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MANAGING THE HIDDEN RESERVOIR: EXPLORING THE SOIL WEED SEED BANK

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Abstract
The soil weed seed bank, hidden beneath our fields and landscapes, holds the potential to either challenge or aid our agricultural pursuits. It is a dynamic repository of nature's strategies, waiting to teach us lessons in adaptation, resilience, and coexistence. Researchers and farmers can forecast which weed species are likely to emerge in a particular field by analyzing the make-up of the seed bank. This makes it possible to focus weed control efforts, minimizing the usage of pesticides and minimizing any negative effects on the environment. The seed bank can be strategically manipulated through crop rotation and cover crops. The germination and growth patterns of weed seeds can be impacted by changing the crops or cover crops that are present in the soil. In the end, we can refine our approach to weed management, moving towards more sustainable and efficient agricultural practices.

Introduction
When we think of agriculture and the processes that go into ensuring successful crop growth, we often focus on factors like soil health, irrigation, fertilization, and climate conditions. But did you know that there's an intricate and hidden world beneath our feet that plays a significant role in shaping our crop ecosystems? This hidden treasure is none other than the soil weed seed bank – a reservoir of potential vegetation that can either benefit or challenge our agricultural endeavors.

What is the Soil Weed Seed Bank?
The soil weed seed bank is essentially a system of natural storage that keeps a variety of weed seeds in the soil while they wait for an ideal environment to grow and germinate. These seeds come from a variety of weed species that have lived in a certain location for a while. These seeds can germinate and increase the weed population in a specific agricultural area or landscape when the right circumstances exist - enough moisture, light, and warmth. (Smith *et al*., 2008).

The Dynamic Nature of the Seed Bank
The seed bank for soil weeds is a dynamic entity. It's not merely a passive accumulation of seeds dormantly buried in the ground. There are different degrees of dormancy among the seeds in the seed bank, thus some of them may go for years or even decades without germination. Weeds' ability to endure harsh conditions and secure their permanence in the ecosystem through this dormancy is an evolutionary tactic. (Cousens, 1991).

Impact on Agriculture
The management of the soil weed seed bank has significant effects on agriculture. While some of these implications would appear unfavorable, such as increasing weed competition for space and

resources, a deeper knowledge of the seed bank might potentially offer insightful recommendations for long-term weed control methods.

1. **Weed Emergence Prediction:** Researchers and farmers can forecast which weed species are likely to emerge in a particular field by analyzing the make-up of the soil weed seed bank. This makes it possible to focus weed control efforts, minimizing the usage of pesticides and minimizing any negative effects on the environment. (Leishman *et al*., 2014)
2. **Crop Rotation and Cover Crops:** The seed bank can be strategically manipulated through crop rotation and cover crops. The germination and growth patterns of weed seeds can be impacted by changing the crops or cover crops that are present in the soil. This method breaks the cycle of weed growth, which over time may result in less weed pressure. (Liebman *et al*., 2001)
3. **Herbicide Resistance Management:** The presence of herbicide-resistant weeds in the seed bank poses a significant challenge. But knowing the genetic makeup and location of resistant seeds inside the seed bank can direct the creation of efficient methods to counteract herbicide resistance. (Neve *et al*., 2009)
4. **Sustainable Weed Management:** The knowledge of the seed bank can help with integrated weed management tactics rather than only depending on herbicides. To keep weed populations under control, this involves combining cultural practices, biological control techniques, and judicious usage of herbicides. (Heap, 2014)
5. **Biodiversity and Ecological Balance:** The complex ecosystem balance includes the soil weed seed bank. Its smart management encourages wider biodiversity and ecological health in addition to agriculture.

Seed Dormancy: A Masterstroke of Adaptation

Seed dormancy is a remarkable adaptation that allows weed seeds to bide their time, waiting for the right conditions before germinating. This built-in time-delay mechanism ensures that not all weed seeds germinate simultaneously, thereby preventing a sudden explosion of weed populations. Some seeds may lie dormant for years or even decades, an ingenious survival strategy that weeds have developed through years of natural selection (Baskin and Baskin, 2014). Understanding the triggers that awaken these dormant seeds can provide valuable insights into timing weed control efforts for maximum effectiveness.

Managing the Unseen: Strategies for Weed Control

Innovative approaches are being developed by researchers and farmers to manage the soil weed seed bank's impact on agriculture. Utilizing cover crops, which are crops put between primary crops to inhibit weed growth, is one such tactic. The emergence of weeds from the seed bank can be efficiently reduced by these cover crops, which can compete with weed seeds for resources and space (Blanco-Canqui and Shaver, 2019). This approach not only curbs weed growth but also enhances soil health and biodiversity.

The Conundrum of Herbicide Resistance

When it comes to herbicide resistance, the soil weed seed bank creates a challenging riddle. Herbicide-resistant weed plants' seeds may end up in the seed bank, where they may produce more resistant weeds in the future. This phenomena emphasizes the value of using a variety of weed management strategies in addition to herbicide use (Busi and Powles, 2017). Farmers can

break the life cycle of resistant weeds and maintain efficient control methods by combining cultural activities, biological controls, and targeted herbicide applications.

A Balancing Act for Biodiversity

Although the soil weed seed bank has primarily been discussed in terms of agriculture, its effects also extend to more general ecological concerns. Biodiversity in agroecosystems can be maintained with effective seed bank management. Farmers may make diversified habitats that support a diversity of species and contribute to the development of resilient and sustainable landscapes by utilizing a variety of crops and management techniques (Tscharntke *et al*., 2012).

Conclusion

The soil weed seed bank, hidden beneath our fields and landscapes, holds the potential to either challenge or aid our agricultural pursuits. While it might seem like an invisible force, its impact on weed dynamics is substantial. Through careful study and management of the seed bank, we can refine our approach to weed control, moving towards more sustainable and efficient agricultural practices that benefit both farmers and the environment. After all, unlocking the secrets of this hidden treasure could lead to a brighter and weed-controlled future for agriculture.

In the end, the soil weed seed bank isn't just a collection of dormant seeds – it's a dynamic repository of nature's strategies, waiting to teach us lessons in adaptation, resilience, and coexistence.

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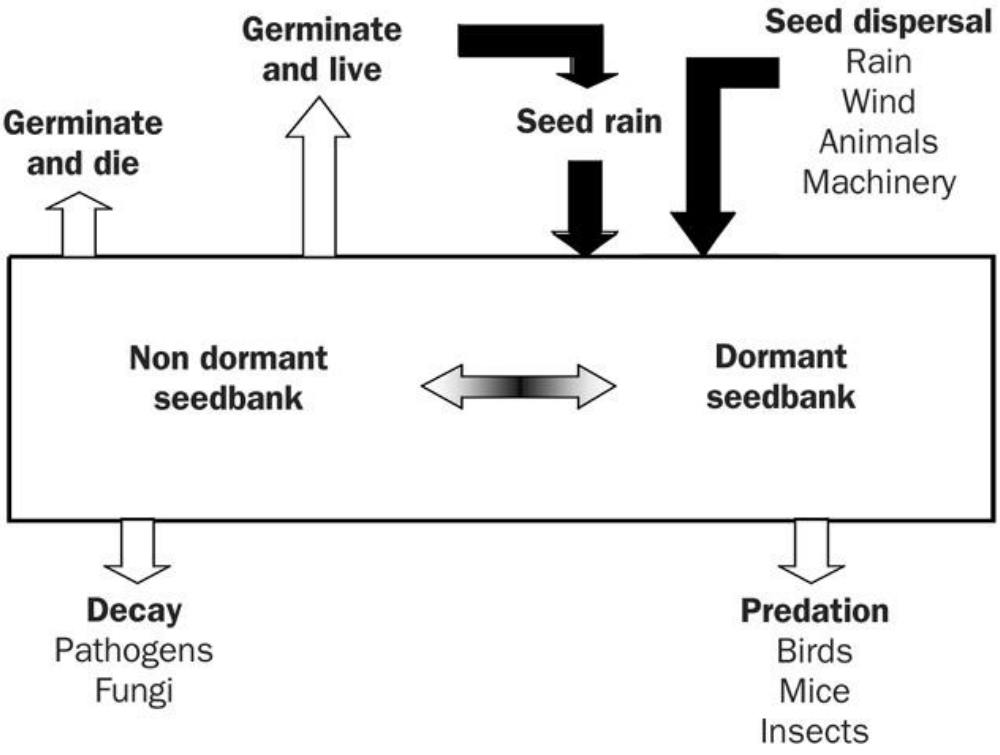

Figure 1. Fate of weed seeds.
(**Source:** Fabian Menalled, Montana State University. Retrieved from www.eorganic.org)

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AGROFORESTRY AND CARBON SEQUESTRATION: A SYNERGISTIC APPROACH FOR CLIMATE CHANGE MITIGATION

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Abstract
Agroforestry offers a multifunctional and resilient approach to modern agriculture. It combines agricultural production with ecological benefits, contributing to biodiversity conservation, soil improvement and diversified income sources. Agroforestry systems play a crucial role in mitigating climate change through carbon sequestration in tree biomass and soil, reducing greenhouse gas emissions and enhancing climate change adaptation. The deliberate integration of trees in agricultural landscapes promotes diverse habitats, natural pest management and nutrient cycling, creating a more sustainable agroecosystem. Moreover, agroforestry presents opportunities for farmers to generate revenue from tree products and livestock rearing. The adoption of agroforestry as a sustainable land-use practice can enhance climate change mitigation, agricultural resilience and overall environmental conservation. Governments, organizations and farmers are encouraged to embrace agroforestry to foster sustainable agricultural development and combat climate change.

Agroforestry is a sustainable land-use system that integrates trees, crops, and/or livestock in a coordinated and complementary manner. It combines agricultural production with the ecological benefits provided by trees, creating a multifunctional and resilient landscape. Agroforestry practices have been used for centuries and are gaining recognition as a viable solution to address various environmental, social and economic challenges in modern agriculture. The core principle of agroforestry is the deliberate integration of trees with agricultural activities. Trees can be strategically planted within agricultural fields, along field boundaries, in windbreaks or in specialized agroforestry systems. The selection of tree species depends on the specific ecological conditions, agricultural objectives and local needs. The trees in agroforestry systems serve multiple purposes and provide a wide range of benefits.

One of the key advantages of agroforestry is its ability to enhance biodiversity and ecosystem services. The presence of trees in agricultural landscapes creates diverse habitats, supporting a variety of plant and animal species. The canopy cover and structural complexity of agroforestry systems provide shelter, food sources and nesting sites for wildlife. This increased biodiversity promotes natural pest management, pollination, soil health and nutrient cycling, ultimately contributing to a more resilient and sustainable agricultural ecosystem.

Agroforestry in agriculture
Agroforestry also contributes to soil conservation and improvement. The roots of trees help stabilize the soil, preventing erosion and reducing nutrient runoff. The leaf litter and organic matter produced by trees contribute to soil fertility and moisture retention. Moreover, the deep-rooted trees can access nutrients and water from deeper soil layers, making them more resilient

to drought conditions and improving the overall water-use efficiency of the agroecosystem. Furthermore, agroforestry systems offer opportunities for diversification and increased farm income. The combination of trees with agricultural crops or livestock provides additional sources of revenue. For example, farmers can harvest timber, fruits, nuts or medicinal products from the trees. Additionally, integrating livestock grazing in agroforestry systems can optimize land use and generate income from both animal production and tree products.

Climate change is indeed one of the most critical global challenges we face today, with far-reaching consequences for various sectors, including agriculture. The agricultural sector plays a significant role in climate change as both a contributor to greenhouse gas emissions and a sector heavily impacted by changing climatic conditions. Agroforestry, an integrated land-use system combining trees with crops or livestock, offers a unique and synergistic approach to mitigate climate change through carbon sequestration. The presence of trees sequesters carbon dioxide from the atmosphere, helping to mitigate greenhouse gas emissions. Agroforestry systems contribute to carbon sequestration through the aboveground biomass of trees and the accumulation of organic matter in the soil. This makes agroforestry a valuable strategy for achieving carbon neutrality and enhancing the resilience of agricultural systems to climate change impacts.

Agroforestry for climate change mitigation

Agroforestry systems facilitate the sequestration of carbon dioxide (CO_2) through the growth and development of trees. Trees are highly efficient in capturing CO_2 from the atmosphere during photosynthesis and converting it into organic carbon which is stored in their biomass. The long lifespan and continuous growth of trees in agroforestry systems allow for substantial carbon sequestration over time, helping to offset greenhouse gas emissions. Agroforestry practices contribute to increased soil organic carbon (SOC) stocks. The presence of trees in agroforestry systems enhances litterfall and the input of organic matter into the soil. This organic matter undergoes decomposition, leading to the accumulation of SOC. Agroforestry systems with deep-rooted trees further enhance SOC sequestration by facilitating the transfer of carbon deeper into the soil profile.

Agroforestry-centric agronomic practices made for erosion control, such as contour planting and windbreaks, effectively reduce soil erosion. By preventing soil erosion, agroforestry systems help retain organic matter in the soil, which would otherwise be lost through erosion. This preservation of organic matter limits carbon losses and promotes the long-term sequestration of carbon in the soil. Agroforestry systems promote biodiversity by creating habitat corridors and providing niches for diverse plant and animal species. Greater biodiversity enhances ecosystem resilience, making agroforestry systems more adaptable to climate change impacts. The presence of diverse vegetation also contributes to increased carbon sequestration potential through higher rates of photosynthesis and biomass accumulation.

Agroforestry practices contribute to the reduction of greenhouse gas emissions. By diversifying agricultural landscapes, agroforestry systems can reduce the need for synthetic fertilizers, thus lowering nitrous oxide emissions. Additionally, reduced tillage in agroforestry systems reduces the release of carbon dioxide from soil disturbance. Integration of livestock in agroforestry can also help manage methane emissions through improved animal husbandry practices. Above all,

agroforestry systems enhance climate change adaptation and resilience in agricultural landscapes. The presence of trees provides shade, moderates temperature extremes and improves water management, thereby reducing the vulnerability of crops and livestock to climate-related stresses. Agroforestry diversifies income sources for farmers, making them more resilient to climate variability and market fluctuations.

In summary, agroforestry offers a range of benefits including biodiversity conservation, soil conservation, diversified income streams, and climate change mitigation and adaptation. Agroforestry systems provide a more resilient and sustainable approach to agriculture, balancing productivity, environmental conservation and social well-being. Agroforestry systems offer a powerful and multifaceted approach to mitigate climate change through carbon sequestration and climate change adaptation. By integrating trees with agricultural activities, agroforestry enhances carbon sequestration in tree biomass and soil, reduces greenhouse gas emissions, promotes biodiversity, and enhances ecosystem resilience. Governments, organizations and farmers should be encouraged to adopt and promote agroforestry as a sustainable land-use practice for climate change mitigation and sustainable agricultural development.

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KALMEGH : THE BITTER HERB WITH SWEET HEALTH BENEFITS

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Abstract
Kalmegh , scientifically known as *Andrographis paniculata*,(Fig. 1) is a medicinal plant that has been used in traditional medicine for centuries. Its origin can be traced back to the Indian subcontinent, specifically to South Asia and Southeast Asia. The plant is native to India, where it is commonly found in various regions. It also grows naturally in other countries in the region, such as Sri Lanka, Pakistan, Bangladesh, Thailand, Malaysia, Indonesia and in India (U.P, Assam, M.P, Tamil Nadu and Kerala). Throughout history, it has been valued for its various health benefits and holds a prominent place in both Ayurveda and traditional medicine system due to its wide range of therapeutic properties. Some studies suggest that Kalmegh may have potential benefits in treating certain types of cancer, diabetes and liver disease.

