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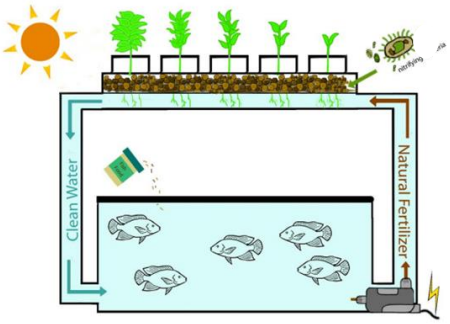

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From the Desk of Editor-in-chief

February 2024|Vol. 04 |Issue No. 02

I would like to introduce the launch of **"AgriGate - An International Multidisciplinary Monthly e-Magazine Volume 04 Issue No. 02 – February 2024"** with immense pleasure. Our team is privileged to dedicate this issue to **Sir C.V. Raman**. Every year in India on 28 February celebrated as **National Science Day** to mark the discovery of the Raman Effect by the Indian physicist Sir Chandrasekhara Venkata Raman. He discovered the Raman Effect on 28 February 1928 and for this discovery, he was honored with the Nobel Prize in Physics subject in 1930.

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

AgriGate- An International Multidisciplinary e-Magazine

Volume: 04 Issue No: 02

SAMPLING IN SOCIAL SCIENCE RESEARCH TO DRAW IMPLICATIONS AND GENERALIZATION OF FINDINGS

Article ID: AG-VO4-I02-01

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Introduction

In social research, sampling plays an important role. Sampling is the act, process or technique of selecting a representative part of a population for the purpose of determining parameters or characteristics of the whole population (Merriam - Webster). Sampling is important in research because of the significant impact that it may have on the quality of results or findings. The validity of statistical analysis depends on the quality of the sampling used. The two most important elements are random drawing of the sample and the size of the sample. A small sample, even if unbiased, can fail to include a representative mix of the larger group under analysis. A biased sample, regardless of size, can lead to incorrect conclusions.

Most researchers will have a 'target population' in mind before conducting research. The target population consists of those people who have the characteristics of the sample one wish to study. If anyone is interested in conducting primary research on the experiences of working-class school children in 2017, then the target population would be all working-class school children. Many researchers use a sampling frame to choose a sample, which is simply a list from which a sample is chosen – this might be a register of all pupils in a school, if someone is conducting research in a school, for example.

Objectives

1. To explain the characteristics of sampling

2. To understand different kind of sampling
3. Identify the benefits of sampling

Details

In social scientific research, a population is the cluster of people, events, things or other phenomena that you are most interested in; it is often the "who" or "what" that you want to be able to say something about at the end of your study. Populations in research may be rather large, such as "the American people," but they are more typically a little less vague than that. For example, a large study for which the population of interest really is the American people will likely specify which American people, such as adults over the age of 18 or citizens or legal residents. A sample, on the other hand, is the cluster of people or events, for example, from or about which you will actually gather data. Some sampling strategies allow researchers to make claims about populations that are much larger than their actually sample with a fair amount of confidence. Other sampling strategies are designed to allow researchers to make theoretical contributions rather than to make sweeping claims about large populations.

There are two broad categories of sampling methods used for social research. They are as follows:

Probability sampling

Methods of sampling under this category are based on the theory of probability. Probability sampling methods ensure that each element in the population has an equal and known chance of being represented in the sample group. For example, if the target populations are of 100 people, each person will have a 1/100 chance of being selected as a respondent in the study.

The following are the four main types of probability sampling methods

- ✓ Simple random sampling (SRS)
- ✓ Systematic sampling
- ✓ Stratified random sampling
- ✓ Cluster sampling

1. Non-Probability Sampling

Methods of sampling under this category, on the other hand, do not give all respondents an equal chance of being selected in the sample group. Non-probabilistic methods rely on judgment,

convenience, and/or logic to select elements instead. For example, a researcher may choose to survey those people who are easily and conveniently available to them.

There are four main types of non-probability sampling methods

- ✓ Quota sampling
- ✓ Snowball sampling
- ✓ Judgmental sampling
- ✓ Convenience sampling

Field Examples

Types of Probability Sampling Methods

Simple Random Sampling (SRS)

This method of sampling is the easiest and most basic method of probability sampling. It uses the "lottery method" or "random number tables", for example, to choose elements from a population. Each element is given a number and software's/processes that give random outputs are used to pick the number of elements defined by the sample size.

For example, if my target population is the adult population in Las Vegas, then I must have a list of each element in this population. I can then use certain software's, Excel for instance, to input every element in the list and use commands that pick a certain number (sample size) of participants to be selected in the sample group randomly.

Systematic Sampling

Systematic sampling is where a researcher selects an interval and random starting point in order to choose their sample. The fixed interval can be calculated by dividing the target population by the chosen sample size.

For example, if I'm conducting a study on students between grades 9-12 from XYZ School, I can use stratified sampling to select a sample group. Assuming there are 300 students in the target population, and the sample size is 10, the interval will be 30 (300 divided by 10). Then, I will pick a number between 1 and 30 (random starting point), after which I will pick every 30th element on my list until I have 10 students for my sample group.

Advantages of Probability Sampling

- Easily generalizable to the whole population.
- Less scope for researcher bias as elements are selected using probabilistic methods.
- Lack of systematic error due to unbiased selection.

Types of Non-Probability Sampling

Quota Sampling

Quota sampling uses "control characteristics" to categories a target population into multiple subpopulations with shared characteristics. After these subgroups are defined, the researcher chooses elements from each subgroup using non-probability sampling techniques such as convenience or judgment. This method of sampling is similar to stratified random sampling as both these methods divide the population into subgroups based on certain variables. However, the main difference between the two is that in stratified random sampling SRS is used to select elements from the subgroups whereas in quota sampling, judgment or convenience is used instead.

For example, if the participation of respondents from every city in Canada is critical to a study, then the researcher must group participant's city wise and choose elements from each of these subpopulations using convenience or judgment.

Snowball Sampling

Snowball sampling is a method of non-probability sampling where the researcher uses their initial group of participants to help create and identify a larger network of those who qualify to be a part of the target population. This method of sampling is often used when the target population of a study is really small, hard to find, and/or inaccessible.

For example, in a study about homeless people, a researcher may ask homeless people that are readily available to them to give a list of areas where more homeless people can be found. In this case, the researcher is using one element, or a few elements, of the target population as a resource to access more people in that population.

Advantages of Non-probability Sampling

- Useful when participation of minority populations is critical in the study.
- Quick and convenient compared to probability sampling methods and can be used when researchers have time constraints.
- Less expensive than probability sampling methods and is apt for social research studies that may have limited resources/finances.

Summary and Conclusion

The social sciences face a persistent problem of sample non representation with no trend for improvement. By tracing the history of sampling, I showed how the design-based framework

for sampling where random selection is the gold standard, although good on paper, provides little practical guidance when the gold standard cannot be achieved. In contrast, the model-based framework provides a systematization of all assumptions, allowing them to be challenged and defended methodically. It also offers guidance on how small-scale studies with imperfect samples can be integrated for greater understanding.

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TECHNIQUES FOR ENHANCING UNDERGROUND WATER TABLE FOR SUSTAINABLE AGRICULTURE

Article ID: AG-VO4-I02-02

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Abstract

This paper investigates diverse techniques for enhancing underground water tables to mitigate water scarcity issues. It assesses the efficacy of methods such as rainwater harvesting, artificial recharge mechanisms, and sustainable land management practices in replenishing groundwater resources. Through a comprehensive review of existing literature and case studies, it elucidates the potential impacts and challenges associated with each technique. The analysis underscores the significance of adopting integrated approaches that consider hydrogeological conditions, socio-economic factors, and environmental sustainability to effectively manage and augment underground water tables. This research contributes to the development of strategies for ensuring long-term water availability and resilience in water-stressed regions.

Keywords: Rainwater; underground water levels; sustainable agriculture

Introduction

Water is necessary for both human life and the expansion of the world economy (Akhter et al., 2021). A third of the world's population depends on GW for drinking, and 700 million more people will need GW in the future. Currently, GW provides 40% of the demand for agriculture. (Anonymous, 2024). Since there is not enough surface water available, groundwater is being overused to meet the rice-wheat system's demand for agricultural irrigation. From 1.92 lakh in 1970–71 to 14.76 lakh now, there are more tubewells than ever before (Anonymous, 2023). According to a recent survey of 150 blocks around the state, 117 blocks are overexploited, six are critical, ten are semi-critical, and only 17 are safe blocks because their

water table is too deep or their groundwater quality is too low for any one farmer to use profitably. In the State, the average yearly decline in groundwater is 50 cm, with the central region experiencing a more severe problem with an average annual decline of over one meter. The Punjab Agricultural University's Department of Soil and Water Engineering has created methods for replenishing groundwater, such as collecting rainwater from rooftops, recharging agricultural runoff and excess canal water by utilizing an abandoned well, collecting rainwater by raising the height of the paddy field's dyke and renovating village ponds.

Rooftop rainwater harvesting

It is possible to collect rainwater from rooftops with a straightforward, reasonably priced construction. When this technique is widely used, it can significantly improve water quality, road conditions, groundwater resources, and sewage load. In Punjab, the number of residential houses in urban and rural areas is 13 and 27 lakhs, respectively.

Fig.1: Roof top rain water harvesting

Using an average covered area of 100 m^2 for each home, 135 million m^3 of rainwater may be collected annually for groundwater recharging based on average rainfall. This will partially arrest the water table's fall while also enhancing the quality of groundwater. Harvesting rainwater requires filtration. Before replenishing, the surface pollution of the rooftop water must be cleaned up because of silt, clay, and other debris. Such water must be filtered in order to be made pure. As evidenced by tests taken from rooftop

water, there are no biological contaminants in runoff collected from rooftops. Rainwater gathered from pucca rooftops is typically pure and uncontaminated by chemicals. The three primary components of the recharge structure are the recharge well, filtration unit, and collection system (Fig.1). The building's cost varies according to the location; it is influenced by the space under the roof, the amount of rainfall, and the ecosystem. Nonetheless, the price often ranges from Rs. 30,000 to Rs. 70,000, depending on the location for a 100–500 m2 roof. These buildings have a 15-to-20-year lifespan.

Abandoned wells for groundwater recharging

It has been noted that during intense downpours, a large amount of runoff from the fields is produced, harming the crops and wasting a substantial amount of water. Allowing excess agricultural runoff to enter the abandoned well is one of the finest methods to use it to replenish water supplies. These wells, which were once utilized for irrigation, are now dry since the groundwater table has dropped. These wells typically have a diameter of 5–6 feet and a depth that ranges from 15–35 feet. Recharging can also be done with the extra canal water. There are occasions when the rainy season boosts farm-level canal water availability. Farmers can then redirect this extra water into an abandoned well to replenish it. Additionally, crop water requirements are often lower during the rabi season. However, if significant rains or other factors increase the availability of canal water, it could pose a problem, particularly for farmers who produce at the end of the harvest season. This water ought to be sent to decommissioned wells for replenishment. It is important to clean the wells in order to use these abandoned wells. These wells can be used as landfills or filled with dirt to prevent unwanted events. In order for more runoff from the nearby fields to enter the abandoned wells, the numerous weeds and other foreign objects surrounding the wells need to be removed. Additionally, safety measures must be implemented to prevent the discharge of toxic gases from wells that are permanently covered by dirt. Typically, gas problems arise around July. To prevent the sealing effect, the upper soil layer that is six inches deep from the bottom of the well should be removed after cleaning. The overflow from the pit could be sent into the well just before the open well to settle the majority of the silt that arrives along the excess runoff/surplus canal water pit. The pit's proportions could be maintained based on the amount of open space that's next to the abandoned well. Generally, a hole that is 1.5 to 2.5 meters in diameter and 2.5 to 3.0 meters deep is sufficient. To prevent collapse, the pit should ideally have a 0.9 m bottom diameter and a conical form. Filling the pit with broken bricks will prevent incoming runoff from directly affecting the bottom of the pit. A

pipe with a diameter of 4-6" may be used to link the pit's flow to the well that was abandoned (Fig. 2). The depth of the abandoned well affects the recharge rate. To prevent any accidents, the well should be covered with wire mesh or a perforated slab.

Increasing dyke height of paddyfields

In order to keep fertilizer and rainwater on the farmer's land, the bund/dyke height of the paddy fields might be raised. It has been suggested that the ideal effective dike height in paddy fields should be 17.5, 22.5, and 27.5 cm for light, medium, and heavy soils, respectively, in order to maximize rainfall conservation. Thus, a paddy field can serve as a recharge basin during the rainy season by following this easy method.

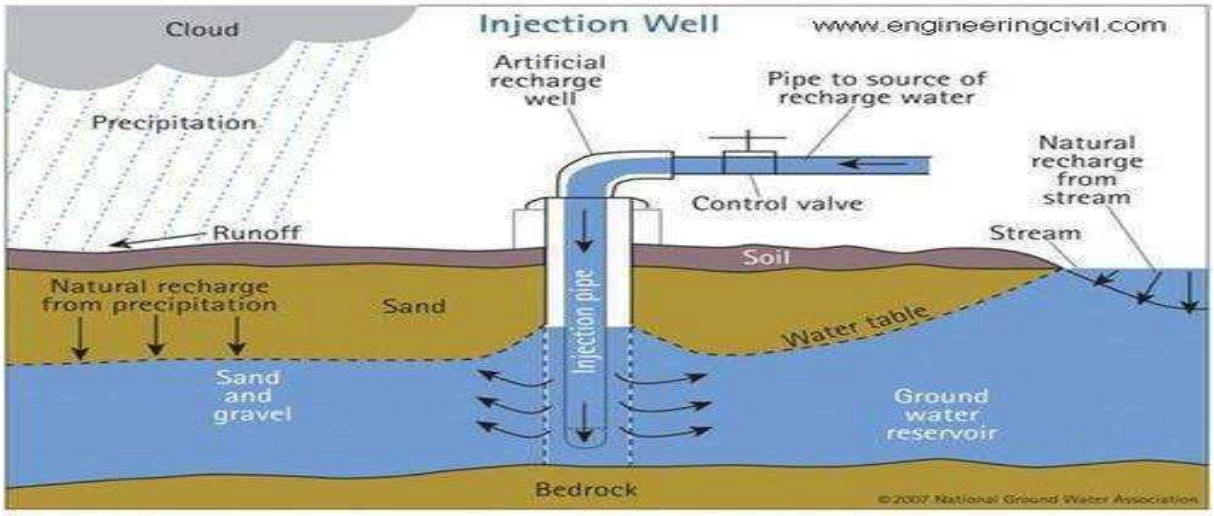

Fig 2: Ground water recharge system mechanisms

Village ponds reconstruction

In the State of Punjab, there are more than 18,000 village ponds. These ponds receive runoff and waste water from the village homes. The amount of water entering these ponds has grown over time due to the village families' access to piped drinking water supplies. To ensure that the water quality is suitable for use in agriculture and to boost the ponds' capacity to hold water, they should be renovated and revitalized. These ponds should have underground pipelines installed to transport the water to fields for farming.

Precautions

It has been noted that farmers are quite enthusiastic about replenishing groundwater. They are using submersible or bore wells to receive the agricultural runoff that is directly diverted from their fields. There is a significant chance that groundwater will get contaminated when doing this. The paddy/agricultural field contains a variety of agrochemicals, including weedicides, fertilizers, microorganisms, insecticides and farm yard waste. We are also contaminating the pure water that we regularly extract for our requirements if we immediately inject this kind of water into the pure groundwater. The water quality will suffer as a result of this as well. Contaminated groundwater is difficult to recover and requires a lot of work to purify. Recharging groundwater is crucial since it will increase groundwater availability, but it shouldn't be done at the expense of tainting our high-quality groundwater. Therefore, when using a groundwater replenishment strategy, one should exercise greater caution and ensure that the quality of the groundwater is not inadvertently compromised. Water conservation is essential, and anyone who genuinely wishes to do so on a personal basis should do so under the supervision of professionals.

Conclusion

The different approaches to managing groundwater make it abundantly evident that an interdisciplinary and comprehensive strategy is required for successful groundwater management. incorporating technocrats, all stakeholders, hydro-geological conditions, environmental issues unique to the area, indigenous water conservation and usage practices, etc. Groundwater management requires an efficient policy framework that takes into account the many facets of the problems associated with overexploitation and water scarcity in order to be sustainable. Appropriate legislation is required to mandate rainwater harvesting for both public and private buildings, particularly in urban areas. Second, the public should be made aware of the importance of replenishing groundwater through a variety of media platforms. Thirdly, to find ways to use and save water, all users should carry out a water audit. Fourthly, waste water is useful for recycling and reusing to support environmental activities. Ultimately, without the motivation and training of both the populace and local government, no plan for maintaining limited resources will be successful. Millions of lives can be changed by water-saving structures when the community gets involved and adopts locally available techniques. Considering all the obstacles to the appropriate management and safeguarding of groundwater sources in relation to

the various levels of action required, an integrated multipronged approach incorporating a thoughtful combination of professional, technical, administrative, and legal measures along with community involvement would pave the way towards fulfilling the requirement of establishing a robust ecological base for guaranteeing sustainable management of groundwater resources.

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CLASSIFICATION, CHARACTERISTICS AND MANAGEMENT OF PARASITIC WEEDS

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Introduction

Parasitism is a close relationship between species, where one organism, the parasite, lives on or inside another organism, the host, causing it some harm, and is adapted structurally to this way of life.

Parasitic weeds

There are certain plants which parasitise fully or partially, on the specific crop plants, such weeds are called parasitic weeds.

Hemi parasite

A plant which obtains or may obtain part of its food by parasitism.

Holo parasite

A plant which is totally parasitic lacking chlorophyll thus unable to synthesize organic carbon.

Facultative parasite

A facultative parasite is an organism that may resort to parasitic activity, but does not absolutely rely on any host for completion of its life cycle.

Parasitic Weeds

There are certain plants which parasitize fully or partially, on the specific crop plants, such weeds are called parasitic weeds.

They attach themselves either to the roots or to the shoot of the host plants and survive on food material available with them. The parasitic weeds are host-specific; they cannot survive in the absence of their host plants. Many weeds are also found to act as host plants to particular parasitic weeds, thus making it possible for them to survive even outside the crop fields.

Those parasites which attack root are termed as root parasites and those attack shoot of other plants are called as stem parasites.

Total Root Parasite - *Orobanche* spp

Partial Root Parasite - *Striga* spp.

Total stem parasite - *Cuscuta* spp.

Partial stem parasite - Loranthus (Bird vine)

***Striga* spp. (Striga - Witch weed; Family: Scrophulariaceae)**

Striga is an annual, parasitic herb with a wide range of host crop plants. In India it is most problematic in pearl millet, sorghum, maize and sugarcane. Of the several species of Striga in India, S. asiatica / S. lutea is found most common. Sorghum and pearl millet are parasitized by two different strains of this species.

Species - Host plant

Striga densiflorus - Sorghum

Striga lutea - Sugarcane

Striga hirsute - Pearl millet

Striga hermonthica – Maize

Management

- Trap crop – Cotton, sunflower, cowpea, groundnut, beans, castor
- Crop rotation
- Pre emergence application of atrazine 1 kg/ha on 3rd DAP and hand weeding on 45DAP with an earthing up to 60DAP combined with the post emergence spraying of 2,4-D at 6 g+ Urea 20 g(2%) in one litre of water on 90 DAP + trash mulching on 120 DAP.
- 2,4-D in standing crop of sorghum just before the emergence of striga.

***Orobanche* spp. (Broom rape; Family: Orobanchaceae)**

It is a phanerogamic parasite on tobacco in all tobacco growing tracts in India. It is endemic every year. In the presence of tobacco plants orabanche seeds germinate. Orobanche is a parasitic weed, much similar to Striga in its behaviour but with two major differences.

- Its shoot have no underground life cycle; they emerge from the soil soon after infecting the host roots.
- It lacks green tissue and so it is a total parasite.

Management

- Trap crop – Pepper, linseed , sorghum , sunhemp, sesame, rice
- Crop rotation
- Plant hole application of neem cake 25g/plant or drenching of copper sulphate 5% provides partial control in tobacco
- Post emergence glyphosate 0.2kg ai/ha - selective control 40 and 60 DAT
- Outside the crop field destroyed by frequent tillage before seed setting

Loranthus (Bird vine)

It is a semi-stem parasite on trees such as citrus, mango, teak, casuarina etc. The sticky seeds are attractive to birds and are spread by them. This vine attacks rose wood, sandal wood and wattle plantation in Nilgris.

Management

- Affected branches should be periodically cleaned or cut down before monsoon
- Spot application of paraquat 0.05 to 1 % spray
- Paraquat + 2,4 D – 3.5 kg each in 160 l/ha in rocker sprayer on the infected area
- High speed chiesel will be helpful to kill the foliage of this parasitic weed
- Paraquat 1% spray will be helpful to kill the foliage

***Cuscuta* spp. (Dodder; Family: Convolvulaceae)**

It is a wiry plant and total stem parasite. The wiry stems of Cuscuta go around the host plant and slowly cover it completely. The two species are *Cuscuta campestris, Cuscuta trifolii*. It develops roots at early stages of development and once attached to the host, the root disintegrates. It is rich in carotenoid pigment which imparts it a golden yellow colour. Stem is thread like, cylindrical and much branched. It forms dense masses which smother host plants. It also develops haustoria masses which penetrate the host plant and extract water and nutrients. In the absence of host plant it dies off. The associated crops are lucerne, lemon, ornamental trees, cowpea, niger, greengram, blackgram, chilli etc.

Management

- Crop rotation – non host crops chickpea and mustard.
- Seeds of lucerne are to be treated with the 5 to 10% is solution of common soluble salt for 5 minutes.
- Spot application of paraquat 0.05 to 0.1% to destroy dodder.

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NUTRITIONAL REQUIREMENTS AND FEEDING MANAGEMENT OF LITOPENAEUS VANNAMEI

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Introduction

Litopenaeus vannamei, commonly known as Pacific white shrimp, is one of the most economically important shrimp species in aquaculture. Successful cultivation of L. vannamei relies heavily on proper nutritional management and feeding practices. This article aims to explore the nutritional requirements of L. vannamei and provide insights into effective feeding management strategies to optimize growth, health, and overall production. Table 1 shows the nutrient requirements in diets for *L. vannamei.*

Nutritional requirements

Table 1. Comparison of recommended minimum nutrient requirements in diets for *L. vannamei* in different production systems.

Nutrient Requirements (%)	*L. vannamei*		
	RAS	Semi-intensive	Intensive
Crude protein	38-44	33-42	40-46
Crude lipid	9-11	7	8
Dig. energy (kJ/kg)	15,820-16,292	14,033-15,380	15,079-15,874
Amino acids (%)			
Arg	2.56-2.94	2.58-2.92	2.69-2.99
His	0.73-0.83	0.73-0.82	0.77-0.84

Ile	1.51-1.71	1.52-1.70	1.59 1.73
Leu	2.52-2.99	2.53-2.98	2.64-3.06
Lys	2.76-3.18	2.72-3.14	2.83-3.22
Met	0.97-1.11	0.98-1.11	1.01-1.13
Phe	1.74_1.97	1.76-1.96	1.83-2.00
Thr	1.31-1.56	1.31-1.54	1.37 1.58
Trp	0.34-0.39	0.34-0.39	0.36-0.39
Val	1.7-2.01	1.72-2.00	1.79-2.04
Fatty acid (%)			
Sum n-3	0.89	0.83	0.87
Sum n-6	0.6	0.6	0.6
EPA + DHA	0.71-1.01	0.67-0.94	0.69-0.98
Cholesterol	667-834	521-727	540-752
Phospholipids	1.1-1.5	1-1.4	1.1-1.4

Protein

Protein is a vital component of the shrimp diet, contributing to growth, reproduction, and overall health. L. vannamei has a high protein requirement, and the protein content in the feed should be carefully balanced to meet different developmental stages. The inclusion of high-quality protein sources such as fishmeal, soybean meal, and other protein-rich ingredients is essential for optimal growth. Table 2 gives Recommended protein and lipid levels of L.vannamei

Table 2. Recommended protein and lipid levels in 5 for L.vannamei **feeds (as fed basis) in relation to body weight**

Size of L.vannamei (g)	Protein level (%)	Lipid level (%)
0-0.5	45	7.5
0.5-30	40	6.2
3.0-15.0	38	6.3
15.0 -40.0	36	6

Lipids

Lipids are another key element in the diet of L. vannamei, serving as a concentrated energy source. The balance of essential fatty acids, including omega-3 and omega-6, is crucial for

proper growth and molting. Vegetable oils, fish oil, and other lipid sources should be incorporated into the diet to meet the specific lipid requirements of the L.vannamei. Table 2 gives Recommended protein and lipid levels of L.vannamei

Carbohydrates

Carbohydrates are important for energy production and metabolism. However, excessive carbohydrate levels can negatively impact L.vannamei health. Proper carbohydrate sources, such as grains and vegetable-based ingredients, should be included in the feed formulation to maintain a balanced diet.

Vitamins and Minerals

Adequate levels of vitamins and minerals are essential for various physiological functions, including enzyme activity, immune response, and reproduction. Formulating feeds with a broad spectrum of vitamins and minerals ensures the overall health and well-being of L. vannamei. Table 3 and 4 shows the mineral and vitamin requirement in L.vannamei diets

Table 3. Mineral requirement in L.vannamei diets

Calcium	2.80%	Iron	300 ppm
Phosphorus	1.80%	Copper	25 ppm
Magnesium	0.20%	Zinc	110 ppm
Sodium	0.60%	Manganese	20 ppm
Potassium	0.90%	Cobalt	10 ppm
		Selenium	1 ppm

Table 4. Mineral requirement in L.vannamei diets

Vitamin	Quantity required per Kg of feed	Vital function	Deficiency symptoms
Water Soluble			
Thiamine (B1)	150 mg	Control carbohydrate metabolism	Anorexia, Poor growth, pigmentation, mortality
Riboflavin (b2)	100 mg	Helps in fatty acid, amino acid and carbohydrate metabolism	Anorexia, Poor growth, abnormal swimming behaviour, Mortality
Pyridoxin (b6)	50 mg	Helps in many enzymatic	Poor growth mortality,

		reactions and in amino acid metabolism	hyperirritability
Pantothetic acid	100 mg	Cholestrol synthesis enzyme reactions	Abnormal gill features, anorexia
Niacin	300 mg	Helps tissue oxidation energy metabolism synthesis of fatty acids	Poor growth, anorexia, lethargy and mortality
Biotin	1 mg	Helps in Carboxylation and transcarboxylation	Anorexia, Slow growth, depigmentation
Insilol	300 mg	Tissue formation	Slow growth, Anorexia
Choline	400 mg	Transmethylation, lipid transport and nerve impulse	Poor growth, fatty tissue
Folic acid	20 mg	Metabolism of amino acids, biosynthesis of purines and amino acids	Poor growth and lethargy
Vit. B12	0.1 mg	Nucleic acid synthesis, carbonhydrate and lipid metabolism	Poor growth, anorexia
	200 mg	Formation of Collagen and steroid hormones	Black death, lightcolour, hepatopancreas, reducing growth
Fat Soluble			
Vit. A	1500 UI	Calcium transport and reproduction, embryonic development	Depigmentaion, soft exoskeleton
Vit. D	7500 UI	Calcium and phosphorus metabolism	Poor growth, soft exoskeleton
Vit. E	400 mg	Antioxidant	Reduced growth and depigmentation
Vit. K	200 mg	Blood coagulation, electron transfer	Hemorrhaging of tisue

Feeding Management

Feeding Frequency

The feeding frequency for L. vannamei depends on their developmental stage. Juveniles may require more frequent feedings, while adults can be fed less frequently. Regular monitoring of feed consumption and adjusting feeding schedules accordingly is crucial for optimizing growth rates. Table 5 provides the feeding schedule of L. vannamei.

Table 5:

Feed monitoring schedule				
Day of culture	Average body weight (g)	Amt. of feed% of biomass	% of feed put per feeding tray	Feed tray monitoring
1-7	0.02-0.4	20.0-170	0.6	2.5
8-14	0.5-1.3	16.8-14.2	0.6	2.5
15-21	1.4-1.9	14.02-11.8	0.8	2.0
22-28	2.0-2.7	11.6-9.9	0.8	2.0
29-35	2.8-3.4	9.7-8.4	0.8	2.0
36-42	3.5-4.2	8.2-7.1	1.0	1.5
43-49	4.3-5.1	6.9-6.1	1.0	1.5
50-56	5.2-6.0	6.0-5.3	1.0	1.5
57-63	6.2-7.0	5.2-4.6	1.0	1.5
64-70	7.2-8.1	4.5-3.9	1.0	1.5
71-79	8.3-9.3	3.8-3.4	1.2	1
78-84	9.5-10.8	3.3-3.0	1.2	1
85-91	11.0-12.5	2.9-2.7	1.2	1
92-98	12.7-141	2.6-2.55	1.2	1
99-105	14.4-15.9	2.5	1.2	1
106-112	16.2-17.8	2.5	1.2	1

Feed Quality

The quality of the feed directly influences L.vannamei performance. High-quality feeds with balanced nutritional profiles should be selected to meet the specific requirements of L.

vannamei at different life stages. Regularly assessing feed quality through nutritional analysis and digestibility studies is recommended.Table 6 shows pellet sizes with regard to L.vannamei body weight.

Table 6. Recommended pellet sizes with regard to L.vannamei body weight

L.vannamei weight (g)	Pellet size (mm)
0-3	1 (crumble)
3-15	2x4
15-40	2.5x5

Feeding Techniques:

Proper feeding techniques are essential to ensure efficient feed utilization and minimize waste. Techniques such as broadcast feeding, tray feeding, and automatic feeders can be employed based on the shrimp density and pond conditions. Monitoring feeding behavior and adjusting feeding practices accordingly can enhance overall productivity.

Feed storage

Feed management should be regulated by feed consumption. L.vannamei appetite will vary according to environmental conditions *i.e.* water quality, sunny/overcast days and physiological conditions such as disease and moulting. Feed consumption may be monitored by the use of feeding trays, the number of which varies with the farmer's ability. Location of trays is important and areas near or before aerators should be avoided. As feed consumption may vary within a day due to environmental factors or condition of shrimps, feed consumption should be monitored daily.

Water Quality Management

Maintaining optimal water quality is integral to the success of L.vannamei farming. Poor water quality can negatively impact feed intake, digestion, and overall health. Regular monitoring of water parameters such as temperature, salinity, and dissolved oxygen levels is crucial for effective feeding management.

Conclusion

In conclusion, the nutritional requirements and feeding management of Litopenaeus vannamei are critical aspects in the successful cultivation of this economically significant shrimp species. Achieving optimal growth, health, and productivity necessitates a thorough understanding of their dietary needs and effective feeding strategies. The primary macronutrients

required by L. vannamei include proteins, lipids, and carbohydrates, with specific attention to essential amino acids and fatty acids. Formulating nutritionally balanced diets that meet these requirements is fundamental for supporting growth and development throughout different life stages. Additionally, the utilization of high-quality feed ingredients, such as fishmeal alternatives and plant-based proteins, contributes to the sustainability of shrimp aquaculture by reducing dependence on marine resources.Feeding management plays a pivotal role in ensuring efficient nutrient utilization and minimizing environmental impact. Feeding frequency, feeding rates, and feed distribution methods are key parameters that demand careful consideration. Implementing a sound feeding regime that aligns with the shrimp's nutritional demands and the pond's environmental conditions is crucial for optimizing feed conversion ratios and minimizing nutrient wastage.Water quality management is integral to the success of L. vannamei cultivation. Monitoring parameters such as dissolved oxygen, ammonia, and nitrite levels helps maintain a suitable environment for shrimp growth. Proper water quality management also ensures that the nutrients provided through the feed are utilized efficiently, reducing the risk of stress and disease outbreaks.Incorporating technological advancements, such as automated feeding systems and real-time monitoring, enhances the precision and effectiveness of feeding practices. These innovations contribute to the sustainability and economic viability of shrimp farming by promoting resource efficiency and minimizing environmental impact. Continued research and development in the field of shrimp nutrition are essential for refining existing feeding strategies and developing novel approaches that address the evolving challenges in aquaculture. Collaborative efforts between researchers, farmers, and industry stakeholders are vital for advancing the knowledge and practices associated with the nutritional requirements and feeding management of Litopenaeus vannamei. By prioritizing sustainable and responsible aquaculture practices, the industry can ensure the long-term viability of shrimp farming while meeting the growing global demand for seafood.

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VARIETAL DEMONSTRATIONS ON HYBRID MAIZE IN BUNDELKHAND REGION: SUCCESS STORY

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Introduction

Four hybrid namely; CP-333, CP-555, CP-585 & CP-999 were demonstrated in 1.5 hectare area of C-13, C-14, D-21 & D-22 blocks at Research Farm, Rani Lakshmi Bai Central Agricultural University, Jhansi during *kharif*-2020.

TABLE-1: DETAILS OF THE MAIZE DEMONSTRATION AT RLBCAU FARM.

S. No.	Variety	Block	Date of sowing	Seed quantity	Spacing
1.	CP-999	C13	30/06/2020	1 KG	40 x 20 cm
2.	CP-858	C13	29/06/2020	4 KG	60 x 25 cm
3.	CP-555	C14	29/06/2020	4 KG	60 x 25 cm
4.	CP-333	D21	29/06/2020	4 KG	60 x 25 cm
5.	CP-333	D22	29/06/2020	4 KG	60 x 25 cm

TABLE-2: DETAILS OF THE MAIZE DEMONSTRATION AT NONER, DATIA FARM

S. No.	Variety	Block	Date of sowing	Seed quantity	Spacing
1.	DHM-121	A-33	17/07/2020	4 KG	40 x 20 cm
2.	DHM-121	A-43	18/07/2020	4 KG	60 x 25 cm
3.	DHM-121	B-21	19/07/2020	4 KG	60 x 25 cm

TABLE-3: LAYOUT OF C-13 & C-14 BLOCKS.

C-14 (CP-555)	
40 cm	
C-13 (CP-999)	C-13 (CP-585)
60 cm	60 cm

TABLE-4: LAYOUT OF D-21 & D-22.

D-21				D-22			
	60 cm					60 cm	
				MAIZE ENRTY TRIALS			

Results

Approximately more than 40 quintal yield has been recorded from the hybrid fields. Crop protection from birds, parrots & other wild animals has been done through using different types of sounds, like clapping, fire cracks and other instruments. A good crop has been harvested with a good number of cobs per plant, number of grains row per cob, number of grains per row, etc. Some important scientific data has been recorded on the following observations like, days to 50 % silking, days to 50 % teaselling, plant height (cm), number of cobs per plant, number of grains row per cob, number of grains per row, cob length (cm), 100-grain weight (g), grain yield per plant (g) and published this research in a scientific repute journal.

TABLE-5: DETAILS & PERFROMANCE OF MAIZE HYBRIDS IN C-13 & 14 BOCKS.

TABLE-6: DETAILS & PERFROMANCE OF MAIZE HYBRIDS IN D-21 & 22 BOCKS.






PERFORMANCE OF CP-333 MAIZE HYBRIDS

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TERMINATOR TECHNOLOGY (GURT) AND VERMINATOR TECHNOLOGY

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Introduction

Genetically engineer plants to produce seeds that grow to maturity, but those seeds will not germinate if replanted. The technique involves a method whereby a gene can be turned on or off in a developmentally regulated fashion. The procedure for controlling the expression of an engineered gene from the outside is the use of chemical inducer or other factor, such as cold treatment. This is referred as terminator technology. Therefore this technology will force the farming community to replace their seeds every time even in case of self pollinated crops such as rice, wheat including pulses . The same will also in the case of open pollinated crops such as sorghum, cotton, sunflower and pigeon pea.

Genetic use restriction technologies (GURTs) are the name given to experimental methods, described in a series of recent patent applications and providing specific genetic switch mechanisms that restrict the unauthorized use of genetic material (FAO, 2001a) by hampering reproduction (variety-specific V-GURT) or the expression of a trait (trait-specific T-GURT) in a genetically modified (GM) plant.

Variety based GURTs (sterile seed technology)

It (also known as suicide/sterile seed/gene technology, or terminator technology) is designed to control plant fertility or seed development through a genetic process triggered by a chemical inducer that will allow the plant to grow and to form seeds, but will cause the embryo of each of those seeds to produce a cell toxin that will prevent its germination if replanted, thus

causing second generation seeds to be sterile and allowing manufacturers to maintain their intellectual property rights and avoid concerns related to GM seed dispersal.

Trait based GURTs

In the case of T-GURTs, one or more genes conferring a single trait are switched on or off through application of chemical inducers (Visser et al. 2001; Pendleton 2004). Therefore, T-GURTs are not intended to affect the viability of seeds, which is in contrast to V-GURTs, which result in sterile seeds. Traits of interest that could be controlled by T-GURTs include male sterility, pest resistance, stress tolerance, nutrient production, seed germination or flower development (Gupta 1998; Pendleton 2004). The goal of this technology is to protect intellectual property (i.e., the 'value-added' transgenic trait of interest) of plant breeders in newly developed varieties by restricting access through a biological mechanism (Eaton et al. 2002). These traits could be activated when needed by induction chemicals. For example, insecticidal genes (e.g., Bt) under the control of an inducible promoter could remain inactivated until an insect pest outbreak justified the application of a chemical to induce the formation of gene products toxic to insects. The inducer chemical would, of course, be under the control and licensing of the seed company; however, the ultimate 'trigger' of this technology could be under the control of producers (Pendleton 2004).

General molecular construction

(i) a repressor gene (the gene switch) that is responsive to an external stimulus (ii) a recombinase gene (the trait activator gene), the expression of which is blocked by the repressor; and (iii) a target gene. With respect to the inducing substance, mostly of chemical origin, it should be biodegradable, nontoxic for the ecosystem, directly applicable in the field or in seeds, and capable of being absorbed by the involved plant, and its catalytic action should be specific for the target genetic system. The induced genetic system should be sensitive to small doses of inducer and the induction should be highly specific. Both T- and V-GURTs can be applied to any type of seed, independently from the contemporary genetic manipulation for the introduction of a trait of interest such as herbicide tolerance, pest resistance or nutritional improvement.

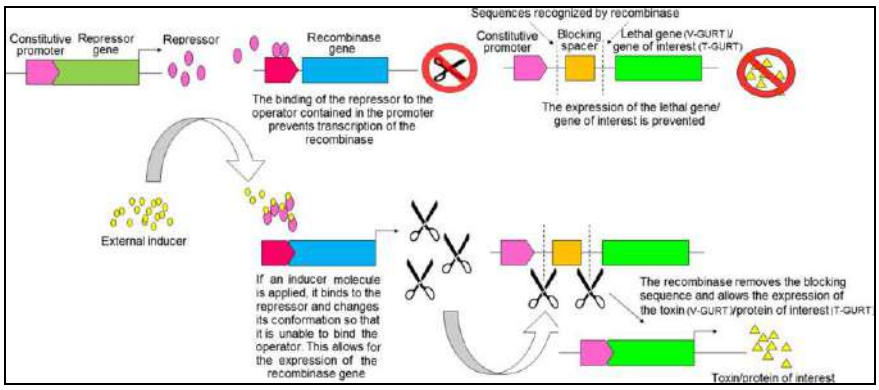
Mechanisms for V- GURTs

V-GURTs, essentially three different restriction mechanisms have been proposed (Visser et al., 2001). The first mechanism of action is that described in the patent (U.S. 5,723,765) by the USDA and Delta & Pine Land (nominally the first V-GURT). This GURT is based on the

transfer of a combination of three genes (transgenes), two derived from bacteria and one from another plant, into a plant's cells: 1. a gene coding for a cytotoxic protein (the terminator or lethal gene), under control of a late embryogenesis abundant (LEA) promoter linked to a DNA spacer (blocking) sequence flanked by specific excision sites (lox sequence) that prevents the activation of the terminator gene. In the '765 patent, the cytotoxic protein is the ribosome inactivating protein (RIP), otherwise known as saporin derived from Saponaria officinalis, which prevents plant cells from synthesizing proteins (Jiang et al., 2008).

The source of each gene and the transformation method were not divulged in the patent. 2. a phage P1 site-specific recombinase gene under the control of a constitutively active promoter (e.g., CaMV 35S) containing one or more tet operons that is subject to repression by the Tet repressor. This gene encodes a protein (Cre) that cuts the specific excision sites flanking the blocking sequence linked to the toxic gene; 3. a Tn10 tet repressor gene under the control of a constitutive promoter and encoding a protein that binds to the tet operon, preventing the expression of the recombinase gene. The presence of an external stimulus (inducer) prevents binding of the repressor to the operon. The external stimulus can be chemical inducers such as agrochemicals, in most cases produced by seed companies possessing the same restriction technologies, and antibiotics. In the case of U.S. patent number 5,723,765, the chemical inducer is the antibiotic tetracycline (Jefferson et al., 1999), although subsequently DPL stated that the tetracycline-inducible expression system (in a patent on Escherichia coli) is not the most suitable choice (Working Group on Article 8(j), 2006).

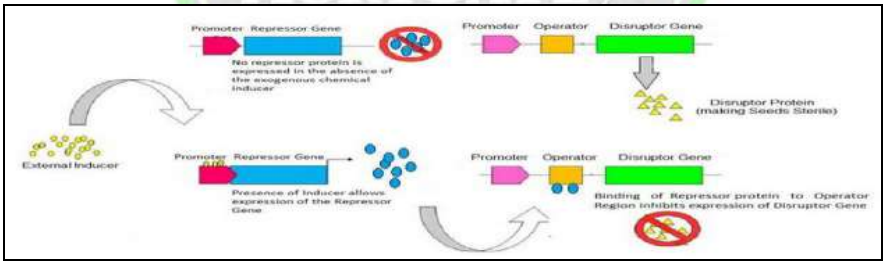
Before being sold to the consumer (in most cases, to the farmer), these seeds are exposed to the inducer that inhibits the function of the repressor, which causes transcription of the Cre recombinase gene, which produces Cre that recognizes the Cre blocking sequence in the lox sequence and splices lox from the genome, thus placing the ribosomal inactivating protein under the direct control of the late embryogenesis abundant promoter. Genes under the control of the LEA promoter are only transcribed during late embryogenesis when the seed accumulates most of its storage oil and protein and is drying down in preparation for the dormant period (Hundertmark and Hincha, 2008). During late embryogenesis, the ribosomal inactivating protein (the terminator gene) is expressed, leading to the abortion of all embryos. Thus, the seeds purchased by farmers will be able to germinate in the field, and the culture will develop normally.



Second mechanism

It is based on a **reversed process** because it is characterized by the presence of **a gene encoding a disrupter protein** permanently active in the seed, which makes it sterile. The gene promoter is under the control of a specific operator sequence. A further **repressor protein**, whose gene is under control of a chemically inducible promoter, can bind to the operator, inhibiting the expression of the disrupter protein.

In the absence of the exogenous **chemical inducer**, no repressor protein is expressed; therefore, the breeder must apply the specific chemical inducer throughout the process of seed multiplication to inactivate the disrupter gene that causes sterility, interrupting the application only at the time of selling the seeds.



Third mechanism

The third strategy is applied to vegetatively reproduced species, such as tuber and root crops and ornamental plants, where growth is prevented during the period in which they are stored to increase the 'shelf life' of the product. This mechanism patented by Zeneca (Syngenta) in 2001 involves a permanently active gene able to block the vegetative growth of the plant, preventing the multiplication of the seeds. This default-expressed blocking gene can eventually be suppressed by application of a chemical activating a second gene allowing the plant to develop.

Purpose of terminator technology

Developed for the purpose of increasing the profit of the seed industry by preventing the farming community to reuse their farm saved seeds from their earlier harvest. As a biological tool, terminator technology is very powerful and long lasting . The other purpose of this technology is to protect useful transgene(s) from being pirated (Singh . 1999).

The Terminator Seeds Development

The promoter used for the Terminator Genes would become active only in the late stages of seed maturation. But, if this promoter and the lethal gene only were inserted into plants, the even the first generation seeds would not sprout. The recombinase gene is kept in control by another type of promoter. A gene on the third bit of DNA keeps producing the protein, which represses the promoter for recombinase. Plants cells are genetically modified by introducing these strips of DNA and plants are regenerated through tissue culture methods. Since the promoter is active only during a certain stage of seed formation, the lethal gene has no chance of being expressed. When the first generation plants go about the business of producing seeds, the blocking sequence is firmly in place to prevent the lethal gene from being active. The first generation seeds are therefore formed without any trouble. The recombinase promptly removes the excision and blocking sequences in the first strip of DNA.

As a result, these seeds can be sold to farmers and will germinate properly to produce healthy plants. However, these second generation plants now carry the promoter and lethal gene bidding their time to spring into action.That time comes when the second generation plants start producing seeds. At the stage when the promoter becomes active, the lethal gene springs to life and the chemical it produces disrupts the process of seed formation. The first strip of DNA (Carrying the promoter for expression in late embryogenesis, the excision sequences, the blocking sequence and the lethal gene) is introduced into a plant cell and regenerated to produce one transgenic parent plant. In a similar fashion, another parent plant is genetically modified to carry germination – specific promoter linked to the recombinase gene. The crossing of the two plants produces plants, which inherit both strips of DNA. When the first generation seeds are planted, the recombinase gene is activated during germination and removes the excision and blocking sequences from the first strip of DNA.

Implications of terminator technology

Private sector will now invest more in development of purelines and OPV. Seed replacement rate will go up. Pre-harvest sprouting may be prevented. Escape transgene(s) can be prevented.

Disadvantages

Molecular biology research may suffer. Prevent the use of farm saved seeds. Seed may be used as a weapon in developing world. Gene becoming free in environment. Loss of soil biodiversity. Terminator and nutritional quality. Terminator and plant genetic resources (TPGR)

Verminator Seeds

This technology will prevent plant growth, rather than killing the seed. The technology makes use of a gene from the fat tissue of a rat, which will block the normal plant growth, unless the blocking process is deactivated by a chemical. The technique has been dubbed as 'verminator' by RAFI and appears to be wider and more flexible than the 'terminator', though intended to serve the same purpose.

During 1998-99, while the debate on terminator was still going on, a new trait-control technology (dubbed by RAFI as 'traitor technology') appeared in more than two dozen patent claims from 12 institutes/seed companies. The technology was also described as t-GURT. This technology did not render the harvested seed sterile and, therefore, did not render it useless for replantation. Instead, it required that the seed be sprayed by a specific herbicide or fertilizer manufactured by the seed company either to enable the seed to germinate or to allow the expression of a desirable trait (e.g., disease resistance) in the plants raised from the harvested seed. Thus, in order to achieve optimum productivity, the farmers will be forced to purchase the herbicide or fertilizer from the same company, from which they purchase the seed. This technology was dubbed as 'traitor technology' by RAFI, who believed that the technology posed a challenge to community plant breeding and national food security.

For Further Reading:

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'NUTRI CEREALS' - A BOON FOR FOOD AND NUTRITIONAL SECURITY

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Introduction

Millets are the group of small-seeded annual grasses that are grown as grain crops for food and fodder with little input even under unfavourable agricultural situations in marginal lands. They constitute an important staple in the semiarid tropics and ensure food and nutritional security. Millets are climate resilient crops that are adapted to a wide range of ecological conditions demanding less water and inputs.

Nutri Cereals

Millets are considered as nutritionally superior to rice and wheat and millets are the cheap source of proteins, minerals, and vitamins. Millets are rich source of dietary fibre, minerals, and B-complex vitamins. It has health promoting phytochemicals like polyphenols, lignans, phytosterols, phyto-oestrogens and phytocyanins. These often function as antioxidants, immune modulators, detoxifying agents, *etc.*, and hence have beneficial effects on human health (Dayakar Rao *et al.*, 2018). The absence of gluten, millets are safe for people suffering from gluten allergy and celiac disease. Millets diets are non-acid forming, easy to digest and non-allergenic (Saleh *et al.*, 2013).

Millet grains contain more nutrients, especially calcium, phosphorus, magnesium and iron are comparatively higher than in other grains. Hence, they are called as "Nutri cereals". They possess the tendency to address nutritional deficiencies. They are considered as ideal food for diabetics due to their high fibre content and low carbohydrate content with low glycemic index. The untapped grain yield potential of small millets coupled with nutritional superiority make millets the potential future food crops. While, sorghum and millets also offer wide scope for industrialization, they form important raw material for potable alcohol and starch production (Ganapathy., 2021).

International Year of Millets, 2023:

To recognize the importance of millets, the United Nations General Assembly at its 75th session in March 2021 declared 2023 the "International Year of Millets (IYoM 2023)" with the Food and Agriculture Organization of the United Nations (FAO) as the lead agency. The following were the objectives of IYoM 2023.

- Raising awareness of the nutritional and health benefits of millets and promoting millets as a key component of the food basket.
- Raising awareness of the contribution of millets to food security and their important role in keeping a check on food wastage.
- Promoting the sustainable cultivation of millets, also under adverse and changing climatic conditions and improving their quality.
- Highlighting their potential to provide new sustainable market opportunities for producers and consumers.
- Promoting a better utilization of crop rotations.
- Enhancing investment in research and development.

List of millet crops

Common name	**Botanical name**	**Vernacular name**
Sorghum	*Sorghum bicolor*	Cholam/Jowar
Pearl millet	*Pennisetum glaucum*	Cumbu
Finger millet	*Eleusine coracana*	Ragi
Little millet	*Panicum sumatrense*	Samai

Kodo millet	*Paspalum scrobiculatum*	Varagu
Barnyard millet	*Echinochola frumentacea*	Kudiraivali
Foxtail millet	*Setaria italica*	Tenai
Proso millet	*Panicum miliaceum*	Panivaragu

Health Benefits of Millets

- Millets are known for low glycemic index (GI) that helps to manage diabetes. The low glycemic index in millet slows down the digestion process and keeps the blood sugar level at a constant ratio.
- Millets are rich in dietary fiber and help in digestion and prevent constipation besides it reduces the bad cholesterol and minimising the risk of cardiovascular diseases.
- Millets are absolutely gluten-free, and it is good for celiac patients.
- Millets are rich in antioxidants that protect our cells from damage by free radicals.
- Availability of tryptophan in millets helps in body weight reduction.
- It helps to protect against heart diseases because soluble fibres present in the millets could absorb bad fats in the body. Hence, the bad fats are removed from the body and protect against heart related diseases.
- Millets are rich in anthocyanin and tannin. Millets are anti-carcinogenic and can be used as a food for preventing cancer.
- Millets contain beneficial antioxidants *viz*., anthocyanin, flavonoids, lignin and phytonutrients which protects against blood cell damage.
- Millets have all kinds of nutrients which improves health and prevents diseases like depression, anxious mood, and insomnia.
- Millets also regulates Nuero (Alzheimer: A type of dementia that affects memory, thinking and behaviour) disorders.

Crop resilient features of Millets

- Millets are C4 crops, it will observe more carbon dioxide from the atmosphere and use it for higher photosynthesis and hence millets are efficient crops in performance under stress conditions.

- Millets can grow in arid and semiarid environment on shallow, low fertile/saline soils. It will need less water for crop growth, and it has shorter growing period of 60-90 days.
- Millets are more environment friendly crops. It requires minimum addition of inorganic inputs, low carbon footprint, Climate positive crops and it will not require hazardous chemicals/pest control agents.
- Millets can be stored for a longer period under ordinary conditions and thus can be used as 'famine reserves', which is important for rain-dependent smallholder farmers. Millets indeed are a crop of the future.

Conclusion

Millet cultivation is declining in many countries, due to lack of awareness on their potential to address climate change and food security. By considering the critical climate changes and various environmental stresses, millets could be the crucial link in the sustainable food supply chain as well as one of the climate resilient solutions. Contribution of millets to nutrition, livelihood and incomes of farming family can play an important role in contributing to food security and eradicating poverty.

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IMPACT OF BIOCHAR ON PHYSICAL, CHEMICAL AND BIOLOGICAL PROPERTIES OF SOIL

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Abstract

The pyrolysis of organic waste materials result in the formation of a product called biochar. The nutritional value of the biochar produced depends on the type of feedstock and the pyrolysis conditions. Biochar is a cost effective and eco friendly product having the potential to improve the soil health and productivity. Biochar is highly valuable due to its large surface area, porosity, nutritive value. Biochar can influence some important soil physical properties which include bulk density, soil porosity, soil structure and water holding capacity. It can also be used as a soil amendment. The alkaline nature of biochar helps in the amelioration of acidic soils. Biochar application will improve the cation exchange capacity and nutrient availability in soils. It has the potential to add organic carbon and create favourable conditions for growth and activity of micro organisms. Therefore the application of biochar can be taken up to soils considering its advantages.

