profit-making sectors in agro-enterprise. Flowers have various uses in human day today life due to its aesthetic value, varying colors, fragrance, texture, diverse form. But flowers being highly perishable, makes it challenging to promote in market following inadequate post-harvest management practices for the growers. Floriculture sector not only includes the loose flowers, cut flowers and ornamentals but also the value-added products derived from the flowers and its parts fetching really good amount of money in market and several industries increasing economic value and providing employments. Value addition of flowers is the process of improving economic value and appeal of any floriculture products by deriving changes in genetics and through processing as well using innovative methods. Different types of value-added products of flowers are listed as: A.) Value addition in loose flowers i.e., floral arrangements, garland, rangoli, floral wreaths, garlands, vein bouquets, button-holes, floral decorations, in marriage celebrations. B.) Value addition in cut flowers i.e. floral arrangements, bouquets, baskets, buttonaire and corsage etc. etc. C.) Value addition in dry flowers i.e., flower baskets, bouquets, pot-pourri, wall hanging, button holes, greeting card, wreaths etc. D.) Concrete and essential oils from certain species and varieties.

Various value-added products are:

Pot Pourri

Potpourri is a special arrangement of dried flowers made from a mixture of aromatic leaves, spices, seeds, roots, and distilled essential oils that are placed on a pillow or packet. A typical element in potpourri is dried flowers. For making pot pourri Rose petals, Marigold petals, Lotus pods, Cock's comb, Jasmine, Lavender, Bougainvillea and Rosemary etc are used. In pot pourri Rose petals are commonly used.

Flower Bouquets

A bouquet is a well put-together cluster of flowers. Apartments and public places can be decorated with bouquets that are organised or held in the hand. Hand bouquets are categorized by several common shapes and styles, such as bouquets, crescents and cascading bouquets. Rose, Tuberose, Orchid, carnation and lily etc flowers are used in flower bouquet.

Boutonniere

A single or several small flowers is worn by man and women on his lapel. Rose or orchid crop along with filler like Thuja leaf is used in Buttonhole. Tulip and Rose flower are used for this.

Veni

Veni is a special type of flower arrangement to ornament long plait of hair at the time of marriage ceremonies or Bharat Natyam dance recital in South India. Various types of flowers used for veni making are Jasmine and Roses.

Corsage

A small arrangement of flower is worn by a person on their wrist. It is larger than boutonniere. A corsage may be worn pinned to the chest, or tied to the wrist. It is usually larger or more elaborate than a boutonniere. Roses, Carnations, Orchids, Chrysanthemums and Lilies are good for corsage.

Rangoli

In general, rangoli means that the pattern of the entrance is composed of colors, but loose flowers can also be used in rangoli in consideration of the environment. Foliage clippings or turf grass clippings is used to create green colour in rangoli. Petals of chrysanthemum jasmine, rose, marigold and daisy are used for rangoli.

Floral Wreath

A floral arrangement in the form of circular garland is commonly woven of flowers and foliage that traditionally shows honor or celebration. Wreaths are especially very famous on funerals as an image of honoring the deceased. Boxwood, Magnolia, Cedar and English Ivy are used as Floral Wreath.

Floral Crowns

Floral crowns product of scented tuberose flowers are typically utilized in ceremonies like 'Annaprasna' or through a queen or a princess in a drama. Rosemary, Lavender, Spray Roses, Strawflower, Wax flower etc are used for floral crowns.

Floral Bangles

Floral bangles are worn by female dancers made of fragrant flowers such as tuberose or jasmine or non-fragrant flowers such as Tabernaemontana and Marigold.
Thevetia peruviana worn by female dancers.

Floral earrings

Floral earrings are made of flowers such as Kadamba, jasmine and tuberose worn by women during dance ceremonies in the memory of epic heroes and heroines such as Rama and Sita.

Floral jewelry

Floral jewelry includes items like garlands, bangles, crowns, earrings, gajra (hair garlands), and veni (hair accessories). These pieces are made from various flowers like jasmine, tuberose, chandani, orchids, marigold, crossandra, barleria, champa, chrysanthemum, and gomphrena. loral jewelry has gained immense popularity among brides, particularly in metropolitan cities, during the mehendi (henna) event of their weddings.

Press dried flower products

The leaves and flowers are dried via way of means of herbarium technique and in the end pasted with fevicol or glue in inventive manner. It includes greeting cards, bookmarks, paper weights, wall hangings, table tops, table mats, etc.

Various edible value-added products are:

Gulkand

Rose petals are also preserved for direct consumption prepared by mixing of rose petals with sugar in equal proportion, considered as anti- oxidant, tonic and laxative. Commonly used varieties are R. *damacena*, R. *chinensis*, R. *pomifera* and R. *gallica* etc. Some other scented rose like Edouard roses are commonly used.

Jasmine tea

Jasmine tea is made of jasmine flower and mostly consumed in China where known as jasmine flower tea. Jasmine tea is often based on green or white tea, but oolong tea bases are sometimes used as well.

Herbal tea

Rose petal or flower buds combined with herbs is known as herbal tea. Sometimes rose petals are used as flavour in regular tea.

Rose syrup

Rose syrup is made of extract of rose petals. Rose syrup is much use in France. Rose scones and marshmallows is the product of French rose syrup, mostly used in the United States. Rose flowers are also used in food, flavour, scent and candied rose petals.

Candle making

Candle making can be enhanced by incorporating dried flowers, which can be achieved in a couple of ways. One method is to attach dried flowers to the surface of plain candles. Another approach involves placing crushed dried flowers onto wax paper and then drizzling melted wax over them before rolling the candle in the flowers. Both techniques add a touch of beauty to the candles.

Rose oil or Rose perfume

Rose oil is extracted from rose petals and its extraction has been acknowledged and practiced in Persia since 17th century. Among the *Rosa spp*., *R. damascena*, *R. centifolia*, *R. gallica* and *R. moschata* are used in extraction of oil. Around 3000-4000 kg rose petals are used to make 1 kg of rose oil. Essential oil main compound is β-citronellol, linalool, phenylethyl alcohol.

Pankhuri and Gulroghan

Dried rose petals are known as pankhuri which are occasionally used for preparing sweets and cold drinks. The rose water oil is prepared from rose petals are known as gulroghan.

Conclusion

Value addition is an important sector for proper utilisation of fresh ornamentals in either garden-fresh or processed form. But the challenges are adequate technology for value added products, proper knowledge and plans for standards to be followed, availability of species and varieties as per market preferences, and approach of various agencies at various levels in different functional areas i.e., research, finance, quality assurance & certification. Value addition is a business strategy that helps in creating new market demands and indulging renewed demand from the consumers. Value addition sector can solve the two major issues- Un-employment and poverty of the nation, by providing a steady source of income to the growers. Government initiative is very essential to benefit the producers and the country's economy on a whole. Encouraging the value addition and adoption of proper and adequate technological interventions of new products and innovative methods. Broadening the mindset of people towards use of the flowers for the other industries and not only ornamental purpose can also help people create a source of additional income.

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TERRARIUM: GLASS LANDSCAPE ART

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Introduction

Indoor gardening refers to the growing plants indoors. Indoor gardening is practiced for different purposes and multiple styles and techniques are engaged for this purpose. The trend of indoor gardening is tremendously increasing as people are more interested to beautify their home and office spaces with different types of plants such as ornamentals, vegetables, and herbals. The reasons for the indoor gardening are purely for delight, satisfaction and to mitigate indoor air pollution etc. Indoor garden can be accommodated in any indoor space of homes, office, restaurants and anywhere the life and colour are needed. The limitation of outdoor spaces demands to imitate the nature in the farm of indoor gardens. In indoor garden, plants are grown in containers, pots, ceramic made pots, or any other container. Terrarium is one such type of techniques used for growing plants generally in a sealable glass container containing soil, and can be opened for maintenance to access the plants inside. Terrariums are a great addition to any space for a countless of reasons. It is a perfect gift, and adds an intriguing natural element to any indoor space. That helps to encourage creativity and act as a wonderful learning resource for kids about tending of live plants. Indoor gardening with terrariums is entertaining and one of the attractive ways to integrate plants into any home furnishings.

Terrariums are classified into two types:

1. Closed terrarium
2. Open terrarium

Material required for the preparation of terrarium

Container to use: A glass jar lidded or open based on the selection of an open or enclosed terrarium.

Growing media consist of potting mixture (1:1:1:1 ration of soil: sand: Farm Yard Manure: cocopeat), charcoal and pebbles of different colour and sizes to build the foundation.

Plants of choice: Varying sizes, colors or textures to keep the terrarium contrast.

Terrarium accessories for decoration Moss/sphagnum moss Spray bottle for misting watering the plants.

Types of containers:

Choosing the right container is essential for the creation of terrarium. Any transparent glass container with a wide mouth with or without a lid can be used to make a terrarium. Suitable containers include aquariums any glass jar, wine bottle, light bulb, glass cloche etc. The glass cloche was often used to protect tender plants in the garden especially for nurturing moistureloving plants. A wide opening in the container allows fitting the hand into the container to add drainage material, soil media, plants, and decorative items.

Media for terrarium:

Appropriate media is important for the sustainable growth of plants inside the terrarium. Three types of layers are important in adding planting media to the terrarium such as drainage layer, soil layer and plant layer are essential. A drainage layer with the non-porous material such as small gravel, sand, or bark chips to create a collection area for drainage. The second layer is the soil layer which consists of growing substrate to anchor the roots of your plants and retain moisture. Common growing media types include potting mix, coconut coir, or sand. Third layer is the plant layer consists of suitable plants for an open or closed terrarium. Other layers like activated charcoal layer for water filtration and purification, ornamental layer for the decorative appeal are optional.

Planting the terrarium:

The largest plants among the selected ones can be planted in the middle of the glass container, and then the smaller ones can be planted around. Decorative items, moss, shells, pebbles or rocks of different size and colours can also be added make terrarium attractive.

Selection of suitable plants:

Tropical plant varieties viz., ferns, mosses, orchids, and air plants, are generally kept within closed terrariums due to the conditions being similar to the humid environment of the tropics. Ferns are versatile and hardy plant species likes warm environment with high humidity and they have huge variety of shape and textures. Air plants, cacti and succulents are good low-maintenance choices for this modern-style terrarium. Succulents are not good choice for closed terrariums and the lack of drainage leads to root rot. It is a great specimen to use in open terrariums because of their low maintenance needs and adaptation to arid environments.

Plants suitable for terrarium

S.No.	Plant	Species
1.	Fern	Pellaea rotundifolia, Phlebodium aureum, Adiantum microphyllum, Nephrolepis cordifolia, Davallia fejeensis, Nephrolepis exaltata etc.
2.	Peperomia	Peperomia prostrata, Peperomia rotundifolia etc.
3.	Air plants	Tillandsia bulbosa, Tillandsia stricta etc.

4.	Foliage	Calathea orbifolia, Philodendron Hederaceum, Fittonia albive nis, Tradescantia zebrina etc.
5.	Moss	Thuidium delicatulum, Hypnum cupressiforme, Tortula ruralis etc.
6.	Bromeliads	Cryptanthus Bivittatus, Neoregilia etc.
7.	Orchids	Miniature Phalaenopsis, Masdevallia, Pleurothallids etc.