Keywords : Kalmegh, Traditional medicine, Ayurveda, Therapeutic properties.

Introduction
Kalmegh is known by various names like “King of Bitters” in (English), Mahatikta (Sanskrit), Kiryato (Gujarati), Mahatita (Hindi), Kalmegh (Bengali), or Fah Talai Jone (Thai) and “Green Chiretta”, Kalmegh is a bitter herb with a history as rich and potent as its taste which emerges as a herbal wonder with an array of health benefits that has captured the attention of both herbal enthusiast and researchers alike. For centuries, it has been revered for its therapeutic virtues in traditional healing systems, and in recent times, its fame has spread to the world of modern medicine. From its roots in ancient Ayurveda to its widespread use in Southeast Asia, this unassuming plant has been a reliable remedy for a lot of illnesses.

Kalmegh, scientifically known as *Andrographis paniculata*, is a medicinal plant deeply rooted in the history of traditional medicine. The herb is rich in Andrographolides, Diterpenoid, Lactones, Flavonoids and other Phytochemicals, each contributing to its pharmacological effects. Modern research has intensified the exploration of Kalmegh, leading to promising findings that align with its traditional uses. Studies have highlighted its potential as an immunomodulatory agent, indicating its ability to boost immune function and provide protection against infection.

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Fig. 1 – Kalmegh (*Andrographis paniculata*)
**Source :- Wellbeing nutrition*

Health benefits of Kalmegh

This Bitter Herb has many potential health benefits due to its active compound andrographolides. In Ayurveda, Kalmegh is often used to reduce fever and combat infections. The bitter compounds in Kalmegh helps stimulates digestive juices and enhance the overall digestive process. It also contains inflammatory compounds and help treat skin problems like eczema and psoriasis . It also help for Acute Respiratory Tract Infection (ARTI). Kalmegh was also used to treat asymptomatic COVID patients in Thailand by the approval of Cabinet of Thailand.

Some of the benefits of Kalmegh include :

1. **Anti - cancer properties :** Studies have shown that andrographolides can kill cancer cells and inhibit tumor growth.
2. **Anti - inflammatory properties :** Kalmegh helps to reduce inflammation in the body, improving conditions such as arthritis and inflammatory bowel disease.
3. **Anti - bacterial and anti - viral properties :** It has antibacterial and antiviral effects, which can help fight infections.
4. **Immune - boosting properties :** Kalmegh boosts the immune system, which can help fight infections.
5. **Liver - protective properties :-** Protects the liver from damage caused by toxins and other harmful substances.
6. **Fever - reducing properties :** Kalmegh was traditionally used to reduce fever.
7. **Respiratory benefits :-** This herb treats respiratory infections such as the common cold, bronchitis and asthma.
8. **Digestive benefits :** It treats digestive disorders such as diarrhea, constipation, and stomach pain.

While Kalmegh has many potential health benefits, some people may experience side effects such as nausea, diarrhea, and allergic reactions. Additionally, it may interact with certain medications, so it is important to talk to a healthcare provider before using this herb if you are taking any medications.

CONCLUSION :

Kalmegh, the green guardian with a legacy spanning generations, continues to be a symbol of hope for those seeking natural remedies to enhance their well-being. Beyond its bitter taste lies a wealth of bioactive compounds, each contributing to its unparalleled healing potential. Whether embracing its ancient roots in Ayurveda or exploring the growing body of scientific evidence, Kalmegh stands as a testament to the wisdom of traditional healing practices and the potential of nature's gifts.

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BEEKEEPING : SUSTAINABLE FUTURE OF AGRICULTURE

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Introduction

Beekeeping, also known as apiculture, is the practice of managing honey bee colonies for the production of honey and other valuable products. Bees play a crucial role in agriculture, significantly contributing in pollination, biodiversity, and ecosystem sustainability. In this article, we will explore the different types of honey bees, their vital role in agriculture, the significance of pollination, and the sustainable practices associated with beekeeping.

Types of Honey Bees

There are several species of honey bees, but the most commonly managed and well-known species is *Apis mellifera*. Within this species, there are various subspecies, each with its unique characteristics and adaptations to different environments. Some of the most popular subspecies of *Apis mellifera* include:

1. **Italian Honey Bees (*Apis mellifera ligustica*):** Known for their gentle temperament and strong brood-rearing capabilities, Italian honey bees are one of the most widely used subspecies in beekeeping.
2. **Carniolan Honey Bees (*Apis mellifera carnica*):** Originating from the central European Alps, Carniolan bees are known for their hardiness and ability to build up rapidly in the spring.

Apis mellifera ligustica

Apis mellifera carnica

Apis mellifera buckfast

Apis mellifera scutellata

Apis mellifera mellifera

Apis cerana indica

3. **Buckfast Bees (*Apis mellifera buckfast)*:** These bees were bred by Brother Adam at Buckfast Abbey in England. They are a hybrid of various subspecies, combining desirable traits such as gentleness, productivity, and disease resistance.
4. **Africanized Honey Bees (*Apis mellifera scutellata*):** Often referred to as "killer bees," they are a hybrid of African and European bees. Africanized bees are known for their aggressiveness and tendency to swarm.
5. **Russian Honey Bees (*Apis mellifera mellifera*):** These bees have evolved in the harsh climate of Russia and are well-adapted to colder regions.

Indian Honey Bess

Indian honey bees (*Apis cerana indica*) are one of the most important species of honey bees commonly found in India and many other countries across Asia. They belong to the same genus *Apis* as the more widely known European honey bees (*Apis mellifera*) but have distinct characteristics that make them well-adapted to the Indian subcontinent's diverse and challenging environments.

Characteristics of Indian Honey Bees:

1. **Size and Colour:** Indian honey bees are relatively smaller in size compared to European honey bees. They have a darker coloration, with distinct black and yellow bands on their abdomens.
2. **Nesting Behaviour:** Unlike European honey bees, which typically build their nests in cavities, Indian honey bees prefer to construct their nests in protected locations, such as tree branches, rock crevices, or building eaves. These nests are commonly referred to as "open-air" or "exposed" nests.
3. **Defensive Behaviour:** Indian honey bees are known for their defensive nature when their nests are threatened. They aggressively defend their colonies and can be more challenging to handle for beekeepers compared to some other subspecies.
4. **Foraging Preferences:** Indian honey bees are highly adaptable and can forage on a wide variety of plants and crops. They are essential pollinators for various native plants and agricultural crops, contributing to both biodiversity and food production.

Importance Beekeeping in Agriculture

Beekeeping plays a crucial role in agriculture, providing a wide range of benefits that significantly impact crop production, food security, biodiversity, and ecosystem sustainability. Let us explore the importance of beekeeping in agriculture:

Honey bees play a crucial role in supporting agriculture by providing pollination services to a diverse range of crops. They visit flowering plants, including fruit trees, vegetables, field crops, medicinal herbs, etc. and facilitating the transfer of pollen and enabling the production of fruits and seeds. Their foraging activities contribute to crop yield enhancement and improved their quality. In addition to pollination, Honey bees also produce honey and other valuable hive products, which have been an integral part of traditional Indian medicine and cuisine for centuries. Honey is used not only as a natural sweetener but also in various medicinal remedies and Ayurvedic treatments.

1. **Pollination:** One of the most critical contributions of beekeeping to agriculture is pollination. Bees, especially honey bees, are efficient pollinators that transfer pollen from one flower to

another, facilitating fertilization and the formation of fruits and seeds. Many crops, including fruits, vegetables, nuts, and oilseeds, depend on pollinators like bees for reproduction. Studies have shown that pollination by bees can lead to increased crop yields, better fruit quality, and improved seed production.

2. **Increased Crop Yields:** The presence of bee colonies near agricultural field results in higher crop yields due to improved pollination. Farmers who practice beekeeping or have access to managed beehives often see significant increases in crop productivity, leading to better economic returns and food availability.
3. **Crop Diversity:** Beekeeping encourages the cultivation of a diverse range of crops. Since bees are generalist pollinators, they forage on various plants, including both cultivated crops and wildflowers. This diversity in cropping patterns helps maintain a resilient and sustainable agricultural system.
4. **Biodiversity and Ecosystem Health:** Bees and other pollinators play a vital role in maintaining biodiversity in both agricultural and natural ecosystems. By pollinating wildflowers and plants, bees support a wide array of animal species that rely on these plants for food and shelter. This interconnected web of life enhances the overall health and stability of ecosystems.
5. **Nutritional Value:** Bees contribute to increase the production of fruits, nuts, and vegetables, which are essential components of a nutritious diet. Access to a variety of nutrient-rich crops improves food security and public health.
6. **Seed Production:** In addition to improving fruit production, bees aid in the formation of seeds in various plants. For crops grown primarily for their seeds, such as sunflower, canola, and sesame, bee pollination is critical for achieving a bountiful seed harvest.
7. **Honey and Other Hive Products:** Beekeeping provides valuable hive products, including honey, beeswax, propolis, and royal jelly. Honey, in particular, is a natural sweetener with numerous health benefits, and other hive products have applications in cosmetics, pharmaceuticals, and alternative medicine.
8. **Soil Fertility:** Bees indirectly contribute to soil fertility by promoting the growth and reproduction of plants through pollination. This enhanced plant growth helps improve the overall health of the soil, which benefits agricultural productivity.
9. **Sustainable Agriculture:** Integrating beekeeping into agricultural practices supports the principles of sustainable agriculture. By enhancing natural pollination processes and reducing the reliance on synthetic pollination methods, beekeeping contributes to the long-term sustainability of agricultural systems.

Significance of Pollination

Pollination is not just essential for agriculture; it also plays a significant role in maintaining biodiversity and ecosystem stability. When bees pollinate wild plants, it promotes seed production and plant growth, supporting a diverse range of animals and insects that depend on these plants for food and shelter. In addition to honey bees, other pollinators like bumblebees, solitary bees, butterflies, and birds contribute to pollination. However, honey bees, with their large colonies and ability to be managed by beekeepers, make a substantial impact on the agricultural sector, thereby indirectly benefiting ecosystems and wildlife.

Economic Impact

Beekeeping can be a source of income and livelihood for many small-scale farmers and beekeepers. Honey and other hive products can be sold locally or exported, contributing to rural economies and livelihoods.

Sustainability in Beekeeping

Sustainable beekeeping practices are essential for maintaining healthy honey bee populations and ensuring the long-term well-being of our ecosystems. Here are some key aspects of sustainable beekeeping:

1. **Bee Health Management:** Regular monitoring of hive health, prompt treatment of diseases and pests, and avoiding the overuse of pesticides are crucial for maintaining strong and resilient bee colonies.
2. **Conservation of Forage and Habitat:** Providing diverse sources of nectar and pollen, including wildflowers, is crucial for bee nutrition. Encouraging the preservation of natural habitats and reducing the use of pesticides in agricultural practices also support bee populations.
3. **Beekeeping Education:** Educating beekeepers about best management practices and promoting sustainable approaches can enhance the health and productivity of honey bee colonies.


4. **Genetic Diversity:** Promoting the use of different honey bee subspecies and maintaining genetic diversity within honey bee populations can improve their adaptability to changing environments and threats.
5. **Responsibly Harvesting Honey:** Beekeepers should harvest honey in a manner that does not harm the overall health of the colony, leaving enough food reserves for the bees during winter.

Conservation and Challenges:

Indian honey bees, like many other bee species, face several challenges that threaten their populations and the ecosystems they support. Some of the key concerns include:

1. **Pesticide Use:** Widespread use of pesticides in agriculture can harm honey bee populations. Pesticides, especially neonicotinoids and other systemic chemicals, can have adverse effects on bee health and foraging behaviour.
2. **Habitat Loss:** Urbanization and deforestation reduce the availability of natural nesting sites for the honey bees, impacting their ability to establish colonies and survive in the wild.
3. **Climate Change:** Altered weather patterns and unpredictable shifts in flowering seasons can affect the availability of nectar and pollen, potentially leading to food shortages for bee colonies.
4. **Bee Diseases:** Honey bees are susceptible to various diseases and parasites, such as Varroa mites, which can weaken and decimate colonies.

Conclusion

In conclusion, beekeeping is of immense importance in agriculture due to its role in pollination, increased crop yields, biodiversity conservation, and sustainable farming practices. By supporting healthy bee populations and promoting responsible beekeeping practices, we can ensure the continued benefits of bees to agriculture and our ecosystems. Indian honey bees and Italian honey bees are an essential part of India's biodiversity and agriculture. Their role in pollination is critical for ensuring food production and ecosystem sustainability. However, honey bees face challenges that require concerted efforts from governments, beekeepers, farmers, and the public to protect their populations and habitats. Conservation measures and sustainable practices can help secure the future of honey bees and the vital ecosystem services they provide. Beekeeping and the role of honey bees in agriculture are invaluable for sustaining food production and ecosystem health. To conserve honey bees and other pollinators, it is essential to promote sustainable agricultural practices, reduce pesticide usage, preserve natural habitats, and raise awareness about the significance of bees in ecosystem health and food security. By understanding the different types of honey bees and implementing sustainable practices, beekeepers and farmers can collaborate to ensure the health and survival of these remarkable pollinators. Through conservation efforts and responsible beekeeping, we can secure a brighter future for both agriculture and the natural world.

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POTENTIAL NUTRI-CEREALS: "MILLETS" IN INDIA

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Abstract

Millets are one of the major underutilized crops with a nutri-cereal potential. Millet crops possessing the quality of resilience against extreme climates. These crops adopt the C4 photosynthetic pathway and more energy efficient, as well as capable of producing more biomass and higher dry matter. Compared to other cereal crops, millet crops generally have higher calcium, iron, thiamin, riboflavin and fiber content than cereal crops such as wheat and rice, as well as good protein, sugar, fat and energy content, making these crops valuable for value addition and processing. There is lack of processing technologies, lack of food subsidies and inconvenience in food preparations which makes millets more obsolete. So, there is a possibility of good economic return to the farmer and related industries, social and economic improvement can be brought at the village level. Considering the importance of these crops in nutritional security, the year 2018 has been declared as the National Year of Millets 2018 in India. With the support of more than 72 countries in the United Nations, the year 2023 has been declared as the International Year of Millet 2023.

Introduction

Nutri-Cereals are one of the earliest grains that are being cultivated and consumed by the people in India and the world. Nutri cereals are the groups of small seeded cereals belonging to the family *Poaceae.* There are up to thirty-five species of field grasses from 20 genera are well known as small millets. Their long storability under ordinary conditions has made "***Famine reserver***" Its can be classified as major nutri-cereals include sorghum and pearl millet. Minor nutri-cereals includes finger millet (ragi), foxtail millet (kangni), proso millet (cheena), kodomillet, barnyard millet (sanwa) and little millet (kutki). Millets are also full of micronutrients like Fe, Zn, Mg, Ca, Mn, tryptophan, phosphorous, fibre and vitamins. These micronutrients act as antioxidants which are essential to human body. Additional specialty of millets is, they need very less water for their cultivation and can with- stand severe climatic conditions. Sorghum and pearl millet are the most important food-grain in India after rice, wheat, and maize in terms of area and production. Finger millet (ragi) and fox tail millet are also form a major part of the food basket in some states like Karnataka, Telangana and Uttarakhand. Other minor nutri-cereals are also being cultivated in varying scales in various parts of the country, mainly by tribal and marginal farmers. There is need of new high yielding, promotional strategies and policies are necessary to increase the area under nutri cereals crops to achieve nutritional security as well as sustain rainfed farming in the country.