Keywords: Biochar, Soil properties, Soil health, Soil fertility

Introduction

Soil is a precious resource and is fundamental for crop production. It is a natural resource and is vulnerable to degradation if not managed well. The demand for food production increases

with the increase in the population and it is very important to keep our soils healthy and productive. Healthy soils have the ability to sustain biological productivity, animal and plant health and environmental quality. Healthy soils is a home for diverse beneficial micro organisms, recycle plant nutrients, improve soil physical properties like soil structure and water holding capacity and helps in mitigating climate change. Soil health can be maintained by application of several natural biowastes and biochar is one of them. Biochar is a carbonaceous material formed from the pyrolysis of agricultural residues, organic wastes, industrial and municipal wastes which help in the maintenance of soil health and fertility. It is produced by thermal decomposition of biomass under low or absence of oxygen[1]. The properties of biochar like pH, cation exchange capacity, higher surface area and its nutrient composition will positively influence the soil properties and soil health.

Impact of Biochar on Soil Physical Properties

The physical properties of soil include bulk density, soil porosity, soil structure and water holding capacity.

Bulk density

The bulk density of the soil is the ratio between mass of the soil to its volume. It is defined as *the dry weight of soil per unit volume of soil*. Soils with a bulk density higher than 1.6 g/cm^3 tend to restrict root growth. Bulk density increases with compaction and tends to increase with depth. Compaction reduces crop yields and restricts the growth of plant cover that helps to protect the soil from erosion. By restricting the infiltration of water into the soil, compaction can lead to increased runoff and erosion in sloping areas or to saturated soils in more level areas. Therefore it is necessary to reduce the bulk density for better root growth and absorption of nutrients in soil. Biochar is highly porous in nature and with its application will reduce the soil bulk density[2].

Soil porosity

Porosity is the pore space in soil between mineral particles filled with either air or water. Porosity varies depending on particle size and aggregation. The soil with low porosity restricts the root growth and movement of air and water through the soil. Low porosity will result in shallow root growth affecting the plant growth and yield. The application of biochar will increase the porosity of the soil and and improves the water and air circulation[3]. Biochar increases the soil porosity by reducing the bulk density and increasing the soil aggregation.

Soil structure

The soil structure is the arrangement of sand, silt, and clay in the soil. The arrangement of these particles into groupings is called as aggregates. The formation of stable soil aggregates is essential for water retention, movement and root penetration. The application of biochar helps in growth and survival of micro organisms in soil. Soil microorganisms excrete substances that act as cementing agents and bind soil particles together thereby resulting in the formation of stable aggregates. Carboxylic and phenolic functional groups in biochar bind the minerals and the soil organic matter which contribute to the soil aggregation.

Water holding capacity

The water holding capacity is the amount of water that a given soil can hold for crop use. It is the ability of a soil to physically hold water against the gravitational force. Higher the surface area of the soil higher is the water holding capacity. The incorporation of biochar increases the surface area of the soil and improves the water holding capacity. Biochar has the capacity to retain water in its internal pores thereby increasing soil moisture content.

Impact Of Biochar On Soil Chemical Properties

The chemical properties of soil include soil pH, soil organic carbon, cation exchange capacity and nutrient availability.

Soil pH

The nutrient availability in soils mainly depends on the soil pH. The pH of biochar depends on the type of feedstocks and the liming capacity of the charcoal. Biochar has a pH between 5.9 and 12.3, with a mean value of 8.9. Since the pH of the biochar is generally alkaline in nature it can be used as an amendment to acidic soils. Addition of biochar to acidic soils can raise the pH of soils and increase the nutrient availability[4].

Soil organic carbon

The organic carbon in the soil is an important indicator in soil health assessment. It is the amount of organic carbon retained in the soil after the decomposition of organic matter. The organic carbon content improves the physical and microbial properties of the soil. Biochar is basically a carbon rich material produced from various organic materials by pyrolysis. Therefore the application of biochar is known to increase the soil organic carbon content in the soil and boost the activity of beneficial micro organisms. The organic carbon will improve the aggregate stability, water holding capacity and nutrient cycling in the soils.

Cation exchange capacity:

The total capacity of a soil to hold exchangeable cations like calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}) and sodium (Na^{+}) is known as cation exchange capacity. It is an important property of soil as it influences soil pH, nutrient availability and stability of soil structure. Addition of biochar as an amendment will increase the CEC of soil and its capacity to hold nutrients.

Nutrient availability

The application of biochar helps in the addition nutrients like nitrogen, phosphorus, potassium, calcium and magnesium and alters their nutrient cycles. It indirectly influences the exchange of nutrients because of its higher reactive surfaces. The effect of biochar on the nutrient availability varies due to the varying nutrient contents of the raw biomass used in its preparation. The biochar also increases the nutrient use efficiency by absorbing nutrients and releasing them gradually.

Impact of Biochar on Soil Biological Properties

Microbial activity

Biochar has the capacity to change the physical and chemical properties of soil and creates a favourable environment for microbes. The higher surface area of biochar attracts ions and organic compounds and increases the potential sites for microbe-substrate interactions. As a result biochar improves the microbial growth and affect the soil enzyme activity that influences various biogeochemical processes[5]. The optimum quantity of biochar along with the fertilizers is found to increase the microbial population. The significant increase in biomass carbon can be noticed with the application of biochar. By enhancing and improving soil microbial activity, biochar also indirectly affects crop growth and development by improving soil fertility and ultimately increasing crop yields.

Conclusion

The application of biochar improves the physical, chemical and biological properties of the soil. It increases the porosity, soil structure, soil aggregation, reduces the bulk density and improves the water holding capacity of the soil. On application to acidic soils it increases the soil pH and facilitates better nutrient availability. It also increases the soil organic carbon content and the activity of beneficial soil micro organisms.

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PROMOTION OF HYBRID MAIZE THROUGH FRONT LINE DEMONSTRATIONS (FLDs) IN BUNDELKHAND

Article ID: AG-VO4-I02-09

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Introduction

FRON LINE DEMONSTRATIONS ON MAIZE DURING *KHARIF*-2021

The Front Line Demonstrations (FLDs) under SCSP were conducted on 90 hectares (ha) area involving 273 farmers during *kharif* season in four districts/two states of Bundelkhand region i.e., Uttar Pradesh (Jhansi & Lalitpur-District) & Madhya Pradesh (Datia & Tikamgarh). Front Line Demonstrations (FLDs) under NFSM were conducted on 10 hectares area involving 25 farmers during *kharif* season in Lalitpur District of Bundelkhand region. The Front Line Demonstrations (FLDs) focused on demonstration of released two single cross hybrids i.e., DHM-117 & DHM-121 in Bundelkhand region during *kharif*-2021. Input details of FLDs are given in the **table-1**.

SELECTION OF THE FARMERS FOR CONDUCTED FLDS ON MAIZE DURING *KHARIF*-2020:

273 Schedule Caste farmers were selected for conducting FLDs on maize during *kharif* season in four districts/two states of Bundelkhand region i.e., Uttar Pradesh (Jhansi & Lalitpur-District) & Madhya Pradesh (Datia & Tikamgarh) in eight villages namely: Punchampura (25 farmers), Nayakhera (25 farmers), Sanora (12 farmers), Karitoran (10 farmers), Emiliya (45 farmers), Barkhiriya (42 farmers), Dhovankheri (74 farmers) & Bastravan (40 farmers). Front Line Demonstrations (FLDs) under NFSM were conducted on 10 hectares area involving 25 farmers of Emiliya village during *kharif* season in Lalitpur District of Bundelkhand region.

Table:-1. Input Details of Front Line Demonstrations (FLDS) 0n maize during *kharif*-2021.

Sl. No.	Details	Quantity to be used
1.	Total number of FLDs conducted	100 FLDs
2.	Total area covered (1 hectare for 1 FLDs)	100 hectare/100acre
3.	Total quantity of seeds used to distribute to the farmers to conduct FLDs on Maize	2000 kg/20 Quintal
4.	Quantity of seed distributed for 1 acre area	8 kg/acre
5.	Quantity of fertilizers (18:18:18 super phosphate) used to distribute to the farmers	3 kg/acre
6.	Hybrids used to conduct FLDs on Maize	DHM-117 = 48 kg DHM-121 = 2052 kg Total = 2000 kg

Table-2: Details of The Farmers Selection Under FLDS on Maize During *Kharif*-2021 In Bundelkhand Region.

S.No.	Name of crop	Variety	Name of villages	Name of District	No. of farmers
1.	Hybrid maize	DHM-117	Punchampura	Tikamgarh	25
2.	Hybrid maize	DHM-121	Sanora	Datia	12
3.	Hybrid maize	DHM-121	Nayakhera	Jhansi	25
4.	Hybrid maize	DHM-121	Karitoran	Lalitpur	10
5.	Hybrid maize	DHM-121	Emiliya	Lalitpur	70
6.	Hybrid maize	DHM-121	Barkhiriya	Lalitpur	42
7.	Hybrid maize	DHM-121	Dhovankheri	Lalitpur	74
8.	Hybrid maize	DHM-121	Bastravan	Lalitpur	40
Total					**298**

SEEDS INPUT DISTRIBUTIONS UNDER SCSP

Total 20 quintal seeds of two single cross maize hybrids i.e., DHM-117 & DHM-121 were distributed to the 273 farmers. The farmers were selected under SCSP for conducted FLDs on maize during *kharif*-2021 in four different districts (Jhansi, Lalitpur, Datia & Tikamgarh) of Bundelkhand region and covered the eight different village namely: Punchampura, Nayakhera, Sanora, Karitoran, Emiliya, Barkhiriya, Dhovankheri & Bastravan of Uttar Pradesh & Madhya

Pradesh. 8 kg seeds / acre were distributed to the farmers for conducted FLDs on maize during *kharif*-2021.

SOWING OF HYBRID MAIZE SEEDS UNDER FLDs AT FARMERS FIELD

The sowing of seeds under FLDs on maize at farmers field were completed during 15/07/20 to 21/07/20. Sowing of FLDs were done following the FLDs practices i.e, ***"Hybrid vs. traditional cultivars"*** at the farmers field in the villages/districts; Punchampura-Tikamgarh, Nayakhera-Jhansi, Sanora-Datia, Karitoran, Emiliya, Barkhiriya, Dhovankheri & Bastravan-Lalitpur of Bundelkhand region during *kharif*-2021 under SCSP.

FERTILIZERS (UREA) DISTRIBUTION UNDER SCSP

6 kg/acre fertilizers (18:18:18 super phosphate) were distributed to the farmers for conducted FLDs on maize under SCSP during *kharif*-2021 at eight villages namey; Punchampura (Tikamgarh), Naykhera (Jhansi), Sanora (Datia), Karitoran, Emiliya, Barkhiriya, Dhovankheri & Bastravan (Lalitpur) of Bundelkhand region which were covered the 273 farmers.

COLLECTED SOIL SAMPLES FROM FARMERS FIELD

Total 80 soil samples were collected from the eight villages namey; Punchampura (Tikamgarh), Naykhera (Jhansi), Sanora (Datia), Karitoran, Emiliya, Barkhiriya, Dhovankheri & Bastravan (Lalitpur) of Bundelkhand region under SCSP programme during *kharif*-2021 for analysis in the laboratory. The details of the collected soil samples are given below in **table-3.**

Table-3: A total 80 soil samples were collected from different villages analyze in laboratory

Sl. No	Name of Villages	Name of District	No. of Soil Samples
1.	Punchampura	Tikamgarh	10
2.	Nayakhera	Jhansi	10
3.	Sanora	Datia	10
4.	Karitoran	Lalitpur	10
5.	Emiliya	Lalitpur	10
6.	Barkhiriya	Lalitpur	10
7.	Dhovankheri	Lalitpur	10
8.	Bastravan	Lalitpur	10
Total Soil Samples			**80**

AGRI-INPUT DISTRIBUTION PROGRAMME IN LALITPUR DISTRICT

Agri-inputs (Seed Bins & Fork Shoval) distribution programme were organized in different village (Emiliya, Barkhiriya, Dhovankheri, Bastravan, Semta Bhagnagar, Mirchwara & Gugarwara) of Lalitpur District. 260 SC farmers were benefitted by the scheme of Schedule Caste Sub- Plan under Front Line Demonstrations on Maize funded by Indian Institute of Maize Research, PAU, Campus, Ludhiana, Punjab. On this occasion a farmers kisan gosthi were also organized for discussion with farmers about cultivation practices, problems & solutions.

REASONS FOR YIELD GAP BETWEEN FLDs AND FARMERS PRAC TICES

In Bundelkhand region farmers have to be left the fellow of field during kharif season and they were not grow any crop due to uncertainty of rainfall in kharif season. Apart from this Directorate of Extension Education, Rani Lakshmi Bai Central Agricultural University, Jhansi were started the Front Line Demonstrations on Maize during kharif-2020 & 2021 funded by Indian Institute of Maize Research, Punjab Agriculture University, Campus, Ludhiana. Farmers were highly benefitted by the SCSP Scheme. Under this scheme hybrid maize seeds & fertilizers were distributed to the farmers free of cost & several field day's and faramer trainings/kisan gosthies were also organized at farmers field by different scientists of different estremes and they were delivered the talk on their specific specialization with time bound. Before iniciated the scheme farmer were not avair about the scheme and grow old cultivars with poor management practices and they were not getting the maximum output bu after benefotted from this scheme they were getted double yield incomparison to old cultivars/traditional practices. The average yield of old cultivars was 12 q/ha. But the yield of hybrid maize was recorded 30-35 q/ha. In last two kharif season. This was the main yield gap between farmers practices and FLDs practices.

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RICE RESILIENCE: HARNESSING INTEGRATED PEST MANAGEMENT TO SAFEGUARD AGAINST MAJOR PESTS

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Abstract

One of the main potential problems for sustainable crop production and environmental management in modern agriculture is the depletion of natural resources, climate change, and environmental degradation. One environmentally promising technology is integrated pest management or IPM. Weeds and insect pests have long threatened rice cultivation systems, severely reducing yields. While controlling weeds, insects, and pests has remained the most effective method of protecting plants, scientists have suggested alternative approaches to pest management in response to environmental threats. The widespread application of integrated pesticide management (IPM) was spurred by the growing awareness of sustainable conventional agriculture.

Keywords:

Rice, Integrated pest management, Rice pest, Biopesticides, Insect pests.

Introduction

The world's greatest population of producers and consumers both depend on rice, making it the most significant food crop worldwide. The world's leading producers, producers' area under cultivation, and producers' productivity (4.9 t/ha) are China, India, and Japan, respectively. Insects and plant diseases are more common in tropical climates, but they are less common in temperate climates than in tropical ones. Insects from more than 100 species use a variety of techniques to target rice. Rice productivity is harmed by these pests. Therefore, controlling those

dangerous pests with a variety of effective pest management approaches is imperative. The FAO states that integrated pest management (IPM) promotes natural pest mechanisms while taking into account the least amount of disturbance to the agroecosystem. By taking into account the cost of input and environmental effects, integrated pest management (IPM) increases farmers' profitability.

Rice Pests

To feed the world's expanding population, more rice needs to be produced. However, in their efforts to boost rice output, rice farmers encounter numerous biotic and abiotic obstacles. Reducing losses to insects and other pressures is necessary to increase yields, especially with the introduction of new high-yielding rice varieties that can withstand drought and flooding. Pest pressure is anticipated to increase when cropping intensity and cultural practices alter to suit production needs.

Insects

From seeding to harvest, every portion of the plant is susceptible to insect-eating. Although the majority of insect species cause relatively little damage, over 800 different insect species have been shown to harm rice in some form. Among those, 20 species are regularly occurring and of great importance in tropical Asia. About 20 insect species are regarded as major pests in the Americas, and 15 insect species are considered major pests of rice in Africa. Here, insects are arranged according to their modes of feeding: root and stem feeders, stem borers, rice gall midges, leafhoppers and plant hoppers, foliage feeders, and panicle feeders.

1.Root and stem feeders

The stems and roots of rice plants provide food for a variety of insects. Certain insects, like white grubs and root aphids, only harm the roots; others, like mealybugs and rice stem maggots, only infest the stems; and still others, like mole crickets, harm the stems and the roots.

ROOT APHIDS

SEED MIDGES

The various insect pests that infest rice crops are associated with different stages of plant growth. Pests like mole crickets, rice seed midges, and rice seedling flies are known to prey on seedlings. Early crop growth and insect damage result in the mortality of seedlings and an uneven stand

2. Stem borers

A significant class of insect pests, rice stem borers are primarily members of the two lepidopteran families, Pyralidae and Noctuidae. Several lepidopterous stemboring species inflict similar damage. Although they do not cause economic harm, feeding by early instar stem borers on leaves and within leaf sheaths results in distinctive orange-tan lesions. Tissue can split a plant's developing section off from its base. When feeding takes place when the plant is still in its vegetative state, the larva's tiller frequently perishes and is unable to generate a panicle.

STEM BORER

GALL MIDGE

3. Rice gall midges

Orseolia oryzae, an Asian species, and *Orseolia oryzivora*, an African species, are the two main, closely related rice gall midge species that attack rice worldwide. The primary pests of both midge species are lowland irrigated rice crops. Furthermore, the harm inflicted by the two species is comparable. An onion-leaf-like "silver shoot" or "gall" is the primary outward sign of an attack. Rather than a panicle developing, there is a gall that does not produce grain.

4. Leafhoppers and planthoppers

West Africa is home to several species of leafhoppers (Cicadellidae) and planthoppers (Delphacidae) that are found in Asia; however, they are not the same species. Although they are of very little significance, West African species resemble Asian species in appearance. Their significance has grown in Asia as rice production has intensified, particularly due to the improper use of pesticides. In addition to directly harming plants by draining the sap from their leaves and stems, numerous African and Asian species are also effective rice virus carriers.

While planthoppers mostly affect the base of the plant, leafhoppers target all of the plant's aerial sections.

LEAFHOPPER

PLANTHOPPER

5. Foliage feeders

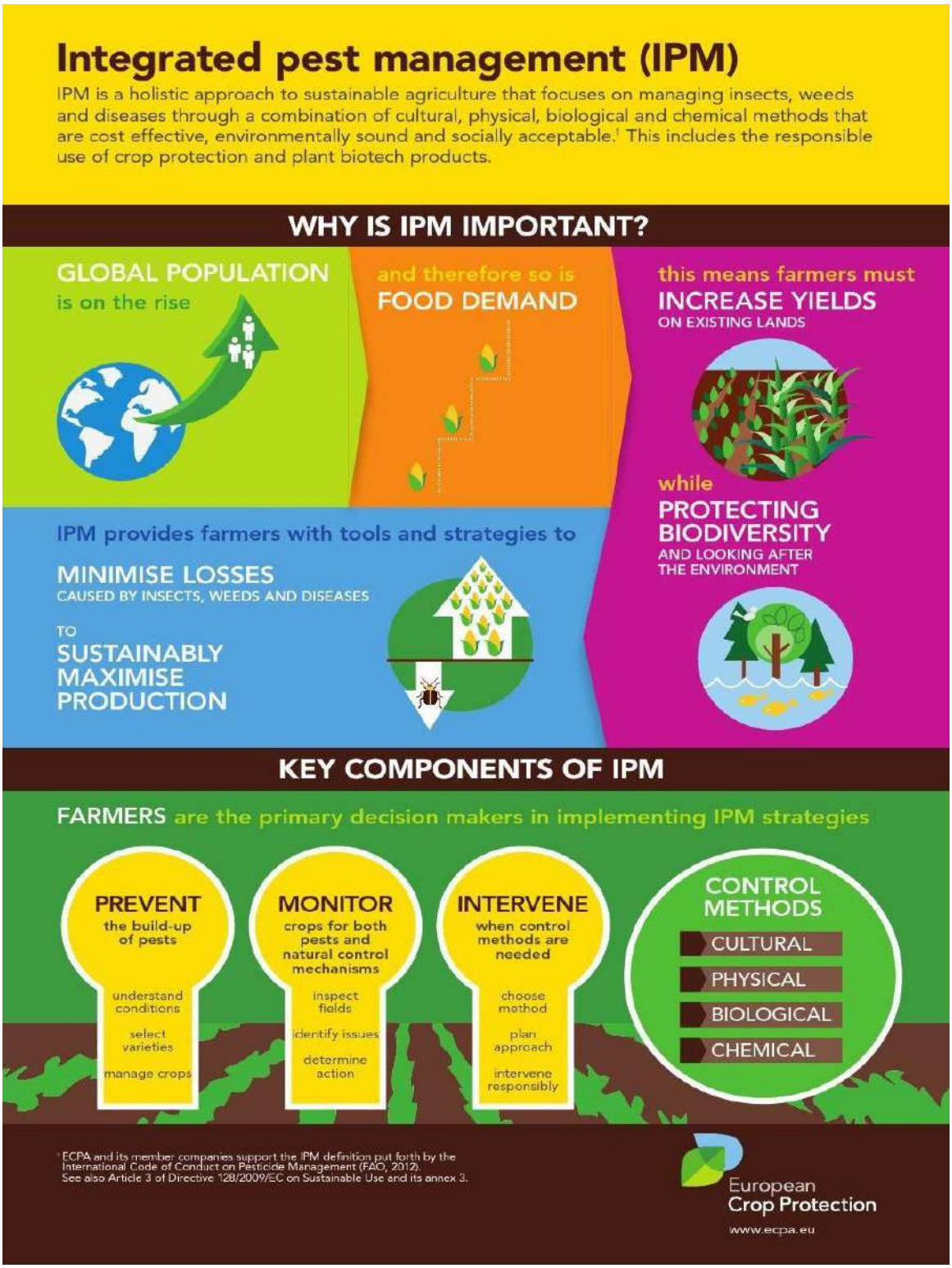
The term "foliage feeders" refers to a broad category that includes mites and other insect orders that feed on rice foliage, such as the Hemiptera, Thysanoptera, Lepidoptera, Diptera, Coleoptera, and Orthoptera (grasshoppers). The rasping-sucking mouthparts of the adult rice thrips, *Stenchaetothrips biformis* (Thysanoptera: Thripidae), lacerate the green tissue of leaves. Young plants are most affected, often 1-2 weeks post-transplant. When damage appears, it shows as tiny, yellowish lines or leaves with silvery lines that eventually curve in the direction of the midrib. Plants in severe infestations wither and become stunted.

6. Panicle feeders

Two types of insects that attack rice panicles: stink bugs, which feed on the milk-like sap that develops in the grains, and floral components, primarily pollen. Earwigs, blister beetles, and panicle thrips are examples of insects that consume the floral portions and stop spikelets from filling, leaving them empty and causing them to abort. Rice bugs are hemipteran insect species that feed on the milk of developing grains. These include members of the families Alydidae, Coreidae, Pentatomidae, and Pyrrhocoridae. The alydids *Leptocorisa acuta*, *Leptocorisa chinensis*, *Leptocorisa varicornis,* and *Leptocorisa oratoriu* are the rice bugs that are most frequently discovered in rice throughout Asia.

Different Practices in Rice IPM

IPM is a way of managing pests that include chemical, biological, cultural, and physical control techniques.



1.Physical methods

When labour costs rise and a less expensive alternative method becomes available, the adoption of this method declines. The physical means of controlling pests in rice include a

variety of techniques, such as removing the pest-infested plant, cleaning bunds, using light traps, and putting oil in the paddy water. For instance, kerosene oil is poured onto a flooded field to combat root weevils. Seed bugs are said to be controlled by the light trap. Roughing is said to have been effective in controlling root aphids.

2. Cultural methods

Different cultural practices, such as field geometry, mixed cropping, planting method, planting density, planting timing, tillage operation, weeding, and straw burning, affect the number of pests that affect rice crops. The intercropping of rice with cotton or pigeon pea led to a reduction in the white-backed plant hopper population. Compared to directly planted crops, rice transplants have been found to have a higher stem borer. Likewise, when planting density rises, so does the population of leaf folders.

3. Biological methods

The biological approach to pest control also involves the use of bio-pesticides, which are made from living organisms or products of living organisms, and pheromones to monitor pest populations, prevent them from mating, and render insect releases sterile. The development, eating, and behavior of rice leaf folder larvae are impacted by a few biological pesticides, including *Vitex negundo* L. leaf extract, Neem seed kernel extract (*Azadirachta indica*) and *Bacillus thuringiensis*.

4. Chemical methods

In IPM practice, the chemical approach is the last option. It covers the application of chemical pesticides in the management of pests. To stop crop loss, pesticides suppress the pests. However, a high pesticide use rate cannot result in long-term, sustainable rice production. The application of pesticides must therefore be grounded on ecological principles, and farmers must be able to benefit from the ecosystem's diversity and productivity. In rice integrated pest management (IPM), chemical pest control can be combined with biological and cultural methods. Using pesticides sparingly aids in the management of pests in rice. Using pesticides selectively aids in preventing or lessening their impact on non-target species.

Conclusion

Overuse of pesticides results in the pest's outbreak and the eradication of beneficial insects. Therefore, the most effective substitute for using pesticides to control pests in rice fields is integrated pest management. IPM combines many methods, including chemical, biological,

cultural, and physical methods, to manage pests in rice fields. Mainly concentrated on implementing integrated pest management techniques that comprise the farmers' involvement in pest management initiatives.

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INSIGHTS ON PREPARATION OF LOW COST CONCENTRATE FEED MIX FOR CATTLE: A REVIEW

Article ID: AG-VO4-I02-11

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Introduction

Balanced Ration is the key factor to influence the productivity of animal as well as declines the cost of animal production. A large quantity of feed resources are available, those are capable to nourish the livestock sector (*Dey A et al*., 2018). For any successful dairy business feed stuffs and feeding management plays an important role, not only in supplying essential requirements to the animal but also in total expenditure on the production. About 65-75% of total investment on dairy goes to the feed cost, so if one can minimize the expenditure on feeds, it will procure more profits. It is mainly helpful for small and marginal farmers in alleviating poverty.

Materials and Methods

Low cost concentrate feed mix is commonly used technique mostly in rural and tribal parts of our country by using the feed stuffs and agricultural by products that are available around the farm and household. With the professional aid from Veterinarians /Animal nutritionists, if feed is well balanced with all the animal requirements (Energy, Protein, Minerals, Vitamins) it will increase the quality of milk and then profits and also decreases the chances of production diseases.

Composition of the ration currently fed to the cows is decided based on dry matter intake required for getting a required level of milk production per day. Due to high cost and non-availability of concentrates and protein sources, locally available supplements are required to optimally feed dairy cows. These should be supplied in higher quantities as a replacement to

concentrates to reduce the feed cost. However, there is a problem to formulate diets that are balanced with respect to protein, energy, vitamins, and minerals and at the same time being low cost. (*S.N Goswami et al*., 2013)

Discussion

In this technique normally high quality feeds are used in minimal quantities to balance the requirement & farm based products, by-products, unconventional feeds which are low in cost and easily available are used to cover the remaining portion.

Commonly cereals like Maize and Sorghum, oil cakes like Soya bean meal, Groundnut oilcake; Cereal by-products like De-oiled rice bran, wheat bran are used in concentrate mixtures because of their high nutritive value, but their cost is high. All farmers can't afford it all the time. Sometimes feeding the animal with this feeds may not be economical to the farmer. To overcome such situations using of conventional ingredients like Horse gram, pulses, broken cereals, mill based oil cakes, agriculture and house hold wastes like broken grains, gram chunni etc are very handful. Adding of these ingredients to the mixture will reduce the quantity of high quality feeds required, there by the decrease the expenditure on feeds.

Preparation of farm concentrate mixtures – In total quantity, cereals (energy requirements) like maize, bajra and sorghum should cover about 15% of total and other low cost cereals or grams like horse gram, red/black gram, cowpea etc. can be used to balance the remaining requirements. Addition of each stuff should not exceed 12- 15%. Total cereal percentage should be about 40%.

Oilcakes (protein requirements) which are produced from the local vendors can be fed to cattle like sesame oilcake and coconut oilcake which not only have good quality protein but also have solid amount of fats and energy content (comparable to commercially available oilcakes which fully extracts oil). These can be brought at low prices and used up to 25-30%.

Cereal by products like left over, broken, de-selected or mis-shapened pulses or brans, gram waste chunni from farm or local mills, rice mill wastes, dried washed gram wastes can also be used in mixture but note that it should not replace the quality and quantity of total cereals given. each product percentage shouldn't extend up to 10-12%. Farmers having mid-season crops or supplementary crops can use that products in the mixture (or) if not available, they can be brought from the markets which are usually low in cost. Molasses, salt and mineral mixture should be added. Addition to these extenders will have its own value.

If industrial wastes and unconventional feed stuffs are being used, they shouldn't exceed 3-4%. Each product should be properly selected, adequately understood and fed in acceptable quantity because sometimes they may deteriorate the production and health of the animal (anti-nutritional factors). Products from Tapioca like tippi, flower wastes, kernel cakes, Tree pods, industry by-products from ginger, turmeric, cardamom, cinnamon, mustard if available in markets can also be used for feeding. Most of this products in feeding shouldn't exceed 3-4% as they are deficient in most of the minerals and vitamins. If these are fed, mineral and vitamin mixtures are mandatory. Sugar cane wastes can be also used which are commonly available at low cost, like molasses it can be added up to 5-6%. Bagasse, dried sugarcane crush, jaggery mud can be used up to 3% in feed.

Key notes

One should keep in mind that addition of these products is to reduce the cost of the feed. These are generally low in cost, that doesn't mean addition of high quality feeds should be excluded completely.

To meet the requirement of animal, addition of high quality feeds is mandatory.

While selecting the feeds we should consider the health, physiological state and nutrition plane of the animal.

Even the feed cost is less, the quality is important.

Feeds with high fibre content should be avoided while selecting the ingredients. While selecting the ingredients sometimes supervision or advisory from the local veterinarian is needed.

Many of the feeds may be less to unpalatable so, animal may consume less feed. to increase palatability molasses and salt can be added.

If feed stuffs are hard, better to soak them before feeding.

Addition of NPN compounds is not required when animal is producing less milk.

Advantages

- Efficient way to decrease the feed cost and increase the profit margin.
- Decrease the burden on the high quality feed stuffs like maize and soya bean by using alternate feed resources.
- Easy to prepare even by illiterate farmers.
- One can use household and farm waste to feed the cattle without wasting it.
- Can generate additional revenue from agricultural by products.

- Scarcity, famines, natural calamities were not much problem in feeding the animals, as they were already conditioned to feeding with farm level ingredients.
- Very helpful in Indian conditions where feed and fodder scarcity is there.
- Very advantageous for small and marginal farmers.

Disadvantages

- Professional aid is needed in some situations, places where is there is no such facilities or extension programmes, this method may not work effectively as expected.
- Anti-nutritional factors, toxins are of important concern.
- Unpredictable digestibility of some feed stuffs as some of them has less or no scientific research background.
- Care should be taken in feeding (quality and quantity) as they may lack some essential nutrients leads to deficiency diseases.
- Same type of feed stuffs used in some places may not be used in other places due to lack of availability.

Conclusion

Low cost concentrate feed mix is only an idea, how to reduce the total feed cost, that doesn't mean it should be followed blindly without basic understanding of feeds and their effect on animal physiology. Without knowledge transfer from professionals, feeding the animal with random feed stuffs will end up in compromising animal health like metabolic, digestive and production diseases which end up in losses. Besides this, following the above technique is highly recommended to small and marginal farmers for successful dairy business.

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PROMOTION OF MILLET CULTIVATION THROUGH SEED PRODUCTION PROGRAMME IN BUNDELKHAND

Article ID: AG-VO4-I02-12

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Introduction

Kodo (JK-137 & TNAU-86), Barnyard millet (Co (KV)2 & DHBM-93-3), Sorghum (CSV-27) & Bajra (PC-701) were selected for sowing as a seed production crops during Kharif-2020 at Research Farm, Datia, M.P., Rani Lakshmi Bai Central Agricultural University, Jhansi, U.P., India. Details are given in the table-01, 02, 03, 04 & 05.

Table-1: Details of millets crop, varieties, class of seeds, quantity of seeds & sowing plan during *kharif*-2020.

S.No.	Crop	Variety	Class of seeds	Quantity of seeds
1.	Kodo	JK-137	B/S	10 kg
2.	Kodo	TNAU-86	T/L	10 kg
3.	Barnyard millet	Co (KV)2	T/L	10 kg
4.	Barnyard millet	DHBM-93-3	B/S	10 kg
5.	Sorghum	CSV-27	T/L	20 kg
6.	Sorghum	CSV-27	T/L	10 kg
7.	Sorghum	CSV-31	B/S	10 kg
8.	Bajra	PC-701	B/S	10 kg
9.	Bajra	PC-701	F/S	6 kg
Total quantity of seeds				96 kg

MILLETS SEED PRODUCTION DETAILS DURING *KHARIF*-2020:

Millets crops were grown as a seed production purposes in line sowing methods under rainfed conditions. Recommended dose of balanced fertilizers were given at suitable crop stages.

ROUGHING & MONITORING SYSTEMS:

Roughing & monitoring were done at before flowering & after flowering stages. Monitored the crops time to time for proper maintenance of physical & genetic purity in the seed production crop

TABLE-2: DETAILS OF SOWING OF MILLETS DURING *KHARIF*, 2020.

S. No.	Crop	Variety	Class of seeds	Block	Area	Farmers	D.O.S.
1.	Kodo	JK-137	BS	B-22, B-13*, B-23*	1.5 ha.	Hariom	08-07-2020
2.	Kodo	TNAU-86	TL	A-25*, A-43*	1 ha.		27/07/2020
3.	Sanwa	Co (KV)2	TL	B-2	1 ha.	Maththi	06-07-2020
4.	Sanwa	DHBM-93-3	BS	B-3*, B-4(a)*	1 ha.		13-07-2020
5.	Sorghum	CSV-27	TL	A-11& A-12	2 ha.	Bharat	08-07-2020
6.	Sorghum	CSV-27	TL	A-13	1 ha.		13-07-2020
7.	Bajra	PC-701	BS	A-22*, B-14	1.5 ha.	Jagdish	06-07-2020
8.	Bajra	PC-701	FS	A-23	1 ha.		06-07-2020
9.	Sorghum	CSV-31	BS	H-4	1 ha.	RLBCAU, Farm, Jhansi	31/07/2020

*means half hectare.

TABLE-3: DETAILS OF MILLET CROPS, VARIETIES & CLASS OF SEEDS.

S. No.	Crop	Variety	Class of seeds
1.	Kodo	JK-137	BS
2.	Kodo	TNAU-86	FS
3.	Sanwa	Co (KV)2	FS
4.	Sanwa	DHBM-93-3	BS
5.	Bajra	PC-701	BS
6.	Bajra	PC-701	BS
7.	Sorghum	CSV-31	BS

TABLE-4: SEED HUB ON MILLETS DETAILS, *KHARIF*, 2020.

S.No.	Farmer	Crop	Seed Class sown	Variety	Block	Area (ha)	Seed given (Kg)	Date of sowing
1.	Bharat	Jowar	TL	CSV-27	A-11 & A-12	2 ha	20 kg	08-07-2020
		Jowar	TL	CSV-27	A-13	1 ha.	10 kg	13-07-2020
2.	Maththi	Sanwa	TL	CO-KV-2	B-2	1 ha	10 kg	06-07--2020
		Sanwa	BS	DHBM93-3	B-3*, B-4(a)*	1 ha.	10 kg	13-07-2020
3.	Hariom	Kodo	TL	TNAU-86	A-25*, A-43*	1 ha	10 kg	27-07-2020
		Kodo	BS	JK-137	B-22,	1 .5 ha.	10 kg	08-07-2020
4.	Jagdish	Bajra	BS	PC-701	A-22*, B-14	1.5 ha	10 kg	06-07-2020
		Bajra	FS	PC-701	A-23	1 ha	6 kg	06-07-2020

*means half hectare.

TBLE-5: SEED HUB ON MILLETS YIELD PERFORMANCE DURING *KHARIF*-2020.

S. No.	Farmer	Crop	Seed Class sown	Variety	Block	Area (ha)	Seed given (Kg)	Date of sowing	Yield
1.	Bharat	Jowar	TL	CSV-27	A-11 & A-12	2 ha	20 kg	08-07-2020	17 kg
		Jowar	TL	CSV-27	A-13	1 ha.	10 kg	13-07-2020	
2.	Maththi	Sanwa	TL	CO-KV-2	B-2	1 ha	10 kg	06-07--2020	5.27 quintal
		Sanwa	BS	DHBM93-3	B-3*, B-4(a)*	1 ha.	10 kg	13-07-2020	6.523 quintal
3.	Hariom	Kodo	TL	TNAU-86	A-25*, A-43*	1 ha	10 kg	27-07-2020	Not Harvested
		Kodo	BS	JK-137	B-22, B-23* & B-13*	1 .5 ha.	10 kg	08-07-2020	9.586 quintal
4.	Jagdish	Bajra	BS	PC-701	A-22* & B-14	1.5 ha	10 kg	06-07-2020	6.53 quintal
		Bajra	FS	PC-701	A-23	1 ha	6 kg	06-07-2020	
5.	RLBCAU,	Sorghu	BS	CSV-31	H-4	1 ha	10 kg	31-07-2020	24 kg

Fig-6: Performance Of Sorghum In H-4 Block During *Kharif*-2020

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Fig.7: Performance of barnyard millets variety tnau-86 during *kharif*-2020

Fig.-8: Performance of bajra variety pc-701 during *kharif*-2020

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Fig.-9: monitoring the performance of kodo variety jk-137 during *kharif*-2020

Fig.-10: Monitoring the harvesting of millets seed production crops during kharif-2020.

Fig.11: Monbitoring the installment of seed processing plant at research farm, datia

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MODERN AND ECO-FRIENDLY METHODS OF LIVESTOCK FARM WASTE MANAGEMENT

Article ID: AG-VO4-I02-13

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Introduction

Sustainable waste processing requires sufficient waste as input and market demand for output products. (Vergara and Tchobanoglous 2012).Such markets will depend on the proposed final use of the product for biowaste, which can be roughly arranged into three end-use groups:

Livestock

Products derived from biological waste can be used as animal feed. This is gaining increasing relevance, given the significant global shift towards diets with consumption enlargement of animal products. Demand for meat and milk in 2050 is expected to be 58 and 70% higher than in 2010. Growing demand for animal products requires more feed. Higher prices for traditional fodder resources such as soy and fishmeal, the risk of their absence in the future and the associated negative environmental consequences in the production of such traditional feeds lead to the emergence of innovations and alternative feeds. Protein products derived from waste products such as insects or worms are increasingly seen as a possible alternative (Makkaret al. 2014).

Agriculture

Biological waste, a source of carbon and plant nutrients can be processed into various types of soil modifications with benefits for both crops and soils. Soil supplements derived from biological waste (for example, compost, digestate) are perceived as low value products by many consumer groups (Gilbert 2015). However, soils are becoming more vulnerable in an

intensive agricultural practice. The rapid carbon turnover (3-5 times faster than in temperate regions) and its extraction, a decreasein the capacity for storing nutrients and water, as well as a decline in erosion resistance, emphasize the need to replenish carbon and plant nutrients. This can be achieved by processing organic waste in agriculture.(Smith et al. 2015).

Bioenergy

Particular attention is paid to the energy contained in biomass waste. Given the growing demand for energy, 1.2 billion people (17% of the world population) do not have electricity and 2.7 billion people (38% of the world population) still rely on irrational waste wood for cooking (OECD/IEA 2015), biowaste energy products are of great interest (Lohri et al. 2016). In addition, expanding global mobility coupled with declining oil reserves in the world, is enhancing the interest in technology for upgrading biofuel products.

The direct use of biowaste on earth is an ancient form of waste management, alsocalled land spreading, and refers to the practice of dispersing unprocessed waste in the fields. Direct land use, animal waste, and outright open burning are classified as “direct use”. The risks of this practice depend on the biological waste composition. Pollution can easily endanger human, animal, and environmental health. The distribution of manure (dropping) in the fields is usually described in the literature on land waste. Thisis especially topical for crops that require large amounts of organic nutrients (Dulac 2001).

Poultry farming is an economically profitable production providing the population with poultry meat, eggs, and their processed products. At the same time, poultryfarms are a source of dropping formation in the amount of much larger than main products (more than 25 million tons per year). One chicken gives about 250 pieces of eggs per year (16-17 kg) and releases up to 50-60 kg of droppings with an average humidity of about 70%; dropping particles contain from 30 to 80% of organic matter.

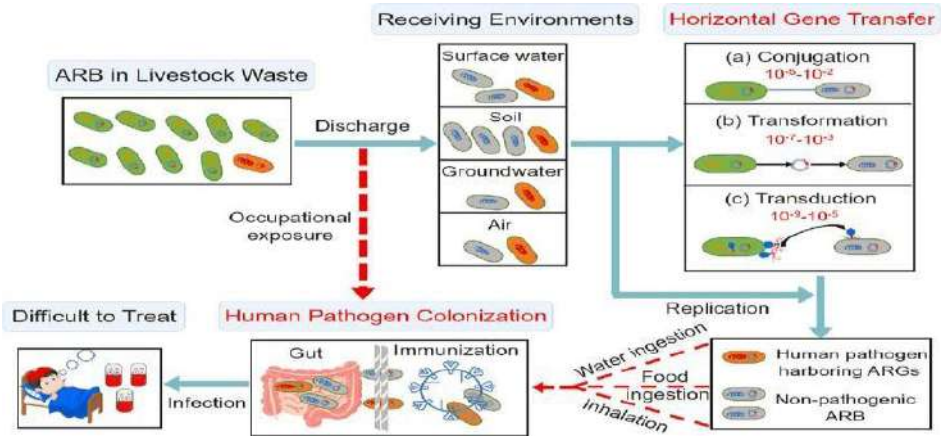
Dropping is a source of toxic gases of ammonia, hydrogen sulphide, methane, andcarbon monoxide polluting the atmosphere and adversely affecting the ozone layer state. It also contains medicines used to disinfect poultry houses. The manure insertion into thesoil without prior quarantine and processing is not allowed. Fresh dropping contains a significant amount of weed seeds and helminth eggs. It is a favorable environment for the development of pathogenic microorganisms. According to the World Health Organization, more than 100 species of various pathogens of animal and human diseases are able to successfully develop in this

environment. For instance, the causative agent of salmonellosis remains viable up to 5 months, tuberculosis -17 months. **(2)**The soil is largely seeded with microflora when such dropping is inserted which creates environmental and sanitary hazards.

Livestock waste is a major source of toxic gases and various potent pathogens related to public health concerns. It comprises of 40% of total global methane production by different livestock and agricultural by-products. Thus, bio waste recycling plays an important role in protecting environment and benefits human health by transforming into different economic products. It is necessary to mitigate this problem by converting the waste into biogas and vermicomposting to increase crop productivity and sustainability for farmers benefits.

According to the census, two leading countries of Asia using biogas technology are India and China that purifies biogas at 150 bar pressure and can be used as CNG cylinders for cooking and vehicle application. It approximately saves upto 11,300 □ /day that constitute a good amount to be looked for.

Traditionally, cow dung was used for cooking food in rural areas of different developing countries. Appropriate use of cattle dung and urine into different pesticides, manure and medicines can generate employment for millions of rural people as well as ithelps in improving soil fertility by declining use of chemicals as fertilizers. The integration of recent works i.e., composting and vermicomposting together, requires less time and substrate that can be converted into various valuable products. Even the waste from livestock can be converted into various valuable products. Even the waste from livestock can be used as feed for integrated fish farming.



Novel techniques in practice-

Biowaste management technologies practiced in urban areas are generally classified into different categories-

Direct use

It is the ancient method of waste management which involves unprocessed bio waste in land application, as direct animal feed and can also be used in combustion. It was reported that animal droppings are the major source of noxious gas production like ammonia, hydrogen sulphide and carbon mono oxide that acts as the prime source of greenhouse house effect and also are vigorous pathogens shedder in soil. According to WHO, more than 100 pathogenic species of organism are capable of surviving in the environment and causing potent health hazard to animal and human both.

Biological treatment

It refers to the technique that uses living organism for the conversion of waste into bio energy that requires mainly the humid environment for microbials' survival. It involves various techniques like-

Composting

Aerobic decomposition of organic matter under controlled condition to form stable organic product that is humus. It was an ancient practice followed by civilians in Japan, China, India as per the documentation by Greek and Roman's. The main factor responsible for composting intensity of microorganism is the ratio of C: N.

Vermi composting

Refers to the stabilization and degradation of organic wasteby microbes and earthworms under controlled microbial conditions

Black soldiers fly

It is the modern technique which involves the conversion of bio waste into insect oil and protein by the use of black soldier fly.

Anaerobic digestion

A well stablished process of engineering involving the decomposition of both liquid and solid waste by various bacterial activities under anaerobic condition. It is also known as biomethanization. It can be practiced on large amount of sludge, algae, slaughter house waste and animal manure.

Fermentation

It is an important step for ethyl alcohol production, which is the leading bio fuel in world market. Bio ethanol can be derived by biomass of starch, sugar and lingo cellulose.

Thermo chemical treatment

It uses heat for several chemical reactions to extract energy carriers as products. They are faster and cheaper as compare to the biochemical reaction. It includes

Pyrolysis

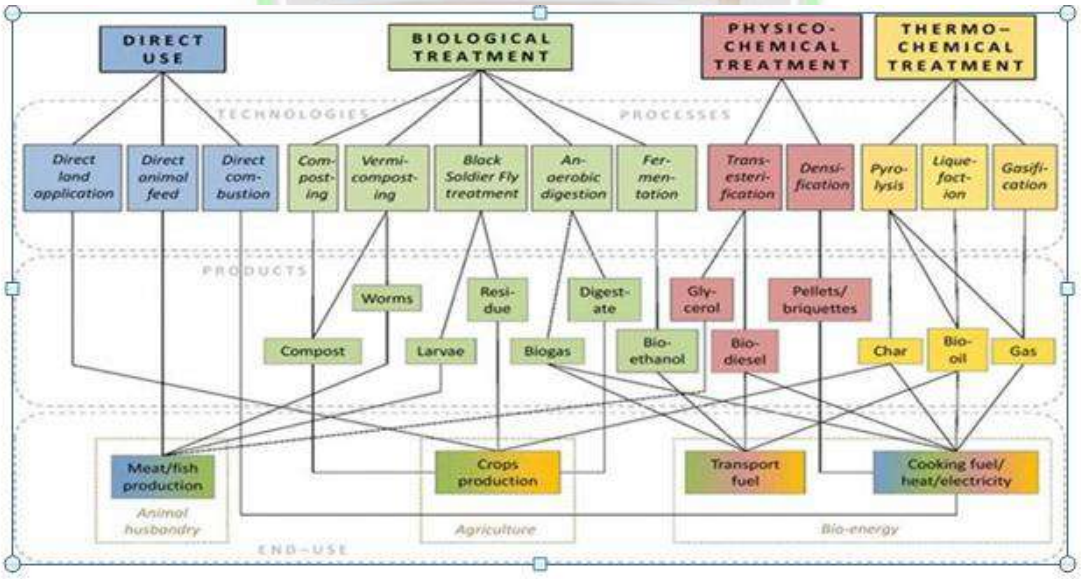
Method that uses 450-55ºC temperature for the decomposition of biomass into various valuable products under anaerobic conditions.

Hydrothermal liquification

Uses compressed hot humid environment for the breakdown of biopolymer compounds into bio raw materials that can be later used as biofuel. It is also known as direct liquification.

Gasification

Thermal treatment converting carbon materials into synthetic gases for the value- added production of fuels and chemicals. It is very eco-friendly and cost- effective technology.



Conclusion

The waste derived from livestock can be managed by various modern techniques to deal with rising energy prices and reduces environmental threats in comparison with the traditional practices. Various examples like CNG cylinders, algae cultivation etc are effective alternatives

for the recycling of potent greenhouse gases into several value- added products. Dead animals, birds, pig carcasses etc can also be successfully decomposed into nutrient rich organic matters. Integrated composting and vermin composting are not only the powerful alternative but also are economically feasible for the people in rural areas. Hence it is necessary to manage the waste derived from animal sources in eco-friendly manner, which ascertain high profit to the animal owners and elevates different environment impacts. Modern technologies for the utilization of agricultural bio waste do not fully contribute to the preservation of the environment and production. At the present stage, industry needs environmentally friendly and cost- effective technology. The use of biotechnological methods makes it possible to turn organic waste into valuable raw materials for obtaining feed, combustible materials, fertilizers, and substrates for the chemical and microbiological industry. It is necessary to develop and study new ideas and technologies and take into account process performance indicators, resource intensity, and ecological safety when assessing their competitiveness. Many scientists agree that the future of waste management is based on nature-friendly technologies because all the necessary processing mechanisms already exist in nature.

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NATURAL FARMING: THE WAY FORWARD & FUTURE IN INDIA

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Introduction

Natural Farming can be defined as "chemical- free farming and livestock based". Soundly grounded in agro-ecology, it is a diversified farming system that integrates crops, trees and livestock, allowing the optimum use of functional biodiversity.

Increasing awareness about health, environmental concerns, climate change raised and safety of food chain have resulted in development and promotion of environmentally friendly, economically & socially sustainable agriculture in the world & India. UNO and FAO have taken initiatives for promotion of nature friendly & eco-based agriculture practices to make conventional agriculture practices more sustainable and effective for local people & native agroecosystem. In this regard, organic agriculture being practiced in 191 countries in 1.6 percent of total agricultural area of the world by 34 lakh farmers. It has grown has a niche environmentally friendly agriculture & efforts are being made to bring it into main stream agriculture. But its high cost of production, comparative low yield and net return in view of market uncertainties & cost of certification are main constraints.

Large number of farmers throughout the world take farming at low input level using local agro-ecosystem resources with low to moderate productivity and sustainable living within the bio-capacity of native agro-ecosystem. A set of nature-based practices adopted by many farmers are cost effective, diversified, less risk prone & affordable in native socio-economic system ensuring balance between living & ecology with wellbeing of nature & human beings. Such practices have been documented as natural farming, eco-farming, perma-culture, Rishi- Krishi, Vedic agriculture, zero-budget natural farming etc. Recently, FAO has

started Agro-ecological initiative at the world level to reduce exploitation-based agriculture practices & support for the safety & sustainability of whole food system rather than input based specialized agriculture. Conservation agriculture, carbon farming, conservation organic agriculture, integrated organic farming systems are such alternative agriculture practices being systematized with support of modern concept of agriculture using state of art & business-based approaches. However, a concept of chemical free diversified agriculture-based farming practices with more concern on affordable native resources and management practices has emerged as a generic term "Natural Farming" in which no external use of resources, use of agro-ecological principles, people participation and common resource management is largely focused for benefit of community and Panch Mahabhuta of Universe.

Natural Farming is a way of chemical free farming based on desi cow and locally available resources, with no chemical fertilizers and pesticides and promotes traditional indigenous practices which give freedom to farmers from externally purchased inputs and is largely based on on-farm biomass recycling with major stress on biomass mulching, use of on-farm desi cow dung-urine formulation; managing pests through diversity, on-farm botanical concoctions and exclusion of all synthetic chemical inputs directly or indirectly and emphasis is given on improving natural nutrient cycling and increase in organic matter in the soil, which can help with climate change resilience and carbon sequestration in soils.

Challenges to Natural Farming in India

Decline in Yields:

- **Sikkim (India's first organic state),** has seen some **decline in yields** following conversion to organic farming.
- Many farmers have reverted to conventional farming after seeing their ZBNF (Zero-Budget Natural Farming) returns drop after a few years.

Unable to Boost Productivity and Income:

- While ZBNF has definitely helped preserve soil fertility**,** its role in boosting productivity and farmers' income isn't conclusive yet.

Lack of Availability of Natural Inputs:

- An often-cited barrier by farmers in transitioning to chemical-free agriculture is the lack of readily available natural inputs. Not every farmer has the time, patience, or labour to develop their own inputs.

Need of Natural Farming: Current Perspective

There is severe and widespread nutrient deficiency (C, N, P and K) in the soils of India as opposed to the known significant growth in consumption of chemical fertilizer (83% growth in the last two decades). To this end, over 5.27 crore soil samples were analysed across 24 states and UTs. The findings reveal a gloomy picture of the soil health status in the country. Around 2.7% of the net sown area (3.8 m ha) in the country is only covered under organic and natural farming despite implementation of different programs and policy initiatives. Out of this, 0.41 m ha is only covered under natural farming. The reason for this half-hearted effort is often a lack of conviction among policy makers. The key issue that typically needs attention is how to ensure a smooth/effective transition and provide viable market access for natural produce. This needs an effective strategy with a sound implementation plan and adequate funds to support it.

Evidence from collected data (2004-2020) from the All India-network project on organic farming (AI-NPOF) indicate that there are three major approaches (i.e., organic approach, integrated approach, and inorganic approaches) with six different methods (organic method, organic innovative method, integrated method (with 75% organic and 25% inorganic), integrated method (each 50% organic and inorganic), inorganic method, state recommended) were used to evaluate 74 cropping systems from 19 centers. This includes 31 crops under study from five major food groups. The key findings are: (1) Yields usually improve over time with organic inputs and bio-inputs (although yields may reduce during the transition phase), (2) Some crops may take more years than others to attain higher or comparable yields - wheat, maize, rice, cluster bean, sesame, cumin, and psyllium husk.