Designing a terrarium

The terrarium designs are limited with the creativity of the designer. It can be designed following theme for example tropical rain forest, fairy garden, water fall, water garden, outdoor garden, etc. The themes may be created by material or plants oriented. The shape of the container and related decorative accessories can be chosen to match the theme of the terrarium.

Designing the terrarium can follow the following principles

Balance

This is the state of equilibrium can be created by symmetrical and asymmetrical way around the central axis. Symmetrical balance is achieved by the exact duplication on both sides. The asymmetrical balance creates curiosity which can be accomplished by the inclusion of different colour, texture, and shape. Unity or harmony: It is the overall effect of various features, styles, and colours of total scene of the terrarium. It can be attained by following the rule of three by planting in odd numbers.

Proportion or scale

It is the size relation of one component with other in magnitude and the sense of distance can be created by planting smaller/fine textured plants in the periphery of the container and larger/coarse textured plants in the centre.

Focal point

The place/point where the viewer's eye is first attracted which can be created by stones, rocks or with different coloured/textured plant.

Rhythm

Repetition of an object or a plant in a cyclic pattern is called rhythm. Simplicity: Overcrowding with plants and objects should be avoided by following simplicity.

Maintenance/after care

Watering is the most essential to operation in terrarium and it can be done with a sprayer. Watering contributes to creating an ideal environment for growing plants due to the constant supply of water, thereby preventing the plants from becoming over dry. The open terrariums need to be wate red weekly once. The terrariums with loose-fitting glass lid need to be watered every 3 months. Closed terrarium with a cork, rubber, or tight glass enclosure, it can stay closed without needing any water. The sealed or closed container creates and maintains moisture. The moisture from both the soil and plants evaporates in the elevated temperatures inside the terrarium and allows for the creation of a small scale water cycle. This water created by evaporation vapours and then condenses on the walls of the container and falls back to the terrarium containing plants and soil below. The dead leaves or plants should be removed immediately which allows the terrarium to look clean and pretty. Lighting is very much required for the plants in terrarium to survive and grow healthily. The light that passes through the transparent wall of the terrarium allows the plants within to photosynthesize. Bright and indirect light in the form of artificial florescent lights or indirect sunlight helps the growth of plants and direct sunlight should always be avoided.

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BIOFUELS AND ITS IMPORTANCE

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Introduction

Biofuels may be solid, liquid or gaseous in nature. Biofuel is considered pure and the easiest available fuels on planet earth. Biofuels are obtained from biomass like wood and straw, which are released by direct combustion of dry matter and convert into a gaseous and liquid fuel. These can be used to replace or can be used in addition to diesel, petrol or other fossil fuels for transport, stationary, portable and other applications. Also, they can be used to generate heat and electricity. Other sources include organic matter like sludge, sewage and vegetable oils matter, which can be converted into biofuels by a wet process like digestion and fermentation.

Bio-fuels

- Fuel produced from any **renewable biomass** material
- Used as **alternative source** of fuels
- They may be,

  Solid - Fuelwood, charcoal, wood pellets

  Liquid – Ethanol, biodiesel, pyrolysis oil, Biobutanol

  Gaseous – biogas, producer gas
- **Biodiesel, Bioethanol**, Biobutanol are the important biofuels.

- Algal fuel is also called as **Oilgae.**

Classification based on feedstock used

	First generation (Edible biomass)	**Second generation** (non-edible biomass)	**Third generation** (algal biomass)
Bioethanol	Sugarcane, maize, sugarbeet	Cellulose, hemicellulose, lignin, pectin	Algae
Biodiesel	Vegetable oil	Jatropha oil	Algal lipid

Importance of Bio-fuels

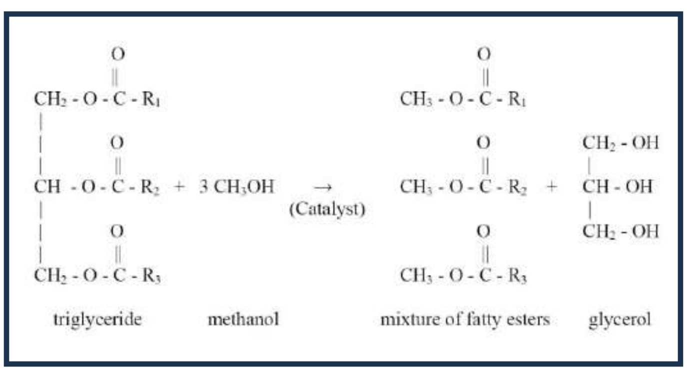
- **Lower emission** compared to fossil fuels
- Reduce **green house gases**
- Increase **energy security**
- Reduce **environmental pollution,** Reduce **import cost**
- Increase **rural economy,** Efficient **use of biomass**

Bio-diesel

- It is the **Mono-alkyl esters** formed from long chain fatty acids of **vegetable oils.**
- Method of production – **transesterification** with methanol and ethanol.
- Composed **of methyl ester and ethyl esters**
- Bio-diesel can be used as **B100 (Pure biodiesel)** or blend with petroleum diesel.
- Blend of **20%** biodiesel with **80%** diesel termed as **B20 grade.**

Production of Bio-diesel – Jatropha seed (oil content – 30 to 35%)

Chemistry in Transesterification



Types of Transesterification

a) Super critical fluid transesterification

No catalyst is used, yield is obtained by maintaining a temperature **(340°C)** pressure **(43 MPa).**

b) Catalytic transesterification

i) Alkali catalyzed

NaOH and KOH are used as catalyst. High yield of bio-diesel. Separation of glycerol and biodiesel is the only problem **(Saponification)**.

ii) Acid catalyzed

Sulphuric acid and sulfonic acid is used. It consumes more time (3 hrs) and require temperature above **100°C**. Formation of **carboxylic acid** reduces biodiesel yield.

iii) Enzyme catalyzed

Lipase enzyme is used. **Glycerol yield is more** compared to bio-diesel. So it is adopted for glycerol production.

Steps involved in alkali catalyzed transesterification

Oil is heated at 60°C

⇩

10g of NaOH Alkali dissolved in 200ml of methanol and Added to heated oil.

⇩

Stirred continuously and maintained at 65°C for one hour.

⇩

Two distinct layers formed, upper layer ester and lower layer glycerine.

⇩

Allow glycerol settlement for 2 hours.

⇩

Glycerol is removed by decantation, centrifugation and distillation.

⇩

Now the ester is washed 3 times with water to remove impurities.

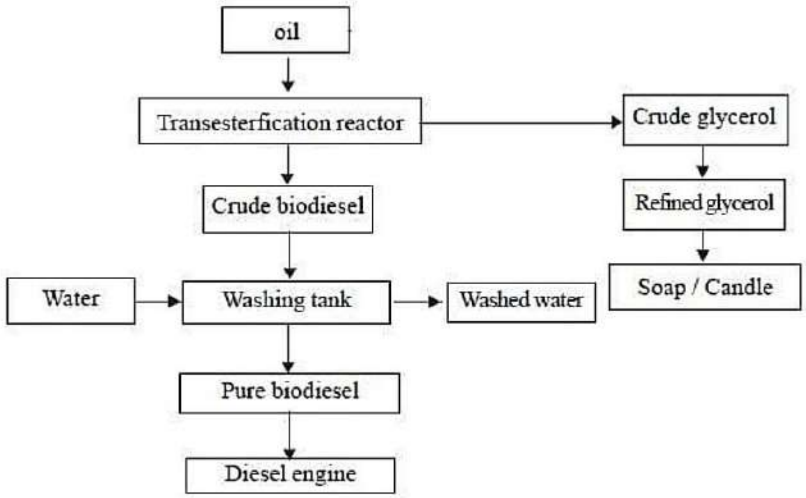
⇩

Washed ester heated for 4-5mins to remove moisture.

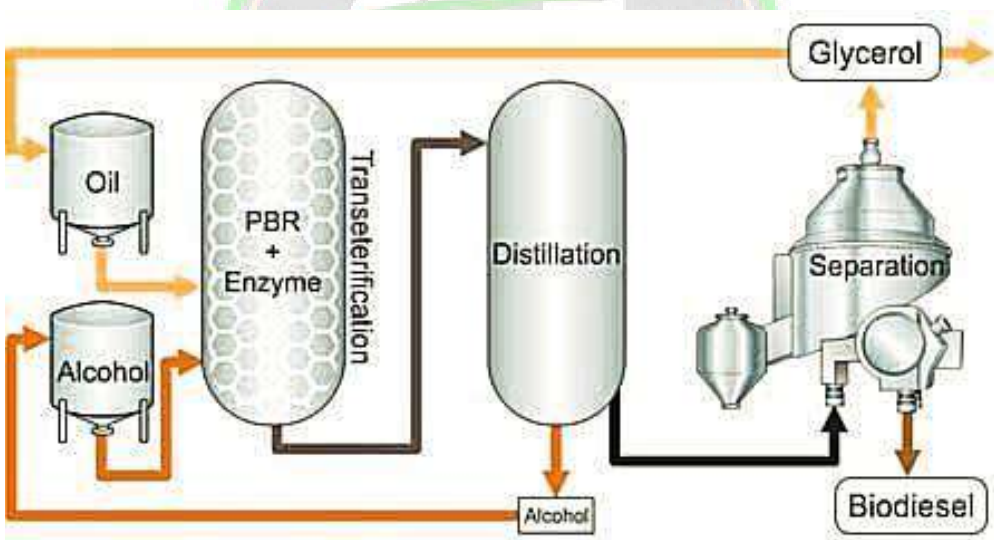
⇩

90% of ester (Bio-diesel) can be obtained with by products.

Flowchart – biodiesel production



Production process Diagram



Properties of bio-diesel

Viscosity

- Viscosity is a measure of the ability of a liquid to flow.
- Measure of resistance to flow.
- Viscosity at 40°C is **5.2 CentiStokes.**

Flash point

- It is the Minimum temperature at which **fuel flashes**, when flame is applied.

- Flash point of bio-diesel **150°C**. Safe value is greater than **60-66°C.**

Calorific value

- Amount of heat released during combustion of specified amount of any substance.
- Calorific value **40 MJ kg^{-1}**

Cetane number

- It is the ignition quality of diesel fuel.
- Cetane rating range between **46 to 64.**
- High cetane number, high efficiency.

Cloud point

- When oil is cooled at specific rate, the temperature at which it becomes cloudy or hazy is called cloud point.
- Cloud point of biodiesel is **13°C.**

Sulphur content

- Sulphur content increase with increase in boiling range.
- Sulphur content for biodiesel is **less than 10 mg/kg.**

Pour point

- The temperature at which the oil ceases to flow.
- Pour point of biodiesel is **16°C.**

By product utilization

Biodiesel produce **4** major by product along with biodiesel.

i) Glycerin

- **(**For every **10 parts of biodiesel** produced, there is **1 part of glycerin** formed.)
- Glycerin can be converted into **Ethanol** through **fermentation** with strain of **E.coli.**
- Glycerin combined with harmless **E.coli** to form **succinate**, which is used to **flavor** food and drinks.
- It can be used to produce **hydrogen rich gas**, which is used in **fertilizers**, food production,and chemical plants.

ii)Waste water

- Water used for **washing purpose** is again **treated and reused**

iii)Remnant methanol

•Excess Methanol can be **boiled off from glycerin** within closed container and directed to condenser.