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Nutri cereals: millets in India

Pearl millet

Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] belongs to family Poaceae and genus *Pennisetum*. Pearl millet is the sixth most important and widely grown potential cereal crop in the world and is the fourth in India after rice, wheat and maize. Pearl millet can grow on poor sandy soils and well suited for dry climates due to its ability to use moisture efficiently compared to sorghum or maize.

Pearl millet is diploid (2n=14) in nature and commonly known as bajra, cat tail millet, and bulrush millet in different parts of the world, which is believed to be originated from West-Africa. It is a highly cross-pollinated crop with protogynous flowering nature which fulfill one of the essential biological requirements for hybrid development. It is C4 species endowed with a very high photosynthetic efficiency and more ability for dry matter production. Pearl millet generally grown in area having marginal soil with low annual rainfall in the range of 200–500 mm. According to the FAO (2014), pearl millet is the sixth most important cereal grown worldwide. It is considered to be an important crop to ensure food security in regions of Africa and India (Passot *et al.* 2016).

Sorghum

Sorghum [*Sorghum bicolor* (L.) Moench] is C4 photosynthetic cereal crop commonly known as sorghum or great millet or jowar. It belongs to grass species cultivated for its edible grain, fodder and biofuel purposes. *Sorghum bicolor* (L.) is typically an annual, but some cultivars are also found perennial. It grows in clumps that may reach over 4 metres height. The grain is small, ranging from 3 to 4 mm in diameter. Sorghum was domesticated in North East Africa near the equator (De Wet, 1978). It belongs to family *Poaceae,* sub-family *Panicoi-dae*, tribe *Andropogonae* and the sub-tribe *Sorghastrae*. Sorghum is truly diploid species having 2n = 2x = 20 chromosome number with a whole draft genome sequence of 730 Mb size. Sorghum has an excellent photosynthetic efficiency and biomass production capacity (Peterson *et al.,* 2002). Sorghum is the fifth most important cereal crop in the world and ranks fourth in India. It is potentially number one cereal for the semi-arid environments in sub-Saharan Africa. The pollination behaviour is often cross pollinated. High fodder yield with the good quality is more preferable by consumer. Its potential as a biofuel crop has been identified and is gaining in importance.

Foxtail millet

Seeds of foxtail millets have been found in various sites in Europe, the Middle East, and Eastern and Central Asia dated to the Neolithic and Bronze ages. Today, this millet is widely cultivated in Europe, China, India, Indonesia, the Korean peninsula, and the former U.S.S.R. Foxtail millet has a fast-ripening mechanism and a high photosynthetic efficiency; hence, it is perfectly suited to be used as a catch crop. Moreover, it is rich in nutrition and has good resistance to pests and diseases. This crop has a good yield with only single pre-sowing precipitation. Zhang and Liu (2007) suggested that foxtail millet is more water efficient compared to maize and sorghum. Foxtail millet is the second largest crop among the millets, cultivated for food in semi-arid tropics of Asia and as forage in Europe, North America, Australia, and North Africa.

Barnyard millet

Barnyard millet ranks second in terms of production (87,000 tons per annum) and productivity (857 kg/ha) after finger millet in India. It is a drought-tolerant crop with a rapid maturation rate and possesses high nutritional qualities. Barnyard millet *Echniochloa utilis* (L.) is also called

Japanese barnyard millet, whereas *Echniochloa frumentacea* (L.) has several names such as Indian barnyard millet, sawa millet, and billion-dollar grass. This type of millet is considered a minor cereal and is grown widely in India, China, Japan, Pakistan, Africa, and Nepal (Gomashe, 2016).

Proso millet

Proso millet is cultivated in China, India and Russia. It is believed that proso millet originated in Central and Eastern Asia, and later spread to India, Russia, the Middle East and Europe. It is a vital crop in Central and Southern India, Afghanistan, Kazakhstan, Northwest China, Australia, Eastern Europe, Russia, USA and the Middle East including Iran, Iraq, Syria, and Turkey (Zarnkow *et al.* 2009). Proso millet is a short-seasoned crop usually cultivated for 60-75 days, requires an average annual rainfall of less than 600 mm and an average temperature of 17 °C during day time is considered optimum.

Kodo millet

Kodo millet originated in India. It is assumed that domestication of this millet took place about 3000 years ago. Kodo millet is well suited for tropical and sub-tropical regions. Kodo millet is said to possess the highest drought resistance among all minor millets and believed to give good yield with a growing period lasting 80–135 days (Ravi, 2004). Kodo millet is native to the tropical and sub-tropical regions of South America and domesticated in India 3,000 years ago.

Finger millet

Finger millet is grown in parts of India and Africa. Taking production statistics into account, it secures the sixth position in India among major cereal grains following wheat, rice, maize, sorghum and bajra (Devi *et al.* 2014). It can thrive at higher temperatures and in soils with higher salinity compared to other cereal crops. Optimum conditions for growing finger millet are temperatures ranging from 11 to 27 °C, soil pH 5 to 8.2, and medium rainfall.

Significant importance of millets

Millets are the main oldest staple food crops of millions of rural poor in the regions of developing world. Millets are unusually hardy and grow well in dry areas as rain fed; thereby consequently there is a progressive increase in the use of these grains as a human food staple, especially in large areas of India and sub-Saharan Africa. Millets are generally thermophilic (thriving at relatively higher temperatures) and xerophilic (can reproduce with limited water input). A wide variety of millets are found in different regions of the world that require different soil types for their normal growth. Millets are commonly referred as "*small seeded grasses*".

Key characteristics of millets

1. Millets are the staple food of the poor and the working classes and hence their health depends on the quality of food consume.
2. Millets are low input crops and often grown in infertile depleted soils. Obviously, they respond remarkably to fertilizer management.
3. Millets are vulnerable to different spectrum of field pests and diseases.
4. Millets are highly self-fertilized crop.
5. Traditionally millets are the constituents of dry land farming system.
6. Millets are generally cooked like rice.
7. Millets possess a wealth of genetic diversity in India.

8. Millets are well protected in glume encasements the processing of the grain to usable form is not only time consuming but also labour intensive.

Health benefit of millets

Millet crops are rich in fiber, antioxidants, minerals, phytochemicals, polyphenols and proteins, thus providing health benefits. These crops improve digestion due to the high fiber content. Keeps the mind calm. Relieves problems like depression, stress, insomnia. Millet contains tryptophan, an amino acid that makes the stomach feel full so that hunger is not felt for a long time and thus proves to be helpful in preventing weight gain. A boon for pregnant women due to high calcium and iron content. Most importantly, the protein contained in these crops can prove to be a boon for diabetes, high blood pressure and heart disease patients due to their gluten-free and low glycemic index.

1. Reduce the risk of cardio vascular diseases (Sorghum, Finger millet, Foxtail & Proso millet).
2. Rich in dietary fiber helps in increasing obesity (Finger millet, Kodo, Barnyard millet).
3. Low glycaemic index food hence control diabetes (sorghum, Pearl millet, Foxtail millet, Kodo and Barnyard millet).
4. Gluten free food recommended for celiac patients (All millets).
5. Effective in the prevention of cancer initiation and progression (Finger millet, Pearl millet,Kodo, Barnyard & Proso millet).

Value addition and different techniques in millet crops

Compared to other cereal crops, millet crops generally have higher calcium, iron, thiamin, riboflavin and fiber content than cereal crops like wheat and rice and also have good protein, sugar, fat and energy content if these crops are valued and processed. There is a possibility of good financial return in the industries associated with it, social and economic improvement can be brought at the village level. In addition, processing can increase product quality and shelf life. Also, the products become more affordable, tasty and attractive. Employment opportunities are increased through these industries, and foreign exchange can also be earned through its exports. By using various modern technologies like agro-processing, biotechnology and nanotechnology in millet crops, agricultural produce can be transformed into innovative forms that are more acceptable to consumers. Generally, with the help of such new technologies, essential nutrients can be added to millet products or agricultural commodities can be produced in their biological state. Also, agricultural products can be modified to increase the bioavailability of some essential nutrients. As a result of this change, the nutritional quality of food increases and farmers can earn more from their agriculture by selling their produce to consumers at a higher price. On the other hand, consumers are willing to pay more for value-added products as people seek high-quality nutritious and healthy millet products to avoid nutritional deficiencies or lifestyle-related diseases as people have become more health conscious at present. Due to increasing awareness, their preference towards consumption of millet is increasing day by day. Due to this, farmers are getting interest in reviving the cultivation of millet crops as the farmers are getting enough affordable prices through increasing the value of millet.

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Bajara roti


Millet Cookies


Ragi Kheer

Bajara Halwa


Millet Bread


Millet VermicelliUpma

Fig 1. Traditional and other value added product of Millet

Bajara dosa


Millet Cake

- The flour of millet crops can be used through value addition to the commonly used flours in the preparation of Chapathi , roti, dosa, upma, halwa and other product .
In addition, there are bakery products bread, cackes, biscuits, cookies and noodles on the market.


Millet pasta

Source:- https://www.nutricereals.dac.gov.in/valueaddedproducts.aspx

Status of nutri-cereals in India

The area of nutri-cereals in the country was 36.90 million ha during 1965-66 which has declined to 14.72 million ha during 2016-17 which is around 60.2 % less area coverage. Why are nutri-cereal crops chosen for nutritional enhancement in table 1.

Top five states	Millet crops
Rajasthan	Bajra/Sorghum
Karnataka	Jowar/Ragi
Maharashtra	Ragi/Jowar
Uttar Pradesh	Bajra
Haryana	Bajra

The area declined under small millets (88.4 %), jowar (67.6 %), finger millet (56 %) and bajra (34.2 %). However, the production of millets has gone up to 16.12 million tonnes during 2016-17 from 14.21 million tonnes during 1965-66 despite more than 60 % decline in area under nutri-cereals during same period. The increase of production around 13.43 % has mainly due to use of HYVs/hybrids, adoption of latest crop production technology. Among the millets, pearl millet occupies 95% of the production (Vinoth and Ravindhran, 2017).

The major nutri-cereals producing States are Rajasthan, Maharashtra, Karnataka, Uttar Pradesh, Gujarat, Haryana, Madhya Pradesh, Tamil Nadu, Andhra pradesh and Uttrakhand.

Issues related to enhancing millet's production

1) Poor genetic yield potential
2) Poor adoption of latest technologies especially farm mechanization.
3) Lack of suitable processing & value addition opportunity.
4) Lack of Marketing and infrastructure.
5) Lack of awareness and necessary skill for processing & value addition of millet crops.

Why decline in millets area?

1) Rapid urbanization
2) Changing consumer tastes and preferences

3) Government policies favoring other crops such as output price incentives and input subsidies
4) Decline in production & quality - blackening of sorghum grains, fetching low price
5) Lack incentive for millet production
6) Lack of better irrigation infrastructure

Nutritional importance of millets

Millets are nutritionally superior to containing a high amount of proteins, dietary fibers, iron, zinc, calcium, phosphorus, potassium, vitamin and essential amino acids (Saleh *et al.,* 2013). In spite of the superior quality of millets, only pearl millet has been prioritized as crop of choice for iron biofortification in India. The major micronutrient content in millets comparison with major cereals in **Table 1**. Year 2023 has been announced by UN celebrtation as the International Year of Millets.

Table 1.	**Nutritional composition of millets as compared with major cereals (Per 100 g)**						
Commodity	**Protein (g)**	**Carbohydrates (g)**	**Fat (g)**	**Crude fibre (g)**	**Mineral matter (g)**	**Calcium (mg)**	**Fe (mg)**
Sorghum	10. 4	72. 6	1. 9	1. 6	1. 6	25	4.1
Pearl millet	11. 6	67. 5	5. 0	1. 2	2. 3	42	8.0
Finger millet	7. 3	72. 0	1. 3	3. 6	2. 7	**344**	3.9
Proso millet	**12. 5**	70. 4	1. 1	2. 2	1. 9	14	0.8
Foxtail millet	12. 3	60. 9	4. 3	8. 0	3. 3	31	2.8
Kodo millet	8. 3	65. 9	1. 4	9. 0	2. 6	27	0.5
Little millet	8. 7	**75. 7**	5. 3	8. 6	1. 7	17	**9.3**
Barnyard millet	11. 6	74. 3	**5. 8**	**14. 7**	**4. 7**	14	5.0
Barley	11.5	69.6	1.3	3.9	1.2	26	3.6
Maize	11.5	66.2	3.6	2.7	1.5	20	3.1
Wheat	11. 8	71. 2	1. 5	1. 2	1. 5	41	5.3
Rice	6. 8	78. 2	0. 5	0. 2	0. 6	10	0.7
Source: Indian Food composition Table, NIN-2017; * Nutritive value of Indian Foods, NIN-2007							

Future thrust

Nutri-cereals production and enhancement is to be sustainable and low cost-effective approaches to address "*famine reserves*". "Millets: a nutri-cereals crops for food security" This approach achieved by:

1) Identification and utilization of technologies generated from basic and applied research.
2) Use of new molecular technology can reduce the time and resource in developing new high yielding varieties of nutria-cereals with desirable quality traits.
3) Strengthening of both basic and applied research.
4) The main focus is to improve the density of macro and micro nutrients in millets as "nutri-cereals" are limiting in the majority of the diet of people in semi-arid tropics.
5) Research on shelf-life and processing traits will also enhance the utilization of millets in future.

6) Quick transfer of technology to the farmer's field for extension-tabulation of crops, nutrients, research status, and concerned publications on biofortification through breeding.

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THE FUTURE OF PROTEIN: EDIBLE INSECTS AND ENVIRONMENTAL IMPACT

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Abstract
Edible insects offer a sustainable protein source with reduced greenhouse gas emissions, minimal land requirements, and efficient water usage. Their nutrient-rich profile addresses malnutrition and food security concerns. Embracing insects as an alternative to livestock can mitigate environmental impacts, fostering a sustainable protein production approach for the future.

Introduction
As the world's population continues to grow, the demand for protein-rich food sources is escalating. Traditional livestock production has long been the primary source of protein, but it comes with significant environmental challenges, such as greenhouse gas emissions, land degradation, and water pollution. There is a need to explore sustainable alternatives, and one such solution gaining momentum is edible insects. In this article, we will delve into the potential of edible insects as a future protein source and their environmental impact.

Edible Insects: A Sustainable Protein Revolution
Edible insects have been consumed for centuries in various cultures, providing valuable nutrition to communities across the globe. In recent years, these tiny creatures have attracted attention as a sustainable and environmentally friendly protein source. The remarkable efficiency of insect farming in comparison to traditional livestock farming is one of the key factors driving this interest. Insects convert feed into edible body mass more efficiently, resulting in lower greenhouse gas emissions and a reduced environmental footprint.

Some of the Edible Insects
- **Crickets (*Acheta domesticus*)**: Crickets are one of the most popular and widely consumed edible insects. They are rich in high-quality proteins, essential amino acids, and minerals like iron and zinc.
- **Mealworms (*Tenebrio molitor*)**: Mealworms are the larvae of darkling beetles and are commonly used in various insect-based food products. They are a good source of protein, healthy fats, and dietary fiber.
- **Black Soldier Fly Larvae (*Hermetia illucens*)**: Black soldier fly larvae, also known as BSFL, are highly efficient in converting organic waste into protein. They are packed with protein and have a favorable amino acid profile.