It is critical that the evidence is consolidated and is recognized and accepted by the larger scientific community, so that it can play a big role in increasing awareness, building capacity and influencing policymakers. It is also important for us to consider and collectively assess holistic evidence on the economic and environmental benefits that can be consolidated with organic and natural farming, instead of just focusing purely on crop yields. There is a need to develop a roadmap that sets the long-term agenda for adoption of agro-ecological approaches across different parts of the country. Similarly, there is a need to specifically focus on supporting farmers during the transition to organic and natural farming through technical and financial support. Existing farmer subsidies and related policies should be reoriented to

the promotion of organic fertilizers and bio-fertilizers instead of synthetic chemical fertilizers.

There is a conflict between incremental innovation (Green Revolution) and radical innovation (Natural Farming). We are in a typical Lewis Trap (Dorin *et al* 2013): 53 % of the world population have many farmers with micro farms. Data from 1961 to 2013 showed that, the lower the land holding, the higher the land productivity. In the 100% natural farming scenario, productivity is slightly lower compared to 100% industrial system scenario. India has a strong comparative advantage in producing food in symbiosis with nature, market values, investments and jobs concentrated upstream to provide a diversity of quality products, as well as services such as water filtering, soil carbon sequestration, or resilience to biotic and abiotic shocks.

The "24 organic" mantra – it is a farm to fork company with about 34,000 farmers based across 12 states in India. They buy-back from 550 cities and export to nearly 40 countries in the world. The broad consumption trends in the country indicate - shrinking bottom level, growing middle class, growing women participation; and behavioural changes creating favourable environments to experiment – market demand moving from loose to packed, healthier products etc. Gaps exist in production of cereal crops such as millets and their consumption. Consumers are ideally looking for value, transparency, and trust. The typical consumer will ask "What is in the produce/product for me with ecological concerns being of secondary importance.

Pioneers of Natural farming in Modern India

There is also a broad tradition of 'natural farming', propounded by advocates such as

- Shri Narayana Reddy (in Karnataka),
- Shri Shripad Dabholkar (Maharashtra),
- Shri G Nammalvar (Tamil Nadu),
- Shri Deepak Suchde (Madhya Pradesh) and
- Shri Bhaskar Save (popularly referred to as the 'Gandhi of Natural Farming', working in Gujarat).

Natural Farming based on 'Zero-Budget' input cost, is a system developed in the 1980s by Shri Subhash Palekar and number of its variants are available in ancient Indian Literature and Vedi agriculture. Farmers practice different kinds of local methods & inputs in natural

farming and it is very difficult to codify them but they all can be grouped under generic name "Natural Farming".

Natural Farming- Revival in modern India

- Natural farming in the country is being propounded by Governor of Himachal Pradesh Shri Acharya Devvrat, who is presently the Governor of Gujarat. His efforts in natural farming has been intensive to take it to Panchayats and villages of the state in past five years.
- Evolution of ZBNF as a grassroots social movement and evolving into a major policy initiative in Andhra Pradesh.

Himachal Pradesh under Prakritik Kheti Khushal Kisan Yojna started Natural Farming under the nomenclature Subhash Palekar Natural Farming (SPNF) in 2018 and now it is implemented at large scale.

Honorable Prime Minister's vision for promotion of Natural Farming

- National Conclave on Natural Farming held at Anand, Gujarat on December 16, 2021, Hon,ble Prime Minister Shri Narendra Modi remarked that "we need not only to re-learn this ancient knowledge of agriculture but also to sharpen it for modern times.
- The Prime Minister said that those who will benefit the most from natural farming, constitute about 80% of the farmers of the country.
- He said that local bodies played a concerted role in selecting 75 farmers from every panchayat and hand-holded them with training and other resources.
- In the 2022 budget speech, Finance Minister Nirmala Sitharaman announced that "chemical-free natural farming will be promoted throughout the country, with a focus on farmers‘ lands in 5-km wide corridors along river Ganga, at the first stage". Nearly 2.7% of the total area under farming in India, is farmed organically or through natural methods, which means using natural processes and inputs to improve the health of soil, crop yield and quality, a move away from commonly used chemical fertilizers and pesticides.

Future of Natural Farming (NF)

- Given the current varied context and scope of natural farming in India, it was indeed found prudent to define the concept of natural farming/regenerative agriculture as there are multiple forms [i.e., organic farming, zero-budget natural farming (ZBNF),

community managed natural farming (CMNF), agro-ecology etc.] of it is used in different parts of India.

- Not only farmers but also the scientific community are confused with different practices or principles that are being used under diverse forms of natural farming. Consequently, it was observed that, there are universally accepted and/or, prescribed and approved guidelines of RA available in the Indian context.
- India achieved food self-sufficiency in the early 1990s following the adoption of the Green Revolution, but affordable food and nutritional security became a key challenge thereafter. Increased food production in the country is achieved by intensive use of NPK fertilizers with an annual growth rate of 8%.
- Consequently, NPK usage increased from 1.4 kg per capita from 1961-70 to 15.6 kg per capita from 2011-2021. However, Nitrogen-Use-Efficiency (NUE) in the country has substantially reduced from 53 to 33% during the last four decades.
- Similarly, the availability of Soil Organic Carbon (SOC) has declined significantly for diverse soil types. These indicators are the major concerns for sustainable food production in the country. Intensive application of synthetic fertilizers is not the culprit for the declined soil health (SH) and reduction of other natural resources, but an imbalance use of farm inputs aimed at improving soil fertility and plant nutrition along with ignorance about conservation of native biodiversity species are the major threats to sustainable farming systems. The selection for crop genotypes which can only produce high yields under intense agriculture has also locked these components into the current farming system. Declining health of natural resources (i.e., soil, water, air and biodiversity) is fueling a decline in mean productivity levels among major staple crops (e.g., wheat productivity CAGR has declined from 3.1 to 1.6% between 1961-1990 and 1991-2020) (see Fig 2). It has become imperative now to move towards natural farming methods to recover what we lost in natural resource and soil health.

National Mission on Natural Farming

To motivate farmers to adopt chemical free farming and enhance the reach of natural farming, the Government has formulated National Mission on Natural Farming (NMNF) as a separate and independent scheme from 2023-24 by up scaling the Bhartiya Prakritik Krishi Paddati (BPKP). The success of NMNF will require behavioral change in farmers to shift

from chemical based inputs to cow based locally produced inputs and thus requires continuous creation of awareness, training, handholding and capacity building of farmers in the initial years. The provision of Rs 459.00 crores for 2023-24 has been proposed after careful consideration and the requirement of increase of budget is not anticipated at this stage.

Plan needed

- Diversification of local farming systems (FS) is required for promoting soil health and mitigating GHG emissions.
- There is a need to develop NF best practices for each agroecology in the country.
- There is a need for a significant policy swift to support NF which produces more nutritious crops such as pulses, oilseeds, and coarse cereals.
- An incentive system needs to be developed to offset the losses of yield/income during the initial years of implementation of NF.
- NF needs scientific evidence, so we need to co-create scientific outputs and validate them at the landscape level.
- There is a need to develop a national and state-level institutional framework for the implementation of NF.
- Policies need to be changed significantly to promote local input use and not to promote their overuse.

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COIR PITH COMPOST: ITS IMPACT IN SOIL FERTILITY

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Introduction

The coconuts contribute nutritional security, food security, poverty alleviation, employment security and social security in the major coconut growing countries. The kernel and husk is separated from once harvested the whole coconut, whether the kernel is used either directly as food or processed further into food products or oil. The endosperm of coconut is used for human consumption, and hence the raw materials and other value added products is obtained from the coconut. The inorganic fertilizers can be replaced by the application of coconut by-products, like coir pith compost. The coir pith is decomposed as very slow because of highly content of lignin (28.25%) is present, and hence it is used as raw organic manures for the crop. Coir pith is defined as an agro-waste produced during coir fibre extraction, constituting about 70% of coconut husk.

Advantages

- In the drought season, it can be act as mulching material for young plantations and conserves the soil moisture.
- The coir pith retained high moisture capacity of about 500-600% and high cation exchange capacity (CEC).

- It contains large amounts of nitrogen and the high content of exchangeable K, Na, Ca and Mg.
- The application of Coir pith compost is used to increased the soil native micro flora.
- It influenced a reduction in bulk density and improved the water holding capacity and organic carbon status of the soil.
- Composted coir pith and it can also provide a supplemental effect with inorganic fertilizers.
- The coir pith compost is preferred as a rooting medium and consider as a better alternate for soil medium.
- The higher quantity of potassium is present in the coir pith.
- The optimum C: N ratio of organic amendments is attributed which resulted in faster disintegration and release of nutrients in the soil.

Nutritive Value of Composted Coir Pith

S.No.	Parameters	Raw composted coir pith (%)	Composted coir pith(%)
1.	Lignin	30.00	4.80
	Cellulose	26.52	10.10
	Carbon	26.00	24.00
	Nitrogen	0.26	1.24
	Phosphorus	0.01	0.06
	Potassium	0.78	1.20
	Calcium	0.40	0.50
	Magnesium	0.36	0.48
	Iron(ppm)	0.07	0.09
	Manganese(ppm)	12.50	25.00
	Zinc(ppm)	7.50	15.80
	Copper(ppm)	3.10	6.20
	C:N ratio	112.1	24:1

Source: TNAU Agritech Portal

- Coir pith is now accepted as soil conditioner which is highly used in acid soils especially in hilly areas.

Fig.1. Coir pith- a raw material from coir industry

Coir Fibre Extraction

- The traditional method of coir fiber extraction from the coconut husk is retting, a laborious and time consuming process.
- However, this natural retting process yields fiber, which is strong and has a golden colour. This is due to the leaching out of deleterious matter by the constant tidal action.
- Defibering of husk is carried out traditionally by soaking in backwaters, which require 10-12 months.
- Novel development using biotechnological approach with selected strains of microbial cultures viz., 'Coirret' developed by Central Coir Research Institute (Coir Board) has reduced the period of retting from 11 months to 3 months.
- The coir fibre can be extracted through MFEM (Mobile Fibre Extraction Machine) developed by the Coir Board that could be taken to the remote villages so that unutilized husks from such areas could be tapped and fibre could be made available to the coir industry.
- The greatest disadvantage of the mechanically extracted fibre is its inconsistent colour and harsh texture.
- The environmental pollution and occupational health hazard from traditional husk retting for coir extraction have been a serious concern not only to general public but also to labours involved in the retting work.

Quality Improvement of Coir Fibre

- A successful cleaner, faster and eco friendly technology of bleaching and softening of coir using "Biochem" has been developed by Coir Board through its Central Coir Research Institute.
- Biochem is a consortium of phenol degrading bacteria grown in softer media (Tamarind extract & Auxisoftener) and the treatment of coir fibre with selected strains of bacterial cultures in Biochem solution yielded a fibre exhibiting a higher degree of light fastness and a softer.
- It is a zero effluent process and cost effective.

Fig.2. Preparation of composted coir pith compost

Applications of coir pith compost

- The recommended dose of coir pith compost is 5t/ha.
- It is advised that composted coir pith compost should be applied basally before taking up of new crop.
- For nursery development in poly bags and in mud pot 20% composted coir pith can be mixed with soil and sand.

- For the application in established trees like coconut, mango and banana and other tree crops minimum 5kg/plant is required.

Limitations in using composted coir pith

- It is not economical to buy the composted coir pith for a farm. It is advisable to prepare of its own.
- Application of fully composted coir pith is required, if it applied immature decomposition process will be late and affects the standing crop for the requirement of nutrients.

Conclusion

Coir pith compost acts as a rich growth medium for both agricultural and horticultural crops. It contains narrow C:N ratio and lesser lignin and cellulose that makes them highly suitable manure. Due to their less bulkiness and high supplying capacity of nutrients in available form this compost may be inevitable carbon source in future in sustainable agriculture for farmers.

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ECOFRIENDLY MANAGEMENT OF CITRUS TRISTEZA VIRUS BY PRE-IMMUNIZATION TECHNIQUE

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Introduction

Tristeza viral infection occurs in almost all citrus-growing areas of the world. It affects practically all kinds of citrus plants but primarily orange, grapefruit, and lime. Severe strains of the tristeza virus can cause severe losses of fruit quantity and quality and result in either a chronic or a quick decline and eventual death of infected trees. Citrus tristeza virus is transmitted by budding or grafting and also by several species of aphids in a semipersistent manner, among them *Toxoptera citricida* (aphid) is the important vector. In Tamil Nadu, the Citrus tristeza virus (CTV) is reported to be serious in acid lime gardens. Acid lime leaves show a large number of vein flecks (elongated translucent area). Fine pitting of the inner face of bark is the characteristic symptom coupled with root decay, twigs dying back, diminishing of fruit set, and finally resulting in complete shedding of the tree and resulting in the skeleton-like appearance of the tree. Trees become stunted and die very quickly. Fruits become smaller in size with reduced yield. Grapefruit and acid lime are highly susceptible to this malady irrespective of rootstock. In this virus, the occurrence of both mild and severe strains has been reported. So, it is possible to inoculate the mild strain to the young acid lime seedlings to confer protection against the severe virulent strain.

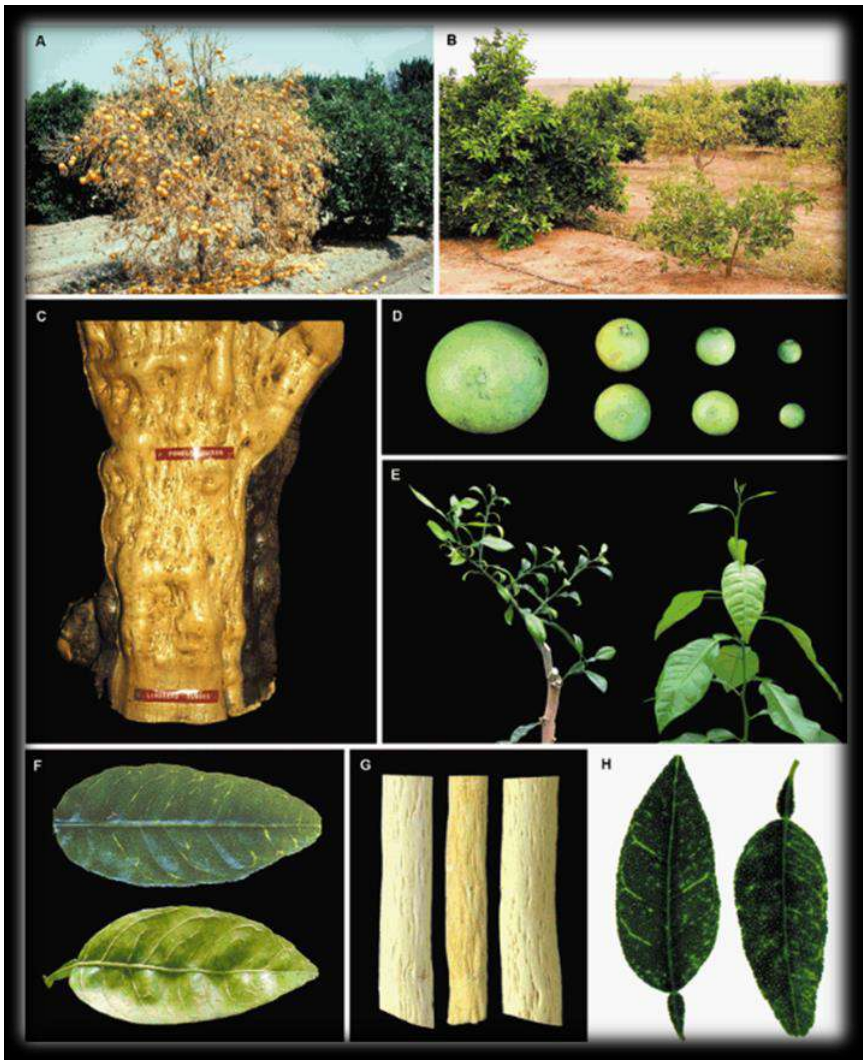
Symptoms of severe strain

The severe strain-infected acid lime trees do not show seasonal new flush formation or normal growth. The leaves show chlorosis along the main and lateral veins with several vein flecks. Defoliation occurs from tip to downwards and exhibits die-back symptoms and the twigs remain barren. Sudden death occurs within a few months after infection. Some trees may

produce sparse foliage and a few smaller fruits of inferior quality. The severe strain also produces stem pitting symptoms. This is characterized by small, long depressions or grooves in the wood of the branches and trunk.

Symptoms of a mild strain

The mild strain of infected acid lime shows only a few flecks appear on the leaves. On stem, development of only less number of pits that are smaller in size. The affected trees survive for more than 30 years with chlorotic leaves, but their productivity is considerably reduced. These trees can be exploited as a source of mild strains.



Citrus tristeza virus-infected plant - Symptoms of severe strain

A. Twigs die back, B. Fruit set diminishes, C.Tree stunted D.Fruit set diminishes

E. leaf size reduced, F.vein flecks, G. Stem pitting

Black citrus aphid -*Toxopteracitricida*

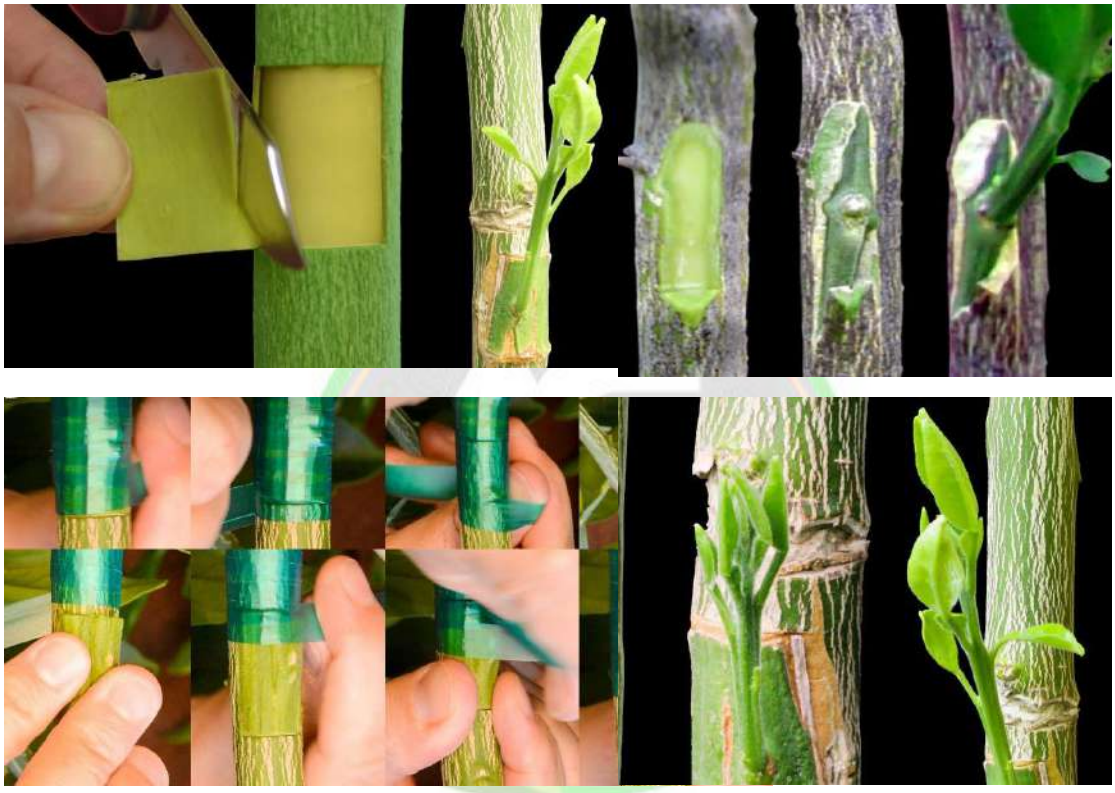
Cross-protection or Pre-immunization technique

Cross-protection or pre-immunization is a phenomenon in which plant tissues infected with one strain (mild or avirulent) of the pathogen are protected from infection by other strains (severe) of the related species of pathogen. It is one of the biological properties of the viruses used to establish relationships among viruses and their strains. However, this has been reported in bacterial and fungal diseases also. Inoculation of plants with certain pathogens often leads to temporary or nearly permanent "immunization" of the plants, i.e., induced plant resistance to a pathogen to which the plants are normally susceptible. Some of these treatments involve only viruses and are known as cross-protection. Its application in controlling virus diseases has met with some success *viz*., in citrus with mild strains of citrus tristeza virus (CTV), cross-protecting tomatoes with mild strains of tobacco mosaic virus (TMV), papaya with mild strains of papaya ring spot virus, apple with mild strains of apple mosaic virus, cocoa with mild strains of cocoa swollen shoot virus, chilies with mild strains of tobacco mosaic virus and mild strains of cucumber mosaic virus and soybean with soybean mosaic virus.

Pre-immunization technique by patch budding

Acid lime seedlings are pre-immunized with mild strains of citrus tristeza virus by patch budding to protect the trees from severe virulent strains. The methodology for the same is as follows: mild isolates are to be selected by choosing the symptomless trees in declining orchards and the strain severity is to be evaluated by vector transmission. Mild strains are to be inoculated by selecting 4 to 5-month-old vigorously growing acid lime seedlings for grafting. The scion materials (rectangular bark pieces of 5 x 2 mm size) are to be collected from the trees with mild

strain virus. The collected scions are to be stored in a cool box to prevent desiccation. The scions are then grafted on the seedlings within 36 hours after collection. Acid lime seedlings can be cross-protected by removing a bark piece of 5 x 2 mm size and then inserting a bark piece of the same size collected from a mild strain infected tree. This patched portion has to be covered with a polythene strip. The grafted seedlings are kept undisturbed and need to be watered at regular intervals for 15 days and observed for union.



Pre-immunization technique by patch budding

If the union remains green it indicates the successful establishment of the grafting. This observation confirms the entry of a mild strain of the virus into the plant system. Such seedlings confer appreciable resistance against a virulent strain. The resistance due to pre-immunization may be because the mild strain occupies the whole plant system and prevents subsequent infection by the severe strain.

Mechanism of cross-protection

The various mechanisms, which give cross-protection to plants include

- ❖ Utilization of essential metabolites required by the second virus by the mild strain.
- ❖ Production of protective substances similar to antibodies in animals.

❖ Virus-specific multiplication sites in the cells are limited. If all the sites are occupied by the first virus for its multiplication, the later virus cannot have a multiplication site.

❖ Aggregates of virus in cells already infected with a virus have specific adsorptive properties. An incoming related strain of a virus becomes absorbed in one of the aggregates already present.

Advantages

In the absence of resistant varieties, adoption of this cross-protection technique is fairly an accepted method, because the cross-protected plants give reasonably higher yields without affecting the quality of produce.

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SOIL MICROBIOME: A NATURAL HUB FOR PLANT GROWTH EXPLOITATION

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Introduction

Soil is a natural reservoir for different types of microbes like pathogenic, beneficial microorganisms and the overall microbial diversity in a wide range of organisms and ecosystems. On an average 10 million microbes are present in per gram of soil with thousands of different species. The different microbial communities present in the soil system are bacteria, archaea, fungi, algae and viruses. These microbes are present both in the rhizosphere and non-rhizosphere regions of soil. Their percentage in the soil environment vary depending upon the surrounding habitat, nutrients needed for the growth and development of microbes, interaction with microbial partners. Any disturbance in the natural soil environment play a major role in disturbing soil microbiome.

Soil health play a important role in plants to produce the food for growing human population. As we know that natural resources are limited and with the use of excessive fertilizers and pesticides for meeting the global food requirements are not sustainable. These practices with high resource use and minimum crop diversity, alter the phytobiome (Matson et al., 1997). Better growth of above ground plant diversity supports the growth of micro diversity by releasing root exudates like simple carbohydrates upon which bacteria depends for their nutrition (Morella et al., 2020). The microbial composition is more abundant and complex in the rhizosphere, up to 10^9 cells per gram in typical rhizosphere soil (Lakshmanan et al., 2017). The microbes are the store house of bioactive compounds. These produce different primary and

secondary metabolites in early growth phase (primary metabolites) and late growth phase (secondary metabolites). Primary metabolites like amino acids, nucleotides, and fermentation end products such as ethanol and organic acids are considered essential for proper growth of microorganisms whereas secondary metabolites have unusual structures and their production arises from intracellular intermediates (amino acids, sugars, fatty acids, etc.), which are condensed into more complex structures by defined biochemical pathways. They are not essential for the growth of the producing cultures, but serve diverse survival functions in nature.

Microbes play multiple role in the soil ecosystem

Phosphate solubilization

Phosphate solubilizing microorganisms (PSMs) are group of beneficial microorganisms capable of hydrolyzing organic and inorganic phosphorus compounds from insoluble compounds. Among these PSMs, strains from bacterial genera (*Bacillus*, *Pseudomonas* and *Rhizobium*), fungal genera (*Penicillium* and *Aspergillus*), actinomycetes, and arbuscular mycorrhizal (AM) are notable frequently present in the soil, as soil is the natural media for different group of microorganisms. Sharma et al., 2021 reported that plant growth promoting *Pseudomonas aeruginosa* An-15-Mg showed maximum phosphate solubilisation of 46mm in plate assay method. Also reported maximum increase in NPK content of soil after consortial bioformulation (two *Pseudomonas aeruginosa* An-14-Mg and An-15-Mg) application in apple plants.

Iron chelation

Iron (Fe) is an essential plant nutrient required in a trace quantity, which is responsible for various metabolic processes like photosynthesis, cell wall metabolism, and respiratory electron transport chain and also provides protection to the plants against various oxidative stress (Dey et al., 2019). Siderophores are iron chelating molecules that bacteria release into the environment to bind iron. Many microbes have developed strategies to increase iron bioavailability.

Nitrogen fixation

Nitrogen-fixing bacteria are known to form symbiotic associations with some members of all major groups of plants, as well as with some fungi. Although there are numerous reports of nitrogen-fixing bacteria occurring in animals, for example termite guts, the significance to their hosts remains to be proven. In global terms, nodulated plants (both legume and actinorhizal) fix

most nitrogen, but many of the other symbioses are very important within their own ecosystems. All non-nodulated nitrogen-fixing symbioses have cyanobacteria as their endosymbiont.

Plant Growth Regulators

Soils are natural hub for diverse group of microorganisms including fungi, bacteria, actinomycetes and plants (Mendes et al., 2013). Plant roots are heavily colonized with microorganisms (compared to soil and other habitats) because of the rich nutrient component of root exudates (Hashem et al., 2016). The rhizosphere is a relatively nutrient-rich environment containing amino acids, sugars, fatty acids and other organic compounds, which attract microbes (Vorholt, 2012) that utilize the various nutrients released by the root. In turn, the microbes synthesize biologically active compounds, including phytohormones (auxins, cytokinins, gibberellins, and ABA), antifungal compounds, enzymes, and compatible solutes. These microbial metabolites play a vital role in plant growth, nutrition and development (Ruiz-Lozano et al., 2012; Sorty et al., 2016; Egamberdieva et al., 2017a). They can stimulate plant growth development, provide resistance to various environmental abiotic and biotic stress factors, improve nutrient acquisition and protect plants from various soil-borne pathogens (Grover et al., 2013; Cho et al., 2015). The beneficial interactions of microbes in plants, their positive effect on plant growth and their improvement of stress tolerance under extreme environmental conditions have been extensively reviewed by Nadeem et al. (2014), and the mechanisms utilized by plant growth-promoting bacteria have been reviewed by Forni et al. (2017).

Antibiosis

The antagonistic microorganisms capable of producing volatile compounds with potential inhibitory activity against plant pathogens are more likely to prevent pathogenic fungi from infecting plants, kill surviving spores in the soil, and limit both the production and the establishment of the disease. The soil bacteria associated with plant roots are potential agents for biological control of soilborne plant pathogens and for promoting plant growth. *Paenibacillus jamilae* HS-26 secreted volatile organic compound, N, N-diethyl-1, 4-phenylenediamine which showed to inhibit the radial growth of plant pathogens *F. oxysporum, B. sorokiniana,* and *R. solani* in adual plate confrontation assay (Schwyn and Neilands, 1987). Illumina MiSeq sequencing data showed a significant reduction in soil borne pathogens and increase in beneficial bacteria in the wheat rhizosphere after treatment with *Paenibacillus jamilae* HS-26 (Wang et al., 2019).

Conclusion

Soil microbiome consists of different types of microbes which directly and indirectly help in growth promotion of plants. These microbes transforms the soil nutrients into available forms by different mechanisms which are easily assessable to plant roots. Therefore the exploitation of these beneficial soil microbes as bio formulations is an eco-friendly, alternative for sustainable environmental practices.

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GEOGRAPHICAL INDICATION (GI) TAGS IN INDIA

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Introduction

"Geographical Indication", in relation to goods, means an indication which includes agricultural, natural or manufactured goods or any goods of handicraft/ industry and includes foodstuff as originating, or manufactured in the territory of a country, or a region or locality in that territory, where a given quality, reputation or other characteristic of such goods is essentially attributable to its geographical origin (GOI, 1999).

What are Geographical Indications (GI) Tags?

Geographical indication (GI) is a sign given to products that have a specific geographical origin and possess qualities that are due to the origin. It helps in identifying the product's source, as part of certification that the product possesses certain qualities and are made according to traditional methods or to its geographical origin. Geographical Indication (GI) can be used for any type of product manufactured, agricultural, food, or even handicrafts. A geographical indication right enables those who have the right to use the indication to prevent its use by a third party whose product does not confirm to the applicable standards.

Law governing GI in India

In the past years, India was not having any registration and protection system of GI for its unique goods. TRIPS agreement provides general protection of GI for member countries and special protection for wines and spirits. India, being a member of WTO and a signatory of TRIPS Agreement, enacted The Geographical Indications of Goods (Registration and Protection)

Act, 1999 and GI Rules, 2002 to put in place the national IP laws in compliance to TRIPS. Thus, India has put in place a *sui generis* system of protection for GI with enactment of a law exclusively dealing with protection of GI. This Act seeks to provide for the registration and better protection of geographical indications relating to goods in India The Act is administered by the Controller General of Patents, Designs and Trade Marks, who is the Registrar of Geographical Indications. The Geographical Indications Registry is located at Chennai.

In respect of geographical indications, Members shall provide the legal means to prevent:

(a) unauthorized use by which it misleads the public as the geographical origin of the good

(b) any use which constitutes an act of unfair competition within the meaning of Article 10b of the Paris Convention (1967).

(c) Additional protection for Geographical Indications

The objectives of the Act are to specify law that protects the interest of producers of such goods and to exclude unauthorized persons from misusing geographical indications. It also promotes goods bearing Indian geographical indications in the export market.

Classification of goods– Name of the classes

The produces or goods can be classified into different class based on its type. There are around 34 class of items which can be classified. Generally, food items are classified under class 29 and 30, whereas agricultural and horticultural products are classified under class 31.

Class 31: Agricultural, horticultural and forestry products and grains which are not included in other classes; live animals; fresh fruits and vegetables; seeds, natural plants and flowers; foodstuffs for animals, malt.

Non registrable GI

The following cannot be registered as GI in India:

- Products which would cause confusions or can be deceived
- The use of which are contrary to any law or contain scandalous or obscene matter
- Contain any matter likely to hurt the religious susceptibilities of class or section of the citizens of India
- Which would otherwise be dis-entitled for protection in a court
- Which are determined to be generic names and therefore not or ceased to be protected in their country of origin, or which have fallen into disuse in that country

- Which although literally true as to the territory, region or locality in which the good originate, but falsely represent to the persons that the goods originate in another territory region or locality

Darjeeling Tea

Madurai Malli

Kashmir Saffron

Chokuwa Rice of Assam

Tirur Betel Leaf

Vazhakulam Pineapple

Pokkali Rice

Navara Rice

Palakkadan Matta Rice

Chengalikodan Nendran Banana

Kuttiattoor Mango

Edayur Chilli

Kaipad Rice

Wayanad Robusta Coffee

Wayanad Gandhakasala Rice

Wayanad Jeerakasala Rice

Kodungallur Pottuvellari

Alleppey Green Cardamom

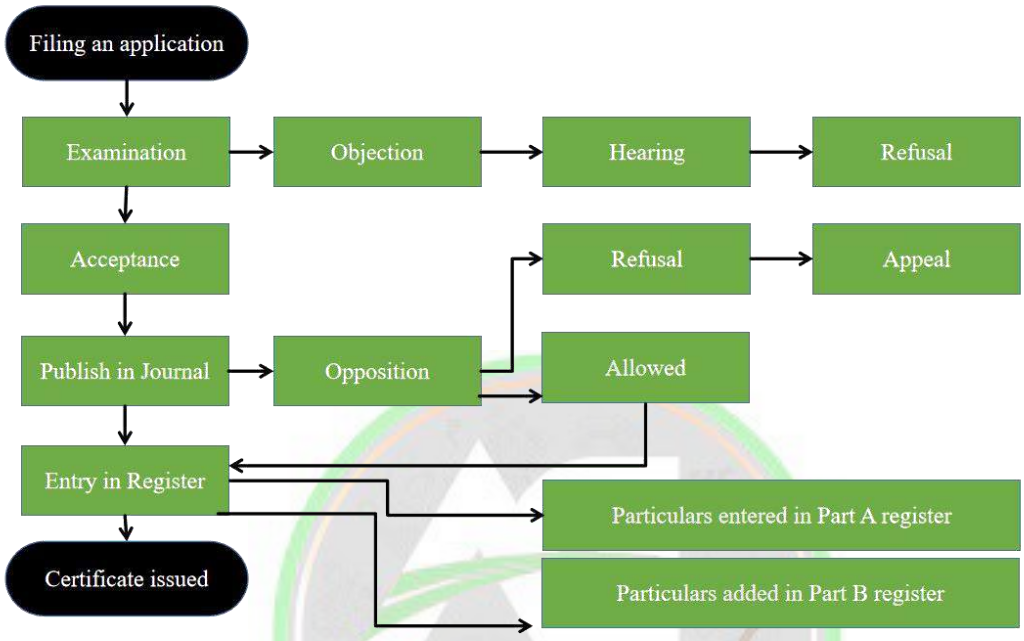
GI registration process

STEP 1: Filing of application

The association of persons or producers or any organization or authority should file a written statement on how the applicant claims to represent their produce.

- Application must be made in triplicate
- The application shall be signed by the applicant or his agent and must be accompanied by a statement of case

- Details of the special characteristics and how the standards are maintained
- Three certified copies of the map of the region to which the GI relates
- Details of the inspection structure to regulate the use of the GI in the territory



Source: https://ipindia.gov.in/the-registration-process-gi.htm

All the details of the applicant together with address should be provided. If there is a large number of producers a collective reference to all the producers of the goods may be made in the application and registered GI will be indicated accordingly in the register. The applicant must have an address for service in India. Generally, application can be filed by a legal practitioner or a registered agent

Applications can be sent to the following address:

Geographical Indications Registry,

Intellectual Property Office Building

Industrial Estate, G.S.T Road

Guindy, Chennai – 600 032

Phone: 044 – 22502091-93 & 98

Fax: 044 – 22502090

E-mail: gir-ipo@nic.in

Website: https://ipindia.gov.in/index.htm

STEP 2: Preliminary scrutiny and examination

- The Examiner will scrutinize the application for any corrections
- The applicant should submit missing documents or make these corrections within one month of the communication
- The content is assessed by a consultative group of experts who are versed on the subject and will ascertain the correctness of particulars furnished. Thereafter an examination report would be issued.

STEP 3: Show cause notice

- If the registrar has any objection to the application, he will communicate such objection and the applicant must respond within two months. If the applicant wishes to appeal, he may make a request within a month
- The registrar can also withdraw an application, if it is accepted in error, after hearing.

STEP 5: Publication in the geographical indications journal

Every application shall be published in the geographical indications journal within three months of acceptance.

STEP 6: Opposition to registration

Any person can file a notice of opposition of the GI application published in the journal within three months. The registrar shall serve a copy of the notice and within two months the applicant shall sent a copy of the counter statement, if not, the application is abandoned. Both sides will lead their respective evidences by way of affidavit and supporting documents.

STEP 7: Registration

When an application for a GI has been accepted, the registrar shall register the geographical indication. If registered, the date of filing of the application shall be considered to be the date of registration. The registrar shall issue to the applicant a certificate with the seal of the geographical indication registry.

STEP 8: Renewal

A registered GI shall be valid for 10 years and can be renewed for 10 years on regular basis on payment of renewal fee.

STEP 9: Additional protection to notified goods

Additional protection for notified goods is provided in the Act

STEP 10: Appeal

Any person aggrieved by an order or decision may prefer an appeal to the Intellectual Property Appellate Board (IPAB) within three months. The address of the IPAB is as follows:

Intellectual Property Appellate Board

Annexe 1, 2nd Floor, Guna Complex,

443, Anna Salai, Chennai – 600 018

Importance of Geographical Indications

- It confers legal protection to geographical indications in India
- Prevents unauthorized use of a registered geographical indication by others
- It provides legal protection to Indian geographical indications which in turn boost exports
- It promotes economic prosperity of producers of goods produced in a geographical territory

List of Geographical Indications (GI) Tags in India related to Agriculture

S.No	Name of GI Tag	State	Year
1	Darjeeling Tea (word & logo)	West Bengal	2004-05
2	Kangra Tea	Himachal Pradesh	2005-06
3	Coorg Orange	Karnataka	2005-06
4	Mysore Betel leaf	Karnataka	2005-06
5	Nanjanagud Banana	Karnataka	2006-07
6	Mysore Malligae	Karnataka	2006-07
7	Udupi Malligae	Karnataka	2007-08
8	Hadagali Malligae	Karnataka	2007-08
9	Malabar Pepper	Kerala, Karnataka & Tamilnadu	2007-08
10	Allahabad Surkha Guava	Uttar Pradesh	2007-08
11	Navara Rice	Kerala	2007-08
12	Palakkadan Matta Rice	Kerala	2007-08
13	Monsooned Malabar Arabica Coffee	Kerala	2007-08
14	Monsooned Malabar Robusta Coffee	Kerala	2007-08
15	Alleppey Green Cardamom	Kerala	2007-08
16	Coorg Green Cardamom	Karnataka	2007-08

17	Eathomozhy Tall Coconut	Tamil Nadu	2008-09
18	Malda Laxman Bhog Mango	West Bengal	2008-09
19	Malda Khirsapati (Himsagar) Mango	West Bengal	2008-09
20	Malda Fazli Mango	West Bengal	2008-09
21	Naga Mircha	Nagaland	2008-09
22	Nilgiri (Orthodox) Tea	Tamil Nadu	2008-09
23	Assam (Orthodox) Tea	Assam	2008-09
24	Virupakshi Hill Banana	Tamil Nadu	2008-09
25	Sirumalai Hill Banana	Tamil Nadu	2008-09
26	Pokkali Rice	Kerala	2008-09
27	Mango Malihabadi Dusseheri	Uttar Pradesh	2009-10
28	Devanahalli Pomello	Karnataka	2009-10
29	Appemidi Mango	Karnataka	2009-10
30	Kamalapur Red Banana	Karnataka	2009-10
31	Vazhakulam Pineapple	Kerala	2009-10
32	Guntur Sannam Chilli	Andhra Pradesh	2010-11
33	Mahabaleshwar Strawberry	Maharashtra	2010-11
34	Nashik Grapes	Maharashtra	2010-11
35	Byadagi Chilli	Karnataka	2010-11
36	Central Travancore Jaggery	Kerala	2010-11
37	Wayanad Jeerakasala Rice	Kerala	2010-11
38	Wayanad Gandhakasala Rice	Kerala	2010-11
39	Gir Kesar Mango	Gujarat	2011-12
40	Bhalia Wheat	Gujarat	2011-12
41	Udupi Mattu Gulla Brinjal	Karnataka	2011-12
42	Ganjam Kewda Flower	Odisha	2011-12
43	Madurai Malli	Tamil Nadu	2012-13
44	Bangalore Blue Grapes	Karnataka	2012-13
45	Kalanamak Rice	Uttar Pradesh	2013-14
46	Kolhapur Jaggery	Maharashtra	2013-14

47	Nagpur Orange	Maharashtra & Madhya Pradesh	2013-14
48	Kaipad Rice	Kerala	2013-14
49	Chengalikodan Nendran Banana	Kerala	2014-15
50	Bangalore Rose Onion	Karnataka	2014-15
51	Naga Tree Tomato	Nagaland	2014-15
52	Arunachal Orange	Arunachal Pradesh	2014-15
53	Sikkim Large Cardamom	Sikkim	2014-15
54	Mizo Chilli	Mizoram	2014-15
55	Assam Karbi Anglong Ginger	Assam	2014-15
56	Tripura Queen Pineapple	Tripura	2014-15
57	Tezpur Litchi	Assam	2014-15
58	Khasi Mandarin	Meghalaya	2014-15
59	Kachai Lemon	Manipur	2014-15
60	Memong Narang	Meghalaya	2015-16
61	Basmati	India	2015-16
62	Ajara Ghansal Rice	Maharashtra	2015-16
63	Mangalwedha Jowar	Maharashtra	2015-16
64	Sindhudurg & Ratnagiri Kokum	Maharashtra	2015-16
65	Waghya Ghevada	Maharashtra	2015-16
66	Navapur Tur Dal	Maharashtra	2015-16
67	Vengurla Cashew	Maharashtra	2015-16
68	Lasalgaon Onion	Maharashtra	2015-16
69	Sangli Raisins	Maharashtra	2016-17
70	Beed Custard Apple	Maharashtra	2016-17
71	Jalna Sweet Orange	Maharashtra	2016-17
72	Uttarakhand Tejpat	Uttarakhand	2016-17
73	Waigaon Turmeric	Maharashtra	2016-17
74	Purandar Fig	Maharashtra	2016-17
75	Jalgaon Bharit Brinjal	Maharashtra	2016-17

76	Solapur Pomegranate	Maharashtra	2016-17
77	Bhiwapur Chilli	Maharashtra	2016-17
78	Ambemohar Rice	Maharashtra	2016-17
79	Dahanu Gholvad Chikoo	Maharashtra	2016-17
80	Jalgaon Banana	Maharashtra	2016-17
81	Marathwada Kesar Mango	Maharashtra	2016-17
82	Joha Rice of Assam	Assam	2016-17
83	Banaganapalle Mangoes	Telangana & Andhra Pradesh	2017-18
84	Gobindobhog Rice	West Bengal	2017-18
85	Tulapanji Rice	West Bengal	2017-18
86	Bhagalpuri Zardalu	Bihar	2017-18
87	Katarni Rice	Bihar	2017-18
88	Magahi Paan	Bihar	2017-18
89	Nilambur Teak	Kerala	2017-18
90	Wayanaad Robusta Coffee	Kerala	2018-19
91	Marayoor Jaggery	Kerala	2018-19
92	Boka Chaul	Assam	2018-19
93	Alphonso	Maharashtra	2018-19
94	Shahi Litchi of Bihar	Bihar	2018-19
95	Sangli Turmeric	Maharashtra	2018-19
96	Coorg Arabica Coffee	Karnataka	2018-19
97	Chikmagalur Arabica Coffee	Karnataka	2018-19
98	Araku Valley Arabica Coffee	Karnataka	2018-19
99	Bababudangiris Arabica Coffee	Karnataka	2018-19
100	Himachali Kala Zeera	Himachal Pradesh	2018-19
101	Sirsi Supari	Karnataka	2018-19
102	Erode Turmeric	Tamil Nadu	2018-19
103	Jeeraphool	Chhattisgarh	2018-19
104	Kandhamal Haladi	Odisha	2019-20

105	Kodaikanal Malai Poondu	Tamil Nadu	2019-20
106	Gulbarga Tur Dal	Karnataka	2019-20
107	Khola Chilli	Goa	2019-20
108	Kaji Nemu	Assam	2019-20
109	Chokuwa Rice of Assam	Assam	2019-20
110	Chak - Hao	Manipur & Nagaland	2019-20
111	Tirur Betel Leaf	Kerala	2019-20
112	Kashmir Saffron	Jammu & Kashmir	2020-21
113	Sojat Mehndi	Rajasthan	2021-22
114	Balaghat Chinnor	Madhya Pradesh	2021-22
115	Kuttiattoor Mango	Kerala	2021-22
116	Edayur Chilli	Kerala	2021-22
117	Harmal Chilli	Goa	2021-22
118	Munsyari Razma	Uttarakhand	2021-22
119	Myndoli Banana	Goa	2021-22
120	Kumaon Chyura Oil	Uttarakhand	2021-22
121	Rataul Mango	Uttar Pradesh	2021-22
122	Tamenglong Orange	Manipur	2021-22
123	Kanniyakumari Clove	Tamil Nadu	2021-22
124	Hathei Chilli	Manipur	2021-22
125	Naga Cucumber	Nagaland	2021-22
126	Mahoba Desawari Pan	Uttar Pradesh and Madhya Pradesh	2021-22
127	Mizo Ginger	Mizoram	2021-22
128	Dalle Khursani	Sikkim and West Bengal	2021-22
129	Mithila Makhana	Bihar	2022-23
130	Alibag White Onion	Maharashtra	2022-23
131	Tandur Redgram	Telangana	2022-23
132	Ladakh Raktsey Karpo Apricot	Ladakh (UT)	2022-23

133	Nagri Dubraj	Chhattisgarh	2022-23
134	Rewa Sunderja Mango	Madhya Pradesh	2022-23
135	Sharbati Gehu	Madhya Pradesh	2022-23
136	Adamchini Chawal	Uttar Pradesh	2022-23
137	Ramnathapuram Mundu Chilli	Tamil Nadu	2022-23
138	Vellore Spiny Brinjal	Tamil Nadu	2022-23
139	Pratapgarh Aonla	Uttar Pradesh	2022-23
140	Banaras Langda Aam	Uttar Pradesh	2022-23
141	Ramnagar Bhanta (Brinjal)	Uttar Pradesh	2022-23
142	Authoor Vetrilai	Tamil Nadu	2022-23
143	Banaras Pan (Betel Leaf)	Uttar Pradesh	2022-23
144	Cumbum Panneer Thratchai	Tamil Nadu	2022-23
145	Indi Limbe	Karnataka	2022-23
146	Sholavandan Vetrilai	Tamil Nadu	2022-23
147	Kari Ishad Mango	Karnataka	2022-23
148	Attappady Aattukombu Avara	Kerala	2022-23
149	Attappady Thuvara	Kerala	2022-23
150	Onattukara Ellu	Kerala	2022-23
151	Kanthalloor Vattavada Veluthulli	Kerala	2022-23
152	Kodungallur Pottuvellari	Kerala	2022-23
153	Ladakh Seabuckthorn	Ladakh (UT)	2023-24
154	Bhandara Chinoor Rice	Maharashtra	2023-24
155	Kanyakumari Matti Banana	Tamil Nadu	2023-24
156	Mushqbudji Rice	Jammu & Kashmir	2023-24
157	Agassaim Brinjal	Goa	2023-24
158	Sat Shiro Bheno	Goa	2023-24
159	Marcha Rice	Bihar	2023-24
160	Goa Mankurad Mango	Goa	2023-24
161	Bhaderwah Rajmash	Jammu & Kashmir	2023-24
162	Goa Cashew	Goa	2023-24

163	Khamti Rice	Arunachal Pradesh	2023-24
164	Uttarakhand Berinag Tea	Uttarakhand	2023-24
165	Uttarakhand Jhangora	Uttarakhand	2023-24
166	Uttarakhand Gahat	Uttarakhand	2023-24
167	Uttarakhand Lal Chawal	Uttarakhand	2023-24
168	Uttarakhand Kala Bhat	Uttarakhand	2023-24
169	Uttarakhand Malta Fruit	Uttarakhand	2023-24
170	Uttarakhand Chaulai	Uttarakhand	2023-24
171	Almora Lakhori Mirchi	Uttarakhand	2023-24
172	Uttarakhand Pahari Toor Dal	Uttarakhand	2023-24
173	Ramnagar Nainital Litchi	Uttarakhand	2023-24
174	Ramgarh Nainital Aadu	Uttarakhand	2023-24
175	Kalonunia Rice	West Bengal	2023-24
176	Kachchhi Kharek	Gujarat	2023-24
177	Ramban Anardana	Jammu and Kashmir	2023-24
178	Koraput Kalajeera Rice	Odisha	2023-24
179	Arunachal Pradesh Adi Kekir Ginger	Arunachal Pradesh	2023-24

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A COMPREHENSIVE EXPLORATION OF SMART FARMING SOLUTIONS THROUGH IOT INTEGRATION

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INTRODUCTION

Precision in agricultural inputs is becoming increasingly important for improving economic productivity, input use effectiveness, and environmental sustainability. As a result, Indian agriculture is transitioning from traditional to precision agriculture. The use of digital technologies is crucial to this transformation. The internet of things (IoT) technologies in agriculture have revolutionized farming practices, allowing farmers to monitor and manage their farms more efficiently [1, 2]. IoT generates huge data that requires fast data analysis, and such task can be completed through Artificial Intelligence (AI) algorithms with better efficiency and high quality of decision making. New logic and methods like machine learning, machine vision, artificial neural network, natural languages processing, etc., have improved the automation process in agriculture. Among these technologies, machine learning and artificial neural networks are the most widely used in research for automation of agriculture sector around the globe. Some examples include: an AI-powered drone to check the field, an IoT-designed automated crop watering system, sensors embedded in the field to monitor temperature, soil nutrients, moisture content and humidity, robotics etc.

The use of IoT in agriculture combines science and technology with farming to enhance overall production efficiency and challenges through,

- better sensing and monitoring of production, including farm resource use, crop development, animal behaviour and food processing.
- better understanding of the specific farming conditions, such as weather and environmental conditions, emergence of pests, weeds, and diseases.
- more sophisticated and remote control of farm, processing and organization operations by actuators and robots, e.g. precise application of pesticides and fertilizers, robots for automatic weeding.
- improving food quality monitoring and traceability by remotely controlling the location and conditions of shipments and products.
- increasing consumer awareness of sustainability and health issues by personalised nutrition, wearables, and domestics.

This technology knowledge report provides an overview of IoT in agriculture to get a better insight how it could contribute to the above-mentioned challenges.

Drone Technology in Agriculture

Unmanned aerial vehicles (UAVs), commonly referred to as drones, are one of the innovative technologies with potential agricultural applications. Drones are equipped with a navigation system, Global Positioning System (GPS), multiple sensors, high-quality cameras, programmable controllers, and autonomous drone tools. Drones are most used for land mapping, pesticide Nutrients, and fertilizers spraying, crop productivity evaluation, drone-based analytics, and sowing. Drones can also be equipped with devices or sensors for resource mapping, such as crop identification, crop area, assessing abiotic and biotic stresses, crop damage assessment, nutrient stress detection, and soil moisture content detection. Drone technology quickly restores traditional agrarian practices, and it has wide applications in agriculture .

Field Mapping and Irrigation Monitoring

Drone technology has appeared as a game-changer in the field of agriculture, offering numerous applications to enhance efficiency and productivity. In the context of Indian agriculture, one crucial application is Agricultural Field Mapping. Drones equipped with high-resolution cameras and advanced sensors are used for detailed mapping of agricultural land. This technology aids in precise land-use planning, identifying dominant crop types, assessing land degradation, and managing soil-physio-chemical properties. Additionally, the mapping provides valuable insights into terrain characteristics, aiding in agriculture planning and agro-ecological

zonation. By leveraging drones for Agricultural Field Mapping, farmers gain valuable information for effective decision-making and resource optimization.

Drones equipped with hyperspectral, thermal, or multispectral sensors detect areas that are too dry or require improvement by the farmer. Drone surveys help improve water efficiency and reveal potential pooling/leaks in irrigation by providing Irrigation monitoring yields calculations of the vegetation index to help realize crop health and emitted heat/energy.

Monitoring, Surveillance of Plant Health, and Fertilizer Spraying

It is critical to track the health of the vegetation and detect bacterial/fungal plagues early on. Agriculture drones can detect which plants reflect varying amounts of green and Near-infrared spectroscopy (NIRS) light. This information is used to generate multispectral images that track crop health. Rapid monitoring and detection of flaws can save crops. In the event of crop failure, the farmer can document the damages to make accurate insurance claims.

Drone technology is transforming traditional farming practices, particularly in the domain of fertilizer application. Drones equipped with specialized spraying mechanisms offer a precise and efficient alternative to traditional methods. In the Indian context, where precision agriculture is gaining prominence, drones play a crucial role in optimizing fertilizer usage. Farmers can benefit from targeted spraying based on data derived from soil moisture, nutrient deficiencies, and pest attacks. The technology helps reduce the overall use of fertilizers, minimizes environmental impact, and maximizes crop yield. Understanding the per-acre or per-hour cost of hiring a drone for fertilizer spraying becomes imperative for farmers to make informed decisions.