•It can be used in **next batch** biodiesel.

iv)Biodiesel waste

•It can be **composted** by mixing with **organic matter** such as leaves, straw, twigs.

Advantages of bio-diesel

- Ecofriendly, reduce emission, less toxic
- **Alternate source** for diesel & petrol.
- Obtained from renewable resources. So it reduce fossil fuels usage.
- **Low sulfur** content, less CO emission
- Bio-diesel have **high lubricity** that **extends engine life**
- Reduce import of conventional fuels
- Biodegradable and easy to handle
- Income to rural community.

Disadvantage of bio-diesel

- Higher viscosity
- Higher fuel consumption
- Poor atomization pattern
- Incomplete combustion and engine failiure.

Book Reference

S.Pugalendhi, R.Shalini, J.Gitanjali, P.Subramanian - 2019 – Introduction to Renewable sources of energy – Tamilnadu agricultural university, Coimbatore. Pg no : 164-170

Er. Sanjay Kumar – 2019 – Renewable energy – Kalyani publishers. Pg no: 141-144.

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IMPROVED PRODUCTION TECHNOLOGIES (IPTS) FOR PRODUCTIVITY OF HYBRID SUNFLOWER

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Introduction

World sunflower area accounts for 20 million hectares and production around 30 million tonnes. Major cultivating countries are Russia (5.41 million hectares), Ukraine (3.69 million hectares), India (2.16 million hectares), Argentina (1.89 million hectares) USA (1.06 million hectares) and China (1.05 million hectares) occupying about 68 % of the total world sunflower acreage. The average productivity of sunflower in India is very low of 615 kg/ ha as compared to other major producers.

In India, sunflower is cultivated in around two million hectares (10 % of the world sunflower area) and production is around one million tonne (4 % of the world sunflower production). The major producers of sunflower are Karnataka (54.86%), Andhra Pradesh (20.83%) and Maharashtra (14.58%). According to the market sources, 70% of the crop is produced in Rabi (November – March) season, and remaining 30% in Kharif (June – September).

The productivity of sunflower in Tamil Nadu is 1240 kg/ha which is higher than the national average of 615 kg/ha. About 68 % of the crop is raised under irrigated conditions. For the past five years sunflower is a crop of choice for farmers in Trichy, Erode, Karur, Dindigul, Tirunelveli, Villupuram and Cuddalore regions.

Improved Production Technology (IPT) for Hybrid Sunflower

Tamil Nadu - Irrigated Agriculture Modernization and Water bodies Restoration and Management (TN-IAMWARM) project which promotes scientific cultivation of Sunflower to improve productivity levels and to ensure better commodity price for domestic sunflower growers.

The following major criterias for adoption as IPT

- ✓ Short duration (90-105 days)
- ✓ Use of hybrid seed
- ✓ Field preparation with ridges and furrow 60cm apart
- ✓ Adoption of wider spacing 60 x 30 cm
- ✓ Split application of recommended fertilizer dose
- ✓ Spray borax @ 0.2% (2g/l of water) at ray floret opening stage and seed filling and /or gently brushing the two capitulums facing each other.
- ✓ Timely management in plant protection measures with suitable pesticides for preventing the major pest and diseases.

Farmers find sunflower as a highly profitable crop, especially in black soils of Southern districts of Tamil Nadu where the crop is largely cultivated under rainfed and irrigated conditions during late kharif/rabi season. Due to its short duration, it ideally is sown more between September and November. Sunflower also scores favourably against the traditional cultivated crops like rabi Jowar, Bajra, Castor and Pulses during the late Kharif /early Rabi season due to following advantages

1. Selection of right hybrid

Selection of the right sunflower hybrid is critical as the final income is dependant on both grain and oil yields. As not all hybrids available in the market maximise both grain and oil yields, farmers need to be cautious while choosing the hybrids. In this aspect, it is appropriate to mention that some of the hybrids like Rasi Hybrid, Cauveri-50, Nuviseed, PAC-36, PAC-8699 and PAC-1091 provide both high grain and oil yields. These hybrids, have potential to yield upto 12 quintals/acre with oil content of >40%, under right growing and management conditions.

2. Time of Sowing and Duration of Hybrid

Farmers need to give very careful consideration to the time of sowing and based on which hybrids of right duration are to be selected. Predominantly, the farmers in southern districts like Viruthunagar, Tirunelveli and Thoothkudi of Tamil Nadu traditionally either keep the land fallow or take up pulses or green manure crop with the start of the first rains and then take up sunflower starting from September to mid of November. Farmers in southern districts have realised higher yields by sowing the crop during these months. Longer duration hybrids (>95 days) are to be sown in the early season while medium-short duration hybrids (85-95 days) give better results, if sown later.

3. Plant Nutrients

Better yields in sunflower can only be realised by applying integrated recommended dosage of fertilisers. Particularly, of importance are, application of FYM / Composted coir pith @ 12.5 t/ha, biofertilizer like Azophos @ 2 kg/ha with soil test based nitrogen, phosphorous, potash and micronutrients like sulphur and boron. Foliar application of Borax @ 0.2 % at ray floret opening stage, Salicylic acid (100 ppm) and nitrobenzene (50 ppm) at vegetative stage and flowering stage improving plant health and increasing grain yields, also help in improving grain weight and oil content.

4. Irrigation/rainfall

Soil moisture, if available in adequate measure, during critical stages of vegetative growth, flowering and seed setting enhances grain and oil yield. For effective water management the crop should be irrigated immediately after sowing followed by life irrigation on 5 DAS and pre flowering, flowering and pod filling stage.

5. Weed management

Pre emergence application of Pendimethalin 2 kg / ha followed by hand weeding at 45 DAS help in better establishment and healthy plants.

6. Pest and Disease Management

Recommended preventive measures and usage of right hybrids provide protection to many of the common pests and diseases in Sunflower. Preventive sprays of pesticides before the first 50 days prevent attack by Heliothes and infestation of Alternaria. Outbreak of viral diseases can also be prevented by sowing the crop after July and by controlling sucking pests like thrips with timely spray of systemic insecticide in the first 40 days. Farmers are suggested to refer to package of practices recommended by local agricultural universities or information provided by the seed companies. When compared with other competing crops in similar maturity groups, Sunflower is indeed very profitable. Farmers would get maximum benefits from this crop by following the scientific cultivation practices already explained above.

Results from Field trials

Field trials were conducted during 2020 - 2021 in black soils for maximizing the yield of sunflower in Sankarankovil, Kuruvikulam, Vasudevanallur, blocks of Tirunelveli and Thoothukudi district of Tamil Nadu. The farmer groups were identified and trained by the agricultural scientists from the Agricultural College and Research Institute (TNAU), Killikulam, Vallanad, Thoothukudi (Dt). The latest improved production technologies were transferred through theory and practical field trainings. Totally 83 demonstrations were carried out. The hybrid seeds varieties *viz.*, Rasi, Nuzivved, Kaveri-50 were sown. The farmers were instructed to adopt the improved production technologies (IPTs) as explained above. In improved production technology (IPT), the range yield of hybrid sunflower seed was 2385-2504 kg / ha over the conventional method (1685 -1935 kg / ha). The per cent increase yield was 23-25 % over the conventional method of cultivation.

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SEED PRODUCTION TECHNIQUES IN WHEAT FOR CULTIVATION IN PENINSULAR ZONE OF INDIA

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Introduction

Wheat is the most important *rabi*-cereal crop in India. It plays a crucial role in food grain production in the country. India is second largest producer of wheat in the world. In India, it is grown mainly in the states of Punjab, Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Uttarakhand, Himachal Pradesh, Karnataka and Maharashtra. There are five wheat growing zones as per climatic conditions such as North-Western Plains, North-Eastern Plains, Northern Hill Zone, Central and Peninsular Zone. During 2022-23, wheat crop was cultivated in 32.44 million hectares in the country, yielding 112.74 million tonnes with an average productivity of 35.43 quintals/ha (Anonymous 2023).

The states of Maharashtra, Andhra Pradesh, Karnataka, Goa and Tamil Nadu (except Nilgiris & Palani Hills) are included in the Peninsular Zone of India. In this zone, *sarbati* wheat (*Triticum aestivum*), *bansi* wheat (*Triticum durum*) and *khapli* wheat (*Triticum dicoccum*) are mainly cultivated as the climate is considered favorable for the same species. Wheat crop has to face high temperature especially during stalk and flowering stage in this region. Therefore, the farmer needs short duration and high temperature tolerant varieties during flowering and full growth stage. The wheat productivity of this region is slightly lower than that of the North West plains (Punjab and Haryana) but from the quality point of view the wheat of the central and peninsular regions is considered superior having export potential.

Species of wheat cultivated in India

- **Sarbati wheat (*Triticum aestivum*)**: It is suitable for *chapatis*, breads, biscuits and cookies. Making *chapatis* and breads requires stronger and expanded gluten and more protein in wheat. Madhya Pradesh, Gujarat, Maharashtra, and parts of southern Rajasthan are considered suitable for cultivation of this wheat.
- **Bansi wheat (*Triticum durum*):** Madhya Pradesh, Gujarat, Maharashtra, Karnataka and parts of southern Rajasthan are considered suitable for cultivation of this wheat. This wheat also grows well in dry and hot climates. *Bansi* wheat has high protein content and is used to make premium *rava* or *suji*. It is the first choice for making pasta, macaroni/noodles due to its high gluten protein and uniform golden color.
- ***Khapli* wheat (*Triticum dicoccum*):** *Khapli* wheat has long narrow grains and is generally used to make *rava*, *kheer* and breakfast foods. It is considered a rich source of protein and carbohydrates. It has excellent grain quality characteristics and has higher dietary fiber content than other species (more than 16%). *Khapli* wheat varieties are famous for traditional food, better taste and more nutritional value. It contains protein (11.8 to 15.3 %) and carbohydrates (78.7 to 83.2 %). It has a low glycemic index which makes it suitable for diabetic patients.

Package of practices for wheat seed production

Wheat is a self-pollinating crop and if proper precautions are taken, wheat farmers can produce wheat seeds and use these seeds for two to three years if properly stored.

Requirements for export quality wheat:

- Moisture content : Less than 12.0%
- The content of other adulterants : Less than 0.70 %
- Protein content : More than 12.0%
- The content of broken or over dried grains : Less than 4.0%
- Damaged grains : Less than 2.0% in wheat
- Grain damage : Less than 1.0%
- Wet gluten : More than 25.0%
- Falling number of grains : More than 300 seconds
- Hectoliter weight : More than 78.0 kg/hl

Varieties: Major wheat varieties recommended for cultivation in Peninsular Zone of India are given in Table 1.