- **Grasshoppers (*Orthoptera order*):** Grasshoppers have been consumed in many cultures for generations. They are a good source of protein, vitamins, and minerals such as calcium and iron.
- **Silkworms (*Bombyx mori*)**: Silkworm larvae are traditionally known for silk production, but they are also consumed in some regions as a nutritious food source. They contain protein, healthy fats, and essential amino acids.
- **Waxworms (*Galleria mellonella*):** Waxworms are the larvae of wax moths and are gaining popularity as a sustainable protein option. They are rich in fat and protein, making them a valuable addition to the diet.
- **Ants (*Hymenoptera order*):** In certain cultures, ants have been a part of traditional diets for centuries. They are a good source of protein and are often used in various culinary dishes.

The Ecological Benefits of Edible Insects

a. Low Greenhouse Gas Emissions: Research by **Oonincx et al. (2010)** found that insects emit significantly lower levels of greenhouse gases, such as methane and nitrous oxide, compared to cattle and other livestock.

b. Minimal Land Requirements: **Veldkamp et al. (2012)** demonstrated that insect farming requires significantly less land than traditional livestock farming. This is crucial for preserving natural habitats and biodiversity.

c. Water Efficiency: A study by **van Huis et al. (2013)** revealed that insects are remarkably efficient in water use, requiring significantly less water than cattle and pigs for protein production.

Edible Insects as Nutritional Powerhouses

Beyond their ecological benefits, edible insects also offer a wealth of essential nutrients. Insects are rich in high-quality proteins, healthy fats, vitamins, and minerals, making them a promising solution to combat malnutrition and food insecurity in various regions of the world **(Rumpold and Schlüter, 2013)**. For example, crickets contain a higher protein content than beef and are excellent sources of omega-3 and omega-6 fatty acids.

Overcoming Cultural Barriers and Perception

While edible insects have a long history of consumption in many cultures, their widespread acceptance in Western societies remains a challenge. Cultural barriers and the "yuck" factor associated with consuming insects need to be addressed. However, initiatives promoting insect-based protein products in creative ways have shown promise in breaking down these barriers **(Tan et al., 2021)**.

Sustainable Insect Farming Practices

Sustainable insect farming practices play a vital role in maximizing the environmental benefits of edible insects. By adopting efficient and eco-friendly farming methods, such as using organic waste as feed and minimizing water usage, farmers can further reduce their environmental impact **(Nakagaki et al., 2016).**

Regulatory Challenges and Future Prospects

The commercialization of edible insects faces various regulatory challenges in different regions. Some countries have embraced edible insects as food, while others require comprehensive legislation. To harness the full potential of insect-based proteins, supportive policies and regulatory frameworks need to be established **(van Huis, 2013)**.

Conclusion

Edible insects hold great promise as a sustainable protein source for the future. Their environmental benefits, nutritional value, and efficient farming practices make them an attractive alternative to traditional livestock. We should look an optimistic way that with continued research, innovation, and societal acceptance, edible insects will play a pivotal role in achieving global food security while minimizing the environmental impact of protein production.

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SUSTAINABLE DEVELOPMENT OF FISHERIES AND COMMUNITIES IN LOKTAK LAKE

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Abstract
Loktak lake being the lifeline for the local communities of Manipur has been degraded over the years due to excessive use of resources, changes in biodiversity, conflicting beneficiary uses, and inappropriate exploitation of the lake's socioeconomic potentials. Fisheries contribute over 3% of gross domestic product and approximately 60% of the fish produced in the State is obtained from the lake and other nearby river basins. The quantity of fish landings has significantly decreased over time. Fishing-related revenues have been significantly influenced by changes in fishing practices, indiscriminate fishing techniques as well as insufficient marketing outlets. These issues have not all been addressed as a whole. Therefore, it is imperative to implement sustainable approaches to preserve biodiversity and enhance fisheries. This article highlights the various approaches taken up for sustainable development of fisheries, livelihood improvement for the local communities vis-à-vis maintaining a balanced ecosystem of the lake.

Introduction
Due to its significant role in the socioeconomic and cultural backgrounds of the communities associated with it, Loktak Lake is the lifeline of Manipur's inhabitants. Being a water body with public access, the lake serves a source of water, food, and shelter for the nearby settlements, as well as a means of daily livelihood for thousands of people. The floating mats or wetlands, locally known as Phumdi, are the unique hallmark of the lake. Although not widely recognized, the lake is also considered as a biodiversity hotspot. The lake was designated as a "Wetland of International Importance" under the Ramsar Convention in 1990 and included in the Montreux Record in 1992 based on its distinctive biodiversity and socioeconomic significance. It is also one among the 75 wetlands chosen for conservation and management under the National Wetland Development Programme. Fisheries contribute over 3% of Manipur's gross domestic product, which renders them a significant economic resource. Around 60% of the fish produced in the State is obtained from the lake and other nearby river basins. It also serves as a spawning grounds for many riverine fishes. The lake's current situation can be put together as follows: environmental degradation, excessive use of resources, biodiversity changes, conflicting beneficiary uses, and inappropriate exploitation of the lake's socioeconomic potentials. The fishing methods employed are primarily traditional and capture oriented. There are approximately 2800 dugout canoes used for fishing, which is of three varieties (Lukai Hi, Iniing Hi and Hijas). The fishing gear used includes spears, cast nets, pole and line, traps (Fig 2), drag nets, gill nets, encircling nets, and lift nets (Fig 1). Wounded gears (barbed and non-barbed) are also employed. Fish aggregation and capture (Athaphum) (Fig 3), which has been extensively explored by Suresh (1999), is the most apparent fishing method in

the lake. The quantity of fish landings has significantly decreased over time. Fishing-related revenues have been significantly influenced by changes in fishing practices, indiscriminate fishing techniques as well as insufficient marketing outlets. Open access to fisheries resources has encouraged indiscriminate fishing without taking into account the capability of fish stocks to regenerate. The lake's water quality has also declined over time as a result of the phumdi's rapid growth, which has restricted the fishes' access to open areas. A number of streams that aid in natural replenishment are under a great deal of stress from the indiscriminate fishing practices. These issues have not all been addressed as a whole. Therefore, it is imperative to implement sustainable approaches to preserve biodiversity and enhance fisheries, which support the livelihood of local fishermen.

Major Threats

The following are the primary threats to the lake ecosystem:

- An upsurge in phumdis and other aquatic vegetation affects water quality, reduces fish populations, and causes disputes amongst fishermen.
- An increase in fishing activity puts pressure on lake resources, particularly as fish catches and incomes fall.
- Reductions in riverine fish populations including Pengba, Khabak, and Shareng as a result of the Ithai barrage's obstruction of migratory routes.
- Fish stocks are on the decline as a consequence of the deployment of imported gear and crafts with small mesh sizes.
- An increase in river pollution and agricultural runoff which lead to diseases and mass fish mortality.

Figure 1: A fisherwoman fishing in Loktak Lake using lift net (Photo courtesy: Peter Adams)

Sustainable development

The implementation of Sustainable Development and Water Resources Management of Loktak Lake (SDWRML) project over the previous years has aided in the development of baseline data for developing strategies with the main goal of enhancing the fisher community's means of livelihood while preserving ecological processes and functions for the sustainable development of lake fisheries.

Community based Fisheries Management

In order to develop sustainable fisheries, a community-based approach has been adopted, with a focus on empowering underprivileged communities, promoting equity in resource access and management, sustainability, and system orientation through determining the demands and priorities of local communities as well as sharing authority and responsibility for management of resources in accordance with institutional arrangements that are recognized and accepted by all parties. Below are mentioned some of the actions that were executed to implement community-based fisheries in Loktak Lake.

- Limiting the proliferation of phumdis.
- Strengthening the fish population with sufficient facilities for restocking.
- Restoration of rare and endangered species, including Pengba.
- Availability of impoverished crafts and gears at subsidized rates.
- Implementing fishing regulations and lake boundary delineation.

a) b)

Figure 2: Fishing traps -a) Bamboo basket and
b) *Kaboo loo* used in Loktak Lake (Source: Devi *et al*., 2013)

Water and Weed Management:

Optimization of the water level, water holding capacity, improvement of water quality, weed control, flood mitigation, and formulation of a water management strategy supported by all stakeholders (Power, irrigation, fisheries, wildlife, tourist, etc.) should all be part of a water and weed management regime. The following steps can be taken up right away

- To prevent floods, adjust the barrage's opening and shutting periods, especially during the monsoon season.

- Weeds and effluent accumulation is being exacerbated by the construction of waterways on the road connecting Imphal and Bishnupur, that leads to blockage of flow of water from the northern part of the lake. This need to be checked for improvement.
- Weed management measures, including manual, mechanical, and biological methods, must be implemented.
- It is essential to carry out the economical exploitation of undesired weed mass as compost, for production of biogas, leveling submerged land, and other applications.

Figure 3: Athaphums, the prominent fishing method in Loktak lake
(Photo courtesy: Sharada Prasad CS)

Fisheries Development

The lake's fish yield can be enhanced to 300 kg/ha/year with appropriate management practices. At this pace, the 14,600 acres of the lake itself could generate 4,380t of fish yearly. More than 4,500 acres of the lake's periphery are open for culture fisheries. An additional 1,250 t of fish can be produced, for a total annual catch of 15,630 t, with a minimum production of 2,500 t/ha (Sugunan, 1998). As a result, the lake alone could meet approximately 64.5% of the State's current fish consumption demands. Since the lake's ecosystem is dominated by macrophytes, it is necessary to introduce fish that feed on macrophytes as well as those that live off of the related fauna and detritus to harness the energy contained in these plants for fish production. In this regard, the technical alternatives listed below can be employed.

Stock Enhancement

In order to promote recruitment, it is necessary to locate and maintain breeding grounds and brooders as well as to facilitate free migration of brooders and juveniles to the lake through removing barriers and constructing fishways on the Ithai barrage. Selective stocking to increase the number of fish that feed macrophytes (*Ctenopharyngodon idella*, *Osteobrama belangeri*), as well as those that consume the surrounding flora and debris (*Labeo rohita, Cirrhina mrigala Cyprinus carpio*, and *L.fimbriatus*) can also be augmented.

Stock Management

The principles of maximum sustainable production, reduced fishing effort, increased size at catch, regulation of the quantity and type of gears, etc. are regularly monitored.

Species Enhancement

Suitable species that are capable of utilizing the prominent food chain in the lake may be introduced from outside. Grass carp and common carp have been used in the past to manage the macro vegetation, but their population in the lake appears to be insufficient.

Fish production and diversity enhancement

Capture fisheries in the lake haven't received much attention. It is very challenging to increase fish productivity and diversity when there is no ownership of the territorial rights, ownership, or regulatory systems. The approach employed for enhancing fish output and diversity focuses on the following aspects:

- Fish seed production for species that are economically important and in risk of extinction through the development of new hatcheries and improving the performance of hatcheries (private owned).
- Creating organizations at the community level to coordinate efforts for the formation and execution of Memorandum of Understanding (MoUs).
- Making use of the unused seedlings for personal use and releasing 50% of them into the lake.

In accordance with the aforementioned requirements, community-owned hatcheries have been established in 9 villages in proximity, including 2 major Chinese circular hatcheries at Toubul and Mayang Imphal with a yielding capacity of 20 lakh spawn per operation and 7 mini hatcheries of 2 lakh spawn per operation. Following proper training and technical assistance, the communities are currently maintaining the hatcheries.

Management Enhancement

Adopting culture fishery systems (pen, cage, and pond culture), establishing sports fishing, and developing protected areas, fishing zones, and sanctuaries wherever possible.

Regulations of fishing

Enforcement of the Manipur Fisheries Act and other State-existing fishing laws must be carefully adhered to. It is necessary to regulate the amount of fishing Phumdis.

Improving harvesting techniques and infrastructural development

A key factor in enhancing the fish output is the use of appropriate gears and crafts. Currently, majority of the gears and crafts employed in the lake are traditional and the yield is comparatively low. With the current state of efficiency, an expected rise in fish production might not be utilized to its full potential. Furthermore, there is a lack of infrastructure to develop and maintain more advanced and effective crafts and equipments. The following actions are suggested for improving harvesting practices:

- The selection of superior building materials for boats, including the type of timber utilized and the treatment method to be applied.
- Building of boat building yard.
- The fabrication and design of fishing gear employing both natural and synthetic fibers, based on an assessment of currently available gear.
- The selection and popularization of acceptable fishing gear with the proper mesh sizes, will be decided by the local community based on ecological factors.

- Facilities for fish vessels to land and dock as well as for net repair, preservation, and storage.

Wildlife:

The Phumdis in the Keibul Lamjao National Park are shrinking. To restore the habitat of Brow Antler Deer's, unwanted Phumdi from other lake areas can be brought over to the park. Several attempts may be made to develop additional habitat in other suitable areas in Manipur or outside. The bird population needs to be protected through the establishment of protected zones and other appropriate measures. Strict compliance with the Wildlife Protection Act and other laws must be enforced.

Restoration of Environment quality

The following actions are recommended for the improvement of the quality of the environment:

- Improving city sewage management and implementation of proper household waste disposal to reduce the amount of effluents in the Manipur River prior to discharging in the lake.
- Improving hygiene in the communities located near the lake.
- Suggesting ecologically suitable insect and disease management and fertilizer in the catchments and adjoining agricultural areas to lessen the influx of chemicals, and
- Restoring the water quality and storage capacity of the lake by desilting and removing the top layer of the lake bottom that has been heavily loaded with effluent.

Catchment area development

The following steps can be used to accomplish this:

- Preventing soil and mineral erosion by discouraging shifting cultivation and deforestation.
- Promoting aforestation and integrated watershed development programs involving the public's participation, and
- Implementing soil and water conservation measures.

Improvement of Livelihood for fisher community through integrated fish farming

Along the shoreline of the lake, a large number of people engage in agriculture and fish farming. The production and revenue from the crop may be greatly increased by integrating the two systems. The incorporation of other farming systems, such as pig, chicken, and duck farms, can generate significant profits since the latter's wastes serve as the primary source of nutrients for the fish farm. Under the project, paddy cum pisciculture and fish cum farming have been implemented in 16 villages, respectively. The beneficiary of the project is compelled by the terms of the MoU to supply an equivalent number of ducklings as well as fish fingerlings to another beneficiary that has been jointly identified by the project and the community organizations after one year of operation. In 9 hill villages, fish cum fishing programs have been taken into action. Piglets and fish fingerlings have been distributed to the local community as part of this initiative, and MoU stipulates that the beneficiary group after a period of one year, must give an equivalent number of piglets and fish fingerlings to a different group. Additionally, integrated farm management training has been provided to the local community members.

According to a revenue analysis of the benefits from the implementation of alternative revenue generation schemes, the fishery cum duckery project generated an added income of Rs. 22,000

per beneficiary, the fishery cum paddy project of Rs. 32,000 per group, as well as the fishery cum piggery project of Rs. 25,000. 2 sites nearby Thanga island and 2 locations in the Hubidak region of the lake are being used for eco-friendly pen culture in collaboration with the State Fisheries Department. In the initial trial operation, a rectangular pen with a range of 50 feet by 20 feet to 100 feet by 40 feet is employed using synthetic nylon nets. In the pen, polyculture of grass carp and common carp has been introduced.

Post harvest and value addition

Due to its high perishability, fish requires proper handling and infrastructure to allow for prolonged storage. As soon as the fish are caught, the freezing procedure needs to begin in order to maintain the fish's freshness. In the project's extended phase, demonstrations of fish and vegetable dryers are being conducted. The Loktak Development Authority and North East Council have put forward a number of initiatives for financial support under the project's extended phase.

The initiatives to be taken up are as follows:

- Provision of ice boxes for transporting and temporary storage of fish.
- An ice plant for supplying ice.
- Offer quick freezing along with adequate storage facilities.
- Facilities for transporting fish with insulated vans.
- Use of carrier vessels for fish disposal caught by fishermen.
- Fish salting and drying facilities.