Automated Planting and Crop Damage Assessment

Drone technology extends its capabilities to the automated planting of seedlings or saplings, providing an innovative solution to labor-intensive tasks. Drones equipped with seeding mechanisms can cover large areas efficiently, ensuring uniformity in planting density. This application is particularly relevant in the Indian agricultural landscape, where large-scale plantations are common. Automated planting using drones enhances the speed and accuracy of the process, contributing to increased efficiency and reduced manual effort. Farmers can benefit from cost-effective and time-saving methods of crop establishment, further promoting sustainable farming practices. Drone startups in India have developed drone-planting systems that allow drones to shoot pods, seeds, and essential nutrients into the soil. This technology not only cuts costs by nearly 85%, but it also improves consistency and efficiency. Agricultural

spraying: Humans are less exposed to harmful chemicals using drone crop spraying. This task can be completed much quicker by agri-drones than by vehicles or planes. Drones equipped with RGB and multispectral sensors can pinpoint and treat problem areas. Professionals claim that aerial spraying with drones is five times faster than other methods.

Agricultural drones equipped with multispectral and RGB sensors detect field areas affected by weeds, infections, and pests. According to this data, the exact amounts of chemicals required to combat these infestations are known, which helps to reduce the farmer's costs.

Case : Locust Swarm :

It is common knowledge that locust swarms consume several kinds of plants, including trees and crops. In communities that primarily depend on these foods for survival, this feeding might destroy the crops grown, resulting in starvation and hardship. Locust swarms have recently invaded numerous regions of India, particularly Rajasthan. These expanding swarms are in danger of becoming an agricultural calamity, with approximately 90,000 Hectares of land in 20 regions affected. Many countries heavily rely on organophosphate insecticides for combatting locust swarms. These are applied by vehicle-mounted and aerial sprayers in small, concentrated amounts. Drones have been set up in Rajasthan to complete the spraying efficiently. Pesticides may be dispersed by drones across an area of about 2.5 acres in about 15 minutes. Drones can be a fast, safe, and practical method to combat locust swarms.

Field Soil Mapping and Fertility Analysis

The drone survey allows farmers to learn about soil properties. Multispectral sensors capture data valid for seed planting patterns, in-depth field soil analysis, irrigation, and nitrogen-level management. Precise Photogrammetry/ 3D mapping enables farmers to analyze their soil characteristics extensively.

The integration of drones into precision agriculture facilitates Soil Fertility and Field Analysis, offering farmers critical insights into their land. Drones equipped with advanced sensors and imaging technology can assess soil moisture, nutrient deficiencies, and overall soil health. In the Indian context, where diverse soil types are prevalent, this application aids farmers in making informed decisions regarding crop selection and suitable cultivation practices. Understanding the per-acre charges for spectral and other analyses becomes essential for farmers seeking such services, ensuring optimal utilization of resources and sustainable farming practices.

Bird Control and Livestock tracking

Drone technology serves as a versatile tool in addressing challenges related to bird control and human-animal conflict in Indian agriculture. Drones equipped with deterrent mechanisms, such as sound or light devices, can be deployed above the field to safeguard crops from bird damage. Additionally, drones provide real-time surveillance, helping farmers monitor and manage potential conflicts with wildlife. The timely intervention enabled by drones contributes to minimizing crop loss and fostering coexistence between agriculture and wildlife.

Drone surveys enable farmers to also track the movements of the cattle. Thermal sensor technology aids in the recovery of lost animals as well as the detection of injury or illness. Drones can perform this function effectively, contributing significantly to vegetation production.

Remote Sensing in Agriculture

Remote sensing is the acquisition of information about an object or phenomenon from distance. This involves an instrument, or a sensor mounted on a platform, such as a satellite, an aircraft, an UAV/UGV, or a probe. The sensor typically measures the electromagnetic sensors that is either reflected or emitted by the target. An IoT based remote sensing uses sensors placed in the different nodes of the farms where the required data is received by the sensors and transmitted to analytical tools for analysis. They are sensitive to anomalies. Sensors collect data on soil moisture levels, temperature, and other environmental factors, providing real-time information on crop health. Farmers can use this information to optimize farming practices for higher yields [3, 4].

Soil Temperature Sensor

Precise soil temperature measurement allows farmers to observe seasonal fluctuations, identify optimal conditions for crop growth, and adapt their techniques accordingly. By employing soil temperature sensors, farmers can continuously and instantly monitor ground temperature, facilitating the detection of subtle shifts and patterns. Whenever the sensor is used to measure the soil temperature, the wires or probe must be inserted into the soil. Depending upon the sensor type, the sensing temperature range varies. The operating range of LM35 sensor is -55 degree to 150 degree and this sensor is very expensive. There are also sensors that collect data in terms of humidity, moisture precipitation, and dew detection and help in determining the weather pattern in farms so that suitable cultivation is done at right time.

Humidity Sensor

This sensor senses, measures, and reports the relative humidity of air or the amount of water vapor in air. These are used in green house automation, hydroponics, optimising plant transpiration, monitoring terrariums and vertical farming environments.

Soil Moisture Sensor

The soil moisture sensor is a device that measures the current soil moisture. Sensors are integrated into irrigation systems in agriculture to help for more precise watering scheduling. Such tools help farmers to reduce or increase irrigation for optimal crop growth.

Weather Station Sensors

Self-contained units are placed in growing fields at various locations. These stations have sensors suitable for local crops and climate. They measure and record various information such as air and soil temperature, rainfall, leaf wetness, chlorophyll, wind speed, dew point temperature, wind direction, humidity, solar radiation, and atmospheric pressure. The data is sent wirelessly to a central data logger at specific intervals. Weather stations are becoming popular for farms of all sizes due to their portability and decreasing prices.

Robotics in Agriculture

Agriculture robots, also called Agribots, are gaining attention due to increasing demands and labor shortages worldwide. In the USA alone, crop production decreased by $3.1 billion annually because of labor shortages. Agrobots have become more notable with advancements in sensors and AI technology. We are still in the early stages of an ag-robotics revolution, with most products in early trial phases and R&D mode [3, 5].

Crop Weeding and Spraying

A multi-functional intelligent machine, A robot that uses vision systems: a colour-based vision system and one gray-level vision system for automatically removing weeds while also allowing for flexible rate irrigation is used in this modern agriculture. This system allows for the weed removal without harming the cultivated crops. Also, with this, one can control over spraying of pesticides and weed killers onto fields.

Machine Navigation

The farm tractors and heavy ploughing equipment can be operated automatically through GPS like Remote-controlled toy cars controlled with a controller. These machines are accurate and adjust themselves based on the terrain, making labor-intensive tasks easier. Their

movements and progress can be monitored on smartphones. These motors have features like automatic obstacle detection with advancements in IoT and machine learning.

Harvesting

The Agribots are utilised to pick the matured fruits and vegetables thereby solving the problem of labor shortage and reducing time consumption. A combination of image processing and robotic arms is used by these machines to determine the fruits to pick hence controlling the quality. Due to high operational costs, crops that have an early focus on agribot harvesting are orchard fruits like apples. Greenhouse harvesting also finds applications with these bots for high-value crops like tomatoes and strawberries. These bots can work in greenhouses to aptly determine the stage of crops and harvest them at the right time.

The agricultural sector is rapidly transforming into a crucial industry that heavily relies on advanced control systems to oversee the increasing complexity of agricultural systems. Every inch of farmland is vital to maximize crop production. Hence, the use of sustainable IoT-based sensors and communication technologies is necessary, and the future of the Indian agrarian community should unquestionably depend on IoT Technology. Hence, the farmers will require in-depth training or collaborations with outside professionals to comprehend the whole procedure. setting objectives, achieving a balance between the software and technology tools used, and understanding the basic principles of employing such technology.

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REMEDIATION TECHNIQUES IN HEAVY METAL CONTAMINATED SOIL AND IT'S STRATEGIES FOR

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Introduction:

Rapid industrialization and extraction of natural resources (soil, water and air) have resulted in huge scale environmental contamination and pollution.

What are Heavy Metals

Heavy metals are high-density metallic elements that can cause toxicity even at very low levels of contamination. Some heavy metals are an essential part of nutrition (Fe, Co, and Zn) or harmless (Ru and Ag); however, they can be harmful and toxic in excess amounts. On the other hand, some heavy metals are highly toxic even in small amounts, such as Cd, Cr, Hg, and Pb etc.

Agricultural sources of heavy metals

Sources	Heavy metal input	Heavy metal
Fertilizers	Phosphate fertilizers, Nitrate fertilizers Potash fertilizers ,Lime	Cr, Cd, Cu, Zn, Ni, Mn and Pb
Pesticides	Herbicide ,Insecticide Fungicide	Primarily Cu, Zn, Cd, Pb and As
Biosolids and manure	Livestock manures ,Compost, Sewage sludge, Fly ash	Zn, Cu, Ni, Pb, Cd, Cr, As and Hg
Waste water	Irrigation with municipal waste water Industrial waste water	Zn, Cu, Ni, Pb, Cd, Cr, As and Hg
Atmospheric deposition	Mining, metal smelting and refining, manufacturing processes, transport and waste incineration:	Primarily Ni, Cd, Pb, Cu, Zn, Hg and Cr

Types of Heavy metals and their effect on human health with their permissible limits

Pollutants	Major sources	Effect on human health	Permissible levels(mg/L)
As	Pesticides, fungicides, metal smelters	Bronchitis, dermatitis, poisoning	0.02
Cd	Welding, electroplating, pesticides, fertilizer	Renal dysfunction, lung disease, lung cancer, bone defects, kidney damage, bone marrow	0.06
Pb	Paint, pesticides, smoking, automobile emission, mining, burning of coal	Metal retardation in children, development delay, fatal infant encephalopathy, chronic damage to nervous system, liver, kidney damage	0.1
Mn	Welding, fuel addition, ferromanganese production	Inhalation or contact damage to central nervous system	0.26
Hg	Pesticide, batteries, paper industry	Tremors, gingivitis, protoplasm poisoning, damage to nervous system, spontaneous abortion	0.01
Zn	Refineries, brass manufacture, metal plating	Damage to nervous system, dermatitis	15
Cr	Mine, mineral sources	Damage to nervous system, irritability	0.05
Cu	mining., pesticide production, chemical industry	Anemia, liver and kidney damage, stomach irritation	0.1

Effect of heavy metals on plants:

- Enzyme inhibition involved in different processes
- Inhibition of nutrient acquisition
- Inhibition of photosystem
- Inhibition of carbon fixation
- Decreased chlorophyll content

- Stunted plant growth
- Decreased seed germination
- Leaf number & area reduced
- Decrease in protein, amino acids, starch contents
- Chlorosis, wilting, necrosis in plants
- Heavy metals tissue accumulation

Effect of Heavy metals toxicity on plant: -

Cd toxicity-

In Castor (Ricinus communis): -

Decrease the production of root and shoot dry matter of the castor and also decrease the photosynthetic pigments.

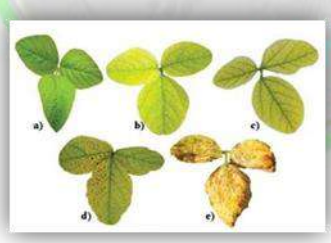
In Soybean (Glycine max): -

Interveinal chlorosis in young leaves with the appearance of dark brown spot, progressing to the drying of the leaves.

In Spinach (Spinacia oleracea): -

Decreased the leaf and root growth; and also reduced shoot and root length of the spinach.

Castor



soybean

Spinach

In Chickpea (Cicer arietinum): -

Decrease the plant height, number of primary and secondary branches, pod and seed yield and biomass production.

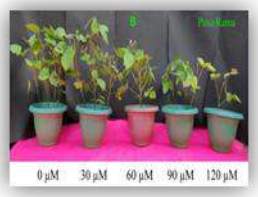
In Mungbean (Vigna radiata): -

It negatively affected germination and seedling growth and decrease the photosynthesis, seed protein contents, yield and yield related attributes.

In Spinach (Spinacia oleracea): -

Reduction of leaf & root growth; in higher concentration of chromium 100 mg/kg^{-1} growth is severely affected and negligible.

Chickpea



Mungbean

Spinach

Pb toxicity-

In Cowpea (Vigna unguiculata): -

Alteration in the growth of roots as well as leaves of plants.

In Maize (Zea mays): -

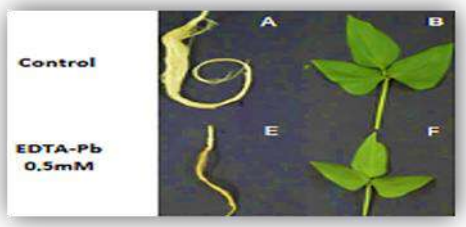
Reduction in germination percentage, suppressed growth, reduced plant biomass, decrease in plant protein content.

In Oat (Avena sativa): -

Inhibition of enzyme activity which affected CO_2 fixation.

In Spinach (Spinacia oleracea): -

Reduction of leaf & root growth; in higher concentration of lead 100 mg/kg^{-1} growth is reduced but it is not much more affected compared to the application of other heavy metal.



Cowpea

Spinach

WHO permissible limits for Heavy metals in plant and soil

Elements	Target value of soil (mg/kg)	Permissible value of plant (mg/kg)
Cd	0.8	0.02
Zn	50	0.60
Cu	36	10
Cr	100	1.30
Pb	85	2
Ni	35	10

What is remediation:

Remediation refers to the process of environmental cleanup of contaminated sites and the techniques to reduce or eliminate contamination from soil or groundwater.

Remediation of Heavy Metal-Contaminated Soils:

- Heavy metals in soil are in the form of cations and retained on soil particles by electrostatic attraction or forming chemical bonds with organic or inorganic ligand ions.
- The overall objective of any soil remediation approach is to create a final solution that is protective of human health and the environment.
- Remediation is generally subject to an array of regulatory requirements and can also be based on assessments of human health and ecological risks where no legislated standards exist or where standards are advisory.

Remediation Techniques:

1) Physical 2) Chemical 3) Biological

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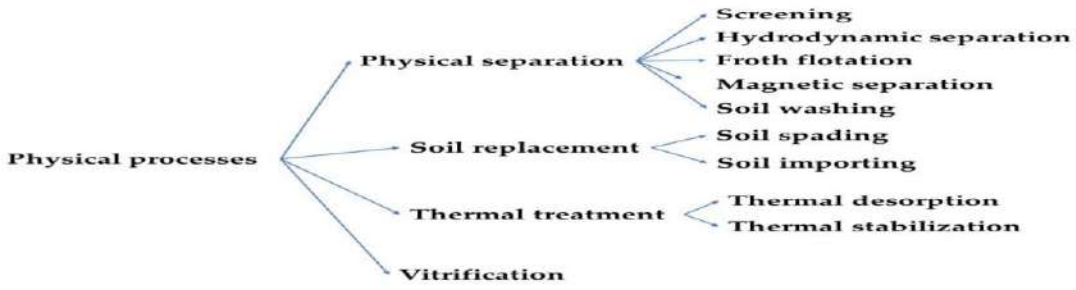
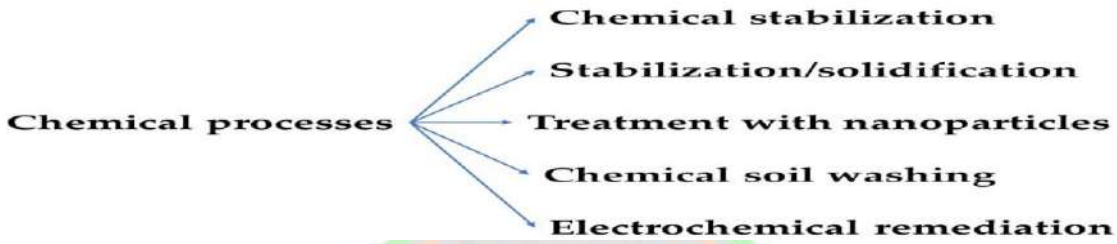
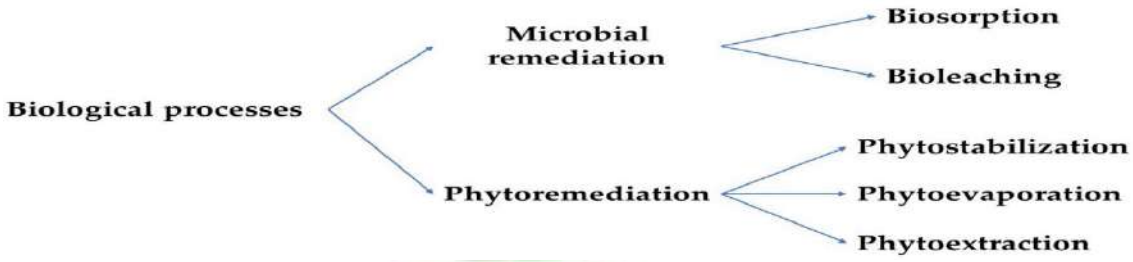


Physical technologies permit removal through physical mechanisms such as physical separation, soil replacement, thermal treatment, or vitrification. These methods allow us to have a high removal efficiency, but they are rather expensive

Chemical techniques exploit chemical phenomena such as ion exchange and chemical reactions to stabilize and fix heavy metals and metalloids into less toxic forms. For these processes, chemical reagents are required.



Bioremediation can be defined as any process that uses microorganisms, fungi, green plants or their enzymes to return the natural environment altered by contaminants to its original condition.



Some fungal species used in metal biosorption

Fungi	Metal adsorbed
Phanerochaete chrysosporium	Ni(II),Pb(II)
Aspergillus niger	Cd
Aspergillus fumigatus	Ur(VI)
Aspergillus terreus	Cu
Penicillium chrysogenum	Au

Various yeast species used for metal biosorption

Yeast	Metal adsorbed
Saccharomyces cerevisiae	Uranium
Saccharomyces cerevisiae, Kluyveromyces fragilis	Cadmium
Saccharomyces cerevisiae	Methyl mercury and Hg (II)

Bacterial species exploited in metal biosorption

Bacteria	Metal adsorbed
Bacillus polymyxa	Cu
Bacillus coagulens	Cr (VI)
Eschereria coli	Hg
Eschereria coli	Cu, Cr, Ni
Pseudomonas species	Cr (VI), Cu (II), Cd (II), Ni (II)

Heavy metal adsorbing capability of various sea weeds

Algae	Metal adsorbed
Chlorella emersonii	Cd
Sargassum muticum	Cd
Ascophyllum sargassum	Pb, Cd
brown sea weeds	Cr
Ecklonia species	Cu(II)

Important and widely reported hyper-accumulators used for metal remediation

Heavy metals	Plant species	Maximum reported concentration (ppm)
Cd	*Thlaspi caerulescens*	500
Cu	*Ipomoea alpina*	12300
Co	*Haumaniuastrum robertii*	10200
Pb	*Brassica juncea, Zea mays*	8200
Ni	*Alyssum lesbiacum, Sebertia acumunata*	47500
Cr	*Brassica juncea, Helianthus annus*	1400

The key factors that may influence the applicability and selection of any of the available remediation technologies are:

(i) cost,

(ii) long-term effectiveness/permanence,

(iii) commercial availability,

(iv) general acceptance,

(v) applicability to high metal concentrations,

(vi) applicability to mixed wastes (heavy metals and organics),

(vii) toxicity reduction,

(viii) mobility reduction, and

(ix) volume reduction

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WHAT WILL BE THE IMPACT OF CROP DISEASES ON GLOBAL FOOD SECURITY?

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Introduction

Meeting global demand of safe and healthy food for the ever-increasing population now and into the future is currently a crucial challenge. Increasing crop production by preserving environment and mitigating climate change should thus be the main goal of today's agriculture. Plant diseases always possess a threat to food security because they damage crops either as pre-harvest or post-harvest losses, thus reducing the availability and access to the food in some deficit areas and demanding high price for the food in those deficit regions. To meet the rising demand for food crops, import and export of planting materials, seeds are in action which in turn carries the pathogen from one region to another. Many new pathogens and pests get introduced in an area where they were not found earlier. Using of resistant sources is the only option to overcome all these problems.

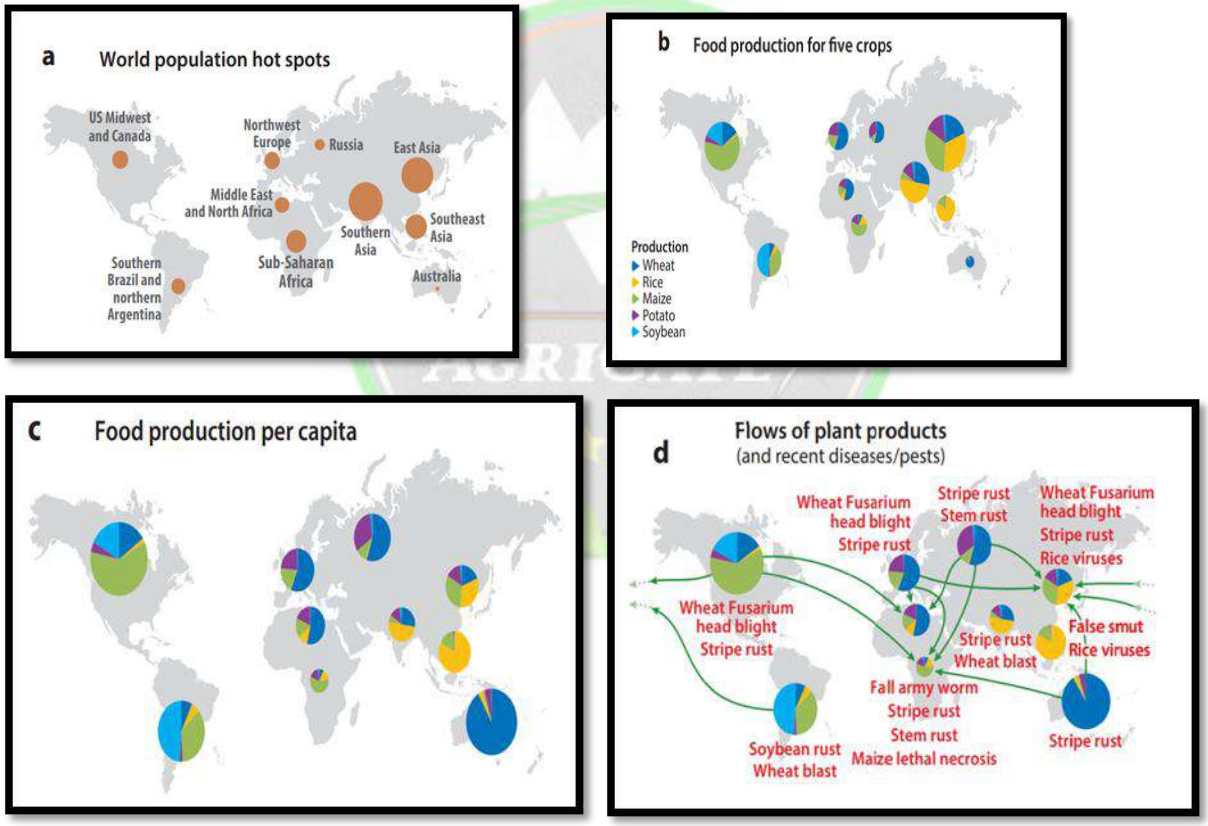
Global food security

- A condition when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996).
- Every year global food security index is measured in 113 countries based on 34 parameters such as nutritional standards, food loss, protein quality, diet diversification, agricultural infrastructure, gross domestic per capita, food safety etc. According to 2024, Finland, Ireland, Norway were the best performing countries, India ranks in 68th position.

Components of food security

1. Food availability: The availability of sufficient quantity and quality of food through domestic production and supply.
2. Food access: Access by individuals for adequate resources for food.
3. Stability: access to adequate resources at all the time.
4. Utilization: Utilization of food through adequate diet, clean water, sanitation and healthcare to reach a state of nutritional well-being.

The Global food system: A simplified view



a) The global population is unevenly distributed on earth with massive production centers in East Asia and Southern Asia.

b) The global food production of main food staples like wheat, rice, maize, potato and soybean is also unevenly distributed with major production centers North America, East Asia and Southern Asia.

c) Because of this production of food per person is surplus in some hot spots like North and South America, Eastern and Western Europe, Australia whereas deficit in Sub Saharan Africa and a region of fragile balance between population and food production in seen in countries like South Asia and East Asia

d) Exchange of trade (food) take place from surplus countries to deficit countries because of is many new pests and pathogens have dispersed through this trade and causes huge yield loss.

Threats for global food security

1. **Over population growth -** According to world population estimation, by 2050, the world's population will increase to about 9.1 billion where more than 75 percent of the population is seen in African and Asian countries. Because of over-population leads to the state of food insecurity. Larger and more urban population will demand more and better food. Due to unequal access to food, 25 percent of world's population is undernourished and 10 per cent starving. The amount of food what we are growing today ill feed only half the population by 2050.
2. **Climate change -** Because of change in weather pattern like raise up or decrease in temperature, sea level rises etc. Due to this many draughts, tropical storms, cyclones, occur which in turn leads to huge loss in yield.
3. **Water stress -** Due to over population, the dependency on water is also increasing day by day. As only 1 percent of global water is available for drinking, by 2025 a state of water stress will increase in agricultural areas due to growing water use efficiency and higher temperatures.
4. **Emerging plant diseases -** As we know that occurrence and severity of disease depends on the susceptibility of host, virulence of pathogen and favorable environmental conditions. Due to international exchange of seed and planting stock and due to global trade and exchange there will be dispersal of many pathogens into regions of the world where previously it was not found and causes huge yield losses.

Impacts of plant diseases on different crops

- **Potato late blight - Western Europe, 19th and twentieth century** *Phytophthora infestans* de Bary is the cause of a famine that killed or displaced a quarter of the Irish

population in the nineteenth century. The entire European potato crop was susceptible to the new pathogen.

- **Wheat rusts-North America, Europe, Africa, and Asia 20th and twenty-first century:** Stem (black) rust, caused by *Puccinia graminis tritici* has historically been an important disease of wheat in Africa, the Middle East, South Asia, Australia and New Zealand, and in North and South America as well Europe.
- **Fusarium head blight on wheat- North America, China, and Europe today:** FHB is an important disease in many wheat producing areas, including Europe, China, the USA, Canada and Brazil. In North America, recurrent epidemics have been reported for many years, but particularly severe epidemics have been taking place from the 1990s until today probably as a result of the expansion of wheat-maize rotation and of conservation tillage practices.
- **Brown spot of rice-South Asia, twentieth century and today:** Brown spot, caused by *Cochliobolus miyabeanus* (Anamorph: *Bipolaris oryzae* (Breda de Haan) Shoemaker) occurs in all the rice-growing regions in the world. The disease is responsible for regular epidemics all over Asia, especially when the crop encounters water and nutrient stresses, i.e., in poor production situations, where soils are marginal, fertilizer inputs limited and water supply, irregular. Extensive survey and crop-loss experimental work led to the estimate that the average rice yield losses to brown spot are in the range of 10% of the attainable yield across tropical Asia, making it one of the main rice yield-reducers.
- **False smut of rice - Asia, today:** False smut, in Asia, has become one of the most important grain diseases of rice. The pathogen *Ustilaginoidea virens* produces clusters of sporangia forming smut balls that are initially orange and then turn green to greenish black with age. These smut balls replace spikelets and affect the formation of adjacent spikelets. Spores of pathogens may contaminate healthy seeds during harvesting and threshing. The rate of milled rice decreases as the number of infected grains increases.
- **Coffee rust - central America, today:** Coffee rust, caused by *Hemileia vastatrix*, has been responsible for dramatic epidemics in various coffee-growing regions of the world, notably in Ceylon (today's Sri Lanka) in the nineteenth century, where it caused coffee cultivation to be abandoned. Recent epidemics in Central America were actually strong and early enough to have a measurable direct effect on coffee yield. Between 2011 and

2014, coffee production in Central America has been reduced by 17%, a loss equivalent to $616 million. However, because of global price decline, this further translated into a 50% fall of the coffee export value from Central America.

Government measures to mitigate the problem

Quarantine regulations

- World Trade Organization's agreement on sanitary and phytosanitary measures as coordinated action to avoid the spread of pests and diseases that threaten food security.
- Safe trading of plant and plant products
- Global exchange of information regarding the new outbreaks of plant pests and diseases.

Conclusion

As population keep on increasing, demand for food will also increase. All of sudden all crop pests and diseases cannot be eradicated completely. Emergence of crop pests and diseases is a continuing process; the only solution in upcoming days is to use the resistant sources/ varieties for crop production and manage the disease/ pest occurrence in new localities and regions, thereby only we can maintain the global food security loss.

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NATURAL FARMING: A BOON FOR THE NATION IN AMRIT KAAL

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Abstract

The technology driven era of *Amrit Kaal* is facing the curse of global warming which leads to deterioration of natural resources as well as the shifting of weather pattern that leads to the reduction in quality yield. Moreover heavy uses of synthetic fertilizers and pesticides adversely affected the soil heath and contaminated the quality food. Therefore, even in the time of artificial intelligence, *Amrit Kaal* is focussing on agriculture practices through conventional methods which is renowned as zero budget natural farming, prakrithik krishi, cow based natural farming, shashwat kheti and chemical free agriculture. The four pillers are Beejamrit, Jeevamrit, Mulching and Whapasa. Natural farming is mainly dependent on *desi* cow, therefore it also aids in conservation of *desi* cows. It assists in amending the soil environment and quality produce with low cost products. Also, the products used in natural farming can build a small industry in remote areas where rural population can actively run it well livelihood.

Keywords: Amrit Kaal, Beejamrit, Jeevamrit, Mulching, Whapasa

Introduction

Although this is the era of technology where human are successful in exploring artificial intelligence, still the condition is facing the biggest challenge in the whole global village is of climate change. This is mainly due to the raise of anthropogenic activities, especially industrial

revolution (Change, 2007) which elevate the global atmospheric CO_2, CH_4 and N_2O concentration by 30, 145% and 15% respectively (IPPC, 2007). Currently, the concentration of CO_2 is about 350 ppm and it is assumed to be 550 by 2040 (IPCC, 2022).

The curse of climate change is not only affecting the human population, but also affective the production and productivity of Indian farming. It is estimated that, the productivity of Indian farming would be decline by 30-40% in upcoming years due to change in weather pattern.(De, 2018). In early days of 1960s the concept of green revolution was also emerged as a potential source for enhancing yield and income of farmers, however in long term it is depicting the failure especially by polluting the soil health and reducing the quality due to synthetic fertilizers and pesticides. Also, according to WHO, over 50 percent of consumable goods contain carcinogenic compounds (Prasad, 2016). Moreover, the cost of synthetic fertilizers, pesticides and also seeds are high which ultimately put the farmers into heavy debt. During the year 2016 about 200k farmers committed suicide because of high debts arises due to costly and deadly crop growth enhancers (Bishnoi and Bhati, 2017)

The budget 2023-24 came with the vision of a time period known as '*Amrit Kaal*' which is up to 2047 and was first announced by Honourable Prime Minister of India Shri Narendra Modi on the occasion of Independence day 2021 with an aim to accomplish "Jan Bhagidari through Sabka Saath Sabka Prayas" through "technology-driven and knowledge-based economy with strong public finances, and a robust financial sector". To achieve the goals of *Amrit Kaal* with the youth power, main focus has been given on the Economic empowerment of women through self help groups (SHGs), Pradhan Mantri Vishwakarma Kaushal Samman (PM VIKAS), Tourism Promotion in Mission Mode and Green Growth.

Also, the potential period of *Amrit Kaal* is focusing on the concept of conventional way of farming- Natural farming or earlier known as zero budget farming in order to amend the problem arises from modern day farming.

Natural farming

Government of India is promoting the concept of natural farming through 'Bharatiya Prakritik Krishi Paddhati (BPKP)' which is sub-mission under 'Paramparagat Krishi Vikas Yojana (PKVY)'. Basically, eight states i.e. Andhra Pradesh, Chattisgarh, Kerala, Himachal Pradesh, Madhya Pradesh, Odisha, Tamil Nadu and Jharkhand are opted for the scheme. The concept of natural farming is a holistic approach which emphasis on farming with nature

without using chemicals or with the use of naturally available substances such as cow dung, cow urine, organic jaggery, soil etc. It aims to sustain the natural resources by enhancing the microbial consortia present in soil which ultimately amend the soil health and leads to quality produce. It is also known as zero budget natural farming, prakrithik krishi, cow based natural farming, shashwat kheti and chemical free agriculture etc.

Need for Natural Farming:

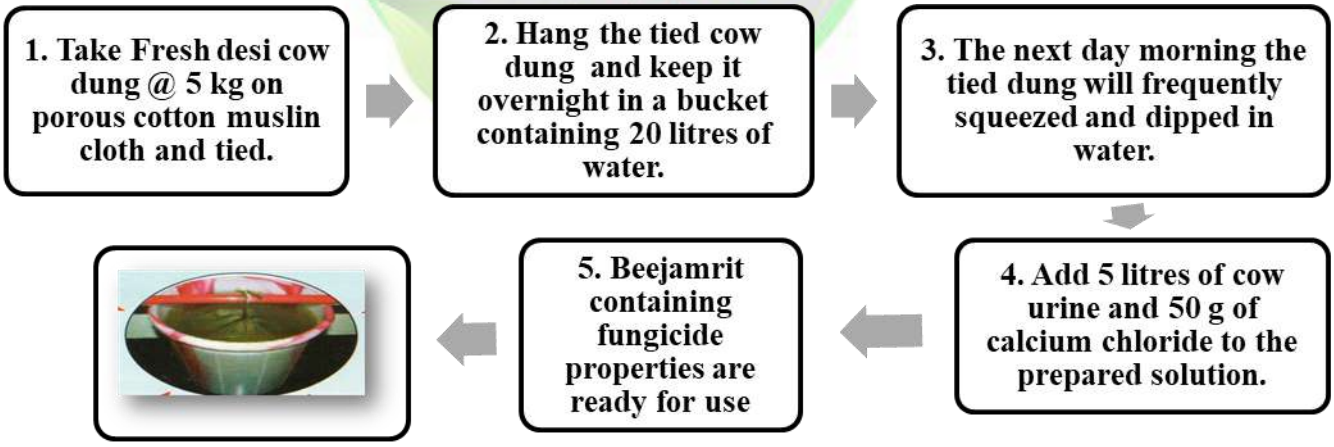
The main reasons that draw our attention towards the need of natural farming include the massive decline in soil health, loss of productivity, soil infertility, desertification, reduced agro-diversity, pesticide pollution, climate change, scarcity of natural resources, heavy subsidies and low investments.

Components of Natural farming:

1. Beejamrit:

It is a blend of four substances i.e. cow dung, cow urine, lime, water and handful of non chemical soil under the tree. It is preferred to collect the soil under the *ficus religiosa* as they contain consortia of good helpful microbes. Treatment of the seeds with beejamrit can control infestation of insect pest and diseases. Lime is source of calcium which also helps in maintaining the pH as cow urine is acidic in nature.

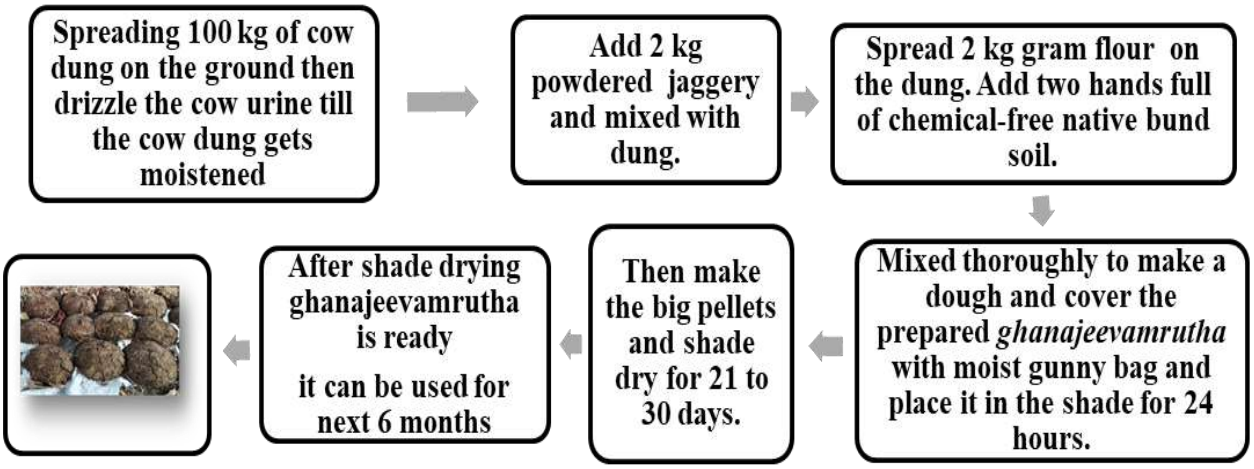
Preparation of Beejamrit



2. Ghanajeevamrit:

It is a dry form product which is used as basal dose in place of farmyard manure. It takes 21-30 days for formation with the shelf life of six months.

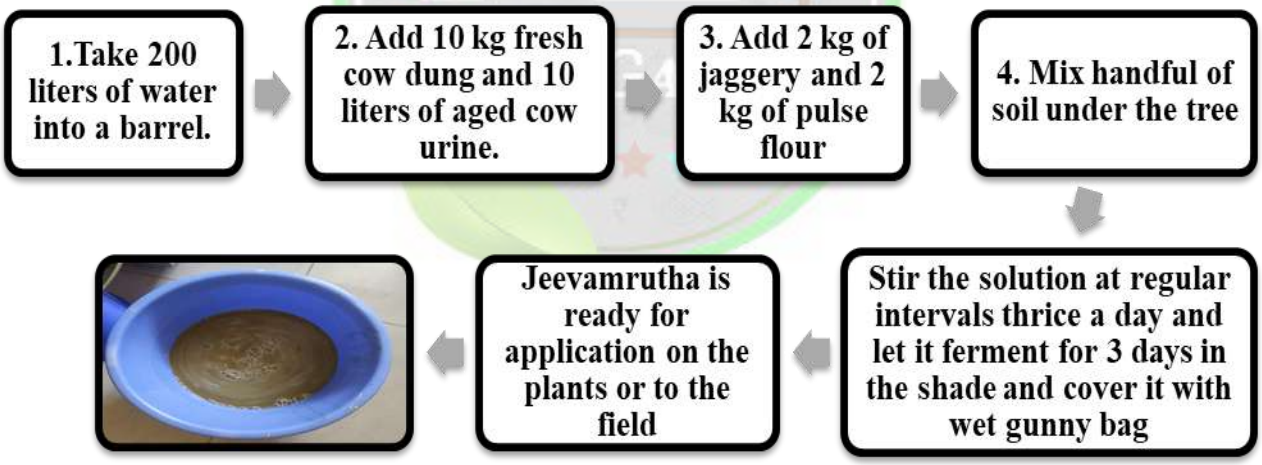
Preparation of Ghanajeevamrit



3. Jeevamrit:

It is traditional fermented liquid microbial culture to enhance the soil fertility of soil and to get better production. It is a mixture of cow dung, cow urine, jaggery, gram flour and handful of soil under the tree. It is rich inoculation of useful bacteria, fungi and actinomycetes.

Preparation of Jeevamrit



4. Mulching or Acchadana:

It is an important aspect to maintain the soil temperature and moisture to create suitable microclimate for growth and development of microorganism.

5. Whapasa:

It helps in improve the aeration and water use efficiency of plants by lessening the quantity and frequency of irrigation.

6. Plant Protection:

Natural or organic or bio-products based bio-pesticides such as neemastra, agniastra, bramhastra, sour buttermilk solution, dashaparni kashaya, shuntiastra etc.

Benefits of Natural Farming

The major advantages that we can have from natural farming include reduction in cost of cultivation, climate change resilient crops, production of quality yield, improve overall soil and plant health with reducing the demand of synthetic fertilizers, reducing water consumption. Sustain biodiversity Conservation of *desi* Cows, reducing the load of subsidies on government. Equal opportunities for men/ women/ youth Provide opportunity for rural start-up in the making and selling of products having shelf life from 3 to 6 months such as Neemastra (six month), Agniastram (three months), Brahmastra (six month), Dashaparni (six months) and Ghanajeevamrutha (six months) etc.

The Constraints of Natural Farming:

One of the major obstacle in natural farming is application of jeevamrit every fifteen days interval which needs the product in large quantity. For the making of product the hard to find core material is availability of desi cow based inputs. Moreover, it is witnessed that, due to low productivity of milk by desi cows they are usually abandon by the farmers. Those abandon cows generally become stray and roam on roads. In India, they are one of the major reason for accidents. On the other hand, natural farming cannot be achieved without *desi* cows. Therefore, there is a need to change the thinking of farmers to accept *desi* cows as their source for fertilizer synthesis in organic way. Moreover, cow rescue units should be made where those stray cows would be collected and their cow urine and cow dung be collected for input and sale. This can be a better alternative to amend the problem of abandoned cows and to generate income by making the availability of cow dung and cow urine.

Conclusion

In this era, where population is increasing and expected to be more than 10 billion by 2050 simultaneously the environment and food is getting contaminated, the way to escape from the problem is adoption of natural farming but in a system way by adopting all the terms and condition of natural farming. Moreover, in present time with high inflation rate sole farming cannot be able to fulfil all human requirements. Therefore, they have to enter into the concept of value addition and marketing by themselves. The observance of Amrit Kaal is a step forward to

support the youth, women and rural localities and to provide an environment where they can live in fresh air and eat pesticide free food and safeguarding the environment.

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BEST MANAGEMENT PRACTICES (BMPS) FOR CARP FISH FARMING

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Abstract

Best management practices (BMPs) for fish farming in aquaculture are essential for ensuring the success and sustainability of fish farming operations. These practices include maintaining optimal water quality parameters, such as oxygen levels and pH, to support fish health and growth. Feeding management is crucial to provide a balanced diet and prevent overfeeding, which can lead to water pollution. Disease prevention and control measures, such as biosecurity protocols and regular health checks, help minimize the risk of disease outbreaks. Managing stocking density to prevent overcrowding and implementing environmentally sustainable practices, such as proper waste management and sustainable feed sources, are also important. By following these best management practices, fish farmers can optimize their operations, promote fish health, and contribute to the long-term sustainability of aquaculture.

Keywords :BMPs, fish farming, pond, pre-stocking, stocking, and post-stocking management

Introduction

Pre-stocking means management before stocking. In fish culture, the management practices involved before stocking fry include preparing the water body and its surrounding environment to ensure optimal conditions for the living and growth of the fry.

Pre-stocking management

New pond

- Pond Construction

- ✓ Site Selection
- ✓ Layout

- Pond Preparation
  - ✓ Liming
  - ✓ Manuring

Old pond

- Pond Preparation
  - ✓ Draining and cleaning of pond
  - ✓ Eradication of weed and predatory fishes, aquatic weeds
  - ✓ Renovation/repair
  - ✓ Liming
  - ✓ Manuring

Select a site with clay loamy soil (20-30% clay) for higher water holding capacity, less seepage, less nutrient loss, and a permanent water source, for the construction of the fish farm.

Ideal Pond Size (in acres)

Nursery pond	0.1-0.25
Production pond	1-5
Brood stock pond	1-5

Layout of Pond

Ideal pond size	Utility dependent (Nursery, grow out or brood stock pond)
Pond shape	Rectangular
Total depth and water depth	Species and utility-dependent
Free board	0.6 to 0.7 m (above water surface)
Pond direction	East-West
Pond bottom	Slope (1-2%) in direction of outlet
Inside slopes	2:1
Dyke width	3 m
Outer dyke slope	1.5:1

Preparation of New Pond

Schedule-I	Schedule-II
1. Fill water in pond 2. Liming (water application) ↓after 10-15 days 3. Manure ↓after 15-20 days Stocking of seed	1. Liming (soil application) 2. Fill water in pond ↓after 10-15 days 3. Manure ↓after 15-20 days Stocking of seed

Liming is done to neutralize the acidity of the pond, disinfect, enhance the decomposition of organic matter, and control algal bloom. Half dose is applied 10-15 days before manuring in new production ponds and the rest in equally monthly doses after stocking. Therefore, lime the production pond in accordance with the pH of the soil.

pH correction and disinfection details (if required)

Soil pH	Annual Lime Requirement (kg/acre)	Pre-stocking dose (kg/acre)
4.0-5.0	800	400
5.0-6.5	400	200
6.5-7.5	200	100
7.5-8.5	100	50
8.5-9.5	no liming	no liming

Manuring/ fertilization of fish pond is done to boost the production of natural food 'Plankton'. Apply organic manures in the form of heaps near dykes. Use any of the following decomposed organic manures or inorganic fertilizers to fertilize the pond for plankton (natural food) production

Manure/Fertilizer	Pre-stocking dose (kg/acre)
Cow dung (farm yard manure)/ Biogas slurry	2000
Chicken/Poultry manure	1000
Vermicompost	1500
Urea + SSP	40+60
DAP	20

Stocking BMPs

Proper stocking management is required for higher survival and growth of fish in the production pond.

Stocking Management
• Seed Source/quality • Seed stocking ✓ Stocking size ✓ Stocking rate ✓ Stocking ratio ✓ Stocking method (Acclimatization of seed to the new environment of pond required) ✓ Stocking time (early morning or evening hours- reduces handling stress)

It is important to procure disease-free and genetically superior fish seed from reliable hatchery.

Stocking size and stocking rate:

Pond	Stocking size	Stocking rate
Nursery	Spawn (2-3 day old)	40-50 lakh/acre
Rearing	Fry (1-2 inches)	40,000-50,000/acre
Production/grow out	Fingerling (3-6 inches)	4000-5000/acre

Stocking ratio: nursery and rearing ponds single species is reared. In case of production ponds fish are reared in different systems (mono, poly and mixed culture).

3:4:3 recommended ratio

Maintain buffer stock of fingerlings in nursery pond for re-stocking of production pond after every harvest.

Post-stocking management

After stocking the fish seed in the pond, BMPs are crucial for ensuring proper growth, survival, and health. This involves managing water quality, providing supplementary feed, liming, manuring, management of insects, weed, and predatory fish, aquatic weeds, algal bloom, periodic sampling, health management, and harvesting.

Water quality management

Maintain optimal growth conditions:

Dissolved oxygen (DO)	> 5.0 ppm (mg/L)
pH	7.5-8.5
Water depth	5-6 feet
Total alkalinity	50-200 ppm
Total hardness	50-200 ppm
Ammonia	< 0.05 ppm
Optimum transparency	20-35 cm

- Avoid overstocking, excessive manuring/fertilizing the pond, and overfeeding.
- Adjust feeding during winters to match the fish metabolism, as excessive feeding will only be wasted and will pollute the pond.
- Add lime @ 100 Kg/acre in two-fortnight instalments, if pH falls below 7.0 (usually in the rainy season), or add gypsum or alum @ 50-100 Kg/acre in two-fortnight instalments, if pH rises above 9.5 (especially in the summer season).
- Aerate the pond using aerators, by the addition of freshwater (exchange 10-20% water periodically), or partial water replacement during the early hours of the day just before sunrise as the fish uses oxygen for metabolism throughout the night causing the DO levels to fall. Aerate the ponds during cloudy days and in the hot summer season.
- Add lime @ 50 Kg/acre if alkalinity and hardness are < 50 ppm, but if the alkalinity and hardness are > 200 ppm, dilute the water from another source having low alkalinity.
- If ammonia levels are high, add zeolite, gypsum/alum (if pH is also above 8.5), aerate the pond, add fresh water, or add oxygen-releasing tablets.
- Regularly disinfect the pond to control microbes and parasites.

- If water has less transparency (<15 cm), stop feeding, manuring, and/or fertilizing (if due to planktons), and add lime and organic manures (if due to suspended solids). If transparency is high (>40 cm), apply manure and/or fertilizers to enhance plankton production.
- Control algae by avoiding feeding and manuring, instead, introduce silver carp.
- Introduce grass carp to keep aquatic weeds under check.
- Clean the pond every 5-6 years by drying, removing the sediments from the bottom, ploughing, sun drying for one week, levelling, liming, and refilling.
- Avoid planting trees around the pond, especially on the east and west sides of the pond.

Supplementary feeding

A balanced diet is essential for optimal fish growth in aquaculture.. Accordingly, supplementary feeding should be undertaken based on the dietary needs and feeding habits of the cultured fish species.

The feed could be either sinking or floating readymade pelleted feed (which causes less wastage, less pollution, provides better FCR, and higher productivity) or farm-made, dry or wet, non-pelleted feed (which causes more wastage and pollution).

Recommended diet composition for farm-made carp feed:

Ingredients	Composition – I	Composition – II
Rice bran	49%	44%
De-oiled Mustard cake	49%	44%
Fish meal	-	10%
Mineral-vitamin mixture	1.5%	1.5%
Salt	0.5%	0.5%

Feed should be provided @ 1.5-2% of total fish biomass either in one single dose or split doses daily after sunrise, at a fixed location and time. Feeding methods include surface broadcasting, bag feeding, dough feeding, or tray feeding

Grass carp must be fed before feeding other fish, with vegetation-based feed such as aquatic weeds (*Azolla*, duckweeds, hydrilla), berseem, maize, bajra, or chopped green vegetable leaves constituting approximately 4-5% of estimated biomass, in a feeding tray.

Manure/fertilize the pond regularly to sustain plankton production, using cow dung/pig dung/biogas slurry (120 kg/acre/week), chicken/poultry manure (60 kg/acre/week),

vermicompost (90 kg/acre/week), SSP (5-6 kg/acre/week), or DAP (1-2 kg/acre/fortnight). To enhance plankton productivity, periodically apply 2-3 days old fermented slurry composed of mixing 10kg de-oiled rice bran + 10kg de-oiled mustard meal + 5kg DAP + 10kg Jaggery/molasses + 100g Yeast + 200l water, depending upon the color of water, every 20-30 days.

Suspend feeding during cloudy weather, disease outbreaks or when DO levels are low and ammonia levels are high in the pond. Gradually reduce feeding and manuring as winter sets in.

Management of insects and weed/predatory fish

Insects can be controlled for a short time by repeated netting, but for long-term effects, a barrier has to be set in between air and water surface by applying oil soap emulsion @ 21 kg oil + 7 kg soap/ acre, or 20-25 l/acre high speed diesel or 30 l/acre kerosene oil, slowly in the direction of wind to form a uniform layer over water surface. This barrier can also be applied during spawn rearing as it doesn't harm fish spawn/fry.

Weed and predatory fish can be prevented from entering the pond by installing galvanized screens at the canal water inlet or by avoiding the addition of canal water during monsoon months. If the unwanted fish has entered, can be removed by repeated netting and dewatering the pond. Application of safe poison like either mahua oil cake (4-6% saponin) @ 800-1000 kg/acre, bleaching powder – Calcium hypochlorite ($CaOCl_2$) @ 150-200 kg/acre, a combination of urea and bleaching powder (urea @ 40 kg/acre + Bleaching powder @ 70 kg/acre), or Derris root powder (5% rotenone) @ 40 kg/acre.

Management of aquatic weeds and algal bloom

Algal bloom can be controlled physically by drying the pond, manually cleaning the pond by netting or uprooting the weeds with barbed wires or rakers, or by mechanized weed cutters, chemically by applying herbicides like copper sulphate @ 1-2 kg/acre (for algal blooms) & 2-4 kg/acre (for filamentous algae), 2,4-D foliar spray @ 2-4 kg/acre or Simazine @ 2-4 kg/acre (for surface floating leafy weeds), Simazine @ 10-15 kg/acre or Diquat @ 800 g/acre (for submerged leafy weeds), 2,4-D foliar spray @ 2-5 kg/acre (for emergent and marginal weeds, and biologically by introducing grass carp for controlling surface floating and rooted weeds, silver carp for controlling algal bloom, common carp for rooted weeds and duckweed cover for blocking sunlight to kill submerged weeds.

Algal bloom can be controlled chemically by applying copper sulphate @ 1-2 kg/acre and lime @ 80-100 kg/acre (for surface algal blooms), and copper sulphate @ 2-4 kg/acre (for submerged filamentous algal bloom), or biologically by introducing silver carp @ 200/acre.

Algal bloom formation can be prevented by avoiding over-manuring, over-fertilization, over-feeding, and removing excess dead organic matter settled at the pond bottom every 5-6 years.

Health management

Factors like poor seed quality overstocking, over or under feeding, contaminated feed, poor water quality, and disease outbreaks can lead to stress in fish. To prevent fish stress, the pond must be disinfected using regular lime or potassium permanganate, using CIFAX as prophylaxis twice (in February/March and November/December) @ 400 ml/acre, treat fish with potassium permanganate after every netting operation, disinfect equipment and nets before and after every use. To boost the immune system, supplement feed with Vitamin C.

Regularly observe the pond for any abnormal fish movement. Observe for signs like fish gasping at the water surface, gathering at the pond dykes or near the inlet, tail-chasing movement, erratic movement, loss of balance, etc. Stay cautious for common disease outbreak symptoms like spots, wounds, ulcers, tumors, parasites on the body, fin and gill rot, excessive mucus production, eye popping, etc.

In case of a disease outbreak, add fresh water and aerate the water, stop feeding and manuring the pond, add potassium permanganate, and consult an expert promptly for timely disease diagnosis and treatment.