Table 1 Wheat varieties recommended for cultivation in Peninsular Zone of India under different sowing conditions

Sowing Condition	Period of sowing	Species	Name of the variety	Year of release	Productivity (q/ha)	Days to maturity
Timely Sown Rainfed Condition	15 to 31 October	*Triticum aestivum*	Netravati (NIAW 1415)	2010	19.0	105
			Vimal (AKAW 3722)	2014	42.0	107
			UAS 347	2015	18.0	96
			UAS 375	2018	21.4	103
		Triticum durum	MACS 4028	2018	20.3	103
			Panchvati (NIDW 15)	2022	15.0	105
Timely Sown Restricted Irrigation condition (Max 2 irrigations)	25 October to 5 November	*Triticum aestivum*	Netravati (NIAW 1415)	2010	28.5	110
			Pusa Ujala (HI 1605)	2017	30.0	105
			Phule Satwik (NIAW 3170)	2020	33.7	107
			Phule Anupam (NIAW 3624)	2022	32.5	107
		Triticum durum	GW 1346	2019	28.5	100
			HI 8802	2020	29.5	106
			HI 8805	2020	30.9	100
			MACS 4058	2020	29.0	105
			NIDW 1149	2021	26.0	103
Timely Sown Irrigation condition	5 to 15 November	*Triticum aestivum*	UAS 304	2013	46.0	110
			MACS 6222	2014	50.0	110
			Phule Samadhan (NIAW 1994)	2016	46.1	115
			MACS 6478	2016	45.0	107
			DBW 168	2018	48.8	112
		Triticum durum	MACS 3949	2017	44.0	111
			DDW 48	2020	44.0	110
		Triticum dicoccum	MACS 2971	2009	50.2	107
			HW 1098	2013	45.5	110
Late Sown Irrigation condition	15 November to 15 December	*Triticum aestivum*	AKAW 4627	2012	39.0	112
			MACS 6222	2014	50.0	110
			Pusa Amulya (HD 3090)	2014	42.1	101
			Phule Samadhan (NIAW 1994)	2016	44.3	110
			PDKV Sardar	2016	39.2	108
			Pusa Wani (HI 1633)	2021	41.7	100

Source of Seed: Always use foundation or certified seed supplied by ICAR Institute, State Agricultural University, Agricultural Seed Centre, State Agriculture Department, State Seed Corporation/National Seed Corporation or recognized Seed Company. Keep the label/tags/bills of the seed material used for sowing.

Seed Treatment: Seed treatment is necessary to prevent seed borne diseases. Seed treatment should be done with Carbendazim at the rate of 1.25 gm per kg seed or Tebuconazole 1.0 gm per kg seed.

Isolation Distance: As per Indian Seed Certification (2013) standard, 3 m isolation distance is required for wheat seed production. But if the nearby area is affected by Smut disease, then the same distance should be up to 150 meters.

Roguing: This is an important step in seed production. Genetic purity as well as physical purity of the seed depends on proper roguing. The seed certification body may reject the seed plot if the off-types in the seed production are not removed. Therefore, it is necessary to identify the plants of other varieties, plants with different characteristics like leaf color, shape, stem color, height, hairiness, shorter or longer flowering period etc should be removed completely. Diseased plants should be destroyed to maintain the genetic purity of the variety.

Irrigation: Irrigation should be given according to the stage of wheat crop growth. Depending on the availability, 4 to 5 irrigation should be given in medium to heavy soils.

Irrigation timings as per crop growth stages

1) Crown Root Initiation stage (CRI) : 18-21 days after sowing
2) Boot stage : 40-45 days after sowing
3) Flowering and milking stage : 60-65 days after sowing
4) Grain filling stage : 80-85 days after sowing

Inter Culturing/Weed Management: Weed free seed production is essential to produce quality seed. This prevents the spread of weeds through the seed chain. The following herbicides should be used in wheat crop.

a) Pre-Emergence Application: Pendimethalin should be sprayed at the rate of 1250 ml per acre for the control of broad leaves and grass weeds up to 3 days after wheat sowing. Use 250-300 liters of water for above spraying.

b) 30-35 days after sowing: Isoproturon (50%) 500 g per acre for control of *Kanaki* (*Phalaris minor*) and for weeds like *Chandvel* / *Hirankhuri*, 2-4-D (38 EC) 500 ml per acre.

Fertilizer Management:

For timely sown irrigated condition: 58:24:16 kg N:P:K per acre should be used. Farmers should apply 52 kg DAP, 84 kg Urea and 26 kg MOP. In this, 52 kg DAP, 15 kg Urea and 26 kg MOP should be applied at the time of sowing. The rest of the nitrogen should be given in the form of urea @35 kg during the first and second irrigation.

Late sown irrigated condition: 52 kg DAP, 26 kg MOP should be applied at the time of sowing and the remaining amount of nitrogen in the form of urea should be applied @ 28 kg each during first and second irrigation.

Crop protection: Wheat crop is damaged by Rust (Stem rust and leaf rust) and leaf blight diseases. Black Rust or stem rust can reduce yield by 20 to 50 %. For control of rust, give two sprays of Propiconazole @ 0.1% + Copper Oxychloride @ 0.2%, at 15 days of interval. For control of blight, spray Copper Oxychloride @ 0.2% + Mancozeb @ 0.2% For control of pests like aphids spray Imidacloprid 17.8 % SL @ 40 ml per acre in 200-250 liters of water. For control of stem borer spray Quinalphos 25% EC 300 ml for 500 liters of water per acre.

Harvesting and Threshing: While harvesting and threshing wheat, care should be taken that seed should not be get mixed with other varieties/species. Keeping in mind the increasing use of harvesters in recent times, it is necessary to clean the machines to avoid mixing the seed of different varieties.

Seed Processing: For successful processing of certified seed, the seed has to be sent to the processing center given by the seed certification agency. The processing is carried out in following steps

a) Pre-cleaning: This separates out particles larger than seeds, such as soil, wood chips, sawdust and other materials. For this purpose, the air flow and mesh assigned by the certification agency is used.

b) Seed Grading: Grading machines, indented cylinders and seed gravity separators are used for grading. By this step; low quality seeds, lightly poached seeds, broken seeds etc are separated. For this, high quality seeds are prepared using the characteristics of wheat seed size, weight and density. Generally 10-12 % of light seeds/grains (out of total weight) are separated and returned to the farmer and high quality seed is used for packing.

Germination and physical purity test: After the processing, the seed sample is sent to the seed laboratory for testing. In this the physical purity, germination capacity and moisture content of the seed are tested. It should have 85% of germination and 98% of physical purity. After successful testing in the laboratory, the seed is labeled as truthful or certified seed. Only then it becomes available for further sale.

Seed storage: Always choose a dry and ventilated system/place for seed storage. The processed seeds are bagged and kept for storage. To avoid damage due to moisture in the seed, the seed should be properly dried before storage i.e. seed moisture should be 10-12%. New bags should preferably be used for seed storage so that seeds of other varieties will not get mixed. Wooden pallets should be used for seed storage so that the seeds do not absorb moisture from the surface of the godown.

References

Anonymous (2023) ICAR- IIWBR, AICRP on Wheat and Barley, Director's Report

Arun Gupta, Charan Singh, Vineet Kumar, Sushila Kundu, Vinod Tiwari and G. P. Singh (2017) Indian Wheat Varieties at a glance Volume II

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DISEASE EPIDEMIC MANAGEMENT STRATEGIES FOR PLANT BIOSECURITY

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Abstract

Since the beginning of agriculture, generations of farmers have been evolving practices for combating the various plagues suffered by our crops. Following our discovery of the causes of plant diseases in the early nineteenth century, our growing understanding of the interactions of pathogen and host has enabled us to develop a wide array of measures for the control of specific plant diseases.

Keywords: Biosecurity, Pathogens, Plant Disease, Epidemic

Introduction

Plant biosecurity can be defined as a set of measures designed to protect crops from EPPs at national, regional and individual farm levels (Waage, and Mumford 2008). Countries are required to comply with international obligations as defined by the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (WTO, 1995).

Why Do Plant Pathogens Emerge?

- Plant diseases increase in incidence, geography, or host range of a pathogen can occur by movement of pathogens in infected plant material, as was the case in the recent introductions of wheat blast into Bangladesh in infected seed. Extreme weather events, such as hurricanes, can transport pathogen spores over continents.
- Years after the introduction of citrus tristeza virus in South America, an insect vector was introduced that led to wider geographic spread of the disease.

- Plant pathogens may shift hosts and gain the ability to infect new hosts when introduced into new regions. For example, CMV does not naturally occur on cassava in South America but moved into cassava in Africa from an unknown host following uptake of cassava as a major food crop there.
- A change in pathogenesis or virulence of an endemic strain can occur, as exemplified by the recent alarm over a new race of the wheat stem rust pathogen in Ethiopia (race TTKTT) with a very high combination of virulence genes and a new race in sicily that could overcome resistance in a widely grown European cultivars of wheat (Jean *et al.*, 2021).
- Newly evolved plant pathogenic species can also occur through interspecific hybridization or mutations within existing pathogen lineages.

Traditional Principles of Plant Disease Control

Avoidance— Prevent disease by selecting a time of the year

Avoidance can be carried out by:- Choice of geographical areas selection of field selection of seed and planting material choice of time of showing disease escaping varieties Modification of cultural practices.

Exclusion—prevent the introduction of inoculum

- Exclusion preventing the inoculum from entering or establishing in the field or area where it does not exist.
- Seed treatment
- Inspection
- Certification
- Quarantine (Federal or State)
- Cleaned farm equipment cleaning farm equipment

Eradication—eliminate, destroy or inactivate the inoculum

- Eradication this principle aims at eliminating a pathogen after it is introduced into an area but before it has become well established or widely spread. It can be applied to
- Individual plants
- Seed lots
- Fields or regions it is generally not effective over large geographic areas

Eradiation can be done by……

- Destroying weeds that are reservoirs of various pathogens or insect vectors of disease
- Biological control of plant pathogen
- Crop rotation
- Soil treatment
- Heat and chemical treatment elimination of potato cull piles weed control

Protection—Prevent infection by means of a toxicant or some other barrier to infection

- Crop rotation soil treatment burning of infected residues crop propane flaming
- Protection preventing infection by creating a chemical toxic barrier between the plant surface and pathogens
- Chemical treatment
- Chemical control of insect vector
- Modification of environment or environment condition
- Modification of host nutrition
- Protection can be done by…… Bananas are covered with plastic sleeves raised planting beds ground sprayers

Resistance—utilize cultivars that are resistant to or tolerant of infection

- Resistant varieties preventing infection or reducing effect of infection by managing the host through improvement of resistance in it by genetic manipulation or by chemotherapy.
- Selection and hybridization of disease resistance
- Mutation for disease resistance
- Susceptible and resistant plant to papaya ringspot virus susceptible and resistant plant

Therapy—Use thermotherapy, chemotherapy and/or meristem culture to produce certified seed or vegetative planting stock

- Therapy of disease plant reducing severity of disease in an infected individual by chemicals.
- Chemotherapy
- Tree Surgery
- Heat Therapy

Strategies of disease epidemic management

1. Forecasting of Epidemic
2. Investigations of Epidemic
3. Control of Epidemic
4. Prevention of Epidemic

Forecasting of Epidemic

Real-time epidemic forecasting provides an opportunity to predict geographic disease spread as well as case counts to better inform public health interventions when outbreaks occur. Epidemic forecasting using predictive modeling is an important tool for outbreak preparedness and response efforts. Despite the presence of some data gaps at present, opportunities and advancements in innovative data streams provide additional support for modeling future epidemics (Desai *et al.*, 2019).