Improvement of marketing channels and infrastructure

Fishermen are frequently exploited by middlemen and intermediates due to a lack of proper marketing outlets. In comparison to the prices sold at the market places, the fisherman seldom receives a reasonable share of their sales. For the fisherman, it is crucial to strengthen the marketing channels. The following tasks has been taken up during the SDWRML project's extended phase:

- Evaluation of the different types of intermediaries in the marketing channel.
- Evaluation of present revenue systems and royalties by cooperatives

Social development

- To preserve the ecology and limit the requirement for hut building on Phumdi, it may be feasible to relocate the lake-dwelling inhabitants of the Phumdi communities to land regions.
- Education and training must be provided to the villagers because only 15 % of them are literate and 95% quit school before graduating their high school education.
- In order to lessen their reliance on lake resources, skill development in alternative professions is essential.

Regulatory Mechanism

It is crucial to develop a clear policy framework for the management and monitoring of the lake's resources and for coordinating the efforts of all of the stakeholders.

Conclusions

Preserving the biodiversity as well as the ecosystem of the Loktak lake has been a primary concern over the years since the lake serves as a source of livelihood for the local inhabitants despite of its

significant role in the socioeconomic and cultural backgrounds. Fish aggregation and capture (Athaphum), which has been extensively explored, is the most apparent fishing method in the lake. However, due to extensive proliferation of the Phumdis, it affects water quality, reduces fish populations, and causes disputes amongst fishermen. There has been observed an increase in fishing activity which puts pressure on lake resources and fish stocks are on the decline as a consequence of the deployment of imported crafts and gear with small mesh sizes. Therefore, the implementation of Sustainable Development and Water Resources Management of Loktak Lake (SDWRML) project over the previous years has aided in the development of baseline data for developing strategies with the main goal of enhancing the fisher community's means of livelihood while preserving ecological processes and functions for the sustainable development of lake fisheries.

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GEOSPATIAL TECHNOLOGY FOR MONITORING THE MOISTURE STRESS IN AGRICULTURAL FIELDS

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Abstract

The natural resources like soil, water and vegetation are key components of an ecosystem. The use of water in agriculture represent the dominant water use in the form of flowing water for irrigation and as rainwater and soil moisture in croplands and forests. Irrigation affects temperature conditions by regulating the temperature of the surface layer of the soil and the ground layer of the air and also makes possible control of the growth and development of plants. The Landsat-8 image are useful to derive Land Surface Temperature (LST) and Moisture Stress Index (MSI) for different land use. The land use land cover, LST and MSI are helpful to identify the area under crop, area under crop with soil moisture stress or low soil moisture and high soil temperature, which help to take the decision for scheduling the irrigation in the agricultural land. The variable estimated for the different dates of the cropping season can be used to evaluate the changes in the crop and soil moisture for different crop growth stages.

Introduction

The requirement of water for agriculture covers a wide range of consumptive and non-consumptive water uses in all the agricultural and its sub-sectors. The soil moisture based method for irrigation water requirement is one of the best methods. The remote sensing plays a very important and key role in the information collection of spatial and temporal variables of the land surface from geographical area. It provides an effective methodology and tool for retrieving the ground parameters for crop evapotranspiration estimation at large scale i.e. regional scale using Surface Energy Balance Algorithm for Land (SEBAL) model (Bastiaanssen et al., 1998, Parmar and Gontia, 2022). Also using the remote sensing technology to estimate the curve number for the determination of the runoff from the catchment (Chavada et al. 2016). The remote sensing based vegetation index like normalized difference vegetation index (NDVI) is helpful for the spatial and temporal estimation of crop coefficients for the estimation of crop evapotranspiration (Duchemin et al., 2006; Er-Raki et al., 2007; Gontia and Tiwari, 2010, Parmar and Gontia, 2021). The utilization of geo-informatics in analyzing crop characteristics, as well as variables such as crop health, crop stress, crop coefficient, drought, soil moisture, moisture stress proves to be valuable in estimating various inputs (Patel and Rank, 2016, Pandya, et al. 2022, Patel, et al. 2023). The remote sensing connection between vegetation index and crop coefficient can be beneficial in estimating crop evapotranspiration and determining irrigation requirements in the canal command area (Parmar and Gontia, 2016, Prajapati and Subbaiah, 2019). The remote sensing helpful in the land use land cover mapping and to identify the different major crops as in Saurashtra regions of Gujarat major crops like groundnut, cotton, sesame etc. Sesame crop and its value added products are some of the key factors of economy of the region (Gojiya, and Gohil 2022; Gojiya et al. 2022). The potential for obtaining soil moisture by using the relationship

between remotely-sensed Ts and NDVI has been investigated by several authors in their studies (Parmar and Gontia, 2016). The moisture stress index and LST values analyzed to understand the status of crop in the area and to identify the area under crop stress.

Use of Satellite Data for Land surface temperature (LST)

The satellite images of Landsat 8 are available to download from USGS website (www.earthexplorer.usgs.gov). Landsat-8, bands 1 to 9 are converted into reflectance and bands 10 and 11 are useful for temperature. The bands have 16-bit unsigned integer format, that have rescaled to the Top Of Atmosphere (TOA) reflectance and radiance. The coefficients of radiometric rescaling are used for the procedure that have provided in the metadata file (MTL file). The thermal constants provided in the MTL file are used to convert TIRS images into the at-satellite brightness temperature. The brightness temperature of Landsat 8 TIRS Band 10, 11 can be calculated using of thermal constants (K_1, K_2) values provided in the metadata file of the Landsat image. The value of LST are lower in the fields with crop at vegetative crop growth stage like wheat and coriander crops and higher value in the cotton crop filed that may be at harvesting stage and in the wasteland area also (Parmar and Gontia, 2019).

Moisture Stress Index (MSI)

Moisture Stress Index is useful for canopy stress analysis and similarly productivity prediction. It was proposed by Hunt and Rock (1989) who first used the index to detect changes in leaf water content using the near- and middle infrared reflection ratio. MSI can be calculated for each of the satellite images using the near-infrared band and the mid-infrared band 5 spectral bands of Landsat images. Interpretation of the MSI was inverted relative to other water vegetation indices; thus, higher values of the index indicate greater plant water stress and in inference, less soil moisture content. The values of this index range from 0 to more than 3 with the common range for green vegetation being 0.2 to 2 (Welikhe *et al.,* 2017). Moisture Stress Index is used for canopy stress analysis, productivity prediction and biophysical modeling. Higher values of the index indicate greater plant water stress and in inference, less soil moisture content. The value of MSI lower in the fields with crop as vegetative crop growth stage like wheat and coriander crops and higher value in the cotton crop filed that may be due to harvesting stage and in the wasteland area also as less soil moisture. Singh *et al.* (2012) reported that at mid-growth stage MSI value was decreased in wheat crop.

Conclusions

The Landsat-8 image based average values of LST in field without crops i.e. waste land shows higher LST value. The average values of Moisture Stress Index (MSI) in the fields with crop shows less due to irrigation. The lower value of LST in agricultural land shows the irrigation facility, horticultural plantation i.e. near to the river and the forest area. The higher value of LST in the land without crop or exposed soil. The lower value of MSI shows the sufficient moisture in the soil. MSI which indicates low soil moisture stress and high soil moisture content. The remote sensing based MSI and LST are helpful to identify the area under crop, area under crop with soil moisture stress or low soil moisture. This help to take the decision for scheduling the irrigation in the agricultural land under the canal irrigation system.

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CHALLENGES AND CURRENT STATUS OF GROUNDWATER USE IN INDIA: TOWARDS SUSTAINABLE MANAGEMENT AND GOVERNANCE

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Abstract

India, with 18% of the global population and occupying 2.4% of the world's geographical area, faces significant challenges in water resource management, particularly in groundwater. The country is the largest consumer of groundwater, with agricultural irrigation being its primary use. Despite a recent improvement in the state of groundwater use, India's surging population, unplanned urbanization, agriculture practices, groundwater pollution, and climate change continue to strain this critical resource. To safeguard long-term water security, comprehensive groundwater governance reforms are necessary. Several institutions, including the Central Water Commission, Central Ground Water Board, Central Ground Water Authority, and Central Pollution Control Board, play vital roles in regulating groundwater management. Public awareness campaigns and active involvement are also essential to promote judicious and sustainable groundwater use in India.

Introduction

India, with approximately 18% of the world's population and occupying around 2.4% of the global geographical area, faces significant challenges in water resource management. The country consumes approximately 4% of the world's total water resources, and a recent World Bank report highlights India as the largest consumer of groundwater. As India's economy and population continue to grow, the demand for groundwater is expected to increase, further straining this vital resource. Groundwater plays a critical role in ensuring both agricultural productivity and access to safe drinking water in rural and urban areas, making it indispensable to India's water security. However, experts argue that there are several gaps in groundwater governance within the country, hindering effective conservation efforts. To address the depleting groundwater levels in India, it is crucial to implement groundwater governance reforms and promote the judicious use of this valuable resource. These measures are essential for sustaining groundwater availability and ensuring long-term water security for the nation.

Current status of Groundwater Use in India

As per the Ministry of Jal Shakti's Dynamic Groundwater Resource Assessment Report for 2022, the annual recharge of groundwater amounts to 437.60 Billion Cubic Metres (BCM). The extraction of groundwater has reached a record low of 239.16 BCM, the lowest since 2004 when it was 231 BCM. The primary usage of groundwater is for irrigation, accounting for 208.49 BCM, followed by domestic use at 27.05 BCM, and industrial use at 3.64 BCM.

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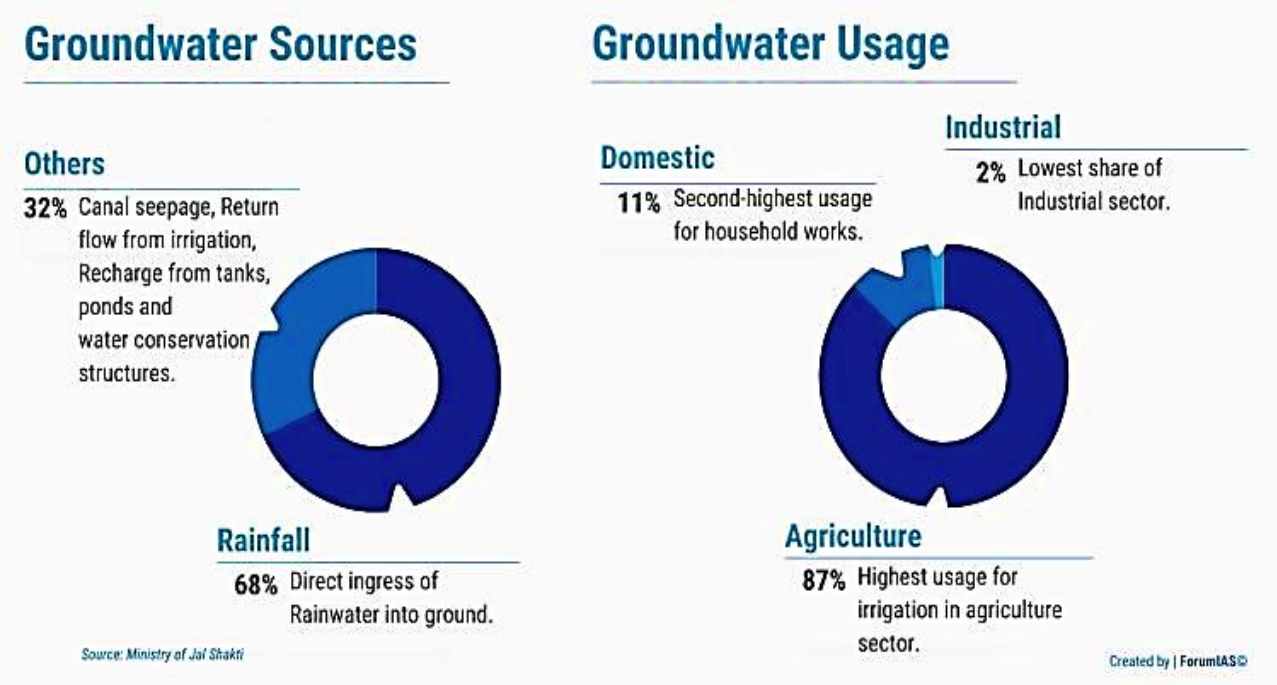
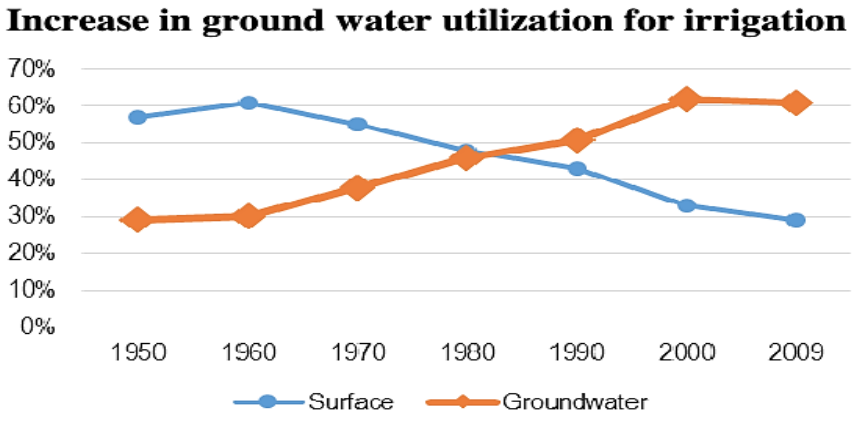


According to a 2021 report by the CAG, groundwater extraction in India has increased from 58% to 63% between 2004 and 2017, surpassing the rate of groundwater recharge. The Central Groundwater Board of India estimates that approximately 17% of groundwater blocks are overexploited, where the extraction rate exceeds the aquifer's recharge rate. Additionally, 5% of blocks are classified as critical, and 14% are classified as semi-critical. The North-western, Western, and Southern peninsular regions face particularly alarming conditions. The Groundwater Resource Assessment for 2022 reveals a 3% decrease in the number of 'overexploited' groundwater units and a 4% increase in the number of units classified as 'safe' compared to 2017. Notably, 909 units showed an improvement in groundwater conditions.



Sources: Agricultural Statistics at Glance 2014, Ministry of Agriculture; PRS.

According to the India Water Portal, India utilizes 25% of the world's extracted groundwater, surpassing both the United States and China. Approximately 70% of water utilized in Indian agriculture today is sourced from groundwater.

Challenges associated with Groundwater Use in India

Population Growth and its Impact on Water Resources: The surging population has a profound effect on water demand. As the urban population grows, the burden of managing waste and contaminated water increases. It is noteworthy that India stands as the largest consumer of groundwater worldwide, accounting for approximately 25% of the total global withdrawal. Groundwater constitutes about 48% of the water supply for Indian cities, a figure that is projected to escalate alongside population growth.

Unplanned Urbanization and its Consequences: The expansion of built-up and paved areas obstructs the infiltration of water into the ground. Additionally, the absence of green cover diminishes evapotranspiration, leading to increased surface runoff and urban flooding. Consequently, the recharge of groundwater is impeded. A study conducted in the United States demonstrated that each 1% rise in impervious surface area contributes to a 3.3% escalation in the magnitude of urban floods. Alteration of Natural Landscape and its Ramifications: The sprawling nature of urban development often disrupts the natural landscape, altering the flow direction within watersheds and modifying the groundwater cycle. This transformation can result in a substantial decline or rise in groundwater levels, diminished well yields, and a decline in water quality.