Harvesting management

Marketable fish are harvested from the fish pond when they reach marketable size of 500 gram to 1 kilogram. Harvesting can be done in one go or through partial harvesting and restocking, also known as multiple cropping system. The approach leads to maximum utilization of the carrying capacity of the pond throughout the year. Partial harvesting can begin in October/November when the fish reach a weight of over 500 grams. The pond should be restocked with an equal number of fingerlings from the nursery pond. It is advisable to maintain a buffer or reserve stock in nursery pond since fish seed is only available during breeding season. During harvesting, carefully observe the fish for signs of diseases or parasite attacks. If any abnormalities are detected, consult an expert for disease diagnosis and treatment, providing

appropriate images and videos of affected fish. Aerate the pond after each harvest to maintain optimal oxygen levels for remaining fish and to promote overall pond health.

Conclusion

The effective management of a fish pond involves a comprehensive approach encompassing various aspects such as water quality management, supplementary feeding, control of insects, weed fish, predatory fish, health management, and harvesting practices. By adhering to BMPs and employing appropriate techniques for each aspect, carp fish farmers can ensure optimal growth and health of the fish stock while maximizing productivity. Regular monitoring, timely interventions, and consultation with experts are crucial for mitigating risks such as disease outbreaks and maintaining a sustainable aquaculture environment. Through careful planning and diligent implementation of management strategies, fish farmers can achieve successful outcomes and contribute to the thriving aquaculture industry.

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EFFECT OF MICROPLASTIC POLLUTION ON MARINE ORGANISMS

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Abstract

Microplastic contamination poses a significant peril to marine ecosystems, arising from diverse human activities like aquaculture, fishing, tourism and both industrial and domestic wastewater systems. These minute plastic particles, generated from the degradation of larger plastic items, permeate both land and water environments, penetrating the food chain and presenting health risks to marine creatures and humans alike. Microplastics adversely affects a broad spectrum of marine organisms, including seaweeds, phytoplankton, zooplankton, fish, crustaceans, mollusks, and corals, through ingestion, accumulation and toxicological pathways. Primary and secondary microplastics originated from various sources such as personal care products, synthetic textiles, paints, packaging materials, among others. Strategies for prevention involve reducing the use of disposable plastics, improving wastewater treatment processes, enforcing regulatory measures and public awareness. Resolving this challenge demand cooperation across different fields and international endeavors aimed at safeguarding marine biodiversity and ecosystem health

Key words: Microplastic, Marine organisms, Prevention

Introduction

Microplastics are small particles of plastic that arise from breakdown of larger plastic items. Human activities such as aquaculture, fishing, tourism, industrial, and domestic wastewater systems are primary pathways through which microplastic enter marine environments. Microplastic fragments found extensively throughout the terrestrial and aquatic ecosystem. It has the potential to infiltrate the food chain, there by posing health hazards to plant, animals, and humans. The enduring presence of minute plastic fragments in the marine ecosystem causes them to be mistakenly eaten by various marine organisms like corals, phytoplankton, zooplankton, fish, crustaceans etc. due to their tiny size. Consequently, these particles are transferred up by the food chain to higher levels. Microplastic also have a detrimental impact on plankton. When microplastics are absorbed by seaweeds, they can disturb the natural flow of nutrients in marine ecosystems. This absorption may lead to changes dynamics for seaweeds, potentially impacting the overall health of the ecosystem. In general, microplastic pollution presents a notable threat to aquatic organisms, potentially causing harmful impacts on their health and overall welfare.

Types of Microplastics

1. Primary microplastic:

It consists of microbeads from personal care products, plastic pellets in industrial processes and plastic fiber like nylon in synthetic textiles. They enter the environment directly through various means such as product usage, accidental spills or abrasion during activities like washing clothes.

2. Secondary microplastic:

It's result from degradation of larger plastic items, due to environmental factors. As larger plastic breaks down, they form smaller particles, contributing to secondary microplastic pollution.

Source of Microplastic

1. Cleansing products:

surfaces are often using primary microplastics like polyester, and polycarbonate as abrasives. These plastics serve as blast media for tasks such as through rim cleansing, paint coating removal, etc.

2. Synthetic textiles:

Household and laundry processes contribute significantly to the production of primary microplastics. Synthetic fibers like polyester and nylon are scraped and dispersed during textile laundering, releasing microscopic particles into the wash water.

3. Paints and wood preservatives:

Primary microplastic are crucial components in paints and preservatives, enhancing surface performance and longevity, especially for wood.

4. Packaging materials:

it's a major source of microplastic, constituting a significant portion of global plastic waste due to their widespread use and disposal practices.

5.Personal care products:

Plastic microbeads serve dual roles as versatile additives in cosmetics and personal care items. They tiny beads function as sorbent and exfoliators, enhancing product performance and consumers experience.

Figure 1. Plastic Pollution in marine water

Microplastic effect on marine organisms

1. Microplastic Effects on seaweed:

Microplastic pollution has been detected in various types of seaweeds, including red, green, and brown varieties. This suggests that seaweed can serve as a pathway for microplastics to enter the food chain [1]. Microplastics exhibits various accumulation mechanisms in macroalgae, with the specific mechanisms depending on the morphology of the algae. The study identified five types of accumulation mechanisms: wrapping, attachment, embedment, entanglement and entrapment [2] The red seaweed nori *Pyropia* spp. Is a widely consumed vegetable that is easily processed. As a result, there are numerous farming areas along the coastal

waters of china dedicated to its cultivation. If the water environments used for nori cultivation are reported to be highly polluted by microplastics, there is a risk that these microplastics may contaminate and persist in this commercially significant seafood species even after processing and packaging [3].

2. Phytoplankton:

Phytoplankton, vital primary producers in aquatic ecosystems, are vulnerable to microplastic contamination, which can have significant repercussions throughout aquatic food webs. Microplastic exert adverse effects on various biological aspects of phytoplankton, including growth rates, chlorophyll content, photosynthesis activity and the generation of reactive oxygen species [4]. These impacts not only disrupt health and functioning of phytoplankton populations but also have broader implications for entire aquatic ecosystem.

3. Zooplankton:

Microplastic are pervasive and abundant in marine environments, representing a significant global environment and economic concern as contaminants. Their small size makes them easily ingestible by a wide array of marine species, including zooplankton. Microplastic can negatively affect various aspects of zooplankton biology, including feeding, reproduction, growth, lifespan [5].

4. Fish:

Fish is a crucial source of protein for human growth and health. However, the contamination of fish by microplastic is a significant concern that needs attention. When fish are exposed to microplastics alone or combination with other pollutants, they may encounter various health problems. Microplastics can lead to tissue damage, oxidative stress, alterations in immune- related gene expression and change in antioxidant status in fish exposures to microplastics can also result in neurotoxicity, growth inhibition and abnormal behavior in fish [6].

5. Crustaceans:

Crustaceans consists of crabs, lobsters, crayfish, shrimps and krills. Aquatic crustaceans, serving as both predators and prey, hold a crucial position in the food web and the transfer of energy. It is highly practical and important to monitor the toxic impacts of microplastics on these aquatic crustaceans. Microplastic have adverse impacts on the life cycles, behaviours and physiological processes of aquatic crustaceans [7].

6. Mollusks:

Microplastic pollution has been observed to induce diverse effects on mollusks. Studies have demonstrated notable physiological impacts on mussels due to polymethacrylate microparticles, which include diminished condition and fitness indices, elevated haemocyte count, decreased cell viability and tissue accumulation [8].

7. Coral:

Research indicates that microplastics can negatively impact corals, resulting in alterations to the diversity, community structure, and function of the symbiotic bacterial communities associated with them [9]. Furthermore, exposure to microplastics can impede the activity of energy metabolism enzymes in coral endosymbionts, potentially causing endosymbiont apoptosis and harm. Studies indicated that both hard and soft corals undergo oxidative stress and cellular damage due to the ingestion of microplastic [10].

Prevention of microplastic pollution in marine water

- Encourage reducing the use of single-use plastics and advocating for sustainable alternatives.
- install and upkeep filtration systems in wastewater treatment plants to capture microplastics before they enter waterways
- implement efficient waste management systems to prevent plastic debris from reaching water bodies through proper disposal and recycling methods.
- Establish and enforce regulations and policies to decrease plastic pollution, including bans on specific single-use plastics and regulations on plastic manufacturing and disposal.

Figure 2. coastal cleanup organised by College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India.

- Back and engage in beach cleanups and other campaigns aimed at eliminating plastic waste from marine environments.
- Educate the public about the environmental impacts of microplastics and advocate for responsible consumption and disposal habits

Conclusion

Microplastic pollution is a major threat to marine ecosystem, steaming from various source and putting marine life and human health at risk. the wide presence of microplastics in both land and water environments, along with their ability to enter the marine food chain, emphasizes the urgent need to address this issue. Through the implementation of preventative measures and the promotion of responsible consumption and disposal practices, we can strive to create cleaner and healthier marine environments for both current and future generations.

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SUPPRESSIVE SOILS AND ITS MECHANISM IN BIOLOGICAL CONTROL

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Introduction

Suppressive soils play an important role in an integrated diseases management. Among all the variables, micro-organism's role is considered a prime importance in farming decision to establish a good crop growth, yield, and disease tolerance. In this context soils having antagonistic micro floras gave the concept pathogen suppressive soil. Soil is a complex mix of organic and inorganic matter that includes thousands of different species, the vast majority of which are still not described. Some of the organisms are pests which cause significant crop losses while others perform as biological agents which control the pests. As a dynamic living resource, soil is the basis of sustainable agriculture, as well as the physical support for most other human activities.

Disease suppressive soils are defined as soils in which the pathogen does not establish or persist, the pathogen establishes but causes no damage or the pathogen causes some disease damage, but the disease becomes progressively less severe even though the pathogen persists in soil. The mechanism of suppression of soil includes antibiosis, competition, parasitism and predation. Though some argue for limiting use of the term disease suppressive to situations involving a clear biological component there is plentiful evidence for the role of both biotic and abiotic elements of the soil having a role in disease suppression. Chemical and physical attributes of soil, including pH, organic matter and clay content, can operate in the suppression of plant diseases directly or indirectly through their impact on soil microbial activity. Although these

abiotic characteristics of soil can contribute to disease suppression, soil suppressiveness is often times directly or indirectly a function of the activity of soil microorganisms or microbial metabolites.

The degree of suppressiveness is linked to soil physical conditions, fertility level, biodiversity and populations of soil organisms and soil management. The soil environment influences crop growth indirectly by affecting weed growth, pests and diseases as well as directly by supplying water and nutrients. However, while the general principles are theorized, there is a lack of detailed knowledge about soil factors and soil environmental conditions that influence the severity of plant disease.

Suppressive Soil

All the soils which are unfit for the development of certain diseases or the natural reduction of the disease's incidence because of the soil inhospitable to the certain plant pathogens.

Classical Definition of pathogen-Suppressive Soils

Soils in which the pathogen does not or persist, the pathogen establishes but causes no damage or the pathogen causes some disease damage, the disease becomes progressively less severe even though the pathogen persists in soil"

Concept of disease suppressive soil

The concept of disease suppressive soil has been described in terms of general suppression and specific suppression.

General suppression of a pathogen is directly related to the total amount of microbial activity in the soil or plant at a critical time in the life cycle of the pathogen. The general suppression is non-specific, operates against most, if not all pathogens and involves the activities of many resident soil organisms.

Specific suppression operates against only certain types of pathogens. Specific suppressiveness has been described for *Fusarium* wilts, *Gaeumannomyces graminis* var. *tritici*, *Phytophthora* spp., *Pythium* spp., *Rhizoctonia solani* and *Thielaviopsis basicola.* In all cases, a particular pathogen causes significantly less disease in suppressive soils than in other soils (conducive soils); the effect is lost when soil is treated with biocides, indicating the involvement of microorganisms. Although general suppression is a component of disease suppressive soils, the

understanding and potential exploitation of the phenomenon termed specific suppression is more commonly the subject of interest

The phenomena of disease suppressive soils have been documented for numerous plant-pathogen systems around the world. Among plant/fungal patho-systems, soils suppressive to Fusarium wilts caused by *F. oxysporum* or take-all of wheat caused by *G. graminis* var. *tritici* have been studied most extensively across a diversity of geographic regions.

Types of suppressive soils

It can be broadly classified into two groups viz., long standing suppressiveness and suppressiveness of recent origin. Latter it is subdivided into two groups namely; Induced and Introduced soil suppressiveness.

Factors influencing soil suppressiveness

Abiotic factors

Crop rotation

In the long-term trials at Avon, South Australia, it was found that the influence of crop rotation on the control of root fungal disease was greatly reduced once the level of soil suppression had increased. Rotations that include a break crop such as grain legume or canola greatly reduce root disease in cereals because these crops do not host the cereal root disease fungi. Canola has a second beneficial effect, the release of chemicals into the soil which kill root disease causing fungi and other soil organisms. Rotations will continue to play an important role in root disease control.

Tillage

Results from the long term trials in South Australia indicate that increased root disease does occur when conservation farming is first introduced, but this can be significantly reduced over time without the reintroduction of burning and tillage. The adoption of conservation farming practices results in the formation of a whole new soil environment and, consequently, the balance in the food web is adjusted. Different elements of the conservation farming system impact on the soil biota in different ways. Soil organisms are concentrated into the top 10cm of soil. The use of minimum tillage reduces soil mixing, maintaining biota concentrations near the surface rather than diluting them through a greater depth. The greater the number of tillage passes, the greater the risk of soil erosion which results in the removal of topsoil, the home of the soil biota and when soil is lost from a paddock it will take soil organisms along with it. Stubble

retention has a significant effect on the level of organic material (carbon) returned to the soil. Plant residues are a vital energy source for many soil biota and readily available carbon energy sources will result in rapid multiplication of the soil population Stubble retention can also reduce moisture evaporation that may be beneficial to some organisms. Conversely, stubble burning not only allows greater moisture loss, but also physically heats the soil surface layer. This will be detrimental to some organisms.

Micronutrients in suppressiveness

When a plant becomes infected by a fungus, its natural defences are triggered and it causes increased production of fungus inhibiting phenolic compounds and flavonoids both at the site of infection and in other parts of the plant. The production and transport of these compounds is controlled in large part by the nutrition of the plant. Therefore, shortages of key nutrients (K, Mn, Cu, Zn, and B) in soil and then in plants reduce the amount of the plants natural antifungal compounds at the site of infection. Many of the micronutrients are implicated in phenol metabolism from control of carbohydrate movement into synthetic pathways (boron) to the final polymerization of lignin (Fe and Mn). Among the micronutrients, Zn and B have significant roles in maintaining structural integrity and controlling permeability of cell membranes membranes is substantially impaired causing membranes become leaky and unstable. Zn and B also have protective roles against the damaging attack of highly toxic oxygen free radicals. Under Zn and B deficiencies release of several organic compounds from both root and leaf cell is obviously enhanced. Several examples are available in literature showing that susceptibility of plants to different diseases such as *Fusarium*, *Rhizoctonia solani* and *Phytophthora* is enhanced by ZN and B deficiency.

Soil texture and structure

Soil texture and structure could have effects on plant diseases because they affect water holding capacity, nutrient status and gas exchange as well as root growth. Poor soil aeration caused by poor soil structure, soil type or water logging was associated with the development of cavity spot (*Pythium* spp.) disease in carrot. The pea root rot complex (*Fusarium* spp.) is known to be affected by compaction, temperature and moisture of the soils.

Soil moisture and temperature

The severity of the soil borne diseases is proportional to the amount of soil moisture and is greatest near the saturation point. Such an example is *Pythium*, which causes damping off of

seedlings and seed decay. The increased moisture seems to affect the pathogen primarily, which multiplies and moves best in wet soils. Increased moisture may also decrease the ability of the host to defend itself through reduced availability of oxygen in waterlogged soil and by lowering the temperature of such soils. Ex: Cavity spot disease of carrot caused by *Pythium violae* and *P. sulcatum*.

Biotic Factors

Soil biota in suppressive and non-suppressive soil: Naturally, all soils have the capacity to suppress disease. But the microbial activity depends on soil moisture, temperature and the ratio of carbon to nitrogen, is the precursor to suppression. Conditions that change biological activity or relationships between organisms can effect suppression. Warm, moist soils with high levels of carbon to nitrogen will have higher levels of microbial activity and a relatively higher level of suppression. The degree of suppression will also relate to the balance between disease-causing organisms and those organisms which feed on these pathogens.

Mechanism of suppressive soils in biological control

In these suppressive soils, various kinds of soil micro flora exist. These micro flora by showing antagonistic effect to the soil borne pathogens reduces the pathogen population. Antagonism is showed in various approaches.

Antibiosis

It is the inhibition or destruction of one organism by a metabolite produced by another organism. *Agrobacterium radiobacter K*1026 produces agrocin 84(Bacteriocin) which is effective against *Agrobacterium tumefaciens*

Antibiotic

A chemical produced by one organism will inhibits or destroys the growth of another organism. *Pseudomonas fluorescens* Pf-5 produces multiple antibiotics including pyoluteorin, pyrrolnitrin and 2,4-diacetylphloroglucinaol.

Volatile compounds and enzymes

- **Ammonia** produced by *Enterobacter cloacae* which inhibits the pathogens *Pythium ultimum, Rhizoctonia solani and Veticillium dahliae.*
- **Hydrogen cyanide** produced by *Pseudomonas fluorescens* inhibits the growth and development of *Thielaviopsis basicola* (black root rot).

- Mixture of extremely bioactive volatile compounds (**alcohols, acids, esters**, **Ketones and lipids**) produced by *Muscodor albus* are various fungal and bacterial pathogens.
- The fungus *Talaromysces flavus* Tf1 produces glucose oxidase, hydrogen per oxide which is effective against *verticillium wilt* of brinjal.

Competition

It is the result of two or more organisms trying to utilize the same food (carbon and nitrogen) or mineral sources or occupy the same niche or infection site. *Pseudomonas fluorescens* produces a siderophore called Pseudobactin which deprives pathogen such as *Fusarium oxysporum* of ferric iron($Fe3^{+}$).

Managing Soil Suppressiveness In Agro-Ecosystems

Incorporation of root colonizing rhizosphere microorganisms:

These organisms can promote Phyto stimulatory and bio fertilising effects plant health by making the plant 'stronger'. Many rhizosphere microorganisms can induce a systemic response in the plant, resulting in the activation of plant defence mechanisms.

Better agronomic practices:

Adaptation of cultural practices has been proposed to decrease the soil inoculum potential or increase the level of suppressiveness to diseases Indeed, disease suppressiveness has been obtained through crop rotation, biofumigation, intercropping, residue destruction, organic amendments, tillage management practices and a combination of those regimes.

Identification microorganism involved in specific pathogen suppression in soils

The fallowing based approaches are beneficial to identify the micro-organisms involved in the suppression of the pathogen. So that it can be mas multiplied and utilized as a tool to management practice for particular diseases.

- Population based approach
- DNA nucleotide sequencing
- Array-based methods
- Examining all micro-organisms
- Culture - based methods

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AN OVERVIEW ABOUT NUTRITIONAL AND FUNCTIONAL PROPERTIES OF RAGI

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Abstract

Ragi (*Eleusine coracana*) comes under the taxonomic Poaceae family and in India, it is most commonly named as Mandua or Ragi or finger millet. In India ragi is an important member of the family of cereals and it is considered as a important crop because of its nutritional value, functional properties, bioavailability and micronutrient content of the grain. Development of value added products that contains ragi provides more beneficial for food and nutritional security of Indians. It is also a rich source of amino acids (isoleucine, phenylalanine, leucine and methionine), minerals (calcium, phosphorous and iron). Due to its high dietary nutritional content, it can provides numerous health benefits such as the anticipation of diabetes (Type 2 diabetes mellitus), anti-inflammatory, anti-tumerogenic, antiulcer, atherosclerogenic effects, antimicrobial, anti-diarrheal and antioxidant capacity. Finger millet is crop reasonably sustainable for poor segment of the world's population. Therefore, this review focuses on the nutritional value and functional properties of the ragi.

Keywords: Ragi, Nutritional value, Functional properties,

Introduction

Ragi (Eleusine coracana) or finger millet is one of the ancient millets in India from 2300 BC and it is most cultivated millets amongst other millets. In India finger millet is commonly called by various names like ragi (in Kannada, Telugu and Hindi), also Mandua/Mangal in Hindi, Kodra (Himachal Pradesh), Mandia (Oriya), Taidalu (in Telangana region), Kezhvaragu in Tamil Ragi comes under the taxonomic Poaceae family and it had an embryo and endosperm covered by seed coat is known as testa, it is available in different colors like white, tan , red,

yellow, violet and brown. Ragi is considered as a nutri cereals because of its highest amount of calcium (344 mg %) and potassium (408 mg %), dietary fibre (11.8g), poly phenols, phytates, minerals and sulfur containing amnio acids (Sharma *et al*., 2017). Ragi is an ideal crop for cultivation under less than favourable climate due to its resilient nature and ability to adapt in semi arid climate. So it mostly cultivated and consumed in semi arid and tropical climate areas in the world. In world ragi occupies fourth rank in production of millet grains after sorghum, pearl millet and foxtail millet. For developing countries like Asia and Africa ragi is an important crop for providing food as well as nutritional security. (Antony *et al*., 2018). Anti nutritional factors like tannin and polyphenols presnt in ragi grains it can interfere the absorption of nutrient content it ca be removed by several pre treatments like soaking, decortications, fermentation, malting and steaming (Chauhan and Sarita, 2018).Consumption of ragi had some health benefits like anti atherosclerogenic, anti tumour, anti diabetic, anti ulcer and anti inflammatory effects, so it is considered as a functional food.

Nutritional importance of ragi

Parameters	**Nutritional value (100 g)**
Carbohydrate (g)	66.82
Protein (g)	7.16
Fat (g)	1.92
Fiber (g)	11.18
Energy KJ	1342

Water soluble vitamins	**mg**
Thiamin	0.37
Riboflavin	0.17
Niacin	1.34
Pantothenic acid	0.29
Total folate	34.66
Total carotenoids	154 ug

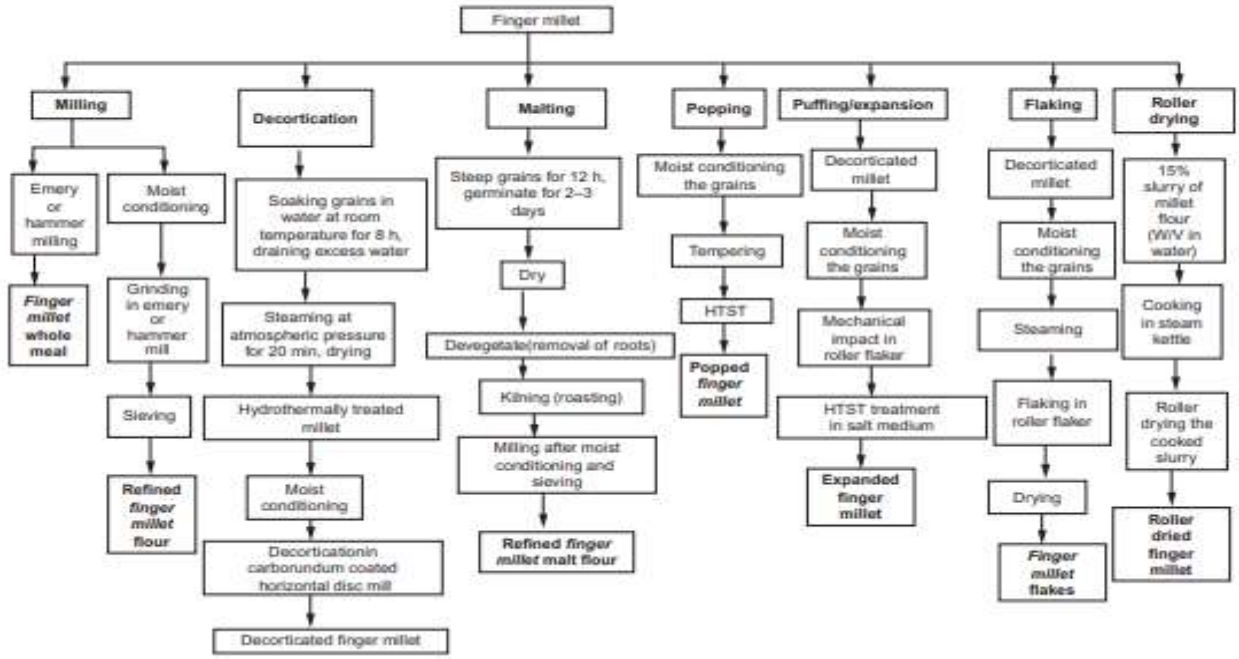
Minerals and trace elements	**mg**
Calcium	364
Iron	4.62
Magnesium	146
Manganese	3.19
Phosphorous	210
Potassium	443
Sodium	4.75
Zinc	2.53

Fatty acid profile	**mg**
Palmitic acid	290
Stearic acid	27.86
Oleic acid	585
Linoleic acid	362
Total saturated fatty acid	317
PUFA	431

Amino acid profile	**g**
Histidine	2.37
Isoleucine	3.70
Luecine	8.86
Lysine	2.83
Methionine	2.74
Cystine	1.48
Phenylalanine	5.70
Threonine	3.84
Tryptophan	0.91
Valine	5.65

Source : Indian Food Composition tables- NIN (2017)

Different processing techniques for ragi based food products



Source - Malleshi, N. G. (2007)

Functional properties of ragi

1.Antioxidant property

Ragi grains had higher antioxidant capacity due to high total phenolic content as well as flavonoids such as epicatechin, procyanidin, gallocatechin, procyanidin dimmer, levels of non enzymatic antioxidants (vitamin E, C and glutathione) and enzymatic antioxidants (catalase, superoxide dismutase, glutathione peroxidase). Veenashri and Muralikrishna (2011).

2. Antiprotein (albumin) glycation property

Ragi seed coat contains polyphenols were effective inhibitors of fructose induced albumin glycation. Dayakar Rao *et al*., (2017).

3.Antimicrobial activity

Polyphenol extract from finger millet seed coat and whole flour active against Bacillus cereus, Aspergillus niger and Fermented finger millet extract- suppress growth of Salmonella sp., Escherichia coli. Viswanath *et al*., (2009). Singh *et al*., (2015).

4.Antiulcerative property Ragi incorporated diet prevents mucosal ulceration. Anjum *et al*., (2021).

5. Aldose reductase (AR) enzyme inhibitory property

Polyphenols and quercitin found in the ragi seed coat it inhibits the aldose reductase enzyme activity which results in the prevention of AR induced caractogenesis. Anjum *et al*., (2021).

6. Blood glucose lowering effect, Nephroprotective properties, Cholesterol lowering

Finger millet's phytochemicals help in slowing digestion process. This helps in controlling blood sugar level in condition of diabetes. It has been found that finger millet based diet helps diabetics as it contains higher fibre than rice and wheat. Found that diet based on whole finger millet has lower glycemic response i.e. lower ability to increase blood sugar level. This is due to presence of factors in finger millet flour which lower digestibility and absorption of starch. Ragi incorporated diets reduces serum cholesterol and phenolics from ragi seed coat matter inhibits the pancreatic amylase and glucosidase helps in controlling postprandial hyperglycemia. Shobana *et al*., (2010).Chandra *et al*., (2016)

7. Inhibition of phospholipases (PL)

Crude polyphenol, quercitin and gallic acid found in ragi had potent inhibitor of PLA 2 from snake venom, it indicates the potential application of ragi in treating inflammatory disorders. S. Sen *et al*., (2011).

8.Inhibition of pathogenic bacterial strains

Protocatechuic, caffeic, gallic, parahydroxy benzoic acid, polyphenols, and quercitin from ragi inhibited the growth of several pathogenic bacteria. Manovina, *et al*., (2022)

9.Improvement on hemoglobin status in children

Germinated ragi is an excellent source of natural iron it helps improvement on hemoglobin status. Remya, M. R. (2016)

10. Natural probiotic treatment for diarrhea

Ragi fermented malted beverage by lactic acid bacteria used as a therapeutic agent. Thamarai Selvi & Harinisri (2021)

11. Production of antihypercholestrolemic metabolites

Solid state fermentation of ragi results in the production of metabolites like statin viz. pravastatin, lovastatin, monacolin J, pravastatin and mevastatin known as monacolins. These metabolites inhibit the enzymatic conversion of hydroxymethyl-glutarate mevalonate by HMG-

CoA reductase, which is the important step in the biosynthetic pathway of cholesterol. Tamilselvan, T *et al*., (2023).

12. Wound healing property

Ragi extracts improved the antioxidant property and results in ameliorating this impairment by improving the NGF (Nerve Growth Factor) and also consumption of ragi helps in relaxing body naturally. It is beneficial in conditions of anxiety, depression and insomnia. It is also useful for migraines. Gull *et al*., (2015).

13. Strengthen the bone and teeth

It is an excellent source of natural calcium which helps in strengthening bones for growing children and aging people. Regular consumption of finger millet is good for bone health and keeps diseases such as osteoporosis at bay and could reduce risk of fracture. Shingote *et al*., (2021)

14. Reducing aging

Ragi are rich in antioxidants and phenolics those are key parameters for good health, aging and metabolic syndrome. Ragi curb cross-linking of collagen and glycation those are responsible for aging in individuals. Chidambaram, P. (2019).

Conclusion

Finger millet is an extremely nutritious cereal and is very beneficial for maintaining a good health. Therefore have received attention for their potential role as functional foods. Ragi's dietary fiber and polyphenols have been recognized to offer several health benefits such as anti-diabetic, protection from diet related chronic diseases, hypocholesterolaemic, antioxidant, and antimicrobial effects to its regular consumers. The functional and nutritional activity have been studied and on review it is found that in comparison to other cereals, finger millet is enriched with several types of minerals, antioxidants, fatty acids and minerals which have a great importance and significance in a healthy nutrition rich diet and essential to maintain a healthy life.

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A REVIEW ON CLIMATE CHANGE IMPACTS ON MARINE ECOSYSTEMS: FROM OCEANIC DYNAMICS TO BIODIVERSITY LOSS

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Abstract

Climate change exerts profound effects on marine ecosystems, altering oceanic dynamics and threatening biodiversity on a global scale. Ocean acidification, resulting from increased atmospheric carbon dioxide, poses further challenges by impeding calcification rates and altering marine chemistry, with repercussions for species relying on calcium carbonate structures. Sea level rise, primarily attributed to ocean warming and land ice melt, presents imminent threats to coastal regions, exacerbating erosion and inundation risks. Additionally, loss of biodiversity, manifested through declines in deep-sea ecosystems, coastal fish diversity, crustacean populations, and coral reefs, underscores the cascading impacts of climate change on marine life.

Keywords :- climate change, biodiversity, fish, acidification, temperature.

Introduction

Climate change refers to significant and long-term alterations in the Earth's climate patterns, including changes in temperature, precipitation, wind patterns, and other aspects of the climate system [1]. Marine ecosystems play a central role in the planet's biology, our comprehension of how anthropogenic climate change impacts them remains inadequately developed [2] . The fluctuation of fish stocks within marine ecosystems, influenced by climate, directly affects the fisheries they support, consequently impacting human populations reliant on specific fisheries [3]. The ecosystem off the west coast of south america experienced a notable and globally significant fluctuation in marine production and fisheries, primarily attributable to

the impact of the el niño-southern oscillation (enso) and decadal variability in ocean climate.anthropogenic climate change has already resulted in decreased ocean productivity, altered dynamics of food webs, diminished abundance of habitat-forming species, shifts in species distributions, and an increased occurrence of diseases within marine ecosystems)[4]. Climate change is not only modifying the total net primary productivity (npp) but also disrupting trophic relationships within ecosystems. These changes result from various factors, such as warming waters, shifts in the distribution and composition of phytoplankton, habitat alterations, modifications to ecosystem structure, decreased dissolved oxygen levels, acidification, and alterations in seasonality [5].

Rising of Sea temperature

During the period from 2000 to 2013, the sea surface temperature (SST) in the Indian Ocean exhibited a noticeable rise attributed to greenhouse gas forcing. This increase varied across the region, with a minimal rise observed in the northern part and a significantly higher increase in the southern portion of the Indian Ocean [6]. Conversely, the Intergovernmental Panel on Climate Change (IPCC) clarified the impact of human activities on climate change in its fifth assessment report. It stated that global temperatures rose by 0.85°C between 1800 and 2012. Projections indicate that by the end of this century, sea levels will increase by 82 cm, and approximately 70–90% of the world's coral reefs would decline with a warming of 1.5°C [7]. Coral reefs stand out as the planet's most remarkable and diverse marine ecosystems. These intricate and prolific structures harbor hundreds of thousands of species, a significant portion of which remains unknown to science. Celebrated for their stunning beauty, unparalleled biological diversity, and exceptional productivity, coral reefs epitomize the magnificence of marine life [8]. Salinity fluctuations are believed to have a significant influence on the distribution of reef-building corals in coastal areas. Corals exist naturally at salinities that range from 32 to 40 [9]. The growth and survival of reef-building corals are profoundly impacted by both the biological and physical characteristics of their environment. Predators like the crown-of-thorns starfish, Acanthaster planci [10], as well as diseases, play significant roles in determining the survival rates of reef-building corals and various other invertebrates associated with coral reefs.

Ocean acidification

The increasing concentration of atmospheric carbon dioxide (CO2) is leading to global warming and ocean acidification [11], These factors are increasingly acknowledged as crucial

drivers of change in biological systems [12]. Due to human activity, the current atmospheric CO2 concentration stands at 380 ppmv and is presently increasing at a rate of 0.5% per year [13]. This rate of increase is 100 times faster than any change observed over the past 650,000 years [14]. The elevated partial pressure of CO2 (pCO2) in seawater, also known as hypercapnia, can affect marine organisms in two primary ways: first, by reducing calcium carbonate (CaCO3) saturation, which impacts calcification rates, and second, by disrupting acid-base (metabolic) physiology. Recent research suggests that the absorption of anthropogenic CO2 by the ocean and the resulting alterations in seawater chemistry have detrimental effects on numerous calcifying organisms. These effects may lead to changes in biodiversity, trophic interactions, and other ecosystem processes[15]. While most macroalgae demonstrate a degree of tolerance to ocean acidification, with approximately a 5% decrease in species diversity projected under RCP 8.5[16], significant changes in algal community composition occur[17], leading to substantial alterations in coastal habitats. In tropical, sub-tropical, and temperate seep sites, episodes of carbonate undersaturation result in the thinning of coralline algae, which typically form a foundational pavement on rocky substrates in the photic zone, crucial for the settlement and growth of other marine organisms[18].

Rise sea level

The accumulation of human-induced greenhouse gases in the atmosphere has triggered global warming, resulting in various visible consequences. These include the rise in Earth's mean temperature, increased ocean heat content, glacier melting, and loss of ice from the Greenland and Antarctica ice sheets. Ocean warming and land ice melt contribute to the rise in sea levels. Consequently, the issue of sea level rise and its effects on coastal areas has garnered increasing attention from the scientific community, as well as from the media and the public.[19] Ocean warming leads to the thermal expansion of seawater, resulting in a rise in sea levels. Additionally, water from the melting of land ice eventually flows into the oceans, further contributing to sea level rise. Data collected from in situ tide gauges since the mid-to-late nineteenth century and high-precision altimeter satellites since the early 1990s consistently demonstrate the observed rise in sea levels[20]. Climate model projections suggest that by the year 2100, most mid-latitudes are expected to undergo a sea level increase approximately in line with the global average, ranging from a few decimeters to around 1 meter. However, specific projections may vary depending on the dispersion of models and the warming scenarios

considered. The Arctic region is anticipated to experience increased sea water freshening due to the melting of sea and land ice, contributing to enhanced sea level rise in this area. Along the eastern coast of North America, higher-than-average sea level rise is projected, primarily attributed to the decline in deep water formation in the Labrador Sea and the consequent slowdown of the Atlantic meridional overturning circulation[21].

Loss of biodiversity

Biodiversity encompasses the diversity of living organisms within a particular area, encompassing the variety of life forms, the genetic diversity they possess, and the ecosystems they collectively form.[22] Organisms within ecosystems exhibit a wide range of sizes and shapes, from simple unicellular prokaryotes to complex multicellular eukaryotic organisms. Each organism fulfills a unique role and contributes to the stability of the ecosystem. Climate change has a significant impact on biodiversity and agricultural practices, affecting both the composition and functioning of ecosystems, as well as agricultural productivity and resilience.[23].

A.Deep sea biodiversity

Marine biodiversity and ecosystems face numerous threats, including pollution, shipping activities, military operations, and climate change. However, fishing currently poses the most significant threat. Specifically, bottom trawling represents the greatest danger to biodiversity in the deep sea. This method of high-seas fishing is particularly destructive to seamounts and the cold-water corals they support. These habitats serve as critical environments for various commercially valuable bottom-dwelling fish species.[24]

B.Coastal fish diversity

Coastal fisheries play a vital role as essential resources for hundreds of millions of people worldwide. However, many scientists highlight the significant overexploitation of fisheries and the resulting decline in fish stocks as the primary factor driving marine ecosystem changes over the past two centuries . Recent findings indicate that oceanographic and climatic variability have also played a dominant role in influencing fish stocks.[25]

C.Crustaceans

The rise in carbon dioxide concentration in water leads to a decrease in seawater pH, resulting in ocean acidification. This has adverse effects on crustaceans, as their outer skeletons primarily consist of aragonite, a form of calcium carbonate that can dissolve in acidic seawater. The decline of these small crustaceans, which are vital components of the ocean's food web, can

have profound impacts on the entire marine ecosystem. Oceanographic studies have indicated that krill, a type of small crustacean feeding on phytoplankton, have experienced an average decline of 80% over the past 30 years.[26]

D.Coral reef

Coral bleaching occurs when corals expel the symbiotic algae living within their tissues, causing them to lose their coloration and turn white. This process results in the loss of important symbionts and can lead to significant changes in reef-building coral communities, with up to 90% of corals being affected. Corals serve as the foundational framework for numerous other species, providing habitat and support for a diverse array of marine life. Fish that rely on corals for food, shelter, or breeding grounds may experience drastic shifts in abundance or even face extinction. Additionally, the impacts of coral bleaching extend to thousands of other organisms, highlighting the vulnerability of marine biodiversity to these events[27].

Conclusion

The intricate web of interconnected factors elucidates the profound impacts of climate change on marine ecosystems. From rising sea temperatures and ocean acidification to sea level rise and loss of biodiversity, the consequences are far-reaching and alarming. These changes not only disrupt the delicate balance of marine life but also jeopardize the livelihoods of millions of people who depend on the ocean for sustenance and economic security. Efforts to reduce greenhouse gas emissions must be intensified to limit further warming and ocean acidification. Additionally, measures to enhance the resilience of marine ecosystems, such as sustainable fisheries management and conservation of critical habitats like coral reefs, are imperative. It is incumbent upon us to act decisively and responsibly to mitigate climate change and protect the invaluable biodiversity of our oceans. Only through concerted efforts and a shared commitment to sustainability can we ensure a healthy and thriving marine environment for generations to come.

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TOPIC – PEARL CULTURE: A BASIC GUIDE TO PEARL PRODUCTION

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Abstract

For centuries, the allure of pearls, symbolizing opulence, purity, and sophistication, has enchanted humanity. While natural pearls remain rare and precious, the advent of pearl culture has made these gems more accessible. This abstract explores the captivating realm of pearl farming, examining its historical roots, methodologies, and cultural significance.Beginning with a historical backdrop, the abstract highlights the ancient tradition of pearl diving and the scarcity of naturally occurring pearls. It then transitions to the evolution of pearl culture techniques, illustrating how scientists emulate mollusc defence mechanisms by implanting nuclei and mantle tissue into specific species. The abstract provides insights into diverse pearl culture methods, ranging from traditional Akoya oysters to freshwater mussels in China, each yielding pearls with distinctive characteristics.Beyond technical aspects, the abstract underscores the economic and societal implications of pearl culture. It emphasizes the substantial impact on livelihoods, particularly in Asian coastal communities, and the role of pearl farming in fostering sustainable aquaculture practices. Concluding with acknowledgment of industry challenges, including environmental considerations and disease risks, the abstract remains optimistic about the future of pearl culture, anticipating advancements in technology and responsible farming practices.

Keywords*:* Pearl; Culture; mabé; nacre; farming; spat;

Introduction

The pearl oysters, classified under the genus *Pinctada* (Roding) and belonging to the family *Pteriidae*, are present in nearly all tropical and subtropical seas. They inhabit the seabed

ranging from low tide levels to depths reaching 80m. While there are reports of 28 species of pearl oysters, only three have been identified as capable of producing pearls of gem quality with commercial value. These three species are *Pinctada maxima* (Jameson), *P. margaritifera* (Linnaeus), and *P. fucata* (Gould). Pearl oysters can be found in various locations, including the Persian Gulf (Bahrain, Kuwait, Dubai, Muscat, and Bushira), Red Sea (Farasan Islands, South of Sabia and Jidda, West of Mecca, and Sudan), Philippines, Japan, China, Korea, Myanmar, Indonesia, Papua New Guinea, French Polynesia, Cook Islands, Australia, Gulf of California, Mexico, Panama, and Venezuela.

In India, the Gulf of Kutch in Gujarat and the Gulf of Mannar in Tamil Nadu are renowned regions for pearl oyster resources. Hornell (1922) [9] extensively documented the history of the pearl fishery in the Gulf of Mannar. Alagarswami and Qasim (1973)[10] have addressed the distribution of pearl oysters in India, as well as the exploitation, farming methods, and technological aspects of pearl culture. Mahadevan and Nayar (1973) [11] conducted a comprehensive review of Indian pearl fishery resources, pinpointing *Pinctada fucata* as the prevalent Indian pearl oyster found in the Gulf of Mannar and the Gulf of Kutch. Rao and Rao (1974) [14] identified six crucial species of pearl oysters along the Indian coasts. The initial insights into the pearl oyster resources in the Gulf of Kutch stem from Hornell's work [9]. Subsequently, Easwaran et al. (1968) [13] outlined the current status of pearl fishery in the Gulf of Kutch, while Pandya (1974)[12] delved into pearl oyster fishery and culture experiments in Gujarat. Here, with this article we shall discuss about the deployment of pearl culture for enhancing the livelihood of women and thus empowering them. It has been tested in the Fiji Islands quite a while back and satisfactory results were seen in improving women's lives [1].

Process Behind Pearl Production

Cultivation of pearls commences with the introduction of a segment of mantle tissue (saibo) obtained from a donor pearl oyster, along with a spherical inorganic nucleus, into the gonad of a recipient pearl oyster. This procedure is widely known as 'seeding' or 'grafting'. The ensuing propagation of the donor mantle tissue results in the development of a 'pearl-sac' encasing the nucleus. The ongoing deposition of nacre from secretory cells within the pearl-sac onto the nucleus ultimately leads to the gradual formation of a cultured pearl, typically taking approximately two years. Mabé pearls are generated through the affixing of hemispherical nuclei to the inner surface of oyster shells, a method referred to as 'seeding', employing a

straightforward technique that can be imparted to community members through suitable training. Following the application of nuclei, the oysters are reintroduced into the ocean, where they undergo a growth period lasting 10–15 months, culminating in the harvest of the resultant mabé pearls. It is a very easy process and can be easily taught and proper training can be taken to make people understand the entire process. The community of women of a particular place may be divided into several group to facilitate providing training to them. Hands on training is a mandatory thing to understand the entire process so it should be done with utmost importance [5].

The primary determinant affecting sexual development and spawning patterns is temperature. Spawning events are typically not constrained to specific seasons, with protracted spawnings observed throughout the entire year. For *Pinctada maxima*, the peak spawning intensity occurs during the summer months [7]. *Pinctada margaritifera* typically displays two distinct periods of maximum spawning [8]. Noticeable fluctuations in seasonal temperatures lead to more discrete spawning events in regions situated at higher latitudes.

Site Selection

The success of a farm is contingent upon the judicious selection of an appropriate site. Inadequate sites may lead to sluggish growth, elevated mortality rates, susceptibility to diseases, and, most significantly, the production of pearls of substandard quality. To ensure the identification of a suitable site, adherence to the following guidelines is imperative:

1. Water Quality: The necessity for clean, unpolluted seawater is paramount. Consequently, the chosen site should be distanced from potential pollution sources, such as garbage dumps, chemical or oil depots, areas densely populated by humans, and freshwater run-off zones, including rivers.
2. Depth: An optimum depth ranging from 25 to 35 meters is recommended.
3. Water Movement: A modest current is advised to facilitate the influx of clean water and a fresh supply of nutrients for the oysters. Excessive current or wave activity can impede farm operations and potentially result in inadequate oyster growth.
4. Security: Given the substantial value of pearls, it is imperative to position farms in areas subject to surveillance either by the farmer or a trusted individual.
5. User Conflict: Areas characterized by heavy boat traffic or fishing activity should be avoided to mitigate potential harm to the farm from propellers and fishing lines.

Furthermore, this minimizes the exposure of the farm to human traffic in general [2].

Obtaining Pearl Oysters

Pearl oysters for aquaculture purposes are sourced through one of three methods: the collection of wild juveniles and adults, spat collection, and the utilization of hatchery-reared animals. The collection of wild animals is frequently employed when establishing a farm for the first time, as it provides an immediate pool of animals for grafting. However, reliance on wild collection is deemed unsustainable due to its rapid depletion of local oyster populations. Additionally, pearls produced by wild-caught oysters tend to exhibit inferior quality compared to those cultivated on farms from an early age.

Spat collection involves the attraction of free-swimming larval stages of pearl oysters to settle on a substrate suspended in the water. This method is prevalent for acquiring Black-lip pearl oysters due to its cost-effectiveness and simplicity. Various materials can be utilized to entice pearl oyster spat, with black polyethylene shade cloth material proving particularly effective. The material is arranged to create folds, providing hiding spaces for the spat to evade predators. Collectors are suspended on longlines approximately 1-2 meters below the water surface. To mitigate fish predation, lines should be anchored at a depth of 20-30 meters and positioned at least 30 meters away from the reef edge. Black-lip pearl oysters typically exhibit a seasonal spawning pattern with two peaks annually.

Grafting

The grafting process represents one of the most financially demanding and pivotal aspects of pearl farming. Grafting, also referred to as seeding, is a surgical procedure wherein a bead or nucleus is surgically implanted into the oyster to initiate pearl formation. This intricate procedure is conducted by a highly skilled technician whose services are remunerated by the farmer. The technician initiates the process by carefully selecting a donor oyster and extracting the mantle responsible for nacre production. Subsequently, the mantle is meticulously trimmed and cut into small squares, approximately 2 mm in size.

One piece of the prepared mantle is then introduced into the gonad of the pearl oyster through a small incision performed by the technician. Following this, a round nucleus is placed onto the mantle tissue, ensuring contact. If executed correctly by the technician, the mantle tissue grows around the nucleus, forming the pearl sac and progressively depositing an even layer of nacre

onto the nucleus, ultimately shaping the pearl. Pearl production spans 18-24 months from seeding until the nacre reaches a thickness of 2-3 mm.

Post-grafting, approximately 10% of the oysters succumb, and an additional 20% reject the nucleus. Numbers surpassing these thresholds may indicate either a subpar technician or the onset of disease. Oysters rejecting the nucleus still hold value, as the residual graft and tissue inside the oyster give rise to an irregular pearl known as a keshi. This keshi can be harvested concurrently with the pearls and marketed as jewellery.

While technicians command a substantial salary for their specialized services, proficient work yields lucrative returns for the farm. In addition to their compensation, technicians necessitate accommodations and sustenance while engaged on the farm, along with a designated "seeding platform," typically a shed located on or in proximity to the farm, where oysters are brought for seeding. The seeding platform must be sturdily constructed, set on a solid foundation, and shielded from strong breezes.

Although hiring a seeding technician incurs notable expenses, mitigating measures include offering a portion of the harvest profits as payment instead of an upfront fee. This not only contributes to cost reduction but also serves as a compelling incentive for the technician to execute seeding tasks with utmost diligence. Technicians often commit to travel only when assured of a substantial volume of work. Small-scale farmers can surmount this challenge by forming a cooperative to jointly hire a technician capable of servicing all the farms collectively [3].

Maintenance

Pearl oysters, particularly following the seeding process, constitute valuable organisms and necessitate meticulous care. Regular surveillance of all sections of the farm at intervals of 2-3 days is imperative to identify and address any broken or damaged lines promptly. Fouling, manifested by the rapid accumulation of algae, sponges, and other bivalves on the shells of pearl oysters, poses a potential threat by impeding feeding and causing damage to the shells if not promptly addressed. A routine cleaning regimen, occurring once every 4-6 weeks, is recommended, with larger farms often employing automated cleaning machinery, while smaller operations typically rely on gasoline-powered handheld pressure sprayers to eliminate fouling. Concurrently, the lines and floats supporting the oysters should undergo cleaning following a similar schedule [4].

Special attention is warranted for small pearl oysters or spat, as they demand additional care. If housed together, meticulous separation is essential to prevent clumping. Regular inspections of their holding containers are indispensable to promptly eliminate potential predators such as crabs or snails, which pose a significant threat to the survival of many spat.

Harvest

The harvesting of pearls holds comparable significance to the seeding process, as oysters demonstrating the capacity to produce high-quality pearls can undergo re-implantation with a new nucleus to yield subsequent pearls. A skilled seeding technician, often the same professional responsible for the initial implantation, executes a precise incision in the pearl sac to extract the pearl. Subsequent to examination, if the pearl attains a standard of high quality, a new and larger nucleus is meticulously inserted into the pearl sac, after which the oyster is returned to the farm. Oysters can undergo re-implantation up to two times, each instance involving a nucleus of a size equivalent to the dimensions of the previously harvested pearl. To illustrate, if an initial 5 mm diameter nucleus results in the production of a 7 mm pearl, a subsequent 7 mm nucleus may be used in the re-implantation process [6].

Conclusion

Though it may look very difficult to execute but the fact is it's very easy and very much doable if proper steps and procedures are taken into account. It will definitely be very helpful to some self-help groups and women. Grafting and harvesting are the most delicate process in this entire culture practice so proper emphasis if given specially to these steps then some affirmative results may be seen. Moreover, if a farmer wants to generate an additional income, then also it's a very great farming practice.

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RECENT INSIGHTS ON TRAITS GOVERNING PHOSPHORUS USE EFFICIENCY IN AGRICULTURAL CROPS

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Abstract

With the burgeoning effects of global warming and climate change, the impetus on developing nutrient use efficient crop genotypes is on the rise. One of the least studied aspects of nutrient use efficiency is the ratio of rate of photosynthesis to leaf nutrient content (Prieto et al., 2023). Among the primary nutrients, nitrogen being a major determinant of photosynthesis, a lot of work has been undertaken in that aspect (Jia and Gray 2004; Hidaka and Kitayama 2009). Nevertheless, phosphorus (P) and potassium are key elements largely limiting photosynthesis (Nguyen et al., 2022; Prieto et al., 2023; Yan et al., 2023), hence it is essential to understand the physiological mechanisms and biochemical basis of photosynthetic nutrient use efficiency. Due to its dynamic nature in the soil, potassium deficiency is a relatively lesser concern to agricultural cropping systems as compared to P (Veneklaas et al., 2012). P is second only to nitrogen in determining the photosynthetic potential, which in turn influences crop growth and productivity. Plant and soil scientists are always in the pursuit to uncover simple and robust traits amenable to conventional or molecular breeding to develop P-efficient crop genotypes combining high photosynthetic potential, to sustain yields under resource-limited soils. Agricultural crops grown in P-impoverished soils would greatly benefit by sustaining high photosynthetic rates, the latter being a major determinant of P use efficiency (PUE). P

application increased photosynthetic nitrogen use efficiency in broad bean through its positive influence on photon saturated photosynthetic rate (maximal photosynthesis) and carboxylation efficiency (Jia and Gray 2004). Owing to the importance of photosynthetic processes in PUE, photochemical quenching was identified as a potential trait for screening phosphorus efficient wheat genotypes (Nguyen et al., 2022). Canopy photosynthesis is positively correlated to total leaf P content (Lambers, 2022), but its relationship to P fractions (inorganic P, metabolite P, nucleic acid P, lipid P, and residual P) remains inconclusive.

Diversity in plant adaptation to low phosphorus stress

The diversity in plant adaptation to low phosphorus (P) stress is prevalent in terms of morphological, anatomical, biochemical, and physiological features. Information on foliar P fractions in native invasive plant species is abundant in comparison to that of domesticated crops, but research focus on the latter is increasing due to their agricultural importance. Table 1 presents the contrasting trends in foliar P allocation between native plants and domesticated crops. Report on the preferential allocation of foliar P fractions, influencing the photosynthetic phosphorus use efficiency (PPUE) in chickpea by Wen et al. (2023) brings a new perspective of investigating intricate details of how and where plants partition essential nutrients (P), rather than an estimate of total P content *per se*. Results warrant further study in several aspects including metabolic and ionic interactions, and genetic regulation of the preferential allocation of foliar P in P-efficient crops with high PPUE, in order to reduce the dependence on P fertilisers and sustain productivity in resource-limited soils.