Investigations of Epidemic

Investigating an outbreak/epidemic is a set of procedures used to identify the cause responsible for the disease, the people affected, the circumstances and mode of spread of the disease and other relevant factors involved in propagating the epidemic and to take effective actions to contain and prevent the spread of diseases. The three major epidemiologic techniques are descriptive, analytic and experimental. Although all three can be used in investigating the occurrence of disease, the method used most is descriptive epidemiology.

Control of Epidemic:- Measures used to prevent or control infectious diseases are **treatment, quarantine, isolation and prophylaxis**. Quarantine and isolation are two measures by which exposed or infectious individuals are removed from the population to prevent the spread of infection. They are applied less often.

Prevention of Epidemic

A common method for reducing the likelihood of disease spread is through **quarantine**, which involves separating an individual who may have come into contact with the infectious agent from other substances.

Conclusion

Plant diseases do not recognize political borders, yet country borders are often used to stop the sharing of information on plant disease outbreaks. The migration of plant pathogens with trade is likely to increase with the emergence of new trade relationships, compounding the impacts of climate change on agricultural productivity in some regions of the world. More comprehensive surveillance strategies for plant diseases that include strategic partnerships among research universities, development agencies, nongovernmental organizations, the private sector and CGIAR are needed. Research programs focused on disease surveillance and epidemiology for the high-impact plant pathogens on major food crops such as wheat, potato, cassava, banana, corn and rice are needed to prevent plant pathogen spread and predict the global burden of plant disease.

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References

Desai, A. N., Kraemer, M. U. G., Bhatia, S., Cori A, Nouvellet, P., Herringer, M., Cohn, E. L., Carrion, M., Brownstein, J. S., Madoff, L. C. and Lassmann, B. (2019). Real-time Epidemic Forecasting: Challenges and Opportunities. *Health Security*, 17(4):268-275. doi: 10.1089/hs.2019.0022.

Jean B. Ristaino, Pamela K. Anderson, Daniel P. Bebber and Qingshan Wei (2021). The persistent threat of emerging plant disease pandemics to global food security, Perspective, 118(23): e2022239118.

Waage, J. K. and Mumford, J. D. (2008). Agricultural biosecurity. *Philosophical Transactions of the ROYAL Society B* 363(1492): 863-76. doi: 10.1098/rstb.2007.2188.

www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/Manage

Z. Li *et al*., (2019). Non-invasive plant disease diagnostics enabled by smartphone-based fingerprinting of leaf volatiles. Nat. Plants 5, 856-866.

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CROPPING SYSTEMS MANAGEMENT

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Introduction

The cropping patterns used on a farm and their interaction with farm resources, other farm enterprises, available technology and environment (physical, biological and socio-economic) which determine their makeup, constitute the cropping system. Cropping system is a land use unit comprising soils, crop, weed, pathogen and subsystems that transform solar energy, water, fuel, nutrients, labour and other inputs into food, feed, fuel and fibre. The cropping system is a subsystem of the farming system.

Need for cropping system:

The cropping system research has adequately demonstrated the following potentials.

- Improved stability of food supply throughout the year
- Increased total food production per land unit per year, generally accompanied by an increase in total income for the farmer
- Improved distribution of income throughout the year
- Increased total employment of labour throughout the year, and
- Improved nutrition for the farm family from crop diversification

Objective of cropping system

The objective of any cropping system is efficient utilization of all resources viz., land, water and solar radiation, maintaining stability in production and obtaining higher net returns. The efficiency is measured by the quantity of produce obtained per unit resource in a unit time.

CROPPING SYSTEMS & PATTERNS

Cropping pattern: The yearly sequence and spatial arrangement of crops and fallow on a given area.

Cropping system: The cropping patterns used on a farm and their interactions with farm resources, other farm enterprises, and available technology which determine their makeup.

Farm house hold system: A group of usually related people who, individually or jointly, provide management, labour, capital, land and other inputs for the production of crops and livestock, and who consume at least part of the farm produce.

Sole cropping - One crop variety grown alone in pure stands at normal density. Also known as solid planting.

Monoculture - The repetitive growing of the same crop on the same land. Monoculture is also called single cropping or mono-cropping. It is a system of growing the same crop on the same land year after year.

Crop rotation - The repetitive cultivation of an ordered succession of crops or crops and fallow on the same land. One cycle may take one or more years to complete.

Live mulch system: Live mulch crop production involves planting a food crop directly into a living cover of an established cover crop without tillage or the destruction of the fallow vegetation.

Mixed cropping: Growing of two or more crops simultaneously and intermingled without row arrangements, where there is significant amount of intercrop competition.

Shifting cultivation or Jhuming or Land rotation: Forest land is cleared and cultivated. Due to cultivation of the same crop on the same cleared forest land year after year; soil productivity is lost and the crop is shifted to other slashed and burnt land. Here same crop is grown year after year. In this case land is rotated but crop is fixed. Therefore, it may also be called land rotation. Shifting of land hence called shifting cultivation. Also called Jhum cultivation. It causes soil erosion. Mostly, practiced in North Eastern states of India and in hilly areas.

Ley farming: It is defined as a system of farming, in which grasses and legumes are included in proper rotation for ley, silage and pasture to care for maximum livestock needs and to improve and conserve the soil fertility.

Sustainable agriculture or Eco farming: Sustainable agriculture is a concept to produce sufficient food to meet the needs of the present generation without eroding the ecological assets and productivity of life supporting systems of future generations. Natural farming is an excellent illustration of sustainable agriculture. It is also known as ecological farming or eco-farming or organic farming. Sustainable agriculture seeks to achieve three main goals viz., economic efficiency, environmental quality and social responsibility.

Alley cropping: A farming system in which arable crops are grown in alleys formed by trees or shrubs, established mainly to hasten soil fertility restoration and enhance soil productivity, and for shelter.

Difference between cropping pattern and cropping system:

Sl.No.	Cropping pattern	Cropping system
1	Crop rotation practiced by a majority of farmers in a given area or locality	Cropping pattern and its management to derive benefits from a given resource base under specific environmental condition
2	Type and arrangement of crops in time and space	The cropping pattern used on a farm and their interaction with farm resources, other farm enterprises and available technology which determine their makeup
3	The yearly sequence and spatial arrangement of crop or crops and fallow on a given area. The proportion of area under various crops at a point of time in a unit area	Pattern of crops taken up for a given piece of land, or order in which the crops are cultivated on a piece of land over a fixed period, associated with soil management practices such as tillage, manuring and irrigation.

Cropping system in wet lands:

Sequential cropping is the most suitable cropping pattern of rice – rice in the wet land areas. Traditionally single crop of rice with long duration cultivars is planted during the rainy period. However, due to the advent of short duration, photosensitive varieties, multiple cropping is being now practiced. The cropping system under wet lands can be grouped in to two categories.

(i)All rice cropping pattern

Rice – Rice

Rice – Rice – Rice

(ii)Mixed rice and upland crop sequence

Rice – Rice – Pulses

Rice – Rice – Green manure

Maize - Rice – Groundnut/ Sunflower/Pulses

Maize - Rice – Blackgram/Sesame/Cotton

If supplemental irrigation facilities are available in rice fallows, crops like cotton, groundnut and gingelly can be grown. If it is not available, only blackgram can be raised with residual soil moisture.

Cropping system in irrigated uplands:

Under irrigated uplands (garden lands) depending upon the water availability or irrigation potential, more than two crops can be grown per annum. Crop sequences and their production potential have been tested under different agro climatic conditions.

Eg: Cotton – Sorghum – Ragi

Cotton – Blackgram – Sunflower

Cotton - Maize –Ragi

Cropping system in dry lands:

Normally only one crop is grown under dry land condition and cultivation is restricted during the rainy season. However, the intensity of cropping can be increased through sequential or intercropping, depending on the rainfall and moisture storage capacity of the soils.

Eg: Cotton, Sorghum, Pearlmillet, Cowpea, Horsegram, Bengalgram and Chilli

Sorghum + Cowpea

Sorghum + Bengalgram

Cropping pattern with varying rainfall and soil moisture storage capacity:

Rainfall (mm)	Storage capacity of soil (mm)	Cropping pattern
350 - 625	100	Single crop in *kharif*
650 - 750	100	Intercropping can be attempted
750 – 900	150	Sequential cropping is possible
>900	200	Sequential cropping is assured

Water requirement of the cropping systems:

Region	Cropping system	Water requirement (mm)
Wetlands	Rice-Rice-Rice	3500
	Rice-Rice-Pulses	2300
	Rice-Rice- Ragi	2750
Garden lands	Cotton-Sunflower-Ragi	1925
	Cotton-Sorghum-Ragi	1975
	Cotton-Maize-Ragi	1985

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SEED TREATMENT FOR BOOST THE CROP PRODUCTION

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Abstract

Moisture, temperature, humidity, and storage conditions are just a few of the environmental elements that affect seed quality. Even when all of these elements are taken into consideration, certain diseases that are transmitted by seeds or pests like insects might still affect seed quality. Seed treatment, which can range from a simple dressing to coating and pelleting, refers to the application of specific physical, chemical, or biological agents to the seed prior to sowing in order to suppress, control, or repel diseases, insects, and other pests that attack seeds, seedlings, or plants. Increased germination, uniform seedling emergence, protection from early-season illnesses and insect pests, improved crop emergence, and crop growth are all advantages of seed treatments. One of the reasons restricting disease management is farmer ignorance about seed treatments, hence efforts should be undertaken at the farmer level to implement the technology. The advancement as well as relevance of a few chosen seed treatment technologies will be explored in this review keeping in mind the aforementioned facts.

Introduction

Before planting, seed treatments like seed dressing, seed coating, or seed pelleting are typically given (Pedrini *et al.*, 2017). The most popular type of seed treatment, also called seed dressing, involves applying dry or wet fungicide and insecticide formulations to the seeds. To improve the performance of seeds in the field, natural bio-formulants like Pseudomonas, Trichoderma, and Rhizobia are applied. Industries typically coat vast quantities of seeds, while seed pelleting is used for crops like carrots and onions that have little seeds (Tamil Nadu Agritech portal, 2020). To keep the quality of the seeds during storage and transportation, treatments can be used as well at the time of harvest. Given these restrictions and an expanding global population, there has been of reduction of inoculums potential and at the same time ensure the sustainability of the production, cost effectiveness and healthy ecosystem and 'seed treatment' is one of these tools 2012's Sanjeev Kumar. Seed treatment can range from a simple dressing through coating and pelleting (ASF, 2010; Dubey K, 2011), just like newborn care is done with the mother. The term "seed treatment" describes the exposure of seeds to specific physical, chemical, or biological agents. These agents are not used to make seeds pest or disease free only; rather, they are treated to offer the possibility of pest and disease control when necessary during the germination, emergence, and early growth of young plants.