Agriculture Practices: Tube-wells have become increasingly prevalent in irrigation practices. However, the combination of flawed crop cycles stemming from farm subsidies and electricity subsidies has led to excessive exploitation of groundwater, particularly in Northwest India. The regions most affected by critically low groundwater levels are Punjab, Haryana, Delhi, and western Uttar Pradesh.

Groundwater Pollution: Groundwater aquifers are being contaminated by infiltration and seepage from various sources, such as roads, industrial sites, waste dump sites, and effluent drains that carry heavy metals and micro-pollutants. Microbiological contamination is also occurring through the sewage system. Major contributors to groundwater pollution include nitrate, arsenic, and fluoride.

Climate Change: The groundwater crisis is further aggravated by climate shocks. Erratic rainfall patterns and prolonged droughts are impeding groundwater recharge, leading to declining water tables in numerous regions.

Major institution for regulating Groundwater Management

Institution	Role
Central Water Commission	Initiating and coordinating schemes for the conservation and utilisation of water resources in the country in collaboration with state governments; and monitoring water quality
Central Ground Water Board	Developing and disseminating technology relied to sustainable use of ground water, monitoring and implementing policies for the sustainable management of ground water resources; estimating ground water resources
Central Ground Water Authority	Constituted under Section 3(3) of the Environment (Protection) Act, 1986 to regulate and control development and management

Institution	Role
	of ground water resources; can resort to penal actions and issue necessary regulatory directives
Central Pollution Control Board	Implementation of the Water (Prevention and Control of Pollution) Act, 1974 which seeks to restore water quality

Conclusion

The latest assessment indicates a slight improvement in the state of groundwater use in India. However, the growing population, urbanization, and the uncertainties arising from climate change are projected to intensify the strain on groundwater resources. Therefore, it is crucial to embrace a proactive strategy for groundwater management in India. Reformation of the water management governance framework is essential to address this issue effectively. To encourage prudent and sustainable groundwater usage, it is imperative to conduct awareness campaigns and actively involve the public in the process.

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INDIAN FOOD INDUSTRY: ITS PRESENT FINANCIAL OVERVIEW

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Introduction

The Indian food processing industry is an important sector of the Indian economy, linking agriculture and manufacturing while catering to the different dietary needs of the country's large population. This research examines important financial indicators, investment patterns, difficulties, and future opportunities in the Indian food processing business.

Industry overview

The food processing business in India is anticipated to be valued $380 billion, with a CAGR of 11% expected to reach $540 billion by 2025. The agro-food processing business is an important cog in the Indian economy, accounting for 8% of the country's GDP. The Indian food processing business is divided into several sub-sectors, including dairy, fruits and vegetables, meat and poultry, fisheries, and drinks. This sector not only adds value to raw agricultural products, but it also plays an important role in guaranteeing food security, minimizing waste, and extending product shelf life. The expansion of the industry is directly related to urbanization, changing customer demands, and advances in food technology (Priyadarshini and Abhilash, 2023).

Financial Performance:

The financial performance of the Indian food processing industry underscores its economic significance:

1. ***Revenue Growth :*** Over the past decade, the industry's revenue has showcased a robust upward trend. The combination of population growth, increasing disposable incomes, and changing lifestyles has led to higher demand for processed and packaged foods. This demand surge has driven revenue growth across the sector's sub-categories. Revenue in the Food market amounts to US$905.2 billion in 2023 with its largest segment: Bread & Cereal Products with a market volume of US$174.30 billion . The market is expected to grow annually by 8.40% (CAGR 2023-2028).

2. ***Profit Margins:*** The industry's profitability varies by segment. Because of high consumer demand and brand loyalty, dairy and packaged goods have traditionally maintained healthy profit margins. However, factors such as input prices, supply chain efficiency, and pricing dynamics can all have an impact on profitability. India intends to become a global food processing powerhouse in order to obtain a competitive advantage in the global food market. To achieve this goal, India plans to enhance its enablers, which can help and expedite the country's food processing industry. One of the primary enablers is financing agrifood value chains. One of India's top priorities is to provide suitable and affordable financing to the food processing sector, particularly to micro, small, and medium enterprises (MSMEs), which account for a substantial amount of the sector.

3. Investment in R&D: Leading companies within the food processing industry have been investing in research and development to innovate and cater to evolving consumer preferences. Product innovation, cost optimization, and process improvements contribute to financial sustainability. The Pradhan Mantri Kisan Sampada Yojana, The Ministry of Food Processing Industries has provided financial assistance to undertake demand-driven R&D work for the benefit of the food processing industry in terms of product and process development, efficient technologies, improved packaging, value addition, and so on, with commercial value, as well as standardization of various factors such as additives, coloring agents, preservatives, pesticide residues, chemical contaminants, microbiological contaminants, and naturally occurring contaminants.

Investment Trends

The Indian food processing industry has been attracting significant investments from both domestic and foreign players:

1. Foreign Direct Investment (FDI): Government initiatives such as "Make in India" and relaxed FDI norms have facilitated increased foreign investment in the sector. Global food processing giants have shown interest in tapping into the Indian market, given its vast consumer base and growth potential.

2. Joint Ventures and Collaborations: To obtain insights into the Indian industry and create a firm footing, several foreign food corporations are forming partnerships with local players. These collaborations also allow for knowledge sharing and technology transfer.

3. Modernization and Expansion: As capital becomes more readily available, several Indian food processing enterprises are focusing on renovating existing facilities, upgrading technology, and expanding production capacities. This not only improves efficiency but also meets rising demand.

Key Challenges:

The Indian food processing industry faces several financial challenges:

1. Infrastructure Gaps: Inadequate cold storage facilities, transportation infrastructure, and inefficiencies in the supply chain all contribute to post-harvest losses, threatening the industry's financial viability.

2. ***Regulatory complexity:*** Complying with complicated regulatory requirements for food safety standards, labeling, and certifications can result in compliance expenses and operational complexity, particularly for smaller businesses.

3. Access to Finance: Small and medium-sized enterprises (SMEs) often struggle to secure affordable financing for modernization, expansion, and technology adoption. This hampers their growth potential.

4. Skilled Manpower: The industry requires skilled personnel across various functions, from food technology to quality control. The scarcity of skilled manpower can lead to increased training costs and inefficiencies.

Government Initiatives

To address these challenges and stimulate growth, the Indian government has launched various initiatives:

1. Pradhan Mantri Kisan Sampada Yojana*:* This scheme aims to develop food processing infrastructure and reduce post-harvest losses. Financial assistance for setting up modern units, cold storage, and logistics facilities enhances the industry's financial viability.

2. Ease of Doing Business: The government's efforts to simplify regulations and provide a conducive business environment contribute to attracting both domestic and foreign investments.

Future Outlook

The future prospects for the Indian food processing industry are optimistic:

1. Demand Growth: As the population continues to grow and urbanize, the demand for processed and packaged foods is expected to escalate. Changing dietary preferences and the need for convenience foods will contribute to sustained demand.

2. Exports: The variety of agricultural products produced in India provides great export possibilities. Exports are projected to contribute to foreign exchange earnings as the business complies to global quality requirements.

3. Health and Wellness Trend: As people adopt healthier eating habits, there is a greater demand for organic and fortified foods, which opens up chances for product diversity and innovation.

4. Technology Adoption: The adoption of advanced technologies, such as food processing machinery, automation, and quality control systems, will enhance operational efficiency and financial viability.

Conclusion

The Indian food processing industry stands as a vital contributor to the nation's economic growth. Its financial performance is marked by revenue growth, profitability variations, and strategic investments. Despite infrastructure, regulatory, and finance hurdles, the industry is positioned for expansion, driven by rising demand, government backing, and technological breakthroughs. To attain its full potential, the industry must solve these obstacles through joint efforts among government, enterprises, and stakeholders. To fully realize its potential, the industry needs to address these challenges through collaborative efforts between government, businesses, and stakeholders. The industry's financial health is intricately linked to its ability to innovate, adapt, and meet the evolving needs of a diverse consumer base.

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LATEST TECHNOLOGY OF FISH PRODUCTION: RECIRCULATION AQUACULTURE SYSTEM (RAS)

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Abstract
Recirculation System (RAS) is a new approach to fish farming. Instead of the traditional method of outdoor fish farming in open ponds, fish are raised in tanks with a 'controlled' environment at high density. The fish in the recirculation system filter and clean the tank water through recycling. Fresh water is used to compensate for water loss due to evaporation in the fish tank and thereby wash away waste material. Optimum growth of fish in a RAS system requires a constant supply of clean water, temperature and dissolved oxygen.

Introduction
Fisheries as a tool to fight poverty and reduce inequality have attracted renewed attention in recent years. Worldwide, more than 30 million fishers and fish farmers and their families derive their livelihood from fisheries Global fish production at an average annual rate of 3.2% of food fish supplies over the past five decades while world population growth is growing at 1.6%.

Recirculating Aquaculture (RAS)
Recirculating aquaculture (RAS) is a system in which aquatic organisms are cultured in water. RAS is usually a highly intensive and closed field fish production system.

in which the company has demonstrated very high production levels of many important species abroad with minimal water use and waste disposal. RAS is a tank-based system in which fish can be reared at high densities under controlled environmental conditions. Aquaculture System (RAS) is operated by filtering the water of the fish tanks so that it Not to be used.

- Expensive land, especially where good water is available
- Greater control over waste and treatment
- Nature allows cultivation of aquatic organisms outside the boundary
- Minimum land requirement
- The risk of contamination is low
- Land and water are conserved
- Independent from adverse weather conditions¬

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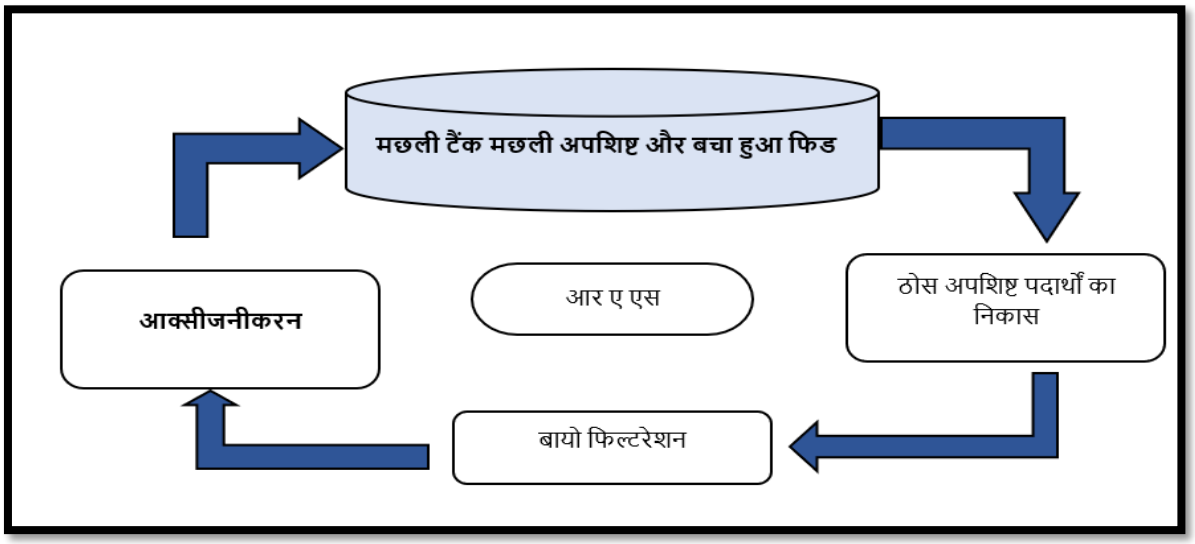

RAS Fish Farming Fish Tank

The tanks for aquaculture fish farming in these systems can be of any shape, such as rectangular, circular, etc. Mostly circular tanks are preferred as they are easy to clean and facilitate easy water circulation. Depends on factors like water requirement and quality. The tank should be built in such a way that it is compatible with the other components of the system. The material required to make the tank can be metal, wood, glass, rubber, concrete or plastic. The inner surface of the tank should be clean and smooth. Each material used for this purpose has its own advantages and disadvantages. Most modern tanks are constructed with vents that have the best waste removal capability and are fitted with suitable mesh screens. These vents also make it easier to dislodge dead fish. Some tanks are also fitted with sensors to detect water level, oxygen, temperature, etc. to automatically control which oxygen is sufficient. The supply tank should also have a diffuser.

RAS fish farming mechanical filter

A practical method of removing waste from a fish tank is possible through mechanical filtration. Modern recirculating systems have an outlet filter with a micron screen of 40 to 100 µm mesh size. The presence of the microscreen has some advantages such as it acts as a biofilter to overload, bioimpurities, improve or facilitate the bioremediation process. Filters the elements present in the water. The solid waste is removed to the sludge tray by spraying water on the filter. Sludge is removed from the tank along with water and sent for external waste treatment.

RAS Pisciculture Biological Filters

It is the most important component of RAS as it helps to remove fine contaminants from the water during wastewater treatment. The media within the filter is made of materials such as plastic sheet, lava rock or sand grains. The properties of the media should be such that it should have high surface area, area for bacterial growth, pores for water circulation, Should be clogging resistant and easy to clean. The size of the biofilter depends on the carrying capacity of the fish. The surface area of the filter should be large enough to accommodate the high density bacteria that can help process the waste in the fish tank. There are two major categories of biofilters:

Submerged Bed Filters - They require aeration before and after the water passes through them.

Emerged Bed Filter - This filter has a continuous supply of oxygen and is of two types:

- Trickling Filter
- Rotating Biological Contractors

Biofiltration can work effectively even when the minimum water temperature and pH level are properly controlled. The minimum water temperature should be between 10 to 35 degree centigrade and the pH should be around 7 to 8.

- Fish species suitable for RAS
- Barramundi / Asian Seabass / Bhetki
- Cobia
- Silver / Indianpompano
- Tilapia Pearlspot / Karimeen
- Pangasius
- Rainbowtrout

Fish food

Fish should be fed to increase the yield of the fish. Fish take oxygen for protein synthesis and produce carbon dioxide and ammonia as waste. So in recirculating aquaculture system, fishes should be fed dry food to avoid pollution and disease in the tank, designing recirculating aquaculture system. The feed conversion rate should be carefully estimated before use and only suitable feed should be given to save money and unnecessary filter charges.

Fish stock management in RAS fisheries

While it is important to keep fish production commensurate with the capacity of a recirculation aquaculture system, several techniques are used to avoid overloading the system with heavy stock densities:

Feeds fingerlings in the quarantine tank before introducing them to the aquaculture tank.
Fingerlings must be kept in a quarantine tank for 3 to 6 weeks to be examined and treated for any disease or infection.
Benefits associated with RAS fisheries
RAS offers a number of advantages over traditional techniques, such as:
Max Output
Low water and soil requirement
Full control of environmental parameters
Easy Growth and Harvest
Effective disease control
less pollution

Conclusion

ARAS is emerging at a good time to meet market demand for fish and the changing needs of land-based farming operations. Recirculation aquaculture systems are the key to the future of aquaculture. This system makes sustainable use of water resources in places where good quality water is scarce. past is too much.

But the scope of RAS is very large in aquaculture. It is eco-friendly in the system, controls the production, and can meet the supply according to the market demand conditions. Besides this, recirculation aquaculture system causes environmental pollution, therefore, in India, there is a need for circular aquaculture to increase fish production and farmers' income. The use of tika can prove to be a boon.