Table 1. Allocation of foliar phosphorus fractions in native plant species and domesticated crops of agricultural importance adapted to low phosphorus conditions

Foliar P fraction	Proteaceae	Fabaceae	Rapeseed	Chickpea	Maize	Rice
Nucleic acid P	Low	High	High	High	Low	High
Lipid P	Low	No change	High	No change	Low	Low

Metabolite P	**High**	**Low**	**Low**	**Low**	**High**	**No change**
Inorganic P	**High**	**Low**	**High**	**Low**	**High**	**Low**
Residual P	**No change**	**No change**	**No change**	**No change**	**No change**	**No change**

Note: Response in agricultural crops is genotype-specific; P-efficient genotype is considered here for the sake of comparison.

Native plant species and domesticated crops: a class apart

Preferential allocation of leaf P fractions and remobilisation of internal P from matured and/or senescing tissues to physiological active regions has been implicated as an important adaptation under P deficiency (Veneklaas et al., 2012). Differential distribution of leaf P fractions is widespread in plants across families, species, regions, and seasons (Kakie, 1969; Liu et al., 2023; Suriyagoda et al., 2023), and a plasticity in allocation of P fractions is required under P deprivation. Inter-specific variation for allocation to leaf P fractions is more prevalent as compared to intra-specific variability (Hidaka and Kitayama 2013; Mo et al., 2019; Liu et al., 2023), with significant influence on species diversity in P-limited regions (Yan et al., 2019). Increasing concentration of CO_2 impacted allocation of leaf P fractions in plants acclimated to low soil P availability by preferential allocation of inorganic P and metabolite P; whereas nucleic acid P and residual P considerably decreased (Zhang et al., 2021). Species or plant families acclimatised to low P availability (Proteaceae) exhibited lower allocation to lipid P and nucleic acid P, as compared to inorganic and metabolite P, and residual P (Tsujii et al., 2023). Leaf P fraction data is abundant for native, invasive plant species, while limited information is available in domesticated crops dominating global agricultural systems (Suriyagoda et al., 2023). Agricultural crops exhibit different stress responses as compared to native plant species, hence the need arises to understand the biochemical basis of PPUE in major crops and genotypes.

Differences in allocation of P fractions to young and physiological active leaves among crop genotypes have been reported in rice (Joeng et al., 2017; Hayes et al., 2022) and maize (Han et al., 2022). Ion synergism (with potassium) was one of the mechanisms of enhancing P uptake in rapeseed grown under low P availability (Yan et al., 2023), by prioritizing investment in

inorganic P and metabolite P rather than remobilisation of lipid P. Because of lipid remodelling under P deficiency, the reduced investment in lipid P fraction increased PPUE in P-efficient rice genotypes (Hayes et al., 2022), while nucleic acid P was relatively high under nutrient stress. Despite contrary reports (Dokwal et al., 2021), remodelling of phospholipids with non-phospholipids has evolved as an important strategy to improve crop tolerance to low P stress (Honda et al., 2023).

Phosphorus efficient plants show preferential foliar P allocation

Chickpea genotypes with similar area-based and mass-based photosynthesis, and same leaf nitrogen content, exhibited stark differences in terms of PPUE; wherein lower total foliar P resulted in high PPUE (Wen et al., 2023). Such a differential response was attributed to differences in the percentage allocation of foliar P fractions, rather than the actual concentration *per se*. Irrespective of genotype, allocation to nucleic acid P was highest (39-47%), followed by metabolite P (21-25%), inorganic P (15-18%) and lipid P (16-18%), with residual P comprising merely 1% of the total foliar P content in chickpea. Higher allocation of nucleic acid P in P-efficient chickpea genotype led to enhancement in PPUE as compared to the P-inefficient genotype. PPUE was negatively correlated to inorganic P and metabolite P, while influence of low P supply on the lipid P fraction was negligible. Further, X-ray elemental analysis ruled out the influence of differential allocation of total P to cell types, such as the mesophyll and epidermal cells on PPUE. Co-existence of calcium and P was observed in mesophyll and epidermal cells across P-efficient and P-inefficient chickpea genotypes. Mesophyll cells showed more sulphur, whereas epidermal cells tended to have more potassium and magnesium. Nucleic acid P mainly comprises ribosomal proteins and rRNA, essential for optimal turnover of protein and enzymes including Rubisco that drives photosynthesis in C_3 plants. Reduced allocation to inorganic P and metabolite P suggested less substrate concentration, which when compensated by higher enzyme concentration, helps maintain a rapid metabolic flux under stress (Lambers, 2022). Phospholipids are predominantly found in endoplasmic reticulum and Golgi apparatus that support protein synthesis, hence the reduced P investment in lipid P fraction through lipid remodelling (Dokwal et al., 2021; Honda et al., 2023) did not hold true in the case of chickpea. Chickpea genotype with lower total foliar P sustained rapid photosynthetic rates, owing to their disparity in allocation of foliar P fractions and a more economic P use strategy in their leaves.

Identification of such P-efficient crop genotypes, and their underlying mechanisms is essential in the context of reduced dependence on P fertilisers for sustainable agricultural systems.

A plethora of opportunities in sugarcane

In line with recent advancement in the physiological and biochemical traits governing phosphorus use efficiency of agricultural crops, sugarcane may also be screened for genotypic differences in terms of photosynthetic phosphorus use efficiency. Further, detailed analysis of foliar phosphorus fractions in contrasting sugarcane genotypes would lead to newer insights. Wen et al. (2023) report enhanced investment in nuclei acid P as an adaptive mechanism under low P stress in P-efficient genotypes. Nevertheless, the safe range of operation remains to be asserted, as in how low is low? Likewise, quantification of specific metabolites or pathways affected under low P stress (Han et al., 2022) would give a greater understanding of the interactions between nucleic acid P and metabolite P. Further, change in pattern of allocation of foliar P fractions under sufficient and excess supply of P would be one of the areas of future research. The intercellular co-existence of calcium and P in response to sufficient and excess supply of P would shed more light on plant's tolerance mechanism. Ionic synergism enhanced plant growth and metabolism under low P stress (Zhang et al., 2021; Yan et al., 2023), hence understanding the ionic interactions by analysing cell-specific ionomes may also be an interesting line of work. Deciphering the molecular mechanisms regulating these alterations under low P stress is essential to identify candidate genes and proteins amenable for molecular breeding and crop improvement.

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SOYMILK INCORPORATED YOGURT

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Introduction

Yoghurt is a dairy production that has more profits than milk. Digestive system in some of people has an allergy to lactose (sugar of milk), but lactose is transformed to lactic acid in yoghurt and dose not create allergy .Fermented milks in general have a good nutritional value that compares favorably with that of milk from which they are made (Abou Dawood et al., 1993). Recently, researchers are interested in the physiologically beneficial phyto chemicals from soya beans and soya products and then effect of blending soya milk with cow milk on Yoghurt or Labneh is done .The study focuses on using Soy milk as prebiotic in manufacturing of Labneh or Yoghurt. Yoghurt decreases event of bowel cancer remarkably and is more effective in absorbing minerals, proteins and vitamins of group due to containing biological adequate conditions. The measurement of vitamins and salts in yoghurt is more than milk in the same volume, because dry matter of yoghurt is more than milk. Yoghurt contains vitamins of B,C,A,D,E and all ingredients and features of milk. Yoghurt strengthen abdomen and helps digestion of food and relax nerves due to containing vitamin B. On the other hand, calcium of yoghurt is absorbed in body faster than milk. Because, lactic acid of yoghurt turns calcium to solution and absorbtion therefor, yoghurt devotes calcium to body more than milk.

Importance of Soy milk

Soymilk is milk produced from soybeans. Soybeans are generally considered to be a source of complete protein. A complete protein is one that contains significant amount of all the

essential amino acids that must be provided to the human body because of the body's inability to synthesize them. For this reason, soy is a good source of protein, amongst many others, for many vegetarians and vegans or for people who cannot afford milk and meat, since it is the least expensive source of dietary protein. The gold standard for measuring protein quality, since 1990, is the Protein Digestibility Corrected Amino Acid Score (PDCAAS) and by this criterion soy protein is the nutritional equivalent of meat and eggs for human growth and health.

Soy milk is enriched with nutritive elements such as proteins, unsaturated fatty acids, lecithins, isoflavones, mineral substances, free amino acids, and polypeptides. Isoflavones, an important component of soybeans and soya products, has been reported protect against cardiovascular diseases, breast cancer, prostate cancer, testicular cancer, uterine cancer and other hormone dependent cancers, and osteoporosis .

Importance of blending soymilk with cow milk

The direct fortification of dairy products with vegetable proteins has been increasing because of reasonably low prices of vegetable proteins compared to animal protein, low fat product and nutritional healthy value, regarding the lactose intolerant. The direct consumption of vegetable proteins in food products also has been increasing over the years because of animal diseases, global shortage of animal protein, strong demand for wholesome and religious food, and economic reasons (Asgar et al., 2010).

The development of nutritionally balanced protein foods to feed the growing population in such countries is receiving increasing attention of the food scientists and nutritionists. Several international agencies and governmental programs in developing countries are confronted with a challenging task of alleviating the so-called protein calories malnutrition problem (Singh and Singh, 1991).The conversions of the soy milk protein is important to produce high quality fully digestible protein. This is somewhat low in sulfur containing amino acids, with methionine being limiting amino acids.

Methodology

Materials

A commercial classic yoghurt starter containing Streptococcus thermophillus and Lactobacillus delbrueckii subsp. bulgaricus (1:1) and ABT-5 culture which consists of S. thermophiles, Lactobacillus acidophilus + B. bifidum were used. Starter cultures were in freeze-dried direct-to-vat set form and stored at -18°C until used.

Methods

Preparation of soymilk

Beans of good quality were selected and soaked overnight 12-18h, at room temperature in ultrapure water contained 0.5% NaHCO3. Once soaked, water was discarded and the grains were re-soaked in boiling water for 15min then, hulls were removed under running water by manual rubbing. The peeled soybeans were next rinsed and drained with cold water several times. Of the water to be added to the soaked beans (1:6 beans: water ratios), about half was added at room temperature (23ºC) and blended with the beans at high speed for 10 min. The remaining water was heated to 80ºC and added to the slurry to enhance protein extraction. This mixture was blended for an additional 3 min. at high speed. The resultant slurry was filtered through 3 layers of cheese-cloth to remove coarse material (okara, which is mainly composed of insoluble fiber material). Thereafter, the isolated soymilk was boiled on a low heat for 5 min. to destroy trypsin inhibitor for improving flavor and cooled down to 25 °C.

Yoghurt preparation

- Control 1- yoghurt made from 100 % Cow milk using ABT culture
- Yoghurt made from 75% cow milk + 25% soymilk and ABT culture
- Control 2 – yoghurt made from 100 % Cow milk using classic culture
- yoghurt made from 75% cow milk + 25% soymilk and classic culture

Yoghurt was made using the procedure normally used in homes. Fresh milk was heated to 85°C for 15 min., cooled to 40°C, inoculated with cultures (0.1g/L of yoghurt mix) and incubated at 40°C for fully coagulation. The produced yoghurt was left at 4°C overnight, mixed and put into cloth bags which were hung for 24 h in a refrigerator to allow for whey drainage. The resulting yoghurt was mixed with 1.5% salt and transferred to plastic cups, covered with polyethylene film and stored.

Acidity

Mixing 25 % of soy milk with cow's milk lowered the acidity value. Increasing of acidity in cow milk yogurt may be attributed to lactose fermentation by starter bacteria which produce higher level of lactic acid. On the contrary, lactose absent in soy milk caused low acidity concentration in resulted yogurt.

Fruit and flavors are added at different steps depending on the type of yogurt. For set style yogurt the fruit is added in the bottom of the cup and then the inoculated yogurt is poured on top

and the yogurt is fermented in the cup. For swiss style yogurt the fruit is blended with the fermented, cooled yogurt prior to packaging.

Package

The yogurt is pumped from the fermentation vat and packaged as desired.

Some other types of yogurt

- Mint flavoured yogurt
- Fruits flavoured yogurt
- Nuts flavoured yogurt
- Fruits and nuts flavoured yoghurt

Conclusion

Supplementation of cow milk with 25 % soy milk using ABT and classic culture were acceptable. ABT cultured yogurt is produced with highly nutritional value The produced yoghurt had low saturated fatty acids and high unsaturated fatty acids level with improved health benefits

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ARTIFICIAL INTELLIGENCE IN FUTURE AGRICULTURE

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Introduction

Agriculture has been at the core of human civilization for millennia, providing sustenance and shaping societies. In the 21st century, agriculture is facing unprecedented challenges. The global population is expected to reach 9.7 billion by 2050, requiring a substantial increase in food production. Climate change, resource scarcity, and the need for sustainable practices further compound these challenges. Fortunately, artificial intelligence (AI) is emerging as a transformative force in agriculture, offering innovative solutions to address these pressing issues. This chapter explores the role of AI in the future of agriculture, covering key applications, benefits, challenges, and ethical considerations.

Crop and Soil Management

AI algorithms are vital for effective crop and soil management. They help in recommending the optimal planting density, crop rotation, and nutrient management based on historical data and real-time monitoring. By tailoring strategies to specific conditions, farmers can maximize yields while minimizing the environmental impact.

Monitoring and Disease Detection

Remote sensing, powered by AI, aids in the early detection of crop diseases and pest infestations. Drones and satellites equipped with AI-driven imaging systems can spot anomalies in plant health. This allows for targeted intervention, minimizing the need for widespread pesticide use, reducing costs, and improving sustainability.

Water Management

Efficient water management is a critical concern in agriculture, particularly in regions facing water scarcity. AI can optimize irrigation systems by monitoring soil moisture and weather conditions in real-time. Smart irrigation systems can adjust water delivery based on actual plant needs, reducing water waste and enhancing crop health.

Vertical Farming and Controlled Environments

AI technology is key to the success of vertical farming and controlled environment agriculture. AI systems can manage variables such as light, temperature, and humidity to create optimal growing conditions for crops indoors. This approach not only minimizes land and water use but also allows for year-round production and protects crops from adverse weather conditions.

1.AI-Enabled Precision Agriculture

Sensing and Data Collection

AI-driven sensors and drones are revolutionizing data collection in agriculture. They can monitor crop health, soil quality, and weather conditions in real-time. Machine learning algorithms analyze this data to provide farmers with actionable insights. For example, drones equipped with multispectral cameras can detect early signs of disease or nutrient deficiencies, allowing for targeted interventions.

Predictive Analytics

AI models can forecast crop yields, disease outbreaks, and optimal planting times. By analyzing historical data, weather patterns, and current conditions, predictive models help farmers make informed decisions, optimize resource allocation, and minimize risks. This reduces the use of water, pesticides, and fertilizers, making agriculture more sustainable.

2.Autonomous Farming

Robotic Farming

Robots equipped with AI algorithms can perform various tasks, from planting seeds to harvesting crops. They can work tirelessly, without human intervention, increasing efficiency and reducing labor costs. Autonomous tractors and robotic weeders are examples of AI-powered technologies that are becoming integral to modern farming.

Weed and Pest Control

AI-driven systems can differentiate between crops and weeds with high precision. This enables the use of targeted herbicides and reduces the environmental impact of chemical applications. Similarly, AI-powered pest detection systems can identify and mitigate infestations before they cause significant damage.

3.Smart Resource Management

Irrigation Optimization

AI can optimize irrigation by analyzing soil moisture data, weather forecasts, and crop needs. Smart irrigation systems adjust water delivery in real-time, reducing water wastage and improving crop yields. This is especially crucial in regions facing water scarcity.

Nutrient Management

AI assists in precise nutrient management by monitoring soil nutrient levels and tailoring fertilizer application accordingly. This prevents over-fertilization, which can harm the environment, and ensures that crops receive the necessary nutrients for healthy growth.

4.Supply Chain and Market Intelligence

Supply Chain Optimization

AI streamlines the supply chain by predicting demand, optimizing logistics, and reducing food waste. This ensures that fresh produce reaches consumers efficiently while minimizing losses.

Market Analysis

AI analyzes market trends, pricing data, and consumer preferences to help farmers make informed decisions about crop selection and pricing strategies. This enables them to adapt to changing market conditions and maximize profits.

5.Ethical Considerations and Challenges

Data Privacy

As AI relies heavily on data, concerns about the privacy and security of agricultural data have emerged. Farmers must ensure that their data is protected from unauthorized access and misuse.

Technological Accessibility

The adoption of AI in agriculture may be challenging for small-scale farmers with limited resources.

Efforts should be made to ensure that AI technologies are accessible to all, fostering inclusivity.

Environmental Impact

While AI can contribute to sustainability, it is essential to assess the environmental impact of AI technologies themselves. Manufacturing and disposing of AI hardware can have negative consequences if not managed responsibly.

Conclusion

Artificial intelligence is poised to revolutionize agriculture, offering solutions to the complex challenges facing the industry. By enabling precision agriculture, autonomous farming, smart resource management, and improved supply chain and market intelligence, AI can increase productivity while minimizing environmental impact. However, addressing ethical considerations and ensuring equitable access to AI technologies are crucial to harnessing its full potential. As we venture into the future of agriculture, AI will play a pivotal role in securing food security and sustainability for generations to come.

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EXPLORING THE INTRICACIES OF FOOD EXTRUSION: A COMPREHENSIVE OVERVIEW

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Introduction

Food extrusion is a fascinating and versatile process that plays a crucial role in the food industry. From breakfast cereals to pasta, snacks to pet food, food extrusion is employed to create a wide array of products with diverse textures, shapes, and flavors. In this comprehensive overview, we delve into the intricacies of food extrusion, exploring its principles, applications, equipment, and future prospects.

Understanding Food Extrusion: At its core, food extrusion involves forcing a food mixture through a shaped opening (die) to produce a continuous stream of a specific shape. This process relies on the principles of fluid mechanics, heat transfer, and rheology. The key components of a typical food extrusion system include:

1. **Extruder**: The heart of the extrusion process, an extruder consists of a barrel, screw(s), and a die. The barrel is heated, and the screw(s) rotate to convey the food material forward while subjecting it to mechanical shear and compression.

2. **Die**: The die determines the final shape and size of the extruded product. It can vary in complexity, ranging from simple round openings to intricate shapes designed for specific applications.

3. **Feed System**: This component introduces raw materials into the extruder. Ingredients may be fed in various forms, including powders, liquids, and pre-conditioned mixes.

4. **Heating and Cooling Systems**: Temperature control is critical in food extrusion to achieve the desired texture, structure, and shelf-life of the final product. Heating and cooling systems are employed to precisely regulate the temperature throughout the extrusion process.

5. **Cutting Mechanism**: Once the extruded product exits the die, it is typically cut into the desired length using a cutting mechanism. The cutting process may be synchronized with the extrusion speed to ensure uniformity.

Applications of Food Extrusion:- The versatility of food extrusion has led to its widespread adoption across various food industries. Some common applications include:

1. **Breakfast Cereals**: Extrusion is commonly used to produce a wide range of breakfast cereals, including flakes, puffs, and granola bars. The process allows for precise control over the texture, flavor, and nutritional content of the final product.

2. **Snack Foods**: Extruded snacks, such as cheese puffs, pretzels, and extruded chips, are popular worldwide. The extrusion process enables manufacturers to create snacks with unique shapes, textures, and flavors, appealing to consumers' preferences.

3. **Pasta and Noodles**: Many types of pasta and noodles are manufactured using extrusion techniques. By adjusting the formulation and processing parameters, manufacturers can produce pasta with different shapes, textures, and cooking characteristics.

4. **Meat Analogues**: Food extrusion is increasingly being used to produce plant-based meat analogues that mimic the texture and appearance of conventional meat products. Extrusion allows for the creation of fibrous structures that closely resemble meat muscle tissue.

5. **Pet Food**: Extrusion is a common method for manufacturing pet foods, including dry kibble and treats. The process ensures uniformity in shape, size, and nutritional composition, meeting the dietary needs of various pets.

Equipment and Process Optimization:- Optimizing the food extrusion process requires careful consideration of several factors, including.

1. **Formulation**: The selection and proportion of ingredients significantly impact the extrusion process and the quality of the final product. Ingredients must be chosen based on their functionality, nutritional value, and processing characteristics.

2. **Processing Parameters**: Parameters such as screw speed, barrel temperature, moisture content, and die design influence the extrusion process's efficiency and the properties of the extruded product. Fine-tuning these parameters is essential to achieve the desired texture, appearance, and nutritional profile.

3. **Quality Control**: Implementing robust quality control measures is crucial to ensure consistency and safety in food extrusion. Techniques such as in-line monitoring of temperature, pressure, and product dimensions help detect deviations from desired specifications.

4. **Equipment Maintenance**: Regular maintenance of extrusion equipment is essential to prevent downtime and ensure product quality. Proper cleaning and lubrication procedures should be followed to prolong the lifespan of critical components.

Future Trends and Innovations:- As the food industry continues to evolve, several trends and innovations are shaping the future of food extrusion.

1. **Sustainable Ingredients**: There is growing interest in using sustainable ingredients, such as alternative protein sources (e.g., insects, algae) and upcycled food by-products, in extruded food products. These ingredients offer environmental and nutritional benefits while addressing resource constraints.

2. **Personalized Nutrition**: Advances in technology, such as 3D printing and precision extrusion, are enabling the customization of food products to meet individual nutritional needs and preferences. Personalized snacks and functional foods tailored to specific dietary requirements are becoming increasingly feasible.

3. **Clean Label Formulations**: Consumers are seeking clean label products made with natural, minimally processed ingredients. Food extrusion offers opportunities to develop clean label formulations without compromising on taste, texture, or shelf-life.

4. **Smart Manufacturing**: Industry 4.0 technologies, including artificial intelligence, machine learning, and Internet of Things (IoT) sensors, are being integrated into food extrusion systems to enhance process control, predictive maintenance, and product traceability.

5. **Functional Foods**: There is growing demand for functional foods enriched with bioactive compounds, vitamins, and minerals. Food extrusion provides a versatile platform for incorporating functional ingredients into a wide range of products, from fortified snacks to meal replacements.

Conclusion

Food extrusion is a multifaceted process with diverse applications across the food industry. By understanding the principles of extrusion, optimizing processing parameters, and embracing emerging trends and innovations, manufacturers can unlock new possibilities for creating innovative, nutritious, and sustainable food products that meet the evolving needs of consumers.

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ADVANCEMENTS IN SEAFOOD PACKAGING TECHNOLOGIES: ENHANCING QUALITY, SHELF LIFE, AND SAFETY

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Abstract

Seafood packaging is a crucial element within the food industry, employing specialized methods and materials to ensure the freshness and preservation of a variety of seafood products. Some Advanced packaging methods designed for seafood, such as modified atmosphere packaging, active packaging, vacuum packaging, retort pouch packaging, and intelligent packaging systems. Modified atmosphere packaging adjusts the air composition to prolong storage duration and uphold product quality, while active packaging incorporates specific compounds to improve safety and extend shelf life. Vacuum packaging establishes a protective environment to deter bacterial growth and maintain product freshness. Retort pouch packaging offers cost-effective preservation and sterilization techniques, while intelligent packaging integrates communication features for monitoring product quality and safety.

Key words: Seafood, Packaging, Shelf life, Bacterial growth

Introduction

Packaging entails enclosing or shielding a product with a container to assist in its distribution, identification, storage, promotion, and utilization. Seafood packaging involves specialized techniques and materials employed to encase, safeguard, and maintain the freshness of seafood products throughout their distribution, retail, and consumption processes. Seafood includes pelagic and freshwater fish, mollusks like clams, oysters, scallops, and squid, crustaceans such as crab, lobster, shrimp, and crayfish, as well as species raised through aquaculture methods. Seafood products, including fish, crustaceans, and mollusks, are highly valued in the food industry due to their exceptional nutritional content and distinct sensory attributes when cooked. Seafood packaging aimed at preventing spoilage is crafted to hinder the decay of seafood items, thereby preserving their freshness and quality over a prolonged duration. Innovative packaging methods have been created to satisfy consumers' needs for safe, high-quality, convenient, and immediately usable products. Modified atmosphere packaging, active packaging, intelligent packaging systems, Retort pouch packaging and other techniques, have been effectively utilized in the packaging of seafood products.

Packaging technologies

1. modified atmosphere Packaging

A modified atmosphere is characterized by changes made to the typical composition of air, which typically consists of 78% nitrogen, 21% oxygen, 0.03% carbon dioxide, and small amounts of noble gases. This alteration aims to establish an optimal environment for prolonging the storage duration and preserving the quality of food and produce. Oxygen (O2) in modified atmosphere packages (MAP) containing fresh fish also helps inhibit the reduction of trimethylamine oxide (TMAO) to trimethylamine (TMA). Nitrogen (N2) is an inert and flavorless gas, primarily utilized as a filler gas in MAP. It is employed to either decrease the proportions of other gases or uphold the package's shape by preventing collapse, which can occur due to the dissolution of carbon dioxide (CO2) into the product. Nitrogen serves to prevent package collapse owing to its limited solubility in water and fat. Moreover, nitrogen is substituted for oxygen (O2) in packages to delay oxidative rancidity and deter the proliferation of aerobic microorganisms. The typical gas ratios used are 60% CO2 and 40% N2 for fatty fishes, while for lean variety fishes, the ratio is 40% CO2, 30% O2, and 30% N2 [1].

2. active packaging

Active packaging represents an innovative concept in food packaging that has emerged in response to ongoing shifts in consumer demands and market trends. The fundamental concept of active packaging involves incorporating specific active compounds into packaging materials or containers to serve particular functions such as antioxidant properties, antimicrobial effects, reduction in cholesterol content, etc. The overarching goal is to uphold product quality and safety while prolonging shelf life. Active packaging technology operates through scavenging or emitting systems, which are integrated into the packaging to either remove gases like oxygen, carbon dioxide, moisture, odors, and ethylene, or to release substances such as carbon dioxide, ethanol, flavors, antimicrobials, and antioxidants throughout the storage and distribution of the product [2].

A. O_2 Scavengers:

The existence of oxygen within the package accelerates the degradation of fish quality through oxidative deterioration and microbial spoilage. In active packaging systems, there's an interaction among the food, the package, and the surrounding environment aimed at preserving quality and extending the shelf life of the packaged food. Oxygen (O2) scavengers, which are the most commercially significant subgroup of active packaging, prove highly effective in reducing residual oxygen levels within the package to less than 100 ppm, thus preserving the original quality and extending the storage life [3].

B. CO2-emitters:

CO2-emitters are elements or mechanisms integrated into packaging materials or containers that emit carbon dioxide (CO2) throughout the storage and distribution of goods. Their purpose is to manage the atmosphere within the packaging, thereby preserving product quality and prolonging shelf life. The technique of preserving food items through CO2 has been widely adopted in Modified Atmosphere Packaging (MAP). Elevated CO2 levels (ranging from 10% to 80%) are employed in foods with high moisture content, such as seafood and meat products, to inhibit surface microbial growth, thereby extending product shelf life. CO2 notably influences the growth of Gram-negative bacteria like pseudomonads [2].

3. Vacuum packaging

Vacuum packaging for seafood entails extracting air from the packaging prior to sealing. This procedure establishes a vacuum environment within the package, which inhibits bacterial

growth and retards seafood deterioration. By averting oxidation and dehydration, vacuum packaging sustains the freshness and quality of seafood, thus prolonging its shelf life. Widely adopted in the seafood sector, this method effectively preserves a variety of fish, shellfish, and other seafood products. vacuum packaging serves as a valuable supplement to delay spoilage and extend the shelf life of fishery products. The process of vacuum packaging entails removing air from the packaging, thereby extending the viable shelf life of numerous cooked foods. It is essential to emphasize that vacuum packaging must be implemented under stringent conditions of hygiene and control [4]. This method is especially beneficial for fatty fishes, where the emergence of unpleasant odors resulting from fat oxidation poses a significant challenge. Vacuum packaging for chilled and refrigerated fishes effectively doubles the shelf life compared to conventional air packaging. Its application to frozen fishes is also widely adopted as it aids in mitigating the issue of freezer burn [5]. A crucial aspect of vacuum packaging is the selection of packaging material with excellent barrier properties. Typically, polyester-polyethylene or nylon-polyethylene laminates are employed. Polyester and nylon offer robust strength and serve as effective barriers against oxygen permeation. Polyethylene demonstrates superior heat-sealing capabilities and is resistant to water transmission [5].

4. Retort pouch packaging

Retort-packaging systems are utilized for preserving and prolonging the shelf life of perishable seafood products. The economic viability of employing the retort pouch for processing, packaging, and distributing processed fruit and vegetable products during a time of increasing energy costs was assessed. It was determined that a retort pouch packaging system represented the most cost-effective packaging solution overall [6]. The retort pouch may consist of an outer layer made of polyester film, a middle layer composed of aluminum foil, and an inner layer constructed of modified polypropylene. Its development was propelled by the introduction of heat-resistant plastic film and non-toxic adhesive compounds. Retort pouches possess characteristics akin to metal cans in terms of preserving food contents. They facilitate quick heating for sterilization, allowing for higher temperature application in shorter durations. Consequently, this minimizes the detrimental impact on taste, flavor, color, and nutritional value of the preserved food contents [7]. Hence, retort pouch packaging systems present a promising solution for extending the shelf life and preserving the safety and quality of seafood products.

5.inteligent packaging

The concept of intelligent packaging has garnered considerable attention in the food packaging sector, aiming to enhance food quality and value through various intelligent functions. These functions include monitoring the quality and safety of the product within its environment, tracing product movement across the supply chain, and sensing and recording pertinent product information [8]. Intelligent packaging integrates an intelligent function, typically communication capabilities, with conventional packaging systems. It furnishes consumers with information by sensing, detecting, or recording external or internal changes in the product. Three primary technologies used for intelligent packaging systems are data carriers, indicators, and sensors. Environmental conditions monitoring involves observing factors that could potentially cause changes in the quality characteristics of the food product, Quality characteristics or quality indicator compounds refer to methods employed for the direct monitoring of the quality attributes of the food product itself [9]. Data carriers are systems utilized solely for storing and transferring data. In contrast, indicators and sensors are employed to monitor the external environment [10,11].

Conclusion

The examination of advanced seafood packaging technologies reflects a collaborative effort in the food sector to maintain freshness, extend product shelf life, and meet consumer demands. Customized solutions such as modified atmosphere packaging, active packaging, vacuum packaging, retort pouch packaging, and intelligent packaging systems address the specific requirements of seafood products. Whether through adjusting air composition or actively engaging with food and its environment, these methods effectively address challenges like bacterial growth, oxidation, and spoilage. As the seafood industry evolves, the integration of innovative packaging technologies demonstrates a commitment to ensuring quality, safety, and environmental sustainability.

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CROP DIVERSIFICATION

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Abstract

Crop diversification means growing more than one crop in an area. Diversification can be accomplished by adding a new crop species or different variety, or by changing the cropping system currently in use. Commonly it can mean adding more crops into an existing rotation. The Indian economy is largely agrarian, with around 55% of the population dependent for their livelihoods on agriculture and allied sectors that generate 15% Gross Value Added (GVA). The green revolution that has brought the major increase in crop yield during 1960s and 1970s in developing Asian countries is now showing signs of slow growth in productivity gains. Intensive agriculture practiced without maintain ecological aspects has led to degradation of soil health, decline in availability of freshwater resources and agro-biodiversity (Kesavan and Swaminathan, 2008). The negative impacts of climate changes have been seen to disrupt the balance between food supply and demand by shifting abruptly from its surplus to deficit. The increasing global temperature and water scarcity will fuel to it by effecting crop production. So, managing food security and its sustainable development is one of the biggest challenges in India. Within this framework, crop diversification or crop shift is a new paradigm of sustainable agriculture.

Why Crop Diversification?

Our objectives like natural resources sustainability, ecological balance, output growth,

employment generation, risk coverage can be attained through following crop diversification which aims to increase total productivity in terms of quality, quantity and monetary value under specific, diverse agro-climatic situations worldwide.

Example of Crop Diversification

- A farmer who grows wheat in one season and then switches to soybeans in the next.
- Planting a mix of vegetables such as tomatoes, peppers, and cucumbers in the same garden.
- Growing corn and soybeans together in a rotation on a larger-scale farm.
- Cultivating both rice and fish in the same flooded fields in some regions.
- Intercropping, where different crops like maize and legumes are planted in close proximity in the same field.

The major driving forces for crop diversification:

(i) increasing income on small farm holdings,
(ii) Minimizing price fluctuation,
(iii) Balancing food demand,
(iv) Improved fodder production for livestock animals,
(v) Conservation of natural resources (soil, water, etc.),
(vi) Minimizing environmental pollution and
(vii) Decreasing insects, pests, weeds and diseases.

Types of Crop Diversification

1. **Improvement in the Structural Diversity:** Makes crops within a particular field more structurally diverse
2. **Genetic Diversification in the Monoculture: Genetic Diversification in the Monoculture**
3. **Diversifying the fields with fodder grasses:** Growing fodder grasses along with food, pulses, oilseeds, vegetables, etc
4. **Rotation of Crops:** Temporal diversity through rotation of crops (Sequential cropping)
5. **Polyculture:** crops (Growing two or more crop species within the same field)
6. **Agroforestry:** Growing crops and trees together (Spatial and temporal diversity)
7. **Mixed Landscapes :** Developing large-scale diversified landscapes through the mixture of crops and cropping systems with diverse ecosystems
8. **Micro-watershed based diversification:** Integration of the crops with other farming components for a yearly income and employment generation,

besides sustaining soil and the environment's health.

The approaches

- ❖ Horizontal approach by crop intensification and crop substitution
- ❖ Vertical approaches- include processing, regional branding, packaging etc. to enhance the product value
- ❖ Land use approach through alley cropping, pasture management etc.
- ❖ Water saving approach (dryland agriculture)
- ❖ Varietal diversification (introducing high yielding varieties for maximized profit)
- ❖ Nutrient management through increased cultivation of legume crops,
- ❖ Pest management (intercropping, resistant variety development),
- ❖ Risk reduction by practicing crop rotation.

Climate change resilient practices

- Development of drought- and high temperature stress tolerant crops with the help of
- biotechnology
- Adopting water and nutrient management practices for more efficient use.
- Development of high yielding varieties
- Genetic engineering

Possible outcomes

(i) Increasing crop yield- that can be obtained by (a) bridging yield gap through reducing water shortage, proper supply and use of inputs and by (b) biotechnological approaches that involve crop and livestock production by enhancing yields, nutritional profile, stress tolerance and crop protection and also GM crops;

(ii) Water resource management- for enhancing farm incomes through adopting irrigation schemes like Integrated Watershed Management Programme (IWMP);

(iii) Focused and better growth on dryland areas- adopting rainwater harvesting and storage;

(iv) Cost reduction- through (a) Smart nutrient management by implementing soil health card programme to all parts of India, (b) Low input agriculture- possible through organic farming, sustainable agriculture and precision farming, (c) Integrated Farming System, (d) Stabilizing income and risk management through mixed farming, sharecropping etc.

So, in short words, crop diversification in agriculture will have a tremendous impact in the uplifting of resource-inadequate farming systems and an overall increase in yield of crops under

the impact of climate changes by mainly maintaining the physical and chemical properties of soil through adopting and practicing the above mentioned methods. It will also generate employment opportunities for rural youth around the year for the utmost benefits of the Indian farmers. There are still various constraints for crop diversification like poor basic infrastructure, inadequate postharvest technologies, very weak agro-based industry etc., but location specific approaches and government policies and strategies for crop diversification need to be approved.

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DURING SEED WAYS FOR VARIETAL DETERIORATION PRODUCTION

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Introduction

Seed is the basic unit for mass multiplication of all crops. Seed production is a systematic scientific approach of mass multiplication of seed with assured quality as per the Indian government recommendations. The multiplied seeds should be in possession of better quality characters specific to genetic and physical purity. Hence it is the responsibility of the seed producer is to maintain the genetic purity, physical purity and physiological quality of any produce produced as seed. Seed production system involves specialized and highly technical skills than crop production programme. Seed production is influenced by many factors as seed is a biological entity amenable to any change. Production of genetically pure and otherwise good quality pedigree seed is an exacting task requiring high technical skills and comparatively heavy financial investment. During seed production strict attention must be given to the maintenance of genetic purity and other qualities of seeds in order to exploit the full dividends sought to be obtained by introduction of new superior crop plant varieties. In other words, seed production must be carried out under standardized and well-organized condition. The principles of seed production are broadly classified as **genetic and agronomic** principles.

Genetic principle

The genetic principle has to be taken care with seed multiplication as continuous usage of varieties may lead to genetic deterioration or otherwise the genetic purity of the seed will be deteriorated and the originality of the variety could not be obtained on further multiplication. In

general the success of agronomic principles rests with genetic principle which reveals on the genetic purity of the base seed used for multiplication. Kadam (1942) suggested the following reasons for genetic deterioration.

i. Developmental Variations

The basic variations in plant characters could be developed and may set in as differential growth responses if the seed crop is grown under environments with differing soil fertility, climate, photoperiods, or at different elevations for several consecutive generations. It is therefore, preferred to grow the varieties of crops in the areas of their natural adaption to minimize developmental shifts.

ii. Mechanical Mixtures

Mechanical mixtures, the most important reason for varietal deterioration, often take place at the time of sowing if more than one variety is sown with the same seed drill, through volunteer plants of the same crop in the seed field, or through different varieties grown in adjacent fields. Fields of two varieties growing next to each other, the seed is usually mixed during harvesting and threshing operations. The threshing equipment is often contaminated with seeds of other varieties. Similarly, the gunny bags, seed bins and elevators are also often contaminate, adding to the mechanical mixtures of varieties. Rouging the seed fields critically and using utmost care during seed production and processing are necessary to avoid such mechanical contamination.

i. Mutations

Mutations do not seriously deteriorate varieties. It is often difficult to identify or detect minor mutations occurring naturally. Mutants such as ‘fatuoids’ in oats or ‘rabbit ear’ in peas may be removed by roguing from seed plot to purify the seeds.

ii. Natural Crossing

Natural crossing is an important source of varietal deterioration in sexually propagated crops. The extent of contamination depends upon the magnitude of natural cross-fertilization. The deterioration sets in due to natural crossing with undesirable types, diseased plants or off types. In self-fertilized crops, natural crossing is not a serious source of contamination unless variety is male sterile and is grown in close proximity with other varieties. The natural crossing, however, can be major source of contamination due to the breeding system of the species, isolation distance, varietal mass and pollinating agent. The isolation of seed crops is the most

important factor in avoiding contamination of the cross-fertilized crops. The direction of prevailing winds, the number of insects present and their activity, and mass of varieties are also important considerations in contamination by natural crossing. It can be prevented by adoption of precaution against cross pollination.

iii. Minor Genetic Variations

Minor genetic variations can occur even in varieties appearing phenotypically uniform and homogenous when released. The variations may be lost during later production cycles owing to selective elimination by the nature. The use of pure breeder's seed in self-pollinated crop varieties can overcome these minor variations. Due care during the maintenance of nucleus and breeder's seed of cross-fertilized varieties of crop is necessary to avoid this Minor genetic variations .

iv. Selective Influence of Pest and Diseases

New crop varieties often are susceptible to newer races of pests and diseases caused by obligate parasites and thus selectively influence deterioration. The vegetatively propagated stock also can deteriorate quickly if infected by virus, fungi or bacteria. Seed production under strict disease free conditions is therefore essential.

v. The Techniques of the Plant Breeder

Serious instabilities may occur in varieties owing to cytogenetic irregularities in the form of improper assessments in the release of new varieties. Premature release of varieties, still segregating for resistance and susceptibility to diseases or other factors can cause significant deterioration of varieties. This failure can be attributed to the variety testing programme. In addition to these factors, other heritable variations due to recombination's and polyploidisation may also take place in varieties during seed production, which can be avoided by periodical selection during maintenance of the seed stock.

vi. Other factors causing the genetic seed deterioration are

- ✓ Break down in male sterility,
- ✓ Certain environmental conditions, and
- ✓ Other heritable variations

Techniques to maintain genetic purity

In any seed production plot the genetic purity has to be maintained with proper care as against the genetic deterioration by avoiding genetic contaminants. The sources for

contamination are Volunteer plants, Offtypes, Specific Disease infection (designated diseases) ,Weeds (objectionable weeds) and Inseparable other crop seed (barley, oats, wheat,rye). The causes on occurrence of off-types are

- Presence of some recessive genes in heterozygous conditions at the time of release of varieties.
  - The recessive genes may also arise by mutation.
  - The heterozygous plants segregate and give rise to off-types.
- Volunteer plants arising from accidentally planted seed or from seed produced by earlier crops.
- Mechanical mixtures constitute the major source of breakdown in genetic homogeneity.

Hence as a precaution measure , off-type plants should be rouged out of the seed production fields before pollination occurs , regular supervision by trained personnel is imperative and it may be necessary to control specific seed borne disease infection (designated diseases),weeds (objectionable weeds) and inseparable other crop seed (barley, oats, wheat,rye)

Agronomic Principles

Agronomic principles include all aspects of production from field to store and again back to field. Seed production involves steps, which are specialized and highly technical unlike the crop production program.

i. Selection of cultivar

It is always advisable to select a variety which is high yielding and well adapted to local climatic and edaphic conditions; having tolerance to pests and diseases. The variety, besides being popular for which there is higher seed demand should also exhibit synchronization in flowering and fruiting that will enable harvesting at a time in many cases. Additional care is required in hybrid seed production programe than varietal seed production programe. Even within the variety or hybrid high yielding ,demanding cultivars suitable to the location has to be selected.

ii. Selection of Seed

Always procure seeds from reliable sources like Government seed Agency, Agricultural University, State seed farms etc. Authenticated source of seed ensures that seed is fulfilling standards of certification (particularly genetic purity). Most importantly, the seed should be proper source. For example, to cultivate a foundation seed crop, seed source should be a breeder

seed, and for certified seed production, seed source should of Foundation class. The bill of purchase should be necessity preserved.

iii. Ecological factors

The agroclimatic conditions of plant ecology includes, temperature, day length, light, wind, rainfall , dew, frost and relative humidity, sunshine hours, dew point, wind velocity and rainfall. For production of best quality seeds, the climate should be selected in such a way that the flowering should not coincide with high rainfall and maturation of seed should be in dry period. Coincidence of high wind during flowering results in poor seed set. Some adverse influence of climatic conditions on crop seeds is as follows.

Crop	Climatic factor	Changes in seed character	Influence on seed quality
Cumbu, Sorghum	Rainfall or high humidity at maturation	Blackening of seed due to Black mould	Fungal attack, low physiological quality
Cumbu	Heavy wind at flowering	Tip sterility	Low seed set and fungal infection
Pulses	Rainfall at maturation	Off coloured seed	Low germination and storability
Peas	High humidity at maturation	Mottled seed	Lesser physiological quality
Groundnut	Rainfall at harvest	Insitu germination	Lesser germination
Brinjal	High temperature at flowering	Pseudo styled flowers	Poor seed set and lesser physiological quality
Tomato	Rainfall at harvest	Insitu germination	Lesser germination
Vegetables (Tomato chillies brinjal)	Rainfall at maturation	Decayed fruits Soiled fruits	Lesser germination and vigour
Bhendi	Rainfall at maturation	Off coloured seed	Lesser germination

Management of climatic factors

- The crop variety to be grown for seed production must have a suitable agro climate, adapted to the photoperiodic and temperature conditions prevailing in that location.
- Specific selected locations would be needed to economically grow crop varieties sensitive to photoperiodism (short days viz., long days) and temperatures.
- The regions with moderate rainfall, humidity and extreme temperatures.
- Most agronomic crops require a dry sunny period and moderate temperatures for flowering and pollination.
- Excessive dew and rains affect normal pollination resulting in poor seed set.
- Extreme temperatures may cause desiccation of pollen and poor seed set.
- Very hot and dry weather conditions adversely affect the flowering of several crops especially vegetables, legumes and fruit crops, which fail to set seed. These crops invariably require cooler climates with low atmospheric humidity to flower and pollinate normally.
- Oilseed crops may tolerate hot weather during flowering, but very high temperatures can result in premature flowering and the production of poor quality seeds.
- Extreme cold temperatures also damage seed quality in the early phases of seed maturation. Thus, locations with extreme agroclimate (summer hot and cold winters) are generally not suitable for seed production.
- Excessive rainfall conditions normally result in a higher incidence of pest and diseases making the harvesting and other operations of seed production extremely difficult. They may also cause delayed maturity and pregermination of seed in many standing crops.
- A mature seed crop becomes increasingly susceptible to shattering, strong winds, and heavy rainfall.
- Ample sunshine, moderate rainfall, climate and absence of strong winds are ideal for the production of high quality seed.

iv. Selection of site

It depends on the response of crop to various edapic or soil factors .The crop should be selected for different soils based on their suitability (Eg. Black soil – Cotton; Red loamy soil – Pulses, Oilseeds and Vegetables; Alluvial soils – Paddy, Sugarcane) for rainfed and gardenland ecosystem. The land for the seed crop must be prepared well. Good land preparation helps in

improved germination, stand establishment and destruction of potential weeds. It also aids in water management and uniform irrigation. Depth of sowing is extremely important in ensuring good plant stands. Small seeds should be planted shallow, but large seeds a little deeper. Seeds would emerge from greater depths in sandy soils than in clay soils, and also in warm soil as compared to cold.

In dry soils, seeds should be planted slightly deeper so that they come in contact with moisture. Care should be taken on Soil water potential , Soil Temperature, Soil crusting and Soil salinity and sodicity (problem soils)on selection of site for seed production as this factor will influence the total germination percentage, mean germination time, intermediate counts on germination, the variation in germination around the germination time It should be well leveled, free from weeds particularly perennial, pests and soil borne diseases. It should not have been under the same crop in preceding season and also devoid of volunteer plants. It should be feasible to isolate it from contaminating crop . The pH of the selected soil should be in the range of 6 to 7.5.

v.Isolation

It is a prescribed distance which separates seed crop from the crop of lower standards belonging to same variety or another variety. The aim of maintaining isolation distance for seed production of cross-pollinated crops is to maintain genetical and physical purity. Isolation distance prevents cross-pollination through transfer of pollens which occur from one crop to the other. In events where there is no such risk of cross pollination since the crop may be self pollinated isolation distance helps kept to avoid mechanical mixture at the time of harvesting with other crop seeds or seeds of the same crop. Besides, isolation is also keeps seed crop away from seed borne diseases. Incidence of pests may also be lesser.

Isolation distance requirement for different crops as per certification standards

Crop	**Foundation seed (m)**	**Certified seed (m)**
Barley, Paddy , Groundnut	3	3
Blackgram, Bengalgram, Greengram, Cowpea, Lablab, Horsegram ,Garlic, Sweet potato, Potato ,Peas	10	5
Cotton Mustard Linseed Tomato	50	30

Pigeonpea, Binjal	200	100
Castor	300	150
Chillies Bhendi ,Amaranths Safflower ,Gingelly Sunflower	400	200
Gourds Onion	1000	500
Maize varieties ,composites and synthetics		
Maize hybrid	400	400
Sorghum varieties		
Sorghum hybrid	200	100
Pearl millet varieties		
Pearl millet hybrid	400	200
Cabbage, Cauliflower, Chinese cabbage ,Knoll-khol, Spinach, Beet leaf, Radish ,Turnip	1600	1000
Beetroot	1600	800
Carrot	1000	800
Cluster bean Cowpea French bean Indian bean Lima bean, Fenugreek	50	25
Coriander	800	400

vii. Preparation of Land

First the land is cleared so that there is no stump, weed plants etc.. Later, land is deeply ploughed and left for sometime so that insects are killed by sun and / or picked up by birds. Before sowing, land is prepared up to good tilth by cross harrowing. Planking sometimes is also needed to break big clods and also to reduce moisture loss as it increases compaction of soils.

viii. Seed treatment

It will be better if seed is treated before planting or sowing in the fields with suitable chemical for breaking dormancy due to hard seed coat and inoculation of legume seed with bacterium culture or with prophylactic pesticide to manage pest problems.

Seed treatment	**Purpose**
Seed treatment with pesticides and biocontrol agents	Protection
Seed fortification , priming ,hardening	Seed invigouration

Seed colouring	Marketing and seed identity
Seed pelleting	Protection at rhizosphere region
Dormancy breaking	Good germination
Biofertilizer treatment	Nutrient absorption ,production

ix. Method of planting/sowing

The crops are planted on flat beds, raised bed, on ridges, along ridges depending on season, soil types etc. however for seed crop sowing in ridges and furrows are the easy and convenient method of sowing/planting for easy movement within the crop and to carry out intercultural operations as earthing up etc. As far as possible, all crops should be sown or planted in rows by dibbling and not by boardcasting.

x.Time of planting

Time of planting is most important to harvest maximum yield and also more crops can be grown in intensive cropping systems. Time of planting of a particular vegetable crop is determined by its environmental requirement. This depends on elevation, proximity to water source, soil, weather, market demand; kind of crap etc. Adjustment of planting to avoid certain pests and diseases, and glut in the market is possible within reasonable limits. It is mostly related to the season Crops are normally sown in different seasons to suit the best agroclimatic condition for production. The generally accepted seasons as per seed certification are *Kharif*, *Rabi* and *Summer* seasons.

Among the seasons *Rabi* is highly suitable for seed production as it ends with dry weather. However the yield will be higher with *Kharif* crop. But if pulses are grown in summer more of hard seed will be produced .On the basis of climatic requirements vegetables are classified as tropical, subtropical and temperate. Tropical vegetables are grown essentially during summer and rainy season (almost all cucurbits, amaranths etc.) Winter season vegetables are tomato, brinjal, chillies, potato, peas, leafy vegetables etc.

xi. Depth of sowing

Depth of sowing is determined on the basis of size of seed. Generally, depth is about 2.5 times more than the diameter of seeds. In crops like beans where cotyledons are pushed out during germination (epigious germination) requires shallow sowing than crops of similar seed size like peas where cotyledons are not pushed out (hypogious germination) during germination. In light soils, seed are sown deeper than heavy soils. When supply of moisture is

sufficient, seed may be sown at shallow depth and when it is lacking then sowing is done at deeper depth. Small sized seeds (ragi,turnip, tomato, pepper, mustard, carrot, cabbage, brinjal and onions) are sown at shallow depth (1 to 1.5, cm) while bigger sized seeds are sown at medium depths *viz*., 2- 3cm (eg.groundnut,maize).

xii. Seed rate

The requirement of seed per hectare of various crops depends on size of seed, weight of seed, purity of seed, viability and percentage of germination and the number of plants require per unit area. For the crops, which are raised by transplanting of seedlings, seeds are sown a in pre-determined unit area of nursery. However, in direct sown crops, the seed rate would vary depending upon (i) viability of seeds, (ii) time of planting, (iii) condition of soil, (iv) size and vigour of young plants and (v) possible incidence of pests and diseases. Thinning is often practiced to provide optimum spacing of healthy plants in direct sown crops.

xiii.Nutrition

Optimum quantity of nutrition should be applied both through organic and inorganic sources based on recommended dose of macro and/or micro-nutrients. Most of the vegetable crops are heavy feeders and therefore, adequate application of macro and micro-nutrients is needed. Balanced nutrition results in higher yields, of good quality seeds. Besides, crop plants have chance to express their true plant type that helps in roguing operation which in turn maintain genetic purity. Nitrogen is essential for better plant growth. Its deficiency causes stunted growth and yellow appearance on the lower leaves and later increases in the upper leaves. Leaves become brown and die in severe deficiency of nitrogen. The time of application of nitrogen further plays vital role in seed production. It should be done at each critical stage of the crop concerned. Phosphorus helps in better root growth and development, fruit setting and seed development, and helps in early maturity and increases disease resistance. Deficiency of phosphorus results in poor plant growth. Generally, vegetable crops require more phosphorus at their early stages of growth, and therefore, its application as a basal dose in the soil is advisable. Potassium helps in flowering and seed development. It improves the photosynthetic efficiency of plants and synthesis of proteins. Deficiency causes poor plant growth and low seed yields. Application of micronutrient should also be taken care of for successful seed production. As soon as, deficiency symptoms start to appear, it should be corrected appropriately.

xiv.Irrigation

Maintenance of optimum soil moisture in vegetable crops favours germination of seeds, general growth, production and the quality of the produce. Number of irrigations and their frequency depend on the soil type, water requirement of the crop, depth of root system, stage of the crop and weather conditions.

xv.Interculture and weed control

Shallow cultivation once or twice during early stage of crop growth will help in controlling weeds and will provide favourable conditions for root formation and development. Sometimes, soil is also drawn from the sides to the base of the plants particularly in groundnut , cotton and tuber crops that provide good bulking rate and also prevents from lodging . Weeding and earthing up is the important intercultural oprerations.

xvi. Roguing

It is the most important operation next to isolation distance in seed crop. The identification and removal of 'off-type' plants from seed crops termed as 'roguing'. This operation maintains genetic purity of a plant type because under this operation any plant in the population that exhibits morphological variation at any stage of growth is removed or uprooted. Such plants are known as off types. Even some of plants which conform to the varietal characteristics may not be acceptable due to some undesirable features (such plants may be segregates) are removed.A seed crop is rogued several times preferably at different time of the day and by walking in different directions. In cross pollinated crops, every effort must be made to carry out roguing before the commencement of flowering. All the plants that do not conform to varietal characteristics and all undesirable and diseased are removed.