Objectives of seed treatment:

1. Its main role is to protect seeds from seed borne diseases and pest attacks.
2. To revive a seed that has been dormant for a long time.
3. Drought tolerance is induced.
4. Early emergence is used to increase the percentage of seeds that germinate.
5. To keep birds and vermin out.
6. Using X-rays, Gamma rays, and colchicines, obtain polyploides (genetic variety)

Benefits of Seed Treatment:

1. Prevents spread of plant diseases
2. Protects seed from seed rot and seedling blights
3. Improves germination
4. Provides protection from storage insects
5. Controls soil insects.

Conditions under which seed must be treated

1) Injured Seeds: Any break in the seed coat of a seed affords an excellent opportunity for fungi to enter the seed and either kill it, or awaken the seedling that will be produced from it. Seeds suffer mechanical injury during combining and threshing operations, or from being dropped from excessive heights. They may also be injured by weather or improper storage.

2) Diseased seed: Seed may be infected by disease organisms even at the time of harvest, or may become infected during processing, if processed on contaminated machinery or if stored in contaminated containers or warehouses.

3) Undesirable soil conditions: Seeds are sometimes planted under unfavourable soil conditions such as cold and damp soils, or extremely dry soils. Such unfavourable soil conditions may be favourable to the growth and development of certain fungi spores enabling them to attack and damage the seeds.

4) Disease-free seed: Seeds are invariably infected, by disease organisms ranging from no economic consequence to severe economic consequences. Seed treatment provides a good insurance against diseases, soil-borne organisms and thus affords protection to weak seeds enabling them to germinate and produce seedlings.

Types of Seed Treatment:

1) Seed disinfection: Seed disinfection refers to the eradication of fungal spores that have become established within the seed coat, or i more deep-seated tissues. For effective control, the fungicidal treatment must actually penetrate the seed in order to kill the fungus that is present.

2) Seed disinfestation: Seed disinfestation refers to the destruction of surface-borne organisms that have contaminated the seed surface but not infected the seed surface. Chemical dips, soaks, fungicides applied as dust, slurry or liquid have been found successful.

3) Seed Protection: The purpose of seed protection is to protect the seed and young seedling from organisms in the soil which might otherwise cause decay of the seed before germination.

Some other types of Treatments

Different seed treatments are used alone or in combination to address or prevent a number of pests, diseases and nutrient deficiencies and to enhance plant growth. These include fungicides, insecticides, inoculants, Plant Growth Regulators, fertilizers and fertilizer enhancers.

1. **Fungicides and Insecticide:** These types of treatments help to protect seeds and seedlings from disease and to fight pests that strike early in the season when seedlings are most vulnerable.
2. **Microbial inoculants:** These products help to improve the nitrogen fixation in legumes or otherwise stimulate plant growth or promote soil biodiversity. ABM is one company that offers microbial inoculant products through Southern States for use on wheat and cereals, soybeans and corn. Bio-Cat microbials is another company that produces

inoculants that increase crop yields. This is achieved by enhancing the biodiversity of the soil with beneficial microorganisms.

3. **Plant Growth Regulators:** This approach assists with the stand establishment of the seedling. It improves the plant's ability to tolerate stress at the early critical stages.
4. **Fertilizers:** These types of treatment are used to enhance fertilizer performance or supply micronutrients to the soil, which helps plant growth. Southern States provides a number of fertilizer treatment options for various crops based on the needs of the emerging plant.

Seed Treatment Active Components and Other Coating Materials

A wide range of materials is used in seed treatments and coatings. These materials were categorized by their composition and origin as synthetic chemicals (SYN), natural products or derivatives from natural products (NP), biological agents (BIO) and minerals mined from the earth (MIN)

1.Active Components

The purpose of active ingredients is aimed at protecting and enhancing seed and seedling performance in terms of germination, growth and development. Elicitors are being investigated as active components for pest management and drought stress. There is increased interest and demand for bio-stimulant- and nutrient-based seed treatments.

2.Liquids

Water is the universal carrier of liquids that are atomized onto seeds during the coating process, and atomization is best achieved with low viscosity liquids. The proportion of water in the applied liquid is adjusted to maintain low solution viscosity. Adjuvant are used as most chemical seed treatment active ingredients have limited water solubility, so surfactants are needed to produce aqueous seed treatment formulations. Surfactants may serve as an active component, and a seed coating technology with surfactants was documented to enhance germination and stand establishment when sown in water repellent soils.

3.Solid Particulates

Solid particulates are the bulking materials used in seed coating technologies and form the physical coating after drying. Solid particulate binders are applied as fine powders and become hydrolyzed as water is applied during the coating process

Seed Coating Equipment and Methods

1.Dry Powder Coating

Dry powder application is a seed coating method used for mixing seeds with a dry powder. The older term for this application method is "planter box" treatment. Dry powders, also known as dusts, are used for fungal or bacterial treatments followed by drying (hydration/dehydration) and seeds can have a shorter shelf-life after application

2.Seed Dressing

Seed dressing is the most widely used method for low dosages of active components onto seeds. Although there are many types of equipment used for coating, the most commonly used device is the rotary coater. Liquids are applied onto a spinning disc and atomized onto seeds that are spinning inside a metal cylinder, then the freshly treated seeds are discharged. A wide range of active materials especially chemical plant protectants can be applied with this method.

3.*Film Coating*

Film coating originally developed for the pharmaceutical and confectionary industries was adapted as a seed coating method. Film coating consists of producing a continuous thin layer over the seed surface. The rotary coater is the primary seed coating equipment used for film coating

4.*Encrusting*

Encrusting is a seed coating method with the addition of liquids and solid particulates that results in a coated seed that is completely covered, but the original seed shape is retained. Encrusted seeds can be referred to as mini-pellets or sometimes as coated seeds. The primary coating methods to produce encrusted seed are the rotary coater or coating pan. The addition of large amounts of water during encrusting requires that the freshly coated seed be dried to back to its original seed moisture content prior to packaging and storing.

Pelleting and Agglomeration

Seed pelleting is a continuation of the encrusting coating process resulting in even greater build-up so that the original size or shape of the coated crop seed is not visible. Material properties for successful pelleting include particle size distribution, porosity, water absorbing and holding capacity and lack of toxicity

Equipments used for Seed Treatment:




Slurry Treaters **Direct Treaters** **Home-made drum mix** **Shovel**

Precautions Suring Seed Treatment:

Most products used in the treatment of seeds are harmful to humans, but they can also be harmful to seeds. Extreme care is required to ensure that treated seed is never used as human or animal food. To minimize this possibility, treated seed should be clearly labelled as being dangerous, if consumed. The temptation to use unsold treated seed for human or animal feed can be avoided if care is taken to treat only the quantity for which sales are assured.

Care must also be taken to treat seed at the correct dosage rate; applying too much or too little material can be as damaging as never treating at all. If the seeds are to be treated with bacterial cultures also, the order in which seed treatments should be done shall be as follows

i) Chemical treatments

ii) Insecticide and fungicide treatments

iii) Special treatments

Chemical treatments to improve germination and vigour potential

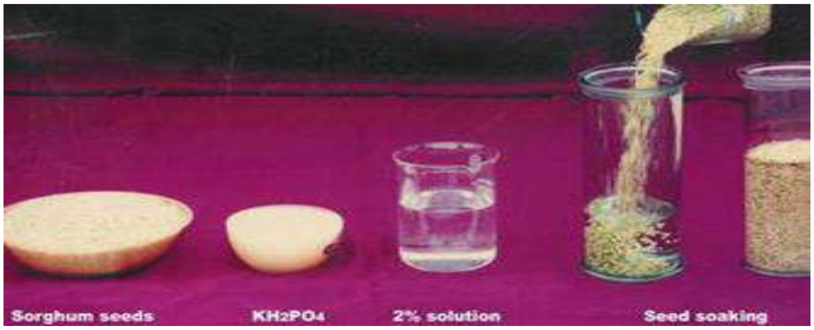
Soaking / treating the seeds with nutrients, vitamins and micronutrients *etc*.,

Examples: Paddy

Seeds can be soaked in 1% KCL solution for 12 hours to improve the germination and vigour potential

Sorghum

Seeds could be soaked in NaCl2 (1%) or KH2PO4 (1%) for 12 hours for improving the germination and vigour potential.



Pulses

Seeds can be soaked in ZnSO4, MgSO4 and MnSO4 100ppm solution for 4 hours to improve the germination and vigour potential.

References

ASF (2010). National code of practice for the use of seed treatments. Australian Seed Federation Limited, pp.1-7. Retrieved: September 4, 2014 from http:// www.asf.asn.au/userfiles.

Pedrini, S., Merritt, D. J., Stevens, J., and Dixon, K. (2017). Seed coating: science or marketing spin? *Trends Plant Sci*. 22, 106–116. doi: 10.1016/j. tplants.2016.11.002.

Tamil Nadu Agritech Portal (2020). TNAU Agritech Portal. Sponsered by Rashtriya Krishi Vikas Yojana (RKVY) Project. Available at: http://agritech. tnau.ac.in/ (Accessed July 21, 2021).

Sanjeev Kumar (2012). Cultural approaches for plant disease management. *Research & Reviews: Journal of Agricultural Science and Technology*, 1(2): 12-21.

Krishna Dubey (2011). Insecticide and fungicide seed treatment. Retrieved: 1 September, 2014 from http:// agropedia.iitk.ac.in/content/insecticide-and-fungicideseed- treatment.

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DETECTION OF SEED BORNE DISEASES THROUGH SEED HEALTH TESTING METHODS

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Abstract

Seed is a small embryonic plant which is an efficient means of introducing plant pathogens into a new area as well as providing a means of their survival from one cropping season to another. Seed health is a well recognized factor in the modern agricultural science for desired plant population and good harvest. Seed borne fungi are one of the most important biotic constrains in seed production worldwide. Seed health testing to detect seed borne pathogens is an important step in the management of crop diseases. Seed health is a measure of freedom of seeds from pathogens. Specificity, sensitivity, speed, simplicity, cost effectiveness and reliability are main requirements for selection of seed health test methods. PCR has many beneficial characteristics that make it highly applicable for detecting seed borne pathogens. Since seed serve as means of dispersal and survival of pant pathogens, it is critical to test its health before using it as planting material. Seed health testing and detection is a first line approach in managing seed borne diseases of plants.

Seed health testing

Seed health is a measure of freedom of seeds from pathogens. The presence or absence of seed borne pathogens can be confirmed through the use of seed health testing. The term seed health includes the incidence of fungi, bacteria, viruses and animal pests such as nematodes and insects in a seed lot. The test used depends on the organism being tested for and the purpose of the test, quality assurance or phytosanitary purposes when seed is exported. Seed testing is necessary for a number of reasons to determine the quality of the seed based on a number of seed quality attributes; to provide a basis for price and consumer discrimination among seed lots and seed sources; to determine the source of a seed problem, thereby facilitating control measures and to fulfill legal and regulatory requirements for certified seed classes and allow for seed movement across international boundaries

Seed health tests have been classified into the following four distinct groups based on the general techniques used to observe the target pathogen *viz.,* Direct inspection, incubation tests, examination of the embryo (embryo count method), Immuno assays and molecular methods.