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YEAST IN AGRICULTURE: UNLOCKING ITS POTENTIAL AS A BIOCONTROL AGENT AND BEYOND

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Abstract
Yeasts are single-celled fungi known for wide-ranging applications and significant impacts on various aspects of our lives. From their role in fermentation and food production to their potential as biocontrol agents and contributions to scientific research, yeasts play diverse roles in agriculture. The diverse characteristics and functions of yeasts, including their ecological significance, applications in agriculture and potential as biocontrol agents are being explored nowadays for their beneficial roles in agriculture. Yeasts offer sustainable solutions for pest management, contribute to nutrient cycling and promote soil health. Their antagonistic properties against plant pathogens and ability to induce systemic resistance make them valuable in integrated pest management strategies. Furthermore, yeasts' involvement in biotechnology and fermentation processes enriches agricultural practices and presents innovative opportunities for sustainable agriculture.

Yeasts are single-celled versatile organisms belonging to the kingdom Fungi with wide-ranging applications. They are microscopic organisms that play significant roles in various aspects of our lives, ranging from food and beverage production to scientific research. From their role in fermentation and food production to their potential as biocontrol agents and contributions to scientific research, yeasts have a significant impact on various aspects of our lives. Their diverse characteristics and functions continue to be explored and utilized in different fields, making them a fascinating group of organisms. Yeasts encompass a diverse group of species, with over 1,500 identified so far. The most well-known and extensively studied yeast species is *Saccharomyces cerevisiae*, commonly known as baker's yeast or brewer's yeast. They play a vital role in the food and beverage industry and are used as leavening agents in baking, where they produce carbon dioxide gas, leading to dough rising. Yeasts are renowned for their ability to undergo fermentation, a metabolic process in which they convert sugars into alcohol and carbon dioxide. This process is widely utilized in the production of bread and alcoholic beverages. In wine making, yeast ferments grape sugars into alcohol, contributing to the production of wine. Yeasts, particularly *Saccharomyces cerevisiae*, have been extensively studied in scientific research. Their simple cellular structure and ease of manipulation have made them a model organism for studying various biological processes. Yeasts are also used in biotechnology for the production of enzymes, pharmaceuticals and industrial chemicals. Some yeast strains have been studied for their potential health benefits when used as probiotics. They may aid in digestive health, immune function and nutrient absorption. Probiotic yeast formulations are used in dietary supplements and functional foods.

Yeasts in Agriculture

Yeasts have ecological significance and are found in various natural environments, including soil, plants and aquatic habitats. It is important to note that the specific applications and benefits of

yeast in agriculture may vary depending on the context, crop or livestock species involved. Proper strain selection, application methods and understanding of ecological interactions are crucial for maximizing the positive contributions of yeast in agricultural practices. They contribute to nutrient cycling, decomposition and the breakdown of organic matter in ecosystems. Yeast plays a significant role in various agricultural processes and has several sustainable ecosystem benefits in the field. They play a major role in the process of nutrient cycling and contribute to the breakdown and decomposition of plant residues and facilitate the release of nutrients back into the soil. This process is crucial for nutrient recycling and maintaining soil fertility in agricultural systems. Furthermore, yeast is extensively used in biotechnology for the production of enzymes, pharmaceuticals, and industrial chemicals. Yeast can contribute to soil health through their interactions with plant roots. They can form beneficial associations with roots, such as arbuscular mycorrhizal symbiosis, enhancing nutrient uptake and promoting soil structure and water-holding capacity.

In cattle rearing, specific strains of yeast are used as probiotics to improve animal health and performance. Yeast-based probiotics can enhance digestive efficiency, support the development of a healthy gut microbiota and improve nutrient absorption in livestock. This can lead to better feed conversion, improved growth rates and reduced incidence of digestive disorders. Yeasts have the ability to degrade and detoxify certain pollutants and contaminants in the environment. They can be employed in bioremediation processes to break down organic pollutants, such as hydrocarbons, pesticides and industrial waste. Yeasts have been used in soil and water remediation projects to mitigate the negative impacts of pollutants on agricultural ecosystems. Few of the yeast strains are rich source of vitamins, minerals and proteins. They can be used as feed supplements for livestock to enhance their nutritional intake and overall health. Additionally, yeast extracts are utilized as nutrient supplements in plant fertilizers to provide essential nutrients and promote plant growth.

Yeast as a biocontrol agent

Nowadays, finding sustainable and environmentally friendly solutions for pest management is of paramount importance. Yeast, known for its fermentation capabilities, is now being recognized for its multifaceted role as a biocontrol agent and beyond. Traditional chemical pesticides have been widely used but are often associated with ecological risks and detrimental effects on human health. In recent years, there has been a growing interest in harnessing the potential of biological control agents, such as yeast, to combat pests and diseases in agriculture.

Certain yeast species have biocontrol properties and are utilized as natural alternatives to chemical pesticides. They can suppress the growth of plant pathogens, such as fungi and bacteria, by producing antimicrobial compounds and competing for nutrients. This makes them valuable in sustainable agriculture practices. Yeast species, such as *Saccharomyces cerevisiae* and *Candida oleophila*, have biocontrol properties and can be used as natural alternatives to chemical pesticides. These yeasts can inhibit the growth and activity of plant pathogens and protect crops from diseases by competing for nutrients, thereby limiting the establishment of pathogens. This natural biocontrol mechanism can help reduce crop diseases without the need for chemical interventions. Yeast can also stimulate the natural defence mechanisms of crops by inducing systemic resistance. When plants are treated with specific yeast strains, they activate their own immune responses, making them more resistant to pathogenic attacks. This priming effect can

enhance plant health and reduce disease incidence. Competence of yeasts with pathogens for nutrients and space contributes to its biocontrol efficacy. By colonizing the plant surface and forming a protective barrier, yeast strains can prevent pathogenic organisms from establishing themselves, thereby reducing the risk of infection.

Yeast, primarily known for its role in fermentation processes, is now being recognized for its immense potential as a biocontrol agent and beyond in agriculture. Its antagonistic properties, ability to induce systemic resistance and competitive exclusion mechanisms make it an effective and sustainable tool for managing plant diseases. Additionally, their contributions to nutrient cycling, fermentation and soil health further highlight its versatility and significance in agricultural systems. Unlocking the potential of yeast in agriculture not only provides environmentally friendly pest management solutions but also opens up new avenues for sustainable and innovative practices in the field. Utilizing the multifaceted role of yeast can lead us towards a more resilient, sustainable, and bio-diverse agricultural future.

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MANUKA HONEY : A MIRCALEOUS FOOD

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Abstract
Since ages past, people have been using honey primarily as a food and medicine. Because it has a calming effect when put to open wounds initially, it has been utilised for its therapeutic benefits in various cultures as a treatment for burns, cataracts, ulcers, and wound healing. Monofloral honey appears to be the most fascinating and promising type of honey in terms of potential as a natural medicine, according to classifications based on origin. Researchers have paid close attention to manuka honey, a monofloral honey made from the Leptospermum scoparium manuka tree, because of its biological features, particularly its antioxidant and antibacterial properties. The article examines the chemical components of manuka honey as well as its numerous significant nutritional and health advantages. First, the chemical components of manuka honey is explained, paying close attention to its polyphenolic component and other beneficial chemicals like glyoxal and methylglyoxal. Then, manuka honey's role in the treatment of wounds is discussed, along with its antioxidant activity and other significant biological benefits.

Keywords : Manuka honey, Antimicrobial, Antioxidant, Phenolic components

Introduction

Honey is a naturally acquired sweet and tasty food that is utilised for its high nutritional content and for it's beneficial assists on human health (Alvarez-Suarez *et al*., 2013). Honey has anti-inflammatory, antibacterial, anti-oxidant, and antimicrobial characteristics, as well as the ability to heal wounds and sunburns. According to many research studies, the antioxidant potential of honey is strongly correlated not only with the amount of total phenolics present, but also with the colour, with dark coloured honeys reportedly having higher total phenolic contents resulting in higher antioxidant capacities (Alvarez-Suarez et al., 2010 ; Alvarez-Suarez *et al*., 2012).

Honey can be grouped into the following groups based on its origin: Honey generally falls into four different groups: (1) blossom honey, which is primarily derived from flower nectar (as contrasted with honeydew honey); (2) the honeydew honey, which is generated by bees after they gather "honeydew" (secretions of Rhynchota insects), which permeate plant cells, ingest plant sap, and then emit it once more: (3) monofloral honey, which is named after the plant that the bees primarily forage on; and (4) multifloral honey (also known as polyfloral) that has several botanical sources, none of which is predominant, e.g., meadow blossom honey and forest honey (Kato *et al*., 2012). Many of the medicinal characteristics of plants may be communicated through honey, according to a theory, hence Fearnley honey may be employed as a carrier for those properties. Manuka honey, a black honey from the monofloral honey family, has captured the interest of the scientific community throughout the world due to its biological characteristics, particularly its antibacterial and antioxidant properties. This honey is produced by the Myrtaceae family's

Leptospermum scoparium manuka tree, which is found in eastern Australia and New Zealand and grows as a shrub or small tree.

Different man tree extracts are employed in traditional medicine as tranquillizers and wound-healing treatments. Likewise, manuka honey has been used for many years to treat infections such as abscesses, surgical injuries, traumatic wounds, burns, and ulcers of various origins. The primary bioactive components in manuka honey as well as the processes behind their biological actions are the subject of ongoing studies. These investigations could help to increase the use of manuka honey in skin care and serve as a foundation for the extraction and purification of chemicals for the creation of biopharmaceutical products with antibacterial and wound-healing characteristics.

Chemical components

Flavonoids may serve as a reliable botanical identifier for honey (Tomas-Barberan *et al*., 1993) given that their antioxidant activity is directly related to their polyphenolic characterisation, which has been shown to be acceptable for differentiating the floral source of honey (Anklam 1998). The primary flavonoids in manuka honey have been identified as pinobanksin, pinocembrin, and chrysin, with small concentrations of luteolin, quercetin, 8-methoxykaempferol, isorhamnetin, kaempferol, and galangin (Yaoa *et al*., 2005; Chan *et al*., 2013; Oelschalaegel *et al*., 2012). The manuka honey's myeloperoxidase (MPO)-activity exclusion is attributed to methyl syringate (MSYR) and leptosin (the new glycoside of MSYR, methyl syringate 4-O-d-gentiobiose). Although the glycoside's biological functions and biosynthetic route/origin are yet unclear, it might be a reliable chemical indicator of the manuka honey's quality.

Health Benefits of Manuka honey

Since ancient times, the value of honey in the context of wound care has been widely recognised. This healing quality is linked to honey's antioxidant and antibacterial activity, which keeps the wound moist, and to the substance's high viscosity, which forms a barrier around the wound to shield it from infection-causing microbes. A twofold impact on the inflammatory reaction can be used to explain why the healing time decreased following honey treatment. First, honey suppresses the growth and spread of inflammatory cells at the site of the wound, preventing a protracted inflammatory response; second, it promotes the synthesis of pro-inflammatory cytokines, promoting normal healing (Tomblin *et al*., 2014) and the growth of the fibroblasts and epithelial cells that line the wound. Additionally, compared to SSD or hydrofiber silver treatment, honey application reduces the size of the burn lesion, has an antimicrobial impact, and fosters better re-epithelialization. Additionally, honey's anti-inflammatory properties reduce damage wrought by free radicals produced as a result of inflammation, stopping any additional necrosis.

In addition to the various phenolic compounds that have been found as having a strong capacity to decrease free radicals, manuka honey also includes a high number of phenolic compounds (Tuberoso *et al*., 2009; Stephens *et al*., 2010), offering a significant antioxidant capacity (Moniruzzaman *et al*., 2013; Jubri *et al*., 2013). When compared, for instance, to the acacia, wild carrot, and Portobello honeys (Alzahrani *et al*., 2012; Schneider *et al*., 2013), which were sourced, correspondingly, throughout Germany, Algeria, Saudi Arabia, and Scotland, Manuka honey actually displays the highest values with regard to of polyphenol content and antioxidant properties. Malaysian monofloral honeys (Moniruzzaman *et al*., 2013) and Tualang honey, a

multifloral jungle honey from Malaysia (Khalil *et al*., 2011) both produced similar results. Electronic paramagnetic resonance has also been used to study the scavenger function of manuka honey towards superoxide anion radicals (Henriques *et al*., 2012; Inoue *et al*., 2005). The findings supported the theory that methyl syringate is responsible for the quenching effects of manuka honey (Fukuda *et al*.,2011).

Conclusion

Manuka honey has an enormous amount of different components in minor and trace concentrations in addition to its major ingredients. These additional constituents have a variety of biological and nutritional effects, such as antioxidant and antibacterial properties. According to the aforementioned data, manuka honey has proven beneficial in treating a variety of health issues and reducing bacterial development in laboratory and clinical studies. The simplicity of application in the treatment of wounds and the lack of antibiotic resistance, that is present when using traditional antibiotics, are crucial properties for the application of this honey in the therapy of clinical wounds.

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MUD CRAB FARMING

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Introduction

One of the most expensive crustaceans on the domestic and international markets is mud crab. They are hardy and can survive prolonged periods of time without water at lower temperatures making them ideal species for live export to other countries and the domestic market. There are four species of mud crab, *Scylla serrata*, *S. tranquebarica*, *S. paramamosain* and *S. olivacea* are popular for commercial fisheries and aquaculture production globally. *Scylla serrata*, commonly known as the Mud crab, Green crab or Mangrove crab is an economically important species of crab found in the estuarines and mangroves of India. Due to its high demand/price, rich flesh content, and quick growth rates in captivity, this species has generated a lot of interest in aquaculture. It is in great demand on the global market, especially in South East Asian nations, making it a possible candidate species for commercial-scale aquaculture. One of the most delicious varieties of crab is this seafood delicacy. This is marketed primarily in live markets abroad and is accessible everywhere. This species is heavily exploited throughout India's coastal region. Mud crab farming began in India in the early 1980s, and today crab culture is growing quickly in the states of Andhra Pradesh, Kerala, West Bengal, and Odisha.

Fig. 1: Mud Crab

Culture methods

1. Grow out culture

In this method, crabs are grown for a period of 5 to 6 months till they attain desirable size. It is generally pond based, with or without mangroves. The pond size varies between 0.5-2 ha, with proper bunds and tidal water exchange. The stocking rates are commonly between 1-3 crabs/m^2, with supplementary feeding. Feeding is usually with trash fish, along with other locally available items.

2. Fattening

In this method soft shelled crabs are reared for a period of a few weeks till their exoskeleton gets hardened. These 'hard' crabs are locally known as "mud" and fetch three to four times better price than the soft crabs.

a. Fattening in ponds

Fattening can be done in small tidal ponds between 0.025-0.2 ha with a water depth of 1 to 1.5 m. Before stocking the soft crabs in the pond, the bottom is prepared by draining the pond water, sun-drying and adding sufficient quantity of lime.

b. Fattening in pens and cages

Fattening also can be carried out in pens, floating net cages or bamboo cages in shallow estuarine waterways and inside large shrimp ponds with good tidal water influx. The size of the cage shall be preferably 3 m x 2 m x 1 m. The cages have to be arranged in a row so that feeding and monitoring can be easily carried out. A stocking of 10 crab/m^2 in cages and 5 crabs/m^2 for pens is recommended. However, these methods are not commercialized like `fattening' in ponds

Fig. 2: Mud Crab Farm

Site selection for crab farming

Site selection is an important process in farming as it decides the success or failure of the mud crab farming**.** Already constructed aquaculture farms along with abandoned shrimp farms are suitable areas for crab farming. Initial stage reservoirs of saltpans can be used for mud crab farming without affecting the saltpan environment. Some other parameter like weather, depth, legal aspects, land based facilities, security and water quality conditions should be addressed for site selection for crab farming.