Designated diseases refers to the diseases specified for the certification of seeds and for which certification standards are to be met with.these diseases would cause contamination ,when they are present in the seed field or with in the specified isolation distance (eg. loose smut of wheat). For this the certification distance has been prescribed as 180 meters.

Crop	**Designated disease**	**Causal organism**
Wheat	Loose smut	Ustilago tritici
Sorghum	Grain smut or Kernel smut	*Sphacelotheca sorghii*
Mustard	Alternaria blight	*Alternaria sp*

Pearl millet	Grain smut Green ear Ergot	*Tolyposporium penicillariae* *Sclerospora graminicola* *Claviceps microcephala*
Sesame	Leaf spot	*Alternaria sp*
Brinjal	Little leaf	*Datura virus 2*
Chilies	Anthracnose leaf blight Leaf blight	*Gloesporium piperatum* *Alternaria solani*
Cucurbits	Mosaic	*Cucumis virus*
Cowpea	Anthracnose	*Colletotricum sp*
Bhendi	Yellow vein mosaic	*Hibiscus virus 1*
Potato	Brown rot Root knot nematode	*Pseudomonas solanacearum* *Meloidogyne incognita*
Tomato	Early blight Leaf spot	*Alternaria solani* *Xanthomonas vesicatoria*

Roughing also to be done to remove the other crop seeds (Expressed in number /kg) ,which are the plants of cultivated crops found in the seed field and whose seed are so similar to crop seed that is difficult to separate them economically by mechanical means. Cause physical admixture with the crop seed only when these crop mature approximately at the same time when seed crop matures)

Crop	**Designated inseparable other crop seeds**
Barley	Wheat, oats &gram
Oats	Wheat, gram & barley
Wheat	Oats, gram &barley

xvii.Plant protection

Seed crops require long period and therefore, chances for insect infestation and disease infection are more. Insect-pests and diseases reduce both the yields and quality of seeds. Therefore, it is necessary to take preventive as well as curative plant protection measures for raising successful vegetable seed crop. Both phytosanitary and chemical control measures should integrate along with appropriate crop rotation for better results.

xviii.Harvesting

The crop is harvested at physiological maturity stage. Seed crop is harvested at the moisture content of about .18-20 per cent and .harvesting can be broadly divided as manual and mechanical. The manual harvest again depends upon the flowering pattern,crops, once over harvest (paddy,sunflower) or in picking (cotton). in vegetables ,in case of pod and legume vegetables, root crops, (Carrot, radish, beet root, knol khol), onion, leaf vegetables (amaranths, palak, methi) fully mature fruits of tomato, brinjal, chillies and cucurbits are harvested and then seeds are extracted and dried.

xix. Drying, grading, packing

Winnowed seeds are either sun-dried and/or in artificial electrically operated driers to the optimum level of seed moisture. In most cases seeds are dried to below 10 per cent moisture depending on kind of crop.

The undersized/dead/light seeds/cut seeds and oversized seeds are discarded and healthy seed lot is obtained. Thus, seed is having more or less equal weight and size. Gravity separators and seed graders are are used for this purpose.Seed should be packed in moisture proof packaging. Usage of old containers/bags for packing is not allowed for seeds. The size of packets depends on demand of the consumers and price of seeds.

xxi Storage

In both way seed is stored in big containers or in small packet. The most important precaution is the moisture percentage in seed at the time of storage. It varies from be 8 to 12 percentage according to kind of vegetable crop. The store should be well ventilated, clean and dry. Under cold storage conditions, seeds can be stored for longer period without losing germination percentage. But, under ambient temperature seeds can only be stored for short period.

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ECO-FRIENDLY MANAGEMENT OF INSECTS AND NEMATODES BY USING PARTHENIUM

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Abstract

Parthenium hysterophorus is one of the wild, noxious weed species among the genera *Parthenium.* Even, this plant has more sesquiterpene lactones like parthenin which is the main secondary metabolite of *P. hysterophorus* helps in many biological activities *viz.*, insecticidal, fungicidal, and nematicidal activities. The presence of cholinesterase in *P. hysterophorus* leaves, stem and inflorescence helps in the progeny reduction of insects and worms. The presence of parthenin helps for the management of plant parasitic nematodes *viz.*, *Meloidogyne incognita, Helicotylenchus dihystera,* and *Rotylenchulus reniformis.* Hence, this weed plant *P. hysterophorus* is also used as an alternative bio-organic method for the management of insects and nematodes. In this point, this paper shortly reviewed the utility of the noxious weed plant *P. hysterophorus* against insects and nematodes.

Introduction

Congrass grass, *Parthenium hysterophorus* is the most common weed plant in several tropical and subtropical countries across the world (The Wealth of India, 2003) which belongs to the family of Asteraceae. This is categorized as a noxious weed for two reasons: (1) highly adaptable to grow anywhere including agricultural areas (Krishnamurthy *et al.*, 1975); (2) it causes allergies and health hazards to humans (Dhawan and Dhawan, 1995). The genus

Parthenium has twenty species in the western hemisphere of India. Among these, *P. hysterophorus* seems to have originated from a natural hybridization between *P. conifertum* and *P. biplantifidum* (Nath,1988). The *P. hysterophorus* plant extracts were tested against the root-knot nematode in many crops like tomato, and brinjal to identify the phytochemical investigations, nematostatic and nematicidal potential of this weed. This article is prepared based on the investigations made by several researchers working with *P. hysterophorus* for the management of root-knot nematodes to enhance the eco-friendly management of plant parasitic nematodes.

Phytochemicals of *Parthenium hysterophorus*

The whole plant of *P. hysterophorus* has two types of sesquiterpene lactones *viz.*, hysterin and dihydroisoparthenin (Picman *et al.*,1981). Accumulation of fumaric acid in stem and leaves and ferulic acids in all parts of the plants except pollen have also been reported. These phenolic acids are responsible for the allelopathic impact of *P. hysterophorus* on other plants (Kanchan, 1975). The sesquiterpene lactone parthenin is one of the main secondary metabolites present in *P. hysterophorus* which has insecticidal, nematicidal, and fungicidal properties. Parthenin is an allelochemical which present in the leaf surface @ 5% level (Rainhardt *et al.*, 2005, The Wealth of India, 2003). Histamine is present in the roots of the plant (Kamal and Mathur, 1991).

Insecticidal Activities of *P. hysterophorus*

The whole plant extract of *P. hysterophorus* reported that regulates the growth activity of cotton stainer, *Dysdercus angulatus* (Kareem, 1984), and *Spodoptera litura* fifth larval stage (Balasubramanian, 1982) was reported. The petroleum ether extracts from the leaves, stem and inflorescence of *P. hysterophorus* show the toxic effect of the life span and progeny production of mustard aphids, *Lipaphis erysimi* adults (Sohal *et al.*, 1992). The presence of cholinesterase antagonistic properties in *P. hysterophorus* is one of the most important compounds that can be used in the control of insects and worms as reported by Dhawan and Dhawan (1995).

NEMATICIDAL ACTIVITIES OF *P. hysterophorus*

Sesquiterpene lactone shows a wide spectrum of biological activities like cytotoxin, phytotoxin, and insecticidal properties (Rodriguez *et al.*, 1967). Parthenin is the major sesquiterpene lactone present in the *P. hysterophorus* shows the nematicidal activities against the root-knot nematode and *Helicotylenchus dihystera* was reported by Hasan and Jain (1984). The aqueous extract of *Parthenium* leaf showed the highest nematode mortality rate (100% mortality

of *M. incognita* and *H. dihystera*) observed after 25 and 48 hours. The compounds parthenin and saponin which are present in *P. hysterophorus* parthenin showed the highest toxic effect against nematodes. 70-100% mortality was observed in parthenin at the concentration of 2500 ppm to 5000 ppm. Crushed leaves of *Parthenium* mixed into the soil are used to reduce root galling in papaya against *Meloidogyne incognita* (de la Fuente *et al.,* 2000). The root and leaf extract of *P. hysterophorus* tested at the concentrations of 0.5, 1.0, 2.0, and 4.0% at different exposure periods showed a higher mortality rate of *Rotylenchulus reniformis* pre-adult stage of nematodes (Prasad and Suverna, 2005). The various formulations of *P. hysterophorus viz.* leaf compost with FYM were tested against root-knot nematode infesting brinjal and showed a good reduction in the soil and root nematodes population was reported by using of *Parthenium* leaf compost 7.5% + FYM (Ashutosh Shukla *et al.,* 2021).

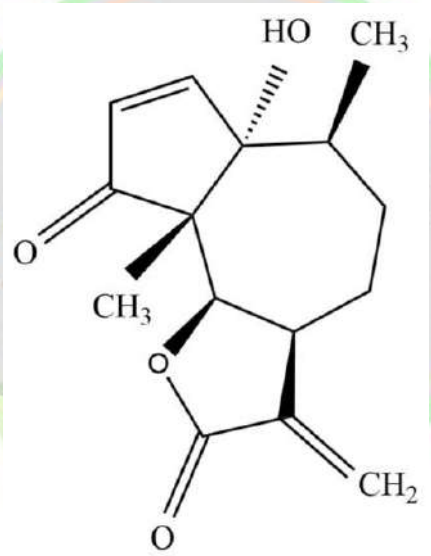

Fig. 1. Structure of Parthenin

Conclusion

P. hysterophorus is one of the noxious weed plants but at the same time, these plants will be helpful for the management of insects, pathogens as well as nematodes through its secondary metabolites like parthenin. Because of this chemical compound, this plant can be used as one of the insecticide and bionematicides instead of chemicals. Hence, the need of continuous research on these and derivation of the commercial formulation is required for the effective bio-organic way of insect and nematode management using *P. hysterophorus.*

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HARNESSING PADDY STRAW FOR ECO-FRIENDLY PLANTING : BIODEGRADABLE HORTICULTURAL POT INNOVATION

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Abstract

Historically, heavy clay, wooden, metal, and stone containers were used for raising horticulture plants under nursery conditions. However, these containers were heavyweight, rotted and broke easily, difficult to sanitize, shipped, and expensive. Attempts to replace these materials with user-friendly and low-cost materials lead to experimentation with old food cans, peat pots, recycled paper pots, etc. It was only in the 1960s; that plastic pots were introduced, and by the 1970s and 1980s, they had almost wholly replaced clay pots and other potting materials, Since then, plastic has been used in various horticultural applications, and its usage has been significantly increasing along with the demand for horticulture produce.

Plastic pots are light in weight, low cost, less fragile, and easy to ship, On the other hand, they are made up of non-biodegradable polystyrene, polyethylene, and polypropylene, which makes them non-biodegradable a severe threat to the environment, another unnoticed problem with plastic pots is restricted aeration to the young growing roots, which is balanced by using a potting mix with high aeration. In addition to this, during transplantation, these plants are removed from the containers either by pulling or by cutting the container wall with sharp blades. During this process, young roots and root hairs may get damaged, reducing water and nutrient uptake efficiency and acting as infection sites for most of the soil-borne pathogens, These

undesirable effects of plastic pot usage on the plants and environment lead to exploring new eco-friendly and sustainable materials for horticulture applications.

Every year, over 600 million tonnes of rice straw is produced after rice harvesting globally. In South and Southeast Asia, the traditional practice of many rice farmers, especially poor smallholders, has been to burn the rice straw in the field to clear the paddy quickly for the next planting. However, studies on rice straw burning have shown that this practice is detrimental, as it produces high GHG emissions as well as toxic particulates that negatively affect human health. Rice straw burning also causes nutrient and biodiversity loss in the soil, which impacts the long-term sustainability of rice fields

A huge amount of waste is generated in India after harvesting crops like wheat and rice, most of which are burned after the valuable constituents have been removed. Some of these wastes are used as animal feeds, for making cattle sheds, and rural house roofs, or as fuel for domestic cooking. In rare cases, they serve as raw materials for small-scale industries, such as pulp/board industries, biogas generation, And recently developed paddy straw Pots that are biodegradable, etc.

Biodegradability is crucial as it enables organic materials to break down naturally into harmless compounds, minimizing environmental impact. Biodegradable products, like paddy straw pots, mitigate plastic pollution, promote sustainable waste management, and contribute to a healthier ecosystem by returning nutrients to the soil without leaving harmful residues, Paddy straw pots offer a sustainable alternative to traditional plastic pots, providing numerous benefits for both the environment and plant health.

1. Environmental Sustainability:

Paddy straw pots are made from agricultural waste, offering a renewable and biodegradable alternative to plastic, By utilizing paddy straw, these pots help reduce agricultural waste and minimize the need for virgin materials, contributing to a circular economy.

2. Plastic Waste Reduction:

Paddy straw pots help reduce the reliance on single-use plastic pots, which are a significant source of plastic pollution in landfills and ecosystems, By choosing biodegradable alternatives like paddy straw pots, gardeners can play a role in mitigating plastic waste and its adverse impacts on the environment

3. Improved Plant Health:

Paddy straw pots provide better aeration and moisture retention compared to plastic pots, promoting healthier root development and reducing the risk of root rot, The biodegradable nature of these pots allows roots to naturally penetrate the pot walls, preventing root circling and promoting stronger, more vigorous plant growth.

4. Nutrient-Rich Composting:

At the end of their life cycle, paddy straw pots can be composted along with the plants, enriching the soil with organic matter and nutrients, The composting process further contributes to soil health and fertility, creating a closed-loop system that supports sustainable gardening practices.

5. Versatility and Adaptability:

Paddy straw pots come in various shapes and sizes, catering to diverse gardening needs from seed starting to transplanting and container gardening. Their versatility makes them suitable for both indoor and outdoor cultivation, offering a practical solution for gardeners of all levels.

6. Community and Economic Benefits:

The production of paddy straw pots can stimulate local economies, providing opportunities for farmers and artisans to repurpose agricultural waste into value-added products, Supporting initiatives that promote paddy straw pots can strengthen community resilience and foster a sense of environmental responsibility among consumers.

7. Educational and Awareness-Building Opportunities:

Promoting paddy straw pots encourages education and awareness about sustainable gardening practices and the importance of reducing plastic waste, By incorporating paddy straw pots into gardening programs and initiatives, educators can inspire future generations to adopt eco-friendly habits and become stewards of the environment.



Conclusion

Overall, paddy straw pots represent a holistic approach to gardening that prioritizes environmental conservation, plant health, and community well-being, making them an essential component of sustainable horticulture. By considering the above facts, the present Article aims to use paddy straw pots for the nursery industry to gain sustainability

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WILL AQUAMIMCRY BE THE NEW GAME CHANGER FOR SHRIMP CULTURE

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Introduction

With almost 7.8 billion people on earth, the demand for aquatic food is increasing hence, the need for horizontal and vertical expansions of aquaculture production systems is highly recommended. At the same time, the intensification of systems should be sustainable with more ecologically sound management practices. Opting for more intensive practice by adopting higher stocking density, and unsystematic use of therapeutics has led to water quality deterioration major problems, and disease outbreaks. Therefore, there is a need to develop technology that gives sustainable production also conserving the environment hand in hand. A technology that provides both economic and environmental sustainability is lacking. Such an eco-friendly and greener alternative for production which do not rely upon any harmful chemicals is the Aquamimicry technology.

History

The Aquamimicry technique was established in 2013 by two long-time shrimp farmers in **Thailand** namely ***Sutee Prasertmark*** and ***Veerasan Prayotamornkul***. This method is based on the hypothesis that shrimp farming practices can be more sustainable by ***mimicking the natural aquatic environment*** *in the aquaculture condition.*

What is Aquamimicry

Aquamimicry is a revolutionary concept that simulates **natural estuarine conditions** by developing **copepods** (zooplankton Blooms) that act as supplementary nutrition to a cultured species. This is a more balanced approach that uses both microalgae and Bio floc in aquaculture.

The concept is well known for reducing the stress associated with fluctuating water quality, and it minimizes favorable environmental conditions to pathogens. This technique involves symbiotic relations between Prebiotics **fermented carbon sources** derivatives (e.g., **Oligosaccharides)** and probiotics (e.g., *Bacillus species*), reduce the application of therapeutics, and contributes to **Green aquaculture**.

Shrimp do not consume phytoplankton directly. They feed on phytoplankton-eating tiny organisms or bacteria that grow on dead phytoplankton cells that gather on the bottom. The culture environment ideally resembles a natural estuary environment with balanced water quality provided by acquired planktons with these Bio floc changes. As a result, feed consumption and water exchange can be minimized.

This technology is demonstrated best for waste utilization, as with the continuous use of carbon sources and probiotics, planktonic growth can be supported. This technique can be very fruitful in uplifting the economic status of shrimp farmers by producing **Disease-free** and **Cost-efficient products** in aquaculture.

Protocol for Aquamimicry

In Aquamimicry, a carbon source such as fermented rice bran (FRB) is added with some probiotics that generate phytoplankton and zooplankton blooms and energize natural pond conditions. These planktons act as supplemental nutrition and improve water quality in fish and shrimp cultures. FRB is made by adding water, some hydrolyzed enzymes, and probiotics to rice bran powder and is then allowed to soak overnight. The pH of incubation water should be in the range of 6–7 and adjusted if necessary. The prepared mixture is allowed to ferment for 24 h and then added to cultured ponds at the rate of 500–1,000 kg|ha. If the rice bran used is in powdered form, it is added gradually to the pond, and if the crumbled form is used, its supernatant/juice is added to the pond, and solid bran particles are fed to fishes in the biofilter pond. The dominance of copepods in the ponds can be observed within a week of application. Now, once the zooplankton is ready, the ponds are stocked with shrimp post-larvae at the stocking density of 20 PLm−2. To sustain the copepod bloom, the stocked ponds are regularly seeded with FRB at the rate of 10 kg ha−1 every month. The stocked shrimps are provided with supplementary nutrition, as they feed easily on particles of FRB and no additional feed is required. For high stocking densities (Semi & Intensive culture), the concept of Aquamimicry can be adopted by stocking

40-60PLm-2. The feed cost can be reduced by up to 40% due to the presence of copepods as supplementary feed.

Advantages of Aquamimicry

- ❖ Water quality parameters will be at the optimal level.
- ❖ By adoption of this technology water quality fluctuation was reduced.
- ❖ Decrease the food conversion ratio.
- ❖ Enhancement of overall nutrition of the shrimp as they feed on FRB and also on copepod generated by addition of carbon source.
- ❖ Black soil formation will be reduced.
- ❖ Better biochemical composition of the plankton also may improve feed efficiency, and enhance the **Shrimp`s Immunocompetence**.
- ❖ The cultured organism is raised in a stress-free condition as all the conditions favorable for pathogenic organism is not promoted.
- ❖ Minimizing water exchanges.

Disadvantage of Aquamimicry

- ❖ Use of a relatively large treatment pond.
- ❖ Difficult to apply this concept to indoor culture technique.
- ❖ Potential chance of occurrence of a new pathogen.

AQUAMIMICRY Vs BIOFLOC TECHNOLOGY

There are some similarities but exist some core differences probiotics can be included during the grow-out phase that maintain beneficial bacterial colonies to improve between both Technology. Generally, both Aquamimicry and the BFT *depend on external carbon source*

addition. In the Bio floc system, to maintain floc, the C: N ratio is to be maintained at 15:1. Heterogeneous bacteria then derive carbon from a supplied carbonaceous substrate. In contrast, in the Aquamimicry method, it is not necessary to adjust the C: N ratio and its ratio is mainly dependent on the *water turbidity level* and *level of intensification* (extensive or intensive) in this system for enhancing the production of floc, for better water quality.

The BFT is considered an economical method for aquaculture by acting as live feed for stocked species, but a major disadvantage of the BFT is the need for continuous and rigorous aeration for suspending generated wastes, which are further metabolized by bacteria for protein generation. In intensive systems, improper placement of aerators also produces strong water currents, which reduces the structural integrity of the floc particles. Further, the decrease in pH and alkalinity due to nitrification with the addition of sufficient carbon are factors that need to be closely monitored and compared to the other shrimp farming methods. Another drawback of bio floc system is that it requires constant aeration to keep the wastes in suspension for proper degradation which adds up to the production cost. By considering these loopholes, a novel technology called Aquamimicry (Cope floc technology) has been initiated in the shrimp farming industry which negates the use of feed or any oxygenation in the ponds.

AQUAMIMICRY IN WATER QUALITY MANAGEMENT

The organic waste chemicals which are used in shrimp aquaculture practices are highly stable and do not tend to break down easily into useful forms. The oxidation of these organic waste components reduces the dissolved oxygen in shrimp ponds by producing bottom sills and leads to the development of toxic metabolites such as hydrogen sulfide, methane, ammonia, and nitrite. It contributes significantly to the mortality rates in the shrimp culture. Thus, Aquamimicry which is considered one of the most important concepts of **In-situ Waste Assimilation** creating blooms of zooplankton (copepods), enhancing the growth of beneficial bacteria and acting as a good source of supplementary nutritional form in shrimp culture, is Aquamimicry, will solve the above-mentioned problems.

SIGNIFICANCE OF FERMENTATION PROCESS IN AQUAMIMIMCRY

Fermentation is a biotechnological process that improves the utilization efficiency of **Lignocellulosic materials** by degrading these complex compounds into simpler forms which in turn can lead to higher nutrient bioavailability, digestion, and growth rates in animals.

Cereals, Rice bran (Carbon source) contain low amounts of some essential amino acids (e.g., methionine, lysine, and tryptophan), **high Fiber levels**, and **Anti Nutritional Factors** that cause poor digestion and growth. The fermentation process can reduce the number of undesirable substances and enriches the nutritional quality of plant proteins and cereals through the activity of microbial-derived enzymes in an anaerobic condition. In this process, microorganisms (e.g., bacteria, fungi, and yeast) use carbohydrates as an energy source and convert them into microbial proteins. This process reduces the amount of fiber and ANF while increasing amino acids, vitamins, minerals, and proteins in fermented products.

Some research proves that the Biochemical compounds of rice bran after the fermentation process were **16.79%, 14.92%, 17.36%,** and **50.94%** for *protein, fat, ash,* and *total carbohydrates,* **increased** respectively. Using rice bran as a fermentation medium increases the availability of nutrients and is a fast, low cost and low-risk process.

IMPORTANCE OF COPEPODS

Cope floc produced during the Aquamimicry process are very advantageous, due to their small size and **short life cycle**, convert energy in the food chain, act as a source of food for marine animals, **are perfect nutrient recyclers**, and are highly suitable for culture because of their **eurythermal** and **euryhaline** characteristics. Zooplankton copepods are very advantageous, they are rich in long-chain polyunsaturated fatty acids (***LC-PUFA*** *including Eicosapentaenoic, Dicosahexanoic, and Arachidonic acids, which are essential for growth and development*), trace elements, pigments, and pool of free amino acids (e.g., taurine) act as a source of food for marine animals, and perfect nutrient recyclers.

Copepods are considered to be the "**nutritionally superior live feeds**". In addition, it has been confirmed that copepods contain high amounts of carotenoids, peptides, vitamins, and minerals (e.g., selenium, iodine, copper, and manganese). Live food organisms contain all the nutrients such as proteins, lipids, carbohydrates, vitamins, minerals, amino acids, and fatty acids, and hence live feeds are popularly known as **"Living Capsules of Nutrition**"

THE ROLE OF PROBIOTICS IN AQUAMIMICRY SYSTEM

Probiotics produce enzymes that limit the activity of pathogenic bacteria by reducing the gut's pH, making it difficult for these bacteria to live at low pH. In addition, probiotics through **the Quorum Quenching mechanism** can disturb **Quorum Sensing** among opportunistic bacteria that regulate virulence factors, and the formation of biofilms, which are the critical

parameters in occurrence of the infectious diseases in farmed aquatic animals. Limiting the activity of pathogenic bacteria can provide a better environment for the proliferation of beneficial microbes in the gut to improve digestion and absorption of nutrients.

NOTE: Quorum sensing (QS) is a **Cell-to-cell communication** mechanism that occurs between inter- and intra-bacterial species and is regulated by signaling molecules called **Autoinducers.** It has been suggested that probiotics can exert a QS inhibitory effect through their metabolites.

Quorum Quenching probiotics are neither bactericidal nor bacteriostatic against the targeted pathogens. Instead, they disrupt QS signals and affect the pathogenicity of their target.

ORGANIC SHRIMP

It is an excision of aquatic technology interactively working together in mimicking the nature of aquatic ecosystems to make live food organisms for the fish or shrimp. Shrimp produced in this technology is ***Red*** due to (**Astaxanthin, amino acids**, and **polyunsaturated fatty acids**) which would boost the ***commercial value*** of the product as "**Organic shrimp**".

Conclusion

India topped the position in shrimp production last year but now we lost to **Ecuador**. Through the influence of the **International market**, we can observe the drop in the price of shrimp in India, but production cost remains constant. To overcome this issue, we need to reduce the cost of production and increase the production of shrimp in our country. These can be achieved by applying new technologies in shrimp farming. In India, **Bio floc** is becoming a booming technology mainly due to its advantages like enhancing immunity, reducing the ammonia level in the system, and reducing the feed intake by 30-40% through the formation of flocs as supplementary feed. These advantages can be achieved in our country by applying bio floc in the right manner but the only factor that is stopping us from achieving our goals is that we are not able to utilize bio floc technology as efficiently as other countries. In India, we are not able to reach this level of profits achieved by other countries *because Indian environmental conditions are not favorable for the bio floc.*

We are not able to maintain and utilize the flocs properly to bring us enough benefits. If we try to maintain a high amount of flocs like other countries, due to some unknown reasons (mostly temperature) flocs crash and produce quick changes in water quality parameters and cause sudden mortality of shrimps. At present all the bio floc farms running are not actual bio floc farms, but mostly they are **Semi floc farms** (maintaining minimal floc) these are not

successful from a **Commercial point of view**. Hence, they are not achieving any advantages of bio floc but end up creating some natural conditions (Enhancing Immunity) for shrimp and increasing immunity in them.

Aquamimicry technology is suitable for Indian conditions so, if we adopted this technology we can achieve better results. Definitely, by using this method in semi-intensive cultures we can achieve nearly 40% feed replacement by copepods and benefits of probiotics and microbial community as well. A technology that provides both economic and environmental sustainability in Aquaculture is Aquamimicry. There is a need to conduct more research and experimentation on this technology for better results, then we can see growth in Shrimp Industry.

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IRRIGATION WATER CONSERVATION TECHNOLOGIES

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Introduction

Irrigation water management is an important component of modern agriculture. By employing efficient techniques, farmers can optimize water resources, reduce costs, improve crop yield and quality, and contribute to sustainable environmental management. Irrigation water management plays an important role in agriculture by ensuring efficient and sustainable use of water resources for crop production. It involves the implementation of various technologies and practices to optimize water use, reduce wastage, and enhance crop yield and quality.

With a growing global population and the challenge of climate change, efficient irrigation water management has become more important than ever. By adopting appropriate water management strategies, farmers can reduce the risks associated with water scarcity, reduce water-related costs, and conserve valuable water resources.

Some of the commonly used water-saving techniques are:-

1. **Micro-irrigation:** One of the most efficient water-saving techniques is micro-irrigation, which includes drip irrigation and sprinkler irrigation. Micro-irrigation systems supply small amounts of water directly to the root zone of the crop, which reduces losses due to evaporation, runoff and deep seepage.

   1.1. **Drip Irrigation**: In drip irrigation, water is supplied drop by drop through emitters to the roots of the plants. It is a water-saving irrigation method where water is delivered directly to the plant roots, reducing water loss due to evaporation and runoff. Examples: Orchard crops- Grapes, Banana, Pomegranate, Orange; Vegetables - Tomatoes,

Chillies, Capsicum, Cabbage; Cash crops - Sugarcane, Cotton; Flowers - Rose, Carnation, Gerbera, Anthurium; Trees - tea, rubber, coffee, coconut; Spices- Turmeric, clove, mint etc.

1.2. **Sprinkler Irrigation:** Sprinkler irrigation is a method in which water is sprayed on the crops through sprinklers. The water droplets are broken into fine particles and sprayed on the plants. Examples- Sugarcane, Cotton, Paddy, Onion etc.

2. **Sub-surface Irrigation**: Sub-surface irrigation is a method in which underground water is supplied. In subsurface irrigation, water is passed through a network of pipes or tubes buried below the surface of the soil are supplied.
3. **Furrow irrigation**: Furrow irrigation is a method in which water flows through furrows or channels between rows of crops.
4. **Mulching**: Mulching refers to covering the soil around the plant with organic material, such as straw or plastic sheets. Mulching reduces evaporation from the soil surface and helps retain soil moisture. It also reduces weed growth and keeps the soil cool.
5. **Crop rotation**: Crop rotation is an excellent technique of water conservation. In crop rotation, farmers alternate between crops that require more water and crops that require less water. For example, cultivation of drought-tolerant crops such as pulses, oilseeds and millets can save more water in the dry season.
6. **Crop selection**: Select crops that are suited to local agro-climatic conditions and have high water use efficiency.
7. **Optimum Planting Timing:** Plant crops at the right time to ensure timely germination and rapid growth, thereby reducing water requirement.
8. **Soil moisture monitoring:** Regularly monitor soil moisture levels through techniques such as tensiometers, gypsum blocks or soil moisture sensors, to ensure that irrigation is applied only when necessary.
9. **Irrigation Scheduling:** Develop irrigation schedule based on soil moisture monitoring data, crop water requirements and local weather conditions.
10. **Soil Conservation:** Ensure proper soil conservation practices such as terracing, contour bunds, or vegetative barriers to prevent soil erosion and increase water infiltration.
11. **Nutrient Management:** Proper nutrient management helps in maintaining crop productivity and reducing water requirement.

12. **Water Quality Management:** Ensure that the quality of irrigation water is suitable for crop growth and reduce water pollution through proper storage and management.
13. **Climate-smart farming practices:** Adopt climate-smart farming practices such as conservation agriculture, inter-cropping and crop diversification to improve water use efficiency and adapt to changing climate conditions.
14. **Drainage Management:** In addition to water supply, effective water management also includes management of surplus water. Drainage is a fundamental component of irrigation water management. It helps prevent water logging, facilitates nutrient management, ensures oxygen availability, controls diseases and pests, preserves soil structure, and promotes sustainability in agriculture. Implementing effective drainage systems is essential to optimize water use, improve crop productivity, and ensure long-term agricultural sustainability.

Drip Irrigation in Tomato crop

Micro sprinkler in

Conclusion

Overall, irrigation water management is a critical component for farmers, which can help them address the challenge of irrigation water management, conserve precious water resources, and improve their productivity and income.

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IMPORTANCE OF VETIVER OIL

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Introduction

Vetiver oil, derived from the roots of the Vetiveria zizanioides grass, has a rich history and a plethora of uses. This article explores the origins of vetiver oil, its chemical composition, and its therapeutic properties. From its calming effects on the mind to its skincare benefits, vetiver oil is a versatile essential oil with a wide range of applications.

The Origins and Cultivation of Veriver

This article explores the origins and cultivation of vetiver, tracing its history from ancient times to modern-day practices. It delves into the geographical regions where vetiver is grown, its traditional uses in agriculture and erosion control, and the sustainable cultivation methods employed by farmers. Additionally, it discusses the environmental benefits of vetiver cultivation, such as soil conservation and carbon sequestration.

The Science Behind Vetiver: Understanding its Chemical Composition and Properties

Focusing on the scientific aspects of vetiver, this article examines its chemical composition, including the presence of compounds such as vetiverol, vetiverone, and alpha-vetivone. It discusses the pharmacological properties of these compounds, highlighting their potential therapeutic effects on the body and mind. Furthermore, it explores the role of vetiver in aromatherapy, skincare, and traditional medicine systems.

The Chemical Composition of Vetiver Oil

Vetiver oil is composed of various compounds that contribute to its unique aroma and therapeutic properties. This article delves into the chemical composition of vetiver oil, highlighting key components such as vetiverol and vetiverone. Understanding the chemistry of vetiver oil is crucial for unlocking its potential benefits in aromatherapy, skincare, and more.

Therapeutic Uses of Vetiver Oil

Vetiver oil offers a multitude of therapeutic benefits for both the mind and body. This article explores its uses in aromatherapy for stress relief and relaxation. Additionally, vetiver oil is known for its skincare benefits, including its ability to soothe inflammation and promote wound healing. Whether used topically or diffused in the air, vetiver oil can enhance well-being and promote a sense of calm.

Vetiver Oil in Traditional Medicine

In many traditional medicine systems, vetiver oil has been used for centuries to treat various ailments. This article explores its role in Ayurveda, Traditional Chinese Medicine, and other healing practices. From its cooling properties to its ability to balance energy, vetiver oil is highly valued for its therapeutic effects. By understanding its traditional uses, we can appreciate the holistic benefits of vetiver oil.

Practical Applications of Vetiver Oil

From skincare to perfumery, vetiver oil has numerous practical applications. This article provides practical tips for using vetiver oil in daily life. Whether adding a few drops to a bath for relaxation or creating a custom perfume blend, vetiver oil can be incorporated into various beauty and wellness routines. By exploring its practical applications, we can harness the full potential of vetiver oil for our health and well-being.

Vetiver in Perfumery: From Earthy Base Notes to Modern Fragrances

This article provides an in-depth exploration of vetiver's role in perfumery, tracing its evolution from a base note in traditional fragrances to a prominent ingredient in modern perfumes. It examines the olfactory profile of vetiver, its versatility as a fragrance ingredient, and its cultural significance in the world of perfumery. Additionally, it highlights iconic perfumes that feature vetiver as a key note and discusses the creative processes behind crafting vetiver-based fragrances.

Vetiver in Traditional Medicine: Healing Practices and Cultural Significance:

Exploring the traditional medicinal uses of vetiver, this article delves into its role in various healing practices around the world. It examines how vetiver is used in Ayurveda, Traditional Chinese Medicine, and other indigenous healing systems to treat a wide range of ailments, including digestive issues, skin conditions, and emotional imbalances. Furthermore, it discusses the cultural significance of vetiver in spiritual rituals and ceremonies.

Vetiver Beyond Earth: Exploring its Applications in Sustainable Development

This article explores the multifaceted applications of vetiver beyond traditional uses, focusing on its role in sustainable development initiatives. It examines how vetiver is utilized in environmental conservation efforts, such as soil stabilization, erosion control, and wastewater treatment. Additionally, it discusses innovative uses of vetiver in renewable energy production, bioremediation, and green infrastructure projects aimed at addressing global challenges such as climate change and water scarcity.

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ANALYSIS OF ECOSYSTEM PRESERVATION AND CONSERVATION STRATEGIES

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Abstract

Ecosystems are regions of nature where living things interact with one another and theirsurrounding environment. The ecosystem is essential for environmental balance. The ever-increasing population and exploitation of nature affect the ecosystem and affects the environment. Organic compounds include production, consumers, and decomposition, abiotic components include rain, temperature, light, wind, humidity, etc., and edaphic factors include soil, pH, topographic minerals, etc. The functions of an ecosystem are thefood chain consisting of producers, consumers - Primary, Secondary, and Tertiary consumers, and decomposers. Likewise the food web. There are two types of ecotourism, terrestrial and aquatic ecology. Terrestrial ecosystems include forests, grasslands, deserts, and tundra ecosystems. Similarly, the aquatic ecosystem has marine and freshwater ecology. There are ten biogeographic resins in India's Trans-Himalayan Region, Himalayas, Indian Desert, Semi-arid areas, Western Ghats, Deccan Peninsula, Gangetic Plains, Northeast India, Coastal Region, Andaman, and Nicobar Islands that are well discussed in importance of the ecosystem types of ecosystem,food chain,food web and ecosystem preservation and conservation strategies thoroughly discussed in this paper.

Keywords : eco system, food chain, strategies ,importance

Introduction

The term ecosystem was coined in 1935 by the Oxford ecologist A.G. Tensely to encompass the interactions among biotic and abiotic components of the environment at a given site

Concept of an Ecosystem

Living organisms cannot live isolated from their non-living environment be-cause the latter provides materials and energy for the survival of the former i.e. there is interaction between a biotic community and its environment to produce a stable system; a natural self-sufficient unit which is known as an ecosystem.Ecosystem are the parts of nature where living orgaisms interact among themselves and with their physical environment.

Structure of ecosystem (biotic and abiotic components)

Functions of Ecosystem

Physical (energy flow), Biological (food chains, food web, ecological succession), and Biogeochemical (nutrient cycling) processes. Concepts of productivity, ecological pyramids and homeostasis.

Types of Ecosystems:

Tundra, Forest, Grassland, Desert, Aquatic (ponds, streams, lakes, rivers, oceans, estuaries); importance and threats with relevant examples from India

Ecosystem services (Provisioning, Regulating, Cultural, and Supporting); Ecosystem preservation and conservation strategies; Basics of Ecosystem restoration.

Importance of ecosystem

An ecosystem is a community of living things and their environment. The environment includes everything that affects the living things in the community, including the air, the water, the soil, the climate, and the other living things in the community.Ecosystems are important because they provide us with many of the things we need to survive. The air we breathe, the water we drink, the food we eat, and the materials we use come from ecosystems. Ecosystems also provide us with many benefits that we don't always think about, such as clean air and water, and places to play and relax.

Ecosystems are also important because they play a key role in regulating the Earth's climate. They remove carbon dioxide from the atmosphere, and they help to stabilize the climate by regulating the amount of energy that is released from the Earth's surface.Ecosystems are also important because they support many of the world's most endangered species. If we lose our ecosystems, we could lose many of the plants and animals that live in them. This would be a huge loss for humanity and for the environment.

Abiotic components (Nonliving):

The abiotic component can be grouped into following categories:-

(a) Climatic Factors: Which include rain, temperature, light, wind, humidity etc. (b) Edaphic Factors: Which include soil, pH, topography minerals etc.

The functions of important factors in abiotic components are given below:

Soils are much more complex than simple sediments. They contain a mixture of weathered rock fragments, highly altered soil mineral particles, organic mat-ter, and living organisms. Soils provide nutrients, water, a home, and a struc-tural growing medium for organisms. The vegetation found growing on top of a soil is closely linked to this component of an ecosystem through nutrient cycling.

The atmosphere provides organisms found within ecosystems with carbon di-oxide for photosynthesis and oxygen for respiration. The processes of evapora-tion, transpiration and precipitation cycle water between the atmosphere and the Earth's surface.

Solar radiation is used in ecosystems to heat the atmosphere and to evapo-rate and transpire water into the atmosphere.Sunlight is also necessary for photosynthesis. Photosynthesis provides the energy for plant growth and me-tabolism, and the organic food for other forms of life.

Most living tissue is composed of a very high percentage of water, up to and even exceeding 90%. The protoplasm of a very few cells can survive if their water content drops below 10%, and most are killed if it is less than 30-50%. Water is the medium by which mineral nutrients enter and are trans-located in plants. It is also necessary for the maintenance of leaf turgidity and is required for photosynthetic chemical reactions. Plants and animals receive their water from the Earth's surface and soil. The original source of this water is precipita-tion from the atmosphere.

(2) **Biotic components:**The living organisms including plants, animals and micro-organisms (Bacteria and Fungi) that are present in an ecosystem form the biotic components.

(a)Producers: The green plants have chlorophyll with the help of which they trap solar energy and change it into chemical energy of carbohydrates using simple inorganic compounds namely water and carbon dioxide. This process is known as photo-synthesis. As the green plants manufacture their own food they are known as Autotrophs (i.e. auto = self, trophos = feeder) The

chemical energy stored by the producers is utilised partly by the producers for their own growth and survival and the remaining is stored in the plant parts for their future use.

(B) Consumers: The animals lack chlorophyll and are unable to synthesise their own food. There-fore, they depend on the producers for their food. They are known as heterotrophs (i.e. heteros = other, trophos = feeder.

The consumers are of four types, namely:

(a) Primary Consumers or First Order Consumers or Herbivores: These are the animals which feed on plants or the producers. They are called her-bivores. Examples are rabbit, deer, goat, cattle etc.

(b) Secondary Consumers or Second Order Consumers or Primary Carnivores: The animals which feed on the herbivores are called the pri-mary carnivores. Examples are cats, foxes, snakes etc.

(c) Tertiary Consumers or Third Order Consumers: These are the large carnivores which feed on the secondary consumers. Example are Wolves.

(d) Quaternary Consumers or Fourth Order Consumers or Omnivores: These are the largest carnivores which feed on the tertiary consumers and are not eaten up by any other animal. Examples are lions and tigers.

(C) Decomposers or Reducers: Bacteria and fungi belong to this category. They breakdown the dead organic materials of producers (plants) and consumers (animals) for their food and re-lease to the environment the simple inorganic and organic substances produced as by-products of their metabolisms. These simple substances are reused by the producers resulting in a cyclic ex-change of materials between the biotic community and the abiotic environment of the ecosystem. The decomposers are known as Saprotrophs (i.e., sapros = rotten, trophos = feeder).

Functions of Ecosystem:

(i)Productivity: A constant input of solar energy is the basic requirement for any ecosystem to function and sustain. Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (g –2) or energy (kcal m–2). The rate of biomass production is called productivity.

(ii) Decomposition: Dead plant remains such as leaves, bark, flowers and dead remain of animals, including fecal matter, constitute detritus, which is the raw material for decomposition.

The important steps in the process of decomposition are fragmentation, leaching, catabolism, humification and mineralisation. Detritivores (e.g., earthworm) break down detritus into smaller particles. This process is called fragmentation. By the process of leaching,watersoluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called as catabolism. It is important to note that all the above steps in decomposition operate simultaneously on the detritus.

Humification and mineralisation occur during decomposition in the soil. Humification leads to accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature it serves as a reservoir of nutrients.

The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as mineralisation

(iii) Physical (energy flow) : The chemical energy of food is the main source of energy required by all living organisms. This energy is transmitted to different trophic levels along the food chain

(iv) Biological (food chains, food web, ecological succession): Food chains and energy flow are the functional properties of ecosystems which make them dynamic. The biotic and abiotic components of an ecosystem are linked through them.

A food web illustrates all possible transfers of energy and nutrient among the organisms in an ecosystem, whereas food chain traces onle one pathway of food. Food webs are very important in maintaining the stability of an ecosystem.

The gradual and fairly predictable change in the species composition of a given area is called ecological succession

(v) Biogeochemical (nutrient cycling) processes: cyclic exchange of material between the living organisms and their non-living environment is called Biogeochemical Cycle.

Types of ecosystem : An ecosystem consists of all the living and non-living things in a specific natural setting. Plants, animals, insects, microorganisms, rocks, soil, water and sunlight are major components of many ecosystems. All types of ecosystems fall into one of two categories: terrestrial or aquatic. Terrestrial ecosystems are land-based, while aquatic are water-based.The word “biome” may also be used to describe terrestrial ecosystems which extend across a large geographic area, such as tundra.

(1)**Terrestrial Ecosystems**

The ecosystem which is found only on landforms is known as the terrestrial ecosystem. The main factor which differentiates the terrestrial ecosystems from the aquatic ecosystems is the relative shortage of water in the terrestrial ecosystems and as a result the importance that water attains in these ecosystems due to its limited availability.

(a) Forest Ecosystems These ecosystems have an abundance of flora or plants and hence in these ecosystems a large number of organisms live in a small space. This means that these ecosystems have a high density of living organisms.

(b) Grassland Ecosystems The grasslands are the areas which comprise mainly of the grasses with a little number of shrubs and trees. Grazing animals, insectivores and herbivores are the main types of organisms which are found in these regions. The three major types of grasslands are the prairies, savannas and steppes.

(c) Desert Ecosystems The common defining feature among desert ecosystems is low precipitation, generally less than 25 centimeters, or 10 inches, per year. Almost 17% of all the land on this planet is occupied by the desert ecosystems.The fauna and flora in these ecosystems is generally not much developed because of the high temperatures, intense sunlight and low availability of water

(d) Tundra Ecosystems As with deserts, a harsh environment characterizes ecosystems in the tundra. In the snowcovered, windswept, treeless tundra, the soil may be frozen year-round, a condition known as permafrost. The mountain ecosystem is the most scattered and diverse in terms of the habitats that it provides. A large number of animals and plants are found in this ecosystem.

2.Aquatic Ecosystem

An ecosystem which exists in a body of water is known as an aquatic ecosystem. The communities of living organisms which are dependent on each other and the aquatic surroundings of their environment for their survival exist in the aquatic ecosystems. The aquatic ecosystems are mainly of two types, the freshwater ecosystems and the marine ecosystems. 18

(a) Marine Ecosystem Marine ecosystems are the biggest ecosystems: They cover around 71% of earth's surface and also contain almost around 97% of the total water present on earth. High amounts of minerals and salts are generally present in the water in the marine ecosystems

and to better understand the amount and composition of the different minerals and salts in the water in different marine ecosystems.

(b) Freshwater Ecosystem: The freshwater ecosystems are very small in magnitude as compared to the marine ecosystems as these covers only 0.8% of the earth's surface and only account for 0.009% of the total water present on earth. There are three basic kinds of freshwater ecosystems and these are Lentic, Lotic, and Wetlands. The lentic ecosystems are slow-moving or still water like ponds or lakes. Lotic ecosystems are fast-moving water like rivers. The wetlands are those systems where soil remains saturated for a long period of time. Many different species of reptiles, amphibians, and around 41% of the world's fish species live in these ecosystems. The faster moving waters contain more dissolved oxygen than the slow moving waters and hence support greater biodiversity.

Pond Ecosystems – These are usually relatively small and contained. Most of the time they include various types of plants, amphibians and insects. Sometimes they include fish, but as these cannot move around as easily as amphibians and insects, it is less likely, and most of the time fish are artificially introduced to these environments by humans.

River Ecosystems – Because rivers always link to the sea, they are more likely to contain fish alongside the usual plants, amphibians and insects.

Ecosystem preservation and conservation strategies

1. Legislation Formal policies and programmes for conservation and sustainable utilisation of ecosytem resources date back to several decades. The concept of environmental protection is enshrined in the Indian constitution in Articles 48a and 51a (g). Major central acts relevant to biodiversity include: Environment Protection Act, 1986; Fisheries Act, 1897; Forest Act, 1927; Forest (Conservation) Act, 1980; Wildlife (Protection) Act 1972 and Wildlife (Protection) Amendment Act 1991. Biological Diversity Act, 2002.

2. In -situ Conservation Conserving the animals and plants in their natural habitats is known as in situ conservation. The established natural habitats are: National parks and sanctuaries; Biosphere reserves; Nature reserves; Reserved and protected forests; Preservation plots ; Reserved forests. Biosphere Reserves are another category of protected areas. Under this, a large area is declared as a Biosphere Reserve where wildlife is protected, but local communities are allowed to continue to live and pursue traditional activities within the Reserve. A programme "Eco-development" for insitu conservation of biological diversity involving local communities was

initiated. It integrates the ecological and economic parameters for sustained conservation of ecosystems by involving local communities with maintenance of earmarked regions surrounding protected areas.

3. Ex-situ Conservation Ex-situ conservation of plants and animals preserve/ or protect them away from their natural habitat. This could be in zoological parks and botanical gardens or through the forestry institutions and agricultural research centres. A lot of effort is under way to collect and preserve the genetic material of crops, animal, bird and fish species.

4. Community Participation in Biodiversity Conservation It is being recognized that no legal provisions can be effective unless local communities are involved in planning, management and monitoring conservation programmes. Successful conservation strategies will have to have the confidence and participation of the local communities.

5. Recording Indigenous Knowledge The lives of local communities are closely interwoven with their environment, and are dependent upon their immediate resources for meeting their needs. These communities have a vast knowledge about local flora and fauna which is very important for biodiversity conservation. Much of this knowledge is orally passed on from generation to generation.

Conclusion

The unit of living organisms interacting with their non -living environment in an orderly self sufficient manner is known as an ecosystem. The structure of an ecosystem is basically a description of the organisms and physical features of environment including the amount and distribution of nutrients in a particular habitat. Ecosytem can be broadly divided into natural and artificial ecosytems. Natural ecosystems are further classified as terrestrial and aquatic ecosystems.

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AQUAPONICS: AN INTEGRATED APPROACH TO FISH FARMING SYSTEM

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Abstract

Aquaponics is an integrated technique to effective and sustainable intensification of agriculture. Universally, improved agricultural practices are needed to improve rural poverty and develop food security. Aquaponics relates several principles including, efficient water use, efficient nutrient use, and the application of biological and ecological approaches to agricultural fish and plant production. This article discusses concept of aquaponics, the three main methods of aquaponic systems: nutrient film technique, media beds, and deep water culture, component of this system, what plants and fishes can be grown and advantages of aquaponics.

Keywords: Integrated, Sustainable, Ecological, Aquaponics

Introduction

Aquaponics is an integrated fish and plant production technology, principally comprising of two sub-systems, viz., ‘Aquaculture’ (raising aquatic animals) and ‘Hydroponics’(cultivating plants in water).In this circulating system, fish waste acts as a natural fertilizer for plants, after that plants take up those nutrients and return clean water to the fish. This farming system is especially valuable in areas where land and water aren’t plentiful and helpful for everyone who wants to grow food, and it can be done just about anywhere that has access to clean water and energy (ECOLIFE Conservation 2017).

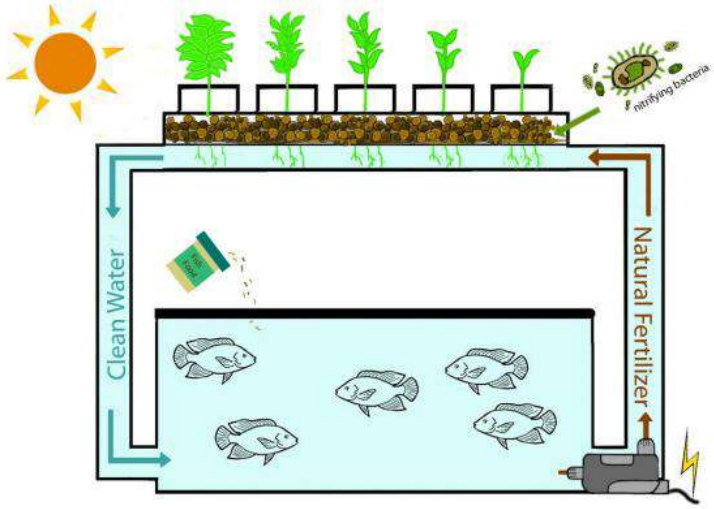


Fig. 1. Design of Aquaponics

Why Need of Aquaponics?

- As current estimates are that 38% of global agricultural land is degraded so normally results in reduced yields due to lack of or insufficient nutrients (The World Bank, 2015).
- Aquaponics is a multipurpose and adaptable method of sustainable farming. These systems can be constructed on just about any scale and designed to fit in almost any space.
- Aquaponics accentuates water conservation. Generally, aquaponics needs 90% less water than traditional vegetable gardens and 97% less water compared to standard aquaculture methods. Furthermore, the recirculating system keeps waste out of watersheds.
- Aquaponic systems operate with little environmental impact, without the use of artificial fertilizers, dangerous herbicides and harmful pesticides to produce high quality, hormone-free fish and organic vegetables.

Principle of Aquaponics:

This process allows the plants, fish, and bacteria to thrive symbiotically and to work together to generate a healthy growing environment for each other, provided that the system is properly balanced.

Methods of Aquaponics:

There are three primary growing methods includes in aquaponics system are Nutrient Film Technique (NFT), Media Based Grow Bed methodand Raft or Deep Water Culture (DWC) (FAO, 2014).

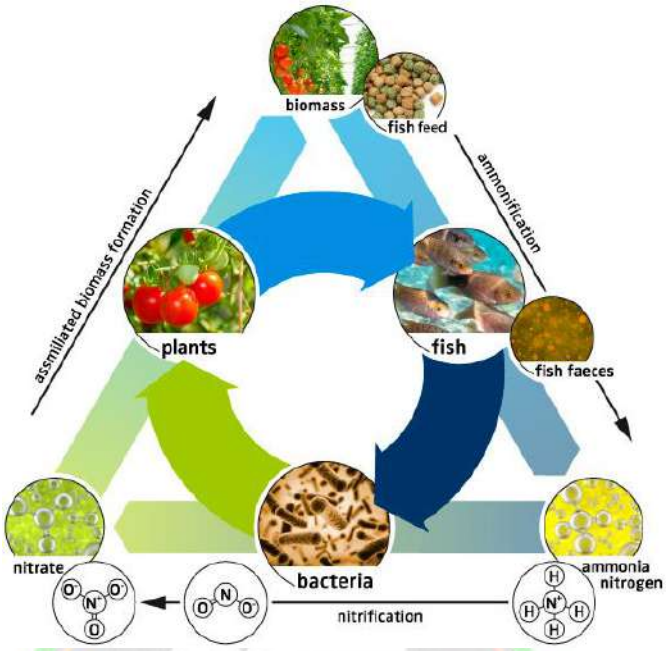


Fig. 2. Recirculating system of Aquaponics

1.Nutrient Film Technique (NFT): This is the most popular technique used in hydroponics and easily adaptable for the use in aquaponics. In this method, a thin layer of nutrient-rich water from the fish tank is pumped through the bare roots of the plants in a watertight channel.