I. Direct Examination

a. Dry seed examination

Direct examination inspection of dry seed is qualitiative and semi-quantitative seed health testing method where the fruiting structures of the fungi are detected under stereomicroscope or effects of fungal pathogens on the physical appearance of the seed are detected. By this method, fungal spores and other fructifications such as pycnidia, perithecia are detected. The seeds severely infected by some organisms are reduced in size or discoloured can also be detected.

b. Washing test

In this method, the inoculum located on the seed surface (Oospores of downy mildew fungi, teliospores of smuts and bunts etc.) is detected. The test consists of microscopic examination of the suspension obtained by shaking the seeds in water containing a tensioactive agent (i.e. Tween 20). The inoculum can be observed after cycles of centrifugation and resuspension of the pellet in water.

c. Embryo count method

This method is used to detect seed borne pathogens which are biotrophs or may grow very slowly on artificial substrate and generally are not able to develop fruiting structures (eg. Ustilaginales) or their development takes many days. (eg. *Septoria*). Staining barley embryos for the presence of *Ustilago nuda* mycelium is a standard method for seed health testing. Fluorescent method is applied for identification of *Septoria nodorum* identification. Percentage of kernels with fluorescent mycelium is counted after incubation of wheat seed. The staining technique was applied to cereal loose smut mycelium where dissected embryos, were macerate in sodium hydroxide and stainined with aniline blue.

II. Incubation methods

The seeds are incubated for a certain period in the agar plate or blotter test under specific environmental conditions in order to allow pathogens on the seed to grow. Different fungi are identified by features such as the form, length and arrangement of conidiophores, size, septation and chain formation of conidia.

a. Blotter test

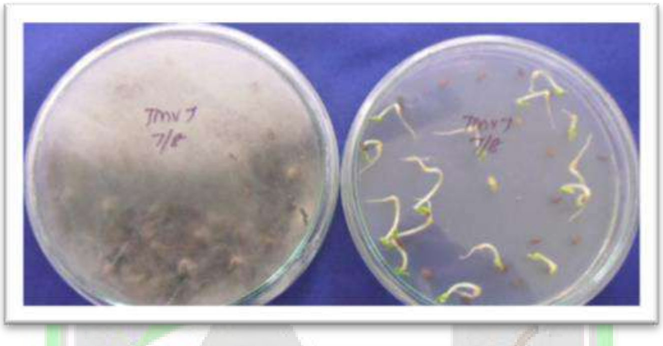
Blotter test is one of the most important methods available for testing seed borne fungal pathogens. The seeds are placed on moistened layers of blotter paper and incubated under conditions that promote fungal growth. The seed may then be allowed to germinate and fungal seed borne infections manifest themselves by pertinent signs or symptoms. The manifestations of the pathogen are influenced by the environmental conditions during incubation. .

The infection of the seed is shown by the presence of mycelium and fruiting bodies also the infections on the germinated seedlings are indicated by the symptoms on the young plants. In some tests, seeds are incubated during which they are allowed to germinate and symptoms are observed (eg. dark spots on the cotyledons of bean seeds infected by the anthrocnose pathogen).

In other tests the germination of seeds is deliberately suppressed to allow seed-borne infection to develop. (eg. to allow the pycnidia of seed borne *Phoma lingam* to develop on brassica seeds)

b. Agar plate method

This method gives information on viability of inoculum in the infected seed sample. The surface sterilized seeds are plated in Petri dishes on a suitable agar and spaced equidistantly according to the size of the seed. The seeds are incubated on the medium for 5-8 days usually at $20^oC \pm 2^oC$ to promote the growth of seed borne pathogens.



c. Freezing method

This method is a modification of the blotter method. The seed is sown on blotter. Cereals are incubated at 10^oC for three days to induce germination, then at 20^oC for two days and other kinds of seed at 20^oC for four days. The seedlings are then frozen overnight at -20^oC and subsequently incubated at 20^oC in near ultraviolet light for 5-7 days. The dead seedlings provide a substrate for profuse development of fungi such as *Fusarium* and *Septoria* in cereals., *Phoma* in beet. Bacterial antagonism can be eliminated by adding an antibiotic such as terramycin to the blotters.

d. Seedling symptom test

An approach to establish more natural conditions obtained by sowing the seed in autoclaved soil, gravel, sand or similar material was developed. Under standard conditions of temperature and moisture, infected seeds and seedlings may develop symptoms comparable with those developed under field conditions. For certain pathogens, this procedure provides information pertaining to field performance of the seed lot in relation to seed borne seedling diseases.

1 Sand method

Sterile, fine-grained sand, well wetted, is used as a medium. The seeds are covered by a 3-4 cm deep layer of water-saturated brick stone gravel or by a 2-3 cm deep layer of coarse grained sand. For small grained seed, the layer of coarse grained sand should be 1 cm deep only. The water supply vary according to the containers used. This method is applied for the detection of *Drechslera*, *Septoria* and *Fusarium* in wheat, oat and barley.

2. Test tube agar method

One seed is sown in test bubes of 16mm diameter containing 10 ml of water agar and incubated at 20^{o}C under artificial light and darkness for 12/12h cycle. The tubes are covered to retain the moisture in groups by aluminium foils which are removed when the seedlings have reached the cover. The length of the incubation is determined by the time needed for the development of seedlings and symptoms. The procedure allows better development of seedlings and symptoms can be easily studied which is visible on roots as well as on the green parts.

III. Serological methods

Serological seed assays rely on antibodies (polyclonal and monoclonal) generated against unique antigens on plant pathogens. Antibodies bind strongly and specifically to their antigens and can subsequently be detected by the enzymatic digestion of substrates or fluorescent tags. Serological assays do not require pure isolation of the pathogen and hence, are applicable to biotrophic and necrotrophic seed borne pathogens.

1. Enzyme Linked Immunosorbent Assay (ELISA)

This method was developed in 1970's and is the most commonly used diagnostic technique that uses antibodies. It involves enzyme mediated colour change reaction to detect antibody binding. This is usually done in a microtitre plate where the degree of colour change, usually measured in a computer controlled plate reader, can be used to determine the amount of pathogen present. This assay is simple, cheap and suitable for processing many samples.

a. Plate trapped antigen ELISA (PTA-ELISA)

The microtitre plate wells are directly coated with the test sample. This is followed by incubation with a specific antibody which binds to the target antigen. In some assays the specific antibody is conjugated to the emzyme (direct detection), and in others the specific antibody is detected by a second generic antibody eg. antirabbit or antimouse, which is conjugated to the enzyme (indirect detection).

1b. Double Antibody Sandwich (DAS-ELISA)

In this method specific antibodies are used to coat the microtitre plate, and then the target antigen from the test sample is coated. An enzyme – labeled specific antibody conjugate is then used for the detection.

2. Immunofluorescence microscopy

It is a highly recommended immunodiagnostic method for bacteria detection. Indirect and direct immunofluorescence cell staining involves microscope detection under ultraviolet light of an antigen after staining with homologous antibody conjugated with a fluorescent dye (eg. fluorescein isothiocyanate). Fluorescence is proportional to the concentration of bacteria in the seed preparation.

3.Immunofluorescence colony staining (IFC)

Immunofluorescence colony staining (IFC) method involves routine indexing and quantitative determination of field thresholds of pathogenic seed borne bacteria. IFC assay is more sensitive and more specific. IFC seed health assay incorporates seed extract with an equal volume of agar medium. The mixture is incubated, dried and exposed to target bacterium – specific antibodies conjugated with a fluorescent dye. Colonies stained with the antibody-dye conjugate can be visualized with fluorescent microscopy and bacteria inside the colonies can be isolated with a glass capillary tube and transferred to a suitable growth medium.

4. Flow cytometry

It is another promising serological technique for use in seed health assays, which automatically sorts and analyzes bacterial cells tagged with dye-conjugated antibodies while in suspension. Several parameters can be determined within a few minutes by measuring the degree of light scattering and fluorescence emitted by thousands of individual cell recovered from an infected seed sample. As a stream containing tagged bacterial cells passes through a flow cell, a laser beam illuminates the cells and excites the fluorescent tags attached to the antibodies. By using different fluorescent detectors, several parameters such as cell size, granularity and cell roughness can be measured simultaneously.

5. Immunosorbent Electron microscopy (ISEM)

ISEM is a rapid, reliable method for testing seeds for virus infection especially when several viruses are present but not suitable when numerous samples require testing for same virus.

6. Immunomagnetic separation (IMS) PCR

In this method small magnetic polystyrene beads coated with antibodies to sequester target cells from heterogenous mixtures (Ojeda and Veridier, 2000). After immobilization with a magnet particle concentrator, the immunomagnetic beads are rinsed to remove inhibitory compounds and non target bacteria. Template DNA can be released from captured cells by boiling and used for PCR or alternatively, captured cells can be plated on to a semi selective medium. IMS-PCR improved the detection threshold 100 fold when compared to conventional PCR. It reduces false-negative reactions by improving the efficacy and reliability of extracting PCR quality pathogen DNA from seeds and eliminating seed compounds that can inhibit PCR.

IV. Molecular Detection methods

Nucleic acid based methods (using probes and / or PCR) are very sensitive and highly specific. Molecular techniques based on hybridization or amplification, especially PCR, have been developed for the most important plant pathogenic viruses and bacteria PCR has many beneficial characteristics that make it highly applicable for detecting seed borne pathogens. These include speed (completed within 2 to 3 hr); specificity (DNA probes can be designed to amplify nucleic acids from the desired genus, species, subspecies, race etc.); sensitivity (single copies of nucleic acids can be detected after amplification) and easy and objective result interpretation (the presence of a DNA fragment of specific size indicates the presence of the pathogen).

1. Polymerase chain reaction (PCR)

Polymerase chain reaction (PCR) is the invitro, primer directed, enzymatic amplification of nucleic acids. In this method, primers (small oligonucleothide probes) designed to anneal to specific DNA sequences in the target organism's chromosomal DNA or RNA, hybridize with and direct amplification of millions of copies of the target sequence. This amplified DNA can be visualized after electrophoresis in ethidium bromide stained agarose gels.

2. Bio-PCR

This method improves the efficiency and sensitivity of PCR by allowing target pathogen populations to increase in a pre-enrichment phase, before DNA extraction and PCR. Selective pre-enrichment increases pathogen populations and results in higher quantities of target DNA, which ultimately results in higher sensitivity. Also, during incubation and enrichment on artificial media, inhibitory compounds are adsorbed or diluted during cell harvest and do not interfere with DNA amplification.

3. Immunomagnetic separation and PCR-(IMS-PCR)

In this method, microscopic magnetic beads (IMBs), coated with antibodies produced against a specific microorganism are used to selectively sequester target cells from suspensions containing heterogenous cell mixtures. The captured cells can be recovered on selective media or DNA can be extracted from them and used for PCR.