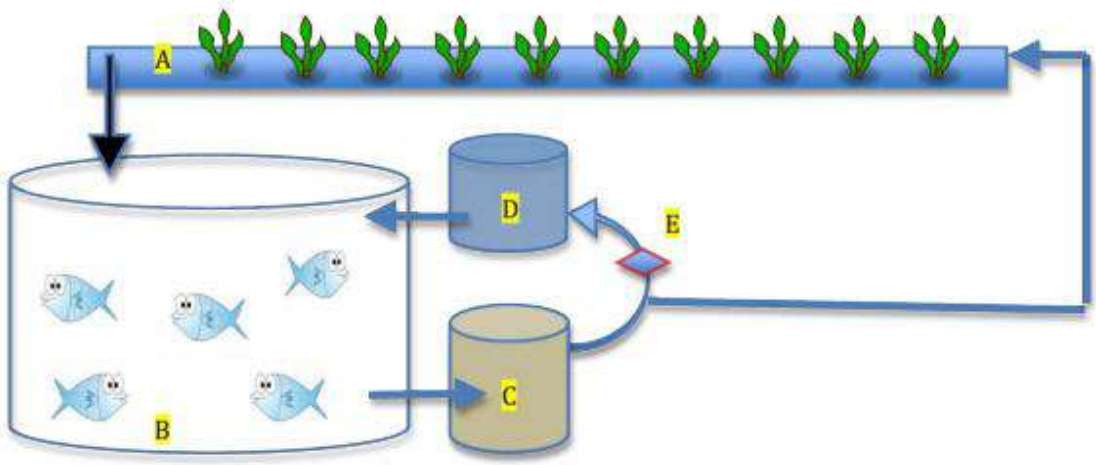


Fig. 3. Nutrient Film Technique (NFT) Aquaponic system

A. NFT Grow Channel
B. Fish Tank
C. Mechanical Filter/ Solids Removal

D. Biological Filter

E. Gate Valve (To direct flow to grow channels)

The depth of the re-circulating stream is very shallow, permittingsupply of oxygen abundantly to reach the plant roots. The main advantage of the NFT system is that the plant roots are exposed to a constant supply of water, oxygen, and nutrients. A disadvantage of NFT is that less buffering against an interruption in the supply of electricity, but overall it is a very productive technique

2.Media Based Grow Bed method:

This is another widely used method by backyard growers. The growing area is a wide deep container with adequate surface area. This container is filled with gravel, or other soil-less growing medium where the vegetables able toplant. The water pump is controlled by an adjustable timer which is useful to circulate water to fill the tub in an “ebb-and-flow” pattern. When the pump runs, the grow bed is saturated with water and the pump is off, the water slowly begins to drain back into the fish reservoir. As it drains, oxygen is drag through the roots. Another means of providing water in an ebb-and-flow pattern is through the use of a bell siphon. Asiphon is a tool for drawing water from a higher container to a lower container. Siphons is able to adapted in an aquaponics setup to control the flooding and draining of grow beds. In this procedure, they are called auto-siphons, siphons can be start and stop in response to changing water levels. Bell siphons can also be used in biological filters to generate a wet/dry environment beneficial to aerobic nitrifying bacteria.

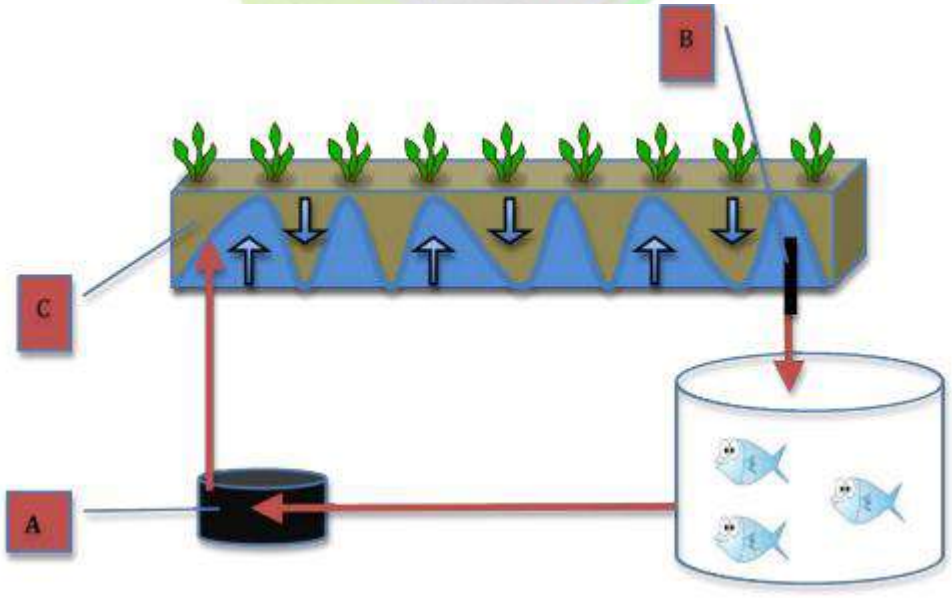


Fig.4.Media Based Grow BedAquaponic system

A. Pump
B. Bell Siphon
C. Grow Tray or Growing media

3.Raft or Deep Water Culture (DWC): This is the most frequently used technique for commercial and large scale aquaponics. With the help of this technique, the plants can be grow on perforated rafts.This types of rafts usually made of Styrofoam or similarly buoyant material, which drift in dedicated water tanks. The roots of the plants are often bare and constantly in the water. This method is highly productive, which requires good aeration and intensive filtration to keep the water clean and clear of solids waste.

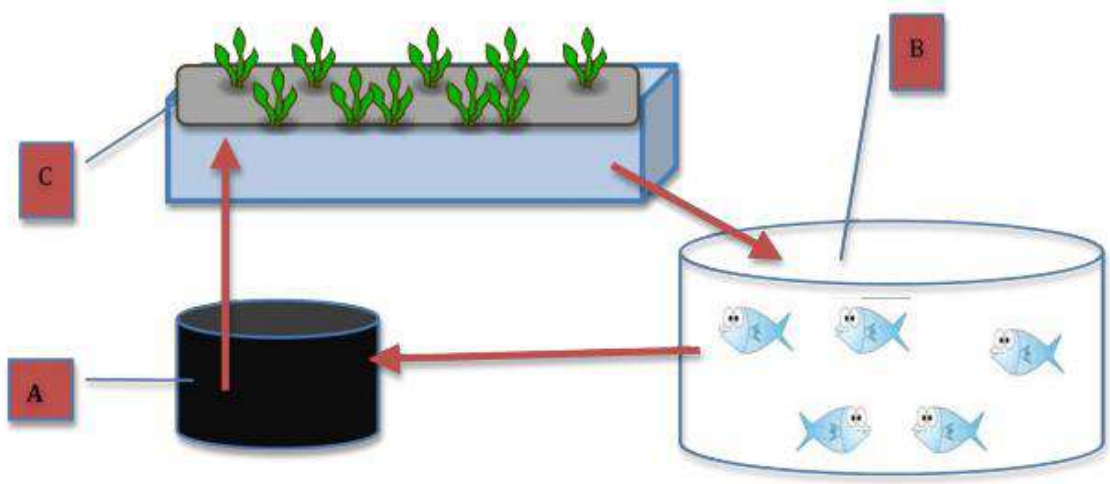


Fig. 5. Raft or Deep Water (DWC) Aquaponic system

A. Mechanical/ Biological filter
B. Fish Tank
C. Growing Raft

Component of Aquaponics(FAO, 2014)**:**

Fish Tanks: Any shape of fish tank will work, round tanks with flat bottoms are recommended. Inert plastic or fibre glass, low density polyethylene (LDPE) tanksare preferable because of their high resistance and food-grade characteristics.White or other light colours are strongly recommended as easier viewing of the fish in order to easily check behaviour and the amount of waste settled at the bottom of the tank.

- **Grow Trays or NFT Channels**: Appropriate size of plastic cement mixing trays and plastic storage containers can work well as growing trays, and rain gutter downspout can be simply adapted to accommodate growing pots.
- **Growing media:** The media should be inert, not dusty, and non-toxic, and it must have a neutral pH thus not affecting on the water quality. It is important to work with material that is comfortable for the farmer. LECA (lightweight expanded clay aggregate) is a popular hydroponic grow media used for aquaponic growing. It is inert, highly porous, andreusable, providing widespread surface area for biological filtration. Other good options for grow media include quartz gravel and rockwool are a specialty product for hydroponic growing.
- **Mechanical Filter:**Functions of mechanical filtration allow the removal of solid waste before being broken down by biological processes. This can be done by placing a polyester filter sock, foam sponge, or similar barrier in the water flowline.Mechanical filtration works best when the filter media like sponge, etc. is not submerged in the water, however positioned above the water line to catch water as it flows from the growing channels back to the fish. The sponge then may be removed, cleaned, and replaced on a regular basis. For larger systems, sand filters, settling tanks, and other commercial filters are a good asset and will support a long way in providing stable water quality.
- **Biological Filter:** Most fish waste is not filterable using a mechanical filter as the waste is dissolved directly in the water, and the size of these particles is too small. The dynamic action of water in a biofilter will break down very fine solids not captured by the clarifier, which further prevents waste build up on plant roots in NFT and DWC systems. Biofiltration is important in aquaponics because ammonia and nitrite are toxic even at low concentrations, while plants need the nitrates to grow.The biofilter must have a large surface area supplied with oxygenated water. The biofiltershold be installed between the mechanical filter and the hydroponic containers. One commonly used biofilter medium is Bioballs. Because they are small in size, specially shaped plastic items that have a very large surface area for their volume (500–700 m2/m3). Other media including plastic bottle caps, volcanic gravel, netting, nylon shower poufs, polyvinyl chloride (PVC) shavings and nylon scrub pads.
- **Water Pump:** An impeller-type submersible water pump is mostly recommended, this type of pump is used as the heart of an aquaponics unit. External pumpsmight be used, but they require additional plumbing and are more appropriate for larger designs. Periodic cleaning is necessary

thus be sure to place the submersible pump in an accessible location. The internal filter will need cleaning every 2–3 weeks. Submersible water pumps will break if they are run without water; never run a pump dry.

- **Sump tank:** A sump is an area where liquid run-off accumulates. In an aquaponics system the sump sites at a point lower than the grow beds and is the tank into which the grow bed drains.Sump tanks should be smaller than the fish tanks, and should be able to hold between one-fourth and one-third of the volume of the fish tank.
- **Air pump / Diffusers:** Aeration is vital to keeping sufficient oxygen levels for fish respiration. It helps to provides extensive water surface area, and agitation helps to increase the dissolved oxygen in the water. Supplemental air pumps, air stones and diffusers, along with airline tubing and gang valves to manage flow can also be used to provide supplemental O_2.

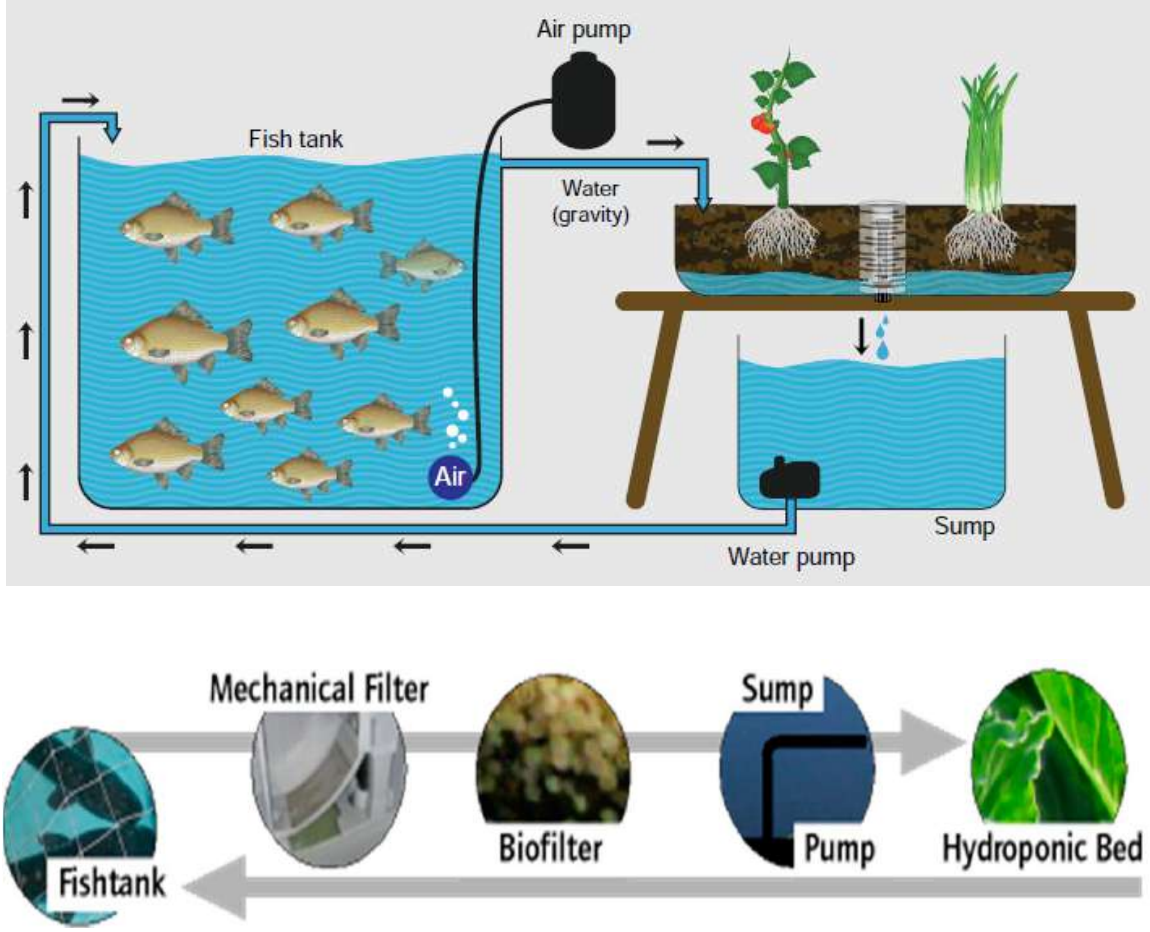


Fig. 7. Components includes in the process of Aquaponics

- **Net Pots:** They are plastic pots that areperforated to allow water flow while having the soil-less growing media.
- **Lighting for indoor systems:** The sun is the best light source for aquaponics. For indoor gardening, there are a number of artificial light options including high output fluorescents, metal halides, mercury vapor bulbs, LEDs, and plasma lights. These will be helpfulto leafy greens like basil, lettuce, and chard. Some vegetables may require extra intense lighting when growing indoors.
- **Water testing kits:**Simple water tests are very important for every aquaponic unit. Colour-coded freshwater test kits are easily available, fairly economical and easy to use, and thus these are recommended. These kits include tests for pH, ammonia, nitrate, nitrite, GH and KH. Other methods include test strips ordigital meters. A thermometer is essential to measure water temperature.

Water quality in aquaponics: Water quality is important for successful fish culture in an Aquaponics system,optimum range of certain parameters are as follows (APHA 2005):

Water parameter	Optimum range
pH	6.5–8.5
DO	4–8 mg/litre
Temperature	
Tropical fishes	22–32°C
Cold-water fishes	10–18 °C
Ammonia and nitrite	0 mg/l
Light	Indirect natural light

What Plants Can Be Grown?

Vegetables:

- Lettuce
- Beans
- Squash
- Broccoli
- Peppers

- Cucumbers
- Peas
- Spinach
- Tomatoes

Fruits:

- Strawberries
- Watermelon
- Banana

Flowers:

- Marigold
- Rose
- Sunflower

Herbs:

- Basil
- Thyme
- Cilantro
- Sage
- Lemongrass
- Wheatgrass
- Oregano
- Parsley

More than 150 different vegetables, herbs, flowers and small trees have been grown successfully in aquaponic systems (FAO, 2014).

Which fish grow best?

A wide variety of fish and other aquatic animals can be cultured in aquaponic systems. Ideal choices for this system are freshwater, herbivorous or omnivorous fish as their sustainability, ease of feeding, and efficient conversion of feed (ECOLIFE Conservation 2017).

- **Tilapia**
  - Ideal for large scale aquaponics systems
  - Easy to breed, starting breeding at 7-8 months of age

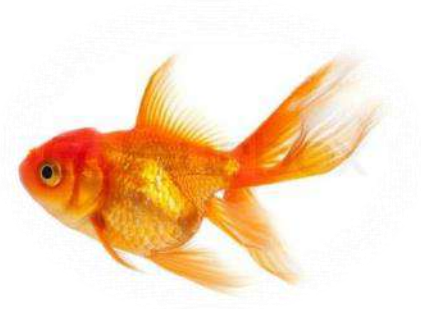
- Grow fast up to 500g in 6 months
- Optimum range of temperature between 65° - 85°F
- An excellent source of lean protein

- **Carp:**
  - Carp, like tilapia, are tolerant to relatively low DO levels and poor water quality
  - But they have a much larger tolerance range for water temperature.
  - Carp can survive at temperatures as low as 4 °C and as high as 34 °C
  - An ideal selection for aquaponics in both temperate and tropical regions
  - Best growth rates are obtained when temperatures are between 25 °C and 30 °C.
  - Examples:Common carp, Silver carp, Grass carp

- **Catfish**
  - Ideal for large scale aquaponics systems
  - 300+ gallon tank necessary because catfish can grow up to a size of 40-50 lbs.
  - Very quickly grow
  - Optimum temperature range 75° - 86°F
  - Can tolerate temperatures between 41° - 93°F
  - Can withstand a wide pH range
  - Resistant to many diseases and parasites

- **Goldfish**
  - Perfect for in-home aquaponics systems
  - Widely available

- Inexpensive
- Produce waste quickly
- Can tolerate temperatures between 50-75°F
- Gentle community fish if placed with similar sized



- **Tropical Fish**

  - Perfect for in-home and smaller aquaponic systems
  - Beautiful and fun option
  - Heater necessary
  - Examples: suckermouth fish, cichlids, mollies, clown loaches, tetras

  Other options of fish to consider are: Catla (*Catlacatla*), Rohu (*Labeorohita*), Perch (*Anabas testudineus*), Channel Catfish (*Ictaluruspunctatus*), Trout (*Oncorhynchusmykiss*), Freshwater Prawn (*Macrobrachiumrosenbergii*)etc.

Advantages (FAO, 2014)**:**

- Two agricultural products (fish and vegetables) are produced from one nitrogen source (fish food).
- Sustainable and intensive food production system.
- Extremely water efficient.
- Qualitative production and higher yields.
- For the growth of plants does not require soil.
- Does not use fertilizers or chemical pesticides.
- Lower risks from outer contaminants and higher level of biosecurity.
- Higher control on production leading to lower losses.
- Can be used on non-arable land such as deserts, degraded soil or salty, sandy islands.
- Creates little waste.

Conclusion

Aquaponics is a new, rapidly emerging, eco-friendly agriculture technology that can integrate Recirculating Aquaculture System (RAS) with hydroponics. This is the efficient technology which providing symbiotic environment for producing fish and plants as well asprovide technical, biological, chemical, environmental and economic advantages. It will be helpful to increase not only sustainability but also the productivities of fish and plants.

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SEA RANCHING: AN EFFECTIVE SYSTEM FOR CONSERVATION OF EXPLOITED RESOURCES

Article ID: AG-VO4-I02-43

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Abstract

Many of the world's marine fisheries no longer yield the benefits they once did, due to over fishing and degradation of the supporting ecosystems. The increased requirement for food fish and the profitable market for expensive seafood, it needs to conserve marine resources by recruiting and managing the fish stocks from the hatchery-produced fish/shrimp seed and allow to grow in natural environment to establish a sustainable population. This article discusses the scenario of sea ranching in the world and India, sea ranching technique, species recruiting criteria and developmental measures.

Introduction

Indian fisheries and aquaculture is an important sector of food production provided that nutritional security, as well livelihood support and profitable employment to more than 14 million people, and contributing to agricultural exports(Murthy et al. 2019).Fisheries and aquaculture helps to provides numerous ancillary jobs related to fish processing, packaging, marketing and distribution, manufacturing of processing equipment, boat construction and maintenance, net and gear making, ice production and supply, research and administration.Althoughthe marine environment in India is under stress due to overfishing, destructive fishing operations, pollution,construction of dams, jetties, reclamation of coastal areas and is probably one of the reasons for decline in fish stocks. The declining marine fish

catches in India strongly affects the fishery economy since last few years.However, we largely depend on capture fisheries to harvest our wild resources without employing any management system or restorative measures. In order to ensure sustainable capture production it is imperative that some or the other management techniques be adopted. One of the techniques is sea ranching. Sea ranching is basically a 'put and take' activity, where cultured juveniles are released into the natural habitat and harvested when they reach a commercially optimal size. Compared with pond culture, this technique requires nominally lowerinputs, as the processes between release and harvest are largely left to nature(Pawase et al. 2006).

Balancing the priorities between growth and competition, artisanal and industrial fisheries and aquaculture have emerged. Thus, a new research area called the blue growth initiative (BGI) has paying attention from many fields of science (FAO, 2018 and Lillebo 2017).In link with the Food and Agriculture Organization's (FAO) BGI framework, the BGI focuses on four components: capture fisheries, aquaculture, the trade and social protection of coastal communities and ecosystem services. Five targets were recommended: (1) achieving sustainable fisheries, (2) reducing habitat degradation, (3) conserving biodiversity, (4) maximizing social-economic benefits, and (5) assessing ecosystem services (FAO, 2016 and Burgess 2018). The terms stock enhancement, restocking, capture-based aquaculture, culture-based fisheries, and sea ranching or marine ranching have often been applied to describe the management activities in coastal fisheries. Many countries, like China, Japan, Korea, and Norway have regarded marine ranching as a strong tool for fishery resources, stock enhancement, conservation, and use (Yang, 2016 and Loneragan 2013).

Table 1. Scenario of Sea Ranching in the world (Bartley and Bell. 2008)

Areas of progress	**Action (Examples of species/countries)**
Decision making and fishery management	Stock description and genetic population structure (Pacific salmon/North America, crabs/Japan)
	Modelling to predict benefits of releases, e.g., Enhancefish
	Base releases on carrying capacity (flounder/Japan, mulloway/Australia)
	Promote restoration of critical nursery habitat (shrimp, sea

	bream/Japan)
	Integrate stocking, restocking and sea ranching into comprehensive biological and social management system (Sweden)
	Involve local fishers/community and establish co-management (seabass and sea bream/Italy; giant clams/Philippines; Freshwater species/Asia)
	Promote natural recruitment using rotational fishing and no-take zones (Scallops Japan/New Zealand, sea cucumber/Pacific)
	Limit access and promote ownership and incentives for stock enhancement (Invertebrates/Japan, scallops/New Zealand)
	Eco-system approach (Oysters/ USA; carps/Asia)
Monitoring and evaluation	Improved tagging (Pacific salmon/North America)
	Genetic marking (flounder, black sea bream/Japan)
Reducing the cost of juveniles	Development of methods for collecting wild postlarvae (spat) and juveniles (Scallops/Japan and New Zealand; spiny lobsters/Australia, Caribbean)
	Combined culture of juveniles for aquaculture and stock enhancement (Shrimp/Japan, China)
Improving survival of juveniles released in the wild	Reduced predation through predator removal, customised release habitats and increased size at release (Scallops/Japan; abalone/Australia; giant clams, sea cucumbers/Pacific, finfish/USA)
	Improved husbandry (Sea cucumbers and giant clams/Asia and Pacific; red sea bream/Japan)
	Identification of critical nursery habitat (Shrimp/Japan, Australia, sea cucumbers/Pacific)
	Improve disease diagnosis and fish health (Atlantic salmon/Baltic Sea)

Sea Ranching in India: In India, sea ranching is until now in its infancy. Though some of the institutes such as CIFRI have attempted ranching of Indian shad- Tenulosa ilisha in estuaries of Hubli, Central Marine Fisheries Research Institute (CMFRI) has attempted ranching of some

oyster species in the backwaters of Kerala. Department Of Fisheries, Government of Tamil Nadu has taken the initiative in replenishing the stock of White shrimp (Fenneropenaeus indicus) and Black Tiger (Penaeus monodon) (Pawase et al. 2006). Rajiv Gandhi Centre for Aquaculture (RGCA) have been undertaking the activities of natural stock enhancement by replenishing the Asian Sea bass, *Lates calcarifer* and the Mud Crab *Scylla serrata* at Pazhayaar estuary in Tamil Nadu. The other program for sea ranching through MPEDA-RGCA of 1000 juveniles of the marine finfish, Cobia was the first of its kind in India. (MPEDA Report, 2012).

The Mandapam Regional Centre of ICAR- Central Marine Fisheries Research Institute (CMFRI) is regularly carrying out the sea ranching of hatchery-produced green tiger shrimp (Penaeus semisulcatus) seeds in the Gulf of Mannar and Palk Bay to replenish the natural stock and to enhance the shrimp productivity(PIB Chennai report, 2022).

Most of the beneficiaries of ranching programs fall into four categories(Lima et al. 2019)**:**

1. Releasing hatchery seeds to improve the self-sustaining populations.
2. Releasing hatchery seeds to rebuild severely depleted fish stocks
3. Natural habitat conservation to maintain the habitat function of stock enhancement and
4. Artificial reef construction to create an artificial hard substrate for reef fish.

East Asian countries have focussed on a concept of aquaculture-based, artificial habitat-based marine ranching (e.g., artificial reef and buoyant raft) and rehabilitation-based marine ranching (e.g., seagrass and seaweed bed) based on advanced engineering, new materials and structures, which has become a worldwide hotspot since the late 2000s (Kitada, 2018 and Zhang et al. 2019)

For the marine ranching-related technologies, ecologists have developed various tools for different targets (Table 2) (Zhang et al. 2019).

Table 2. Aims of and tools for marine ranching.

Aims	Tools
Conserve or protect ecological structures to enhance stock and biodiversity	Ecosystem approaches to fishery (EAF), marine ranching spatial planning
Protect ecologically valuable habitats and restore degraded habitats	Conservation and restoration of typical habitats (e.g., seaweed bed, mangrove, seagrass, etc.)
Construct high biological productivity habitats for the sustainable use of fishery	Artificial structure construction (e.g., artificial reefs, cages, buoyant rafts, artificial seaweed,

resources	mangroves, seagrass habitats).
Conserve vulnerable or regionally extinct species	Special marine protected areas (SMPA), species enhancement, and releasing
Promote appropriate use of marine space	Integrated multi-trophic aquaculture (IMTA), multi-trophic and spatial planning based marine ranching
Avoid and resolve social-economic conflicts	Spatial planning public or stakeholder engagement and regulatory system

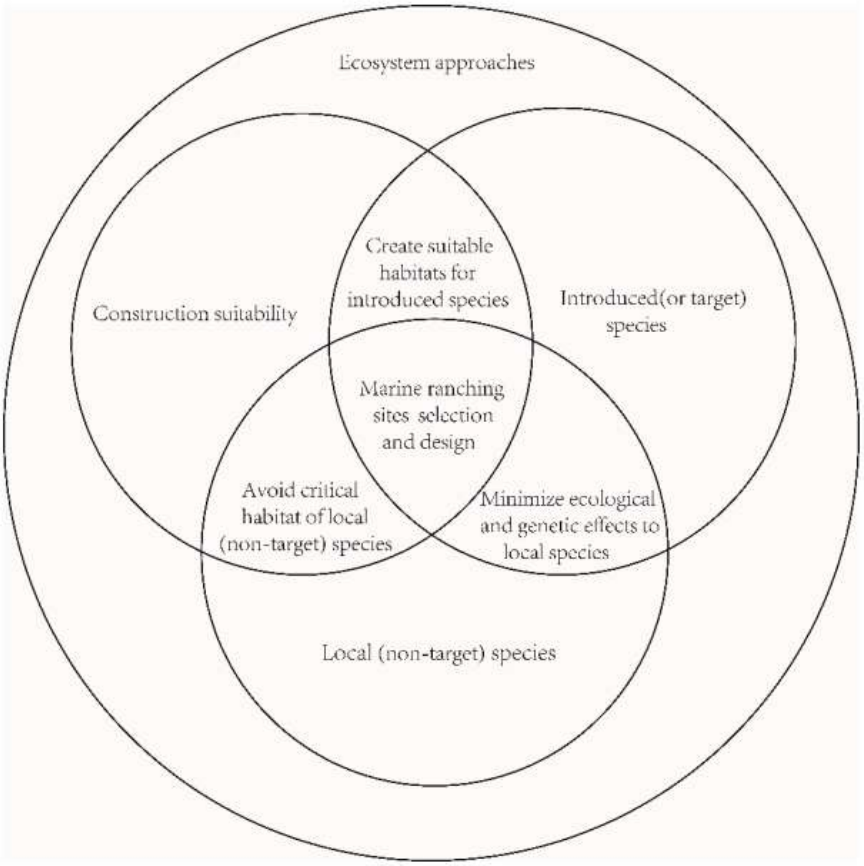

Figure 1. Conceptual diagram of the ecosystem approaches to marine ranching

The sea ranching technique involves: (Rao, 1996)

(1) Brood stock development

(2) Breeding

(3) Larval rearing on large scale

(4) Nursery rearing

(5) Release of seed at suitable sites and

(6) Monitoring of the released and natural stocks to assess the impact

Ranching is beneficially carried out in bays, lagoons, shallow water bodies and in the protected ecosystems.

Species can be recruited (Mustafa et al. 2003)**:**

The ranching could be beneficial if healthy fin and shell fish populations are targeted. Therefore, White shrimp (*Fenneropenaeus indicus*), Black Tiger (*Penaeus monodon*), Kuruma prawn (*Penaeus japonicus*), Lobster (*P. homarus, P. polyphagus, P. ornatus, P. longipes* and *P. versicolor*), Mud crab (*Scylla serrata*), Sea bass (*Lates calcarifer*), Red snapper (*Lutjanus campechanus*), Mullet (*Mugil cephalus*), pearl spot (*Etroplus suratensis*), Silver pompano (*Trachinotus blochii*), Indian pompano (*Trachinotus mookalee*), Cobia (*Rachycentron canadum*), Orange spotted grouper (*Epinephelus coioides*) are suitable species for sea ranching.

Constraints in development(Pawase et al. 2003)**:**

The practice of releasing fish/shrimps produced in a hatchery into the nature has been censured in other areas of the world for not being effective at increasing fishery production, for the following reasons:

1. As not being cost-effective

2. As being an inappropriate substitute for other more urgently needed fishery management actions, such as habitat restoration or reduction in fishing effort.

3. As being threat to native biodiversity through displacement of local species, either by competition, predation, or spread of disease, or through genetic mixing of hatchery and local stocks, thus breaking down locally adapted gene complexes, is a growing concern in many stocking programmes throughout the world.

4. Inadequate public support for lack of knowledge about the techniques being implemented.

5. Difficulties in assessing post-ranching effects.

Developmental measures needed to be considered (Rao, 1996 and Pawase et al. 2003):

1. Majority of the fishermen population are belongs to relatively poor class. Similarly, they do not possess correct biological knowledge on the available fish species. It is, therefore urgently required to acquaint the fisherman with the need of conservation of the native

resource. Conservation of the native resource will help in maintaining ecological balance among the species.

2. Requires adequate infrastructural facilities such as hatcheries and associated inputs, nursery and transportation facilities, identification of suitable release sites and facilities for continuous monitoring of the released stock.
3. The suitable environment like ecology, hydrobiological parameters, fishing pressure, availability of protected area should be taken into consideration before selecting the candidate species for ranching.
4. The hatchery-produced seed needs to be grown to a proper size before releasing into the nature. Careful acclimatization to the new environment is necessary before any such release. Also, probable predators of the species have to be kept away using net enclosures wherever possible.
5. From fishers to protect the same till they reach substantial size in natural waters before harvesting.
6. Cooperation from hatchery operators to supply disease free seeds.
7. In order to increase survival of the introduced stocks in the wild, artificial habitats have to be created, coastal areas have to be improved, and mangrove forestation has to be encouraged.
8. Certain steps for monitoring of the ranching trials should be adopted.

Conclusion

Sea ranching is very effective method for improving fish production, it needs to be set up within the right environment. The specimens of this population will grow, attain maturity and reproduce like their wild counterparts and contribute for the stock enhancement of the specific reason. When ranching is done within the right environment, it can prove to be a profitable method to produce a good quality crop and beneficial for fishers who are looking forward to break the orthodox of conventional fishing and expect to get the fish catches substantially.

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GUAR CULTIVATION

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Introduction

Guar or cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] [2n=14], a native to the Indian subcontinent is a drought tolerant, multi-purpose legume crop cultivated mainly in the *kharif* season in arid environments . It is commonly known as guar, chavli, kayi, guari, khutti. Guar is grown mainly in India, Pakistan, United States and also in some part of Africa and Australia. In old times, Guar was only used as rich protein to feed cattle. It is also used as green vegetable in India. After Second World War there was major shortage of locust bean gum which adversely affected the textile and paper industries. At that time Guar Gum was found as the most suitable substitute for scarce locust bean gum.

Nutritional Information

Nutrition Content	Amount per 100 g
Energy	16Kcal
Moisture	81g
Protein	3.2g
Fat	1.4g
Carbohydrate	10.8g
Vitamin A	65.3IU
Vitamin C	49 mg
Calcium	57 mg
Iron	4.5 mg

** (Kumar and Singh, 2002)

Guar is a drought resistant crop and can be grown successfully in areas where average rainfall is 30-40 centimeter. Accordingly, it is definitely a kharif season crop in North India, but some varieties have been found to grow during March to June as spring- summer crop and other varieties grow during July to November as rainy season crop under South Indian climatic conditions. It is a crop preferring warm climate and grows well in the subtropics during summer. Proper germination of seeds and root development takes place between 25 and 30 degree C temperatures. It cannot stand water logging conditions at all. It is a photosynthetic crop, it comes into flowering and fruiting when sown in kharif season only. (Singh *et al. 2008*)

In India, the crop is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab and to a limited extent in Uttar Pradesh and Madhya Pradesh. Rajasthan alone comprises almost 78 per cent area and 81 per cent production to the national basket of Guar. India is the largest producer and exporter of guar in the world accounting for about 80% of total production. The status of industrial crop because of high gum content (galactomannan) in the endosperm of its seeds, which has multiple industrial use such as oil well drilling, textile printing, paper, explosive, mining, frozen food, bakery, dairy products, beverages, pet foods, slimming aids, diabetic treatment, tablet preparation, ointment, soaping and shampoo, etc. and thus an important foreign exchange earner for the country.

Cultivation practices

Guar is a rain fed monsoon crop, which requires 8-15 inch of rain in 3-4 spells and is harvested in October - November. It is sown immediately after first showers say in July and harvested around November each year. The crop yield is directly related to the monsoon. It requires a relative long growing season of 20-25 weeks.

Climatic requirements	300-400mm rainfall and 25-30 degree C temperature
Soil type	Well drained medium to light soil with pH 7.0-8.5

Time of Sowing	E Early crop is sown from February - march and the main crop is sown with advent of monsoon, at the end of June or in beginning of July, in certain area sowing is extended to September- October.
Seed Rate	15 to 20 kg/ ha.
Layout and Spacing	In layout flat bed and spacing 60 X 30 cm or 45X10 is recommended
Manuring	10-12 tonnes of FYM and 20:60:20 NPK kg/ha should be applied. ½ dose or full dose P and K should be applied at the time of sowing.
Interculture operation:	Irrigation should be given in early sown guar when it is necessary. There is on need for irrigation for rainy season crop.
Irrigation:	Irrigation should be given in early sown cluster bean whence it is necessary. There is on need for irrigation for rainy season crop.
Harvesting:	The green pods for vegetable purposes are harvested from the plant by twisting or by cutting, when they attain the marketable stage. Whereas when grown for seeds, the crop is left until the plants are mature.
Yield:	A good crop of guar yields about 200 to 300 q/ha of green fodder and 10-15 q/ha of grains.

State wise production of guar gum in India

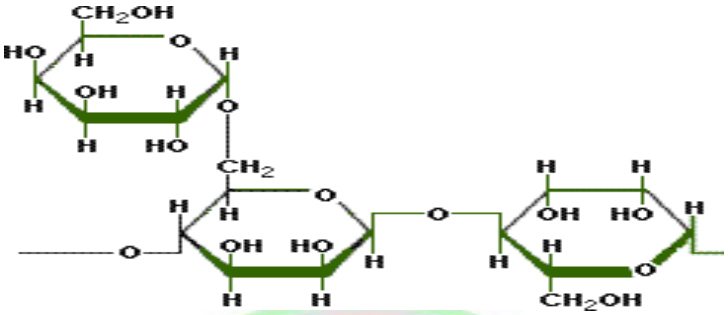
STATE	PRODUCTION(LAKH MT)
Rajasthan	7.00
Haryana	1.00
Gujrat	1.00
Punjab and others	0.10
Total	9.10

(Anonymous, 2011).

Components

Guar Gum mainly consists of hydrocolloidal polysaccharide with a high molecular weight, which consists of galactopyranose- and mannopyranose- units in glycoside linkage which can be chemically described as galactomannan

Chemical Structure



The molecular structure reveals that GUAR GUM is a straight chain galactomannan with galactose on every other mannose unit. Beta 1-4 Glycosidic linkages couple the mannose units and the galactose side chains are linked through alpha 1-6. The mannose to galactose ratio has been estimated at 1.8 : 1 to 2: 1.

PROPERTIES OF GUAR GUM

- One advantageous property of guar gum is that it thickens without the application of heat.
- Easy solubility in cold and hot water.
- Film forming property.
- Resistance to oils, greases and solvents.
- Better thickening agent.
- Water binding capacity.
- High viscosity
- Functioning at low temperatures

USES OF GUAR GUM

- Natural thickener
- Emulsifier
- Stabiliser
- Bonding agent
- Hydrocolloid
- Gelling agent

- Soil Stabiliser
- Natural fiber
- Flocculants
- Fracturing agent

Varieties of guar for different regions:

Sr.No	Region	Varieties
1	Northern India	Pusa Navbahar, Pusa Mausami, Pusa Sadabahar, GH-10, HFG-119, Ageta Guara-111, Guar No.2, FS-277, Durgapur Safed, S-299-7, G-1, G-2, G-4, HG-12, D-111, D-128, G-429, HG-75, B-17, B-2796, IGFRI-5212
2	Southern India	Pusa Navbahar, Pusa Sadabahar, GH-10, HFG-119, Saradbahar, IC 11704, P-28-1, CP-78, S-299-7, IC-11521, IC-11388.

**Ganesh Prajapat (2012)

Application of Guar Gum in Industry

A) Guar Gum Powder in Food Chain

Guar gum is one of the best **thickening additives**, **emulsifying additives** and **stabilizing additives**. In Food Industry Guar gum is used as gelling, viscosifying, thickening, clouding, and binding agent as well as used for stabilization, emulsification, preservation, water retention, enhancement of water soluble fiber content etc.

Some food products in which guar gum powder is used:

- Ice Cream, soft drinks & concentrates, puddings
- Chocolate milk, flavoured milks
- Jams, jellies, fruit spreads, jelly sweets
- Bread, biscuit and other baked foods
- Ham and sausages
- Soft cheese and cheese spreads
- Canned or retorted food of fish and meat
- Myonnaise, ketchup, sauce and dressings
- Noodles and pasta

In Frozen Food Products: Guar gum reduces crystal formation, act as a binder & stabilizer to extend shelf life of Ice-cream.

In Baked Food Products: Guar gum provides unparallel moisture preservation to the dough and retards fat penetration in baked foods.

In Dairy Products: Guar Gum improves texture, maintains uniform viscosity and color.

In Sauces & Salad preparations: Guar gum acts as a water binder in sauces & salad dressings and reduces water & oil separation.

In Confections: Guar gum controls viscosity, bloom, gel creation, glazing & moisture retention to produce the highest grade confectionary.

In Beverages: Guar gum provides outstanding viscosity control and reduces calories value in low calories beverages.

In Pet Food: Guar gum forms gels & retains moisture, acts as a thickening, stabilizer and suspending agent for veterinary preparations.

B) Guar Gum in Pharmaceutical Industries

Guar gum powder is used in pharmaceutical industries as Gelling/ Viscosifying/Thickening, Suspension, Stabilization, Emulsification, Preservation, Water Retention/Water Phase control, Binding, Clouding/Bodying, Process aid, Pour control for following applications.

In tablet manufacturing it is used as a binder and disintegrating agent and in micro-encapsulation of drugs.

- Suspensions
- Anti-acid formulations
- Tablet binding and disintegration agent
- Controlled drug delivery systems
- Slimming aids
- Nutritional foods

Guar Gum is an important non-caloric source of soluble dietary fiber. Guar gum powder is widely used in capsules as dietary fiber. Fiber is a very important element of any healthy diet. It is useful in clear and cleanses the intestinal system since fiber cannot be digested. This keeps the intestines functioning properly and also improves certain disorders and ailments. All natural fiber diet works with body to achieve a feeling of fullness and to reduce hunger. Its synergistic mix of

guar gum and fiber mixture when taken with water expands in stomach to produce a feeling of fullness.

C) Guar Gum in Cosmetic Industries

- Used as a thickener, protective colloid in Skin cares products, creams and lotions.
- Also used in toothpaste, and shaving cream for easy extruding from the container tube.

D) Guar Gum Powder in Industrial Use

In Industrial Applications guar gum powder is a very versatile product and finds its different applications, as thickening, sizing agent, wet-end strength additive, gelling agent and water barrier, flocculation aid, for waste water treatment, as emulsifier, binder. Also used for mud formulations, enhanced oil recovery, polymer flooding, well treatment, lost circulation plugging etc. Mining grade guar gum is used in mining industry as a floatation agent flocculating or setting better quality agent. Fast hydration guar gum powder for oil drilling applications is an important advantage of guar gum. Altrafine Gums in India supply oil drilling grade guar gum**,** guar gum for paper industry**,** guar gum as an emulsifying, guaran and sickle pod.

Guar Gum Industrial grade powder is used in some industries as follows

Textile Printing & Sizing, Fire Fighting, Ceramics, Pharmaceuticals, Printing Inks, Mosquito Mats, Synthetic Resins, Paper Industry, Battery Electrolytes, Water Treatment, Floatation Agent, Water Paint , Carpet Printing, Oil Well Drilling, Explosives, Mining etc.

1) Guar Gum for Paper Industry

- Guar Gum provides better properties compared to substitutes.
- It gives denser surface to the paper used for printing.
- Guar Gum imparts improved erasive and writing properties, better bonding strength and increased hardness.
- Due to improved adhesion, it gives better breaking, mullen and folding strengths.

2) Guar Gum for Textile Industry

- Guar Gum gives excellent film forming and thickening properties when used for textile sizing, finishing and printing.
- It reduces warp breakage, reduces dusting while sizing and gives better efficiency in production.

3) Guar Gum in Oil Field Applications

- Industrial grade Guar gum powder are use in oil well fracturing, oil well stimulation, mud drilling and industrial applications and preparations as a stabilizer, thickener and suspending agent.
- It is a natural, fast hydrating dispersible guar gum and is diesel slurriable.
- In the oil field industry, guar gum is used as a surfactant, synthetic polymer and deformer ideally suited for all rheological requirements of water-based and brine-based drilling fluids.
- High viscosity Guar Gum products are used as drilling aids in oil well drilling, geological drilling and water drilling.
- These products are used as viscosifiers to maintain drilling mud viscosities that enable drilling fluids to remove drill waste from deep holes.
- Guar gum products also reduce friction in the holes, and so minimising power requirements. Some Guar Gum products act to minimise water loss should occur in broken geological formations.

4) Guar Gum in Metallurgical and Mining

- Guar gum is widely used as a flocculants to produce liquid solid separation
- Guar gum is also used in flotation. It acts as a depressant for talc or insoluble gangue mined along with the valuable minerals

5) Guar Gum in Explosives Applications

- Gelling agents for gel sausage type explosives and pumpable slurry explosives
- Cross linking agents for gel and slurry explosives systems.

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PUFA: A REGENERATIVE SOURCE FOR AQUATIC ANIMALS AND HUMAN POPULATION

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Abstract

In this modern world, the human population is increasing drastically day by day. Fishes and some other aquatic organisms have more DHA and EPA but its contribution in human diet is very low. Even the population in this technological world was struggles their lives daily in a hot evacuated chamber. The essential PUFAs cannot be synthesized in human body; only they depend on other sources. The essential PUFAs like n-3 and n-6 more in the fishes, it can balanced the human nutrition and make free from cardiovascular and neuro-secretion problems and support to the pregnant women which mainly for the babies in a healthy condition. This article reviewed that the advantages of PUFAs and the sources of obtaining PUFAs and role of global climate change relation to n-3 and n-6 PUFAs in the nutrition deficient world. *Mucor rouxii* PUFAs genes in *Saccharomyces* sp. showed that reduced proteasomal activity and increased oxidative stress.

Keywords: DHA, *Mucor rouxii*, *Saccharomyces*, *Schizochytrium*, antioxidant carotenoids, cardiovascular problems

Introduction

Fats are the primitive energy deposition of animals and higher classification of species and it is a combination of glycerol esters. It can be used for the long-term energy requirements when there is an inadequate of energy intake. A long chain polyunsaturated fatty acid (PUFA) (C20 and C22) belong to the omega (ω) 3 family and it developed from marine organisms and also important in partition of human diet as well as many neutraceutical and pharmaceutical

purposes [1,2]. Eicosapentaenoic acid (C 20:5) and docosahexaenoic acid (C 22:6) are the important ω-3 PUFAs and arachidonic acid (AA) (C20:4) is only vital fatty acid of ω-6 PUFA. Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) are responsible for the human and higher animals health.

Sources of PUFAs

Pisces: A pisces are the major source for the PUFAs requirements. Marine fishes have lower level of linolenic (C18: 2n-6) and linoleic acids (C18: 3n-3). As comparative to marine fishes, a freshwater pisces have more ω-3 PUFAs [3]. The essential fatty acid ratio (ratio of n-3 and n-6 availability) is higher in marine fishes about 5 – 10. PUFAs in fishes actively promote the gonad maturation, egg and larvae nutritive growth development [5] and also enhance the sperm fluidity and flexibility of spermatozoa membrane in common octopus, *Octopus vulgaris* [4]. Instead of acquiring PUFAs from fatty acids, consumption of fish oil capsules along with supplementary diet is the great bioavailability source among the human needs. Halibut showed the higher range of DHA (25%) and anchovy showed higher EPA value (9.0 – 18.2%) in the following Table 1[6].

Table1. EPA and DHA content in fish oils (Racine and Deckelbaum, 2007)

Oil sources from fishes	% Total Fatty Acids	
	EPA	DHA
Anchovy	9-18.2	8.7-13
Sardine	12.4-14.5	9.8-12.5
Mackerel	6.1-5.7	7-8.7
Herring	7.4	6.7-8.7
Salmon	12.7-13.4	10.0-10.2
Halibut (wild)	12.2	25.4
Sand eel	10.9	9.7
Menhaden	10.6	6.4-9.2
Capelin	9.9	7.9
Tuna	4.6	18.3

2.**Bivalves:** Bivalves are very good source of higher quality PUFAs (EPA and DHA) which was obtained from the phytoplanktons. Based on fat content (%), the bivalves classified into lean fat

(8%) [15].Consumption of bivalves as freshly harvested raw ones compared to cooked food because the cooked product lost upto 50% of ω-3 PUFA. Marine bivalves were having higher ω-3/ ω-6 ratio than most other marine fishes [7].

3.Algae:

Algae are the responsible feed at the larvae stages of fish development. Many macroalgae seaweeds are enriched with more vitamins and essential fatty acids for human diet. Microalgae have the superior fatty acids of lipid stability because it contains antioxidant carotenoids and vitamins and also microencapsulation of lipids in the algae cell wall. Among many algal groups (diatoms, chrysophytes, cryptophytes, dinoflagellates) that produce high levels of ω-3 PUFAs. The dinoflagellate *Crypthecodinium cohnii* produce fatty acids as it contains more DHA amount in the form of triacylglycerides [8].

4.Protists:

Thraustochytrids, the heterotrophic, marine, straminipilan protists commercially used for the production of PUFAs (DHA) in human health and aquaculture. *Schizochytrium* and *Crypthecodinium cohnii* were produced DHA mainly by fed batch method and available as nutritional supplemental diet for adults and also feed source for to enhance DHA level in aquatic animal larvae species in the following Figure 1. Maximum amount of lipids produced at the exponential stage and it can be harvested DHA generally varies from 4 to 7 days [9].

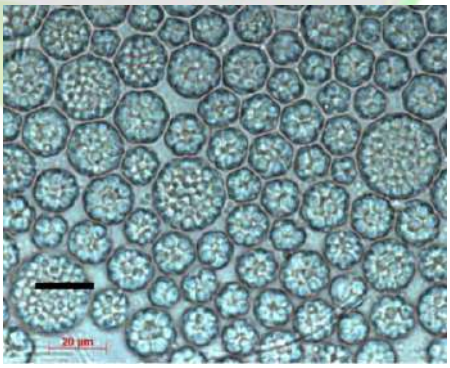

Fig.1 Microscopic examinations of *Schizochytrium* cells showed numerous lipid bodies (Soure: Raghukumar, 2008)

5.Yeast (Fungi)*:*

Mucor rouxii PUFA genes incorporated i*n Saccharomyces cerevisiae* cause the transcription response which incorporation into membranes on cell viability and cell sensitivity towards oxidative and proteotoxic stress.

It is new molecular sight for the future research on influence of PUFAs in eukaryotic cellular process [10].

Regulational usage:

- Modulation of physiological and pathological conditions through inflammatory response [11].
- PUFAs are the best treatment for arthrosclerosis, cancer, rheumatoid arthritis, Alzheimer's and age-related macular degeneration.
- Regulation of blood pressure normal and inhibit the synthesis of low density lipids in relation to aggression of blood vessel.
- AA and DHA action site in the brain and blood vessels and are most essential for pre- and post-natal brain and retinal developmental process.
- Eicosanoids such as prostaglandins, prostacyclins and leukotrienes action on modulatory vascular resistance and wound healing process [12, 13].
- In mammals, EPA induces the significant down-regulations of lipogenic genes in muscle β- acetyl co-A carboxylase and liver fatty acid synthetase.
- World Health Organization and other countries recommended that intake of 0.3 to 0.5 g/d of EPA +DHA and 0.8 to 1.1g of α-linolenic acid [14].
- EPA and DPA acts as a dietary supplementations ; Resolvins are actively to take part in resolving inflammation; Marisen 1 are for macrophage mediators in resolving inflammation and prostaglandins in activation of γ-PPAR activation and inhibit the platelets aggregation [16]
- Also improve the larvae development of aquatic organisms and act as a reservoir of energy source when the inadequate of food availability to aquatic and terrestrial organisms.

Conclusion

A future generation will be going to face nutritional famine by non available of resources. The lipids having the high energy calorific value compared to other sources. Fishes are main source of PUFAs and it cannot be satisfactory to the increasing population. Nowadays a technology on implementing to the production of PUFAs and tends to reach out all the corners of the world. PUFA are the only novel technology for the acquirement of EPA and DHA.

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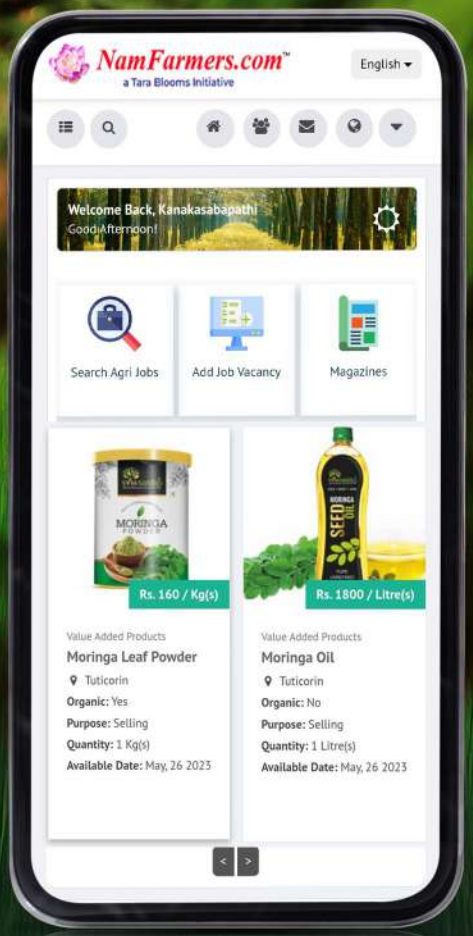

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