3. Magnetic Capture Hybridization and PCR (MCH-PCR)

MCH-PCR uses single stranded DNA probes to capture and concentrate specific DNA fragments that are used as templates for PCR.

4. Rapid – cycle Real time PCR

DNA amplification is coupled with the production of a fluorescent signal that increases proportionally with the numbers of amplicons produced. The fluorescent signal is monitored on a computer in real time and provides an indirect visual representation of DNA amplification.

Detection of amplified DNA can be accomplished by staining with SYBR Green 1 that binds double-stranded DNA indiscriminately or with the use of specific reporter probes like Taq-Man. Taq-Man probes are synthesized with reporter and quencher dye molecules at the 5' and 3' ends respectively. In this configuration there is no fluorescence but when they are separated the reporter dye fluoresces. With the Taq-Man system, the first step in PCR is the annealing of a complementary probe to the template DNA. Taq DNA polymerase has 5' exonuclease activity (cleaves off nucleotides from the 5' end of non template complement DNA) and during the extension step of PCR, the Taq-Man probe is excised. separating the reporter dye from the quencher molecule. This results in fluorescence that is detected by photosensors. The intensity of fluorescence is directly related to the excision of reporter dye molecules, which is directly related to DNA amplification. Other detection systems including fluorescent resonance energy transfer (FRET) and molecular beacon probes are also employed for real time PCR.

5. DNA microarray technology

DNA chips or microarrays represent another DNA based detection assay that may be applied to test seeds for pathogens. In this method, the nucleic acid molecules hybridize specifically with molecules with complementary sequences. In DNA ship technology, oligonucleotide probes are attached to a small (approximately 1 cm^2) glass or silica based surfaces (Chips). Hundreds to thousands of oligonucleotides can be attached to specific locations on each chip. These oligonucleotides can be complementary to DNA sequences that are unique to certain microorganisms and hence can be used to detect pathogens in seed samples.

6. Use of markers

This is another approach to understand the epidemiology of seed borne pathogens. The most commonly employed types of markers have been naturally occurring genetic markers, including antibiotic resistance, vegetative compatibility and molecular markers unrelated to phenotypes.

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FERMENTED AND NON-FERMENTED BEVERAGES: EXPLORING THE WORLD OF FLAVORS AND CULTURES

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Abstract

Beverages have been an integral part of human culture for centuries, quenching thirst, providing comfort, and often carrying cultural and social significance. Among the diverse array of beverages available, a key distinction lies in whether they are fermented or non-fermented. Fermentation, a natural and ancient process, has been employed by various cultures worldwide to create not only drinks with unique flavors but also to preserve nutrients and extend shelf life. On the other hand, non-fermented beverages encompass a wide range of options that are often enjoyed for their refreshing qualities and immediate consumption. In this exploration, we delve into the world of fermented and non-fermented beverages, uncovering their differences, production processes, cultural significance, and impact on human health.

Fermented Beverages: Unveiling the Magic of Microbes

Fermentation is a biological process in which microorganisms, such as bacteria, yeast, or fungi, break down carbohydrates into alcohol and other byproducts. This transformative process leads to the creation of distinctive flavors, aromas, and textures, setting fermented beverages apart from their non-fermented counterparts. The involvement of microorganisms in fermentation introduces an element of complexity and unpredictability, making each batch of fermented drink a unique creation.

The Fermentation Process

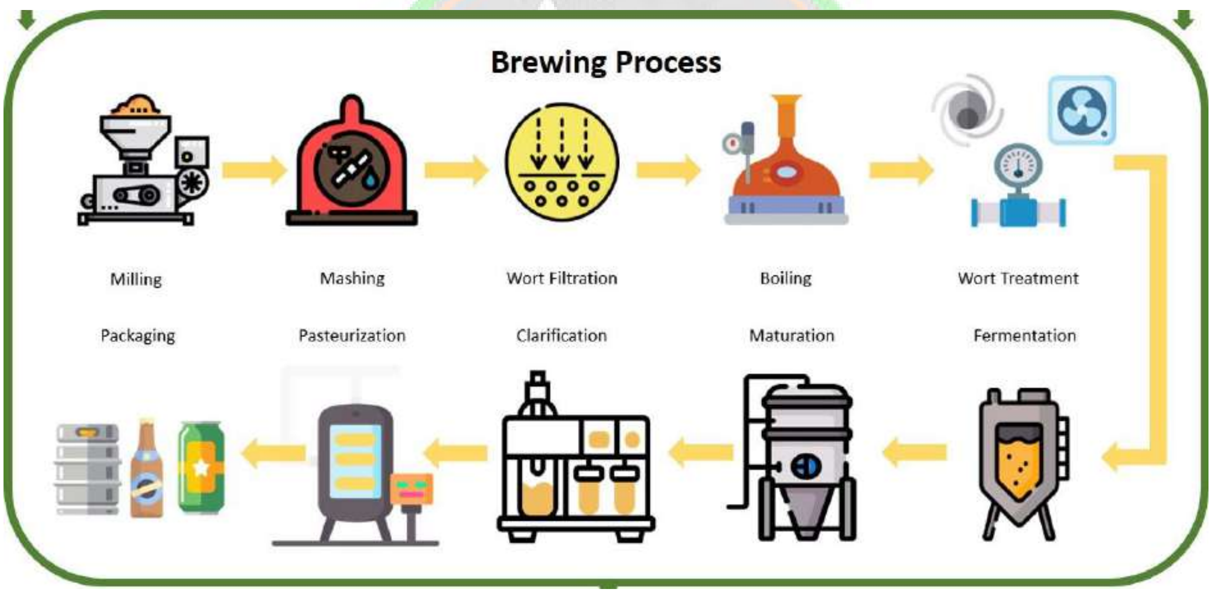
1) **Preparation:** Ingredients like fruits, grains, vegetables, or dairy are selected, cleaned, and sometimes cooked or mashed to make the carbohydrates accessible to the microorganisms.

2) **Inoculation:** Microorganisms are introduced to the prepared mixture. The specific microbes used vary depending on the desired beverage. For instance, yeast is often used for alcoholic fermentation, while bacteria like Lactobacillus are common in the fermentation of dairy products.

3) **Fermentation:** Microorganisms consume the carbohydrates and convert them into alcohol, acids, and other compounds. This stage can last from a few hours to several months, depending on the beverage and desired characteristics.

4) **Aging:** Some fermented beverages benefit from aging, during which flavors continue to develop and mature.

5) **Bottling and Preservation:** After reaching the desired flavor profile, the beverage is bottled and sealed, which can halt the fermentation process. However, some beverages may continue to evolve in the bottle over time.



Diverse Fermented Beverages and Their Cultural Significance

Fermented beverages have played a pivotal role in the culinary and social traditions of numerous cultures around the world. Let's explore a few examples:

1) **Wine:** Dating back thousands of years, wine is perhaps one of the most well-known fermented beverages. Grapes are the primary ingredient, and yeast naturally present on the grape skins initiates the fermentation process. Wine holds deep cultural and religious significance in various societies, often being associated with celebrations and rituals.

2) **Beer:** Another ancient creation, beer is produced by fermenting malted barley or other grains with yeast. The process of brewing beer has evolved into a sophisticated art, with different types, flavors, and styles emerging from various regions. Oktoberfest in Germany and craft beer movements around the world highlight beer's cultural impact.

3) **Kombucha:** Originating in China, kombucha is a fermented tea beverage. It is made by fermenting sweetened tea with a symbiotic culture of bacteria and yeast (SCOBY). Kombucha is known for its fizzy nature, tangy taste, and potential health benefits.

4) **Mead:** Often referred to as "honey wine," mead is made by fermenting honey with water. It has a rich history in many cultures, including ancient Egyptians, Vikings, and Greeks. Mead can vary from dry to sweet and is often infused with fruits, spices, or herbs.

Health Benefits and Considerations

Fermented beverages have gained attention not only for their unique flavors but also for their potential health benefits. Many of these beverages contain probiotics, which are beneficial microorganisms that can positively impact gut health. Probiotics may help improve digestion, boost the immune system, and support overall well-being. However, it's important to note that not all fermented beverages contain high levels of probiotics, and the health benefits can vary widely depending on the beverage and its production process. Consumption of fermented beverages should also be done in moderation, especially those with alcohol content. While moderate alcohol consumption might have certain health benefits, excessive consumption can lead to various health issues, including addiction, liver problems, and increased risk of accidents.

Non-Fermented Beverages: Instant Gratification in a Glass

Non-fermented beverages, in contrast to their fermented counterparts, do not undergo the microbial transformation process of fermentation. They are typically enjoyed fresh and are known for their immediate refreshing qualities. These beverages span a wide spectrum, from simple choices like water and fruit juices to more complex creations like smoothies and mocktails.

The Diversity of Non-Fermented Options

1) **RTS, Squash, Nectar:** Developed by help of fruit juice or fruit pulp with additive sugar and acidity at degree of control.

2) **Fruit Juices:** Freshly squeezed or commercially processed, fruit juices are beloved for their vibrant flavors and nutritional content.

They provide a convenient way to enjoy the essence of fruits.

3) **Carbonated Soft Drinks:** Also known as soda or pop, these beverages are infused with carbon dioxide to create fizziness. They come in a variety of flavors and are often associated with casual dining and social gatherings.

4) **Smoothies:** A blend of fruits, vegetables, yogurt, or milk, smoothies provide a convenient way to pack in nutrients and flavors. They can be customized to suit individual preferences.

5) **Mocktails:** Mocktails are non-alcoholic versions of cocktails, offering complex flavors without the presence of alcohol. They are often crafted using a combination of fruit juices, syrups, herbs, and garnishes.

Non-Fermented Beverages and Lifestyle

Non-fermented beverages have become intertwined with modern lifestyles, offering convenience, variety, and instant satisfaction. They are often consumed on the go, during work breaks, and in social settings. The rise of health-consciousness has also led to an increased demand for beverages that are not only tasty but also beneficial for well-being. While non-fermented beverages can be refreshing and enjoyable, it's essential to be mindful of the sugar content in some of these options. Many commercially available fruit juices and soft drinks can contain high levels of added sugars, which can contribute to health problems like obesity, diabetes, and tooth decay. Opting for natural, unsweetened versions or making your own beverages with minimal added sugars can help mitigate these risks.

The Symbiotic Relationship: Fermented and Non-Fermented Beverages

Fermented and non-fermented beverages coexist in a symbiotic relationship, offering a balanced spectrum of flavors, cultural significance, and health considerations. The world of beverages provides us with a unique lens through which to explore the interplay between tradition and innovation, natural processes and human creativity. From the mysterious alchemy of microbes transforming simple ingredients into complex flavors to the immediate refreshment of a chilled glass of fruit juice, our beverage choices reflect our diverse tastes, values, and experiences. As we continue to navigate our culinary journeys, let's embrace the richness of both fermented and non-fermented beverages, savoring each sip as a celebration of our shared human heritage.

AgriGate Editorial Team

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