Ideal water quality parameter for crab farming

For crab farming maintaining water quality parameters is very important for successful culture. The most desirable range of water quality is given below

Parameters	Range
Water salinity	15-30 ppt
Water temperature	23-32 °C
pH	8-8.5
Water depth	≥80 cm
Dissolved oxygen	≥4 ppm

Ideal soil for crab farming

Silty - clay, clay loam or clayey soil with enough layer of clean mud is appropriate. This kind of soil can respond well to the biological requirements of mud crabs while moulting or in their post moult soft stage or while feeding It is also the kind of soil that can retain desirable water depth for mud crabs.

Stocking

Stocking should be done with seeds having intact appendages, and without injury, and further seeds should be at uniform size. Differential size leads to cannibalism. Seeds should be stoked when water temperature is low; early morning or late evening preferably night. Stocking density in crab culture is generally far less than the shrimp farming. The stocking density has a major effect on crab growth, survival and production, and it is generally ranged between 0.5 and 3 crabs/m^2.

Feeding

Despite the growing interest of crab aquaculture, formulated diets for grow-out mud crabs have yet to be available. Management of fwd is the most crucial element for successful aquaculture as feed is the major input of crustacean aquaculture. The reared crabs are fed once in a day preferably in the late evening either with trash fish or molluscan meat at a rate of 5 to 10% of their body weight.

Common diseases of mud crab in India

Disease Name	Causative Agent	Clinical Symptoms
Viral Diseases		
White spot syndrome	White spot syndrome virus	Characterized by spherical to ovoid shaped white spot on the inner side of carapace
Bacterial Diseases		
Bacterial necrosis	*Vibrio spp., Pseudomonas spp., Aeromonas spp.* and *Spirillium spp.*	Characterized by break down of chitin of the exoskeleton, leading to erosion and melanization (dark brown to black pigmentation)
Filamentous bacterial disease	*Leucothrix mucor*, *Thriothrix spp.,*and *Flexibacter spp.*	Characterized by poor feeding and growth, discolouration of

Disease Name	Causative Agent	Clinical Symptoms
		gills and associated secondary infections
Luminescent bacterial disease	*Vibrio harveyi*	Characterized by loss of appetite, reduced growth, dark hepatopancreas and mortality in large numbers
Fungal Disease		
Egg loss in berried female	*Haliphthoros* spp.	Characterized by destruction and loss of egg
Larval mycosis	*Fusarium* spp., *Lagenidium* spp. and *Sirolpidium* spp.,	Characterized by locomotory difficulties due to mycelial growth and In serious infections extensive non-septate highly branched mycelia invade throughout the body
Parasite Disease		
Bitter crab disease	*Hematodinium* sp	Characterized by opaquely discoloured carapace, cooked appearance, milky body fl uid, unpalatable fl avour and high mortality

Harvesting

The harvesting of crab can be effectively done in tide feed ponds by letting in water through the sluice into the pond during high tide. As the water flushes in, crab tend to swim against the incoming water and congregate near the sluice gate and they can be caught with the help of scoop net. The crabs are partially harvested by baited lift nets and bamboo cages. Complete harvest can be done by scoop net at sluice gate and also by hand picking at low water level. The expected survival rate would be 70 to 80%.

Packing

First pair of largest leg with chelate leg of each live crab should be firmly tied up with the body by nylon thread to curb there movement and to avoid fighting among them. After Wet seaweeds are kept in between the packed layers of crab to enhance their moist and cool condition during the transport from place to place for local consumption. The tired up crab are washed with fresh seawater and packed either in bamboo basket or in perforated thermocole box.

Marketing

Crab is generally sold in live condition for both local consumption and live crab export trade. For the marketing purpose mud crab are graded as extra large (1kg and above), large (500g to 1kg), medium (300 to 500g) and small (200-300g). the mature and berried female crab are usually sold for higher price. The meaty crab weighing above 300g are considered for live export, while the under size crab (less than 300g) and crab which have lost their limbs are sold at local market. They are marketed only in live condition, as there is an aversion among the consumers for dead crab.

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OOHO: THE EDIBLE WATER BUBBLE - AN ECO-FRIENDLY ALTERNATIVE TO PLASTIC PACKAGING

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Introduction

Over 430 million tonnes of plastic are manufactured each year, yet only about two-thirds of it is used once before being destroyed. On top of the 200 million metric tonnes of plastic that are now thought to be moving through our marine habitats, research from the Ocean Conservatory estimates that 11 million metric tonnes of plastic enter our ocean every year. There is plastic everywhere around us. It may come in a variety of shapes, from plastic water bottles and trash bags to synthetic fishing nets. In order to achieve UNEP's ambitious objective of an 80% decrease in plastic waste over the next two decades, the first and most important step is to eliminate unneeded common plastics, particularly excessive packaging, according to the "Turning off the Tap" study from UNEP. The study recommends adopting practices like recycling more effectively, switching to more ecologically friendly options, and reusing refillable bottles.

The utilization of biodegradable packaging plays a significant role in promoting a cleaner environment by minimizing the accumulation of packaging waste. In recent times, there has been notable progress in the development of natural polymers specifically designed for packaging purposes, effectively reducing the adverse impact of pollution caused by traditional packaging materials. Also, there is an emerging solution of plastic pollution towards biodegradable water packaging which greatly benefit from the utilization of composite materials derived from bio-based raw materials. Among these materials, alginates hold significant importance in the development of biodegradable packaging. The cell wall of brown algae is a popular source of alginate, and alginate is extracted from seaweed for a variety of uses(Braihi*et al*., 2020) Nowadays edible water is a recent eye catching invention in the field of protecting plastic pollution, it is made up byencapsulating water within a delicate and eco-friendly edible membrane (Alginate), eliminating the need for traditional packaging and reducing waste. These spheres contain "spherified" water and offer a unique way of consuming water without generating disposable waste.

More about Alginate

Various species of brown seaweed can serve as a viable source of alginate. It's important to note that the chemical structure of alginate differs among different genera of seaweed. Likewise, the properties of the extracted alginate exhibit a similar level of variability, reflecting the diverse nature of seaweed-derived alginate.

Brown seaweeds such as *Ascophyllum, Durvillaea, Ecklonia, Laminaria, Lessonia, Macrocystis*, and *Sargassum* are known to meet the mentioned criteria. They possess the ability to produce high-quality alginate that forms strong gels and yields thick aqueous solution(FAO, 2003).From 1950 to 2019, there has been a substantial growth in the global cultivation of brown seaweed. The cultivation increased from 13 megatonnes to 16.4 gigatonnes, exhibiting an average annual

growth rate of 10.9%. Notably, this growth rate surpassed the global aquaculture growth rate of 7.9% for all species during the same period, the most common two genera of brown, cold-water seaweeds are kelp (*Laminaria/Saccharina*) and wakame (*Undaria*)(Cai *et al*. 2021).

How alginate is extracted from seaweed

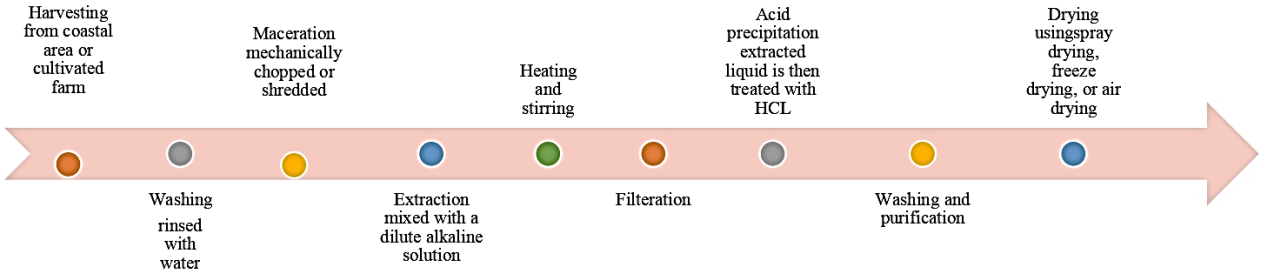

Fig. 1 Extraction of alginate from Seaweed

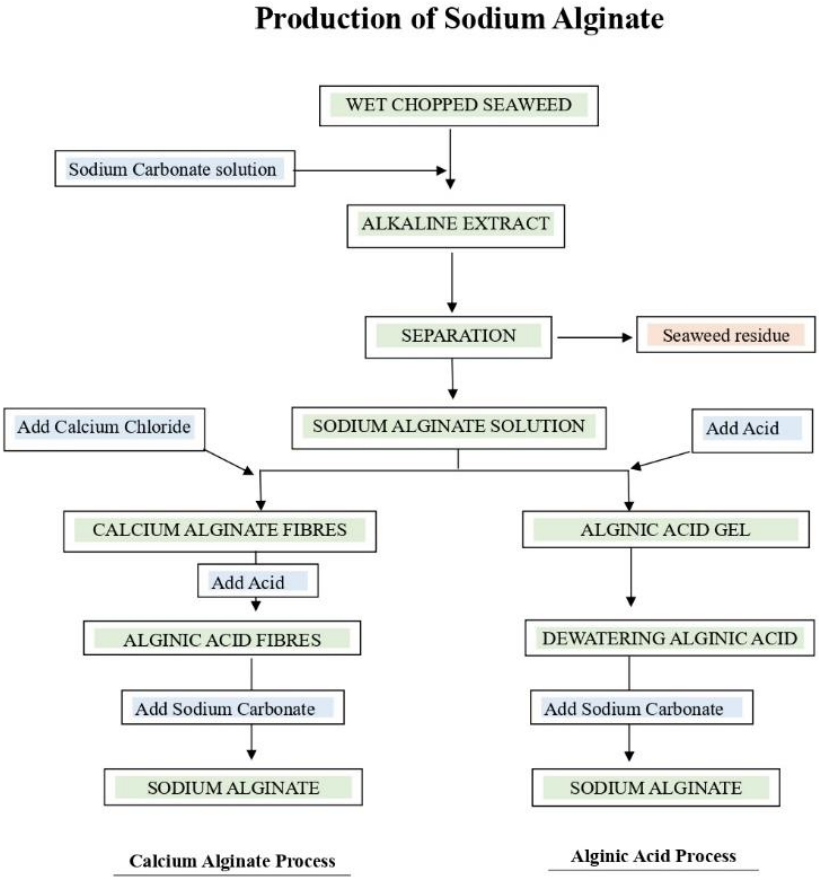

Fig. 2 Production of sodium alginate

How edible water is prepared

London-based startup Skipping Rocks Lab is paving the way for a potential future where edible water bottles become a reality. Their innovative product, Ooho, the inception of Ooho originated

from the creative minds of three design students, Rodrigo García González, Pierre-Yves Paslier, and Guillaume Couche while studying at Imperial College London in 2014. The trio successfully crafted a prototype for an edible bottle, the concept of spherification serves as the foundation for the development of edible packaging, as seen in Ooho. This culinary technique, famously used to create tapioca balls in bubble tea and simulate caviar, involves submerging an ice ball into a solution of brown algae extract and calcium chloride. Through this procedure, a thin membrane that is spherical in shape surrounds the ice, allowing it to stay intact while it melts and returns to room temperature. The membrane is made of food-grade materials, making it either edible or biodegradable, depending on personal taste. It doesn't naturally have a taste, but in the future, it could be possible to add flavours to Ooho to make it more palatable (OOHOWATER ADMIN 2019).

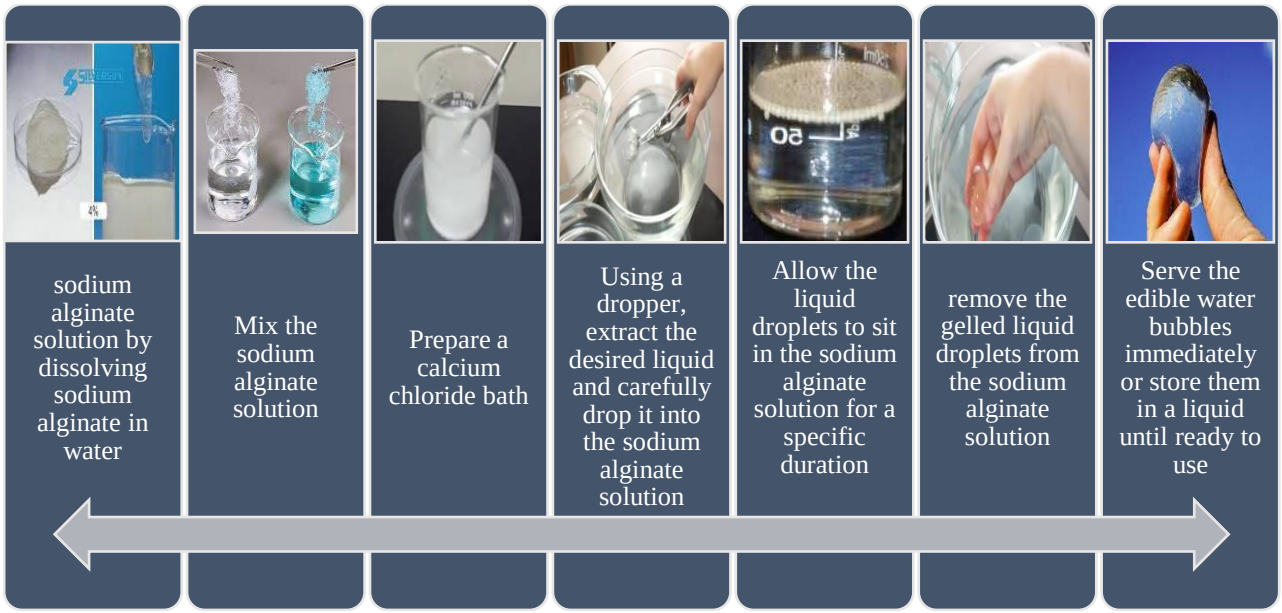

Fig. 3 Flowchart showing the preparation of edible water

Benefits of edible water OOHO

Ooho offers a significant advantage by potentially reducing the production costs associated with packaged water. The synthesis of each Ooho costs a mere 2 cents, in stark contrast to plastic-bottled water where a significant portion of expenses arise from packaging alone. By minimizing production requirements and eliminating litter.

The eatable water bubbles can be easily manufactured using readily available supplies such as sodium alginate and calcium chloride, and the water can retain its qualities after being covered with a prepared alginate cover, which can decompose after a short time when buried in the soil. Ooho presents an environmentally friendly solution. These attributes position them as a sustainable and non-toxic alternative to petroleum-based plastic packaging, making them particularly appealing to eco-conscious consumers. Consequently, water orbs have the potential to disrupt the sales of plastic packaged water and establish themselves as a more sustainable choice.

Conclusion

Seaweeds have enormous promise in a variety of businesses and can considerably advance several Sustainable Development Goals (SDGs). Food and food supplements, animal feed,

cosmetics, nutraceuticals, medicines, textiles, wastewater treatment, biofertilizers/plant enhancers, biofuels, and bioplastic packaging are just a few of the many industries in which they are used. Spherification offers the potential to drastically lower the quantity of plastic trash that builds up in landfills and seas as technology is developed, made more accessible, and wins widespread acceptance. Edible packaging may significantly reduce the negative effects of plastic pollution on the environment by providing an alternative to conventional plastic packaging. By reducing the negative effects connected with the disposal of plastic garbage, this novel solution has the potential to have a significant positive influence on our world with increasing acceptance and awareness. Even while water orbs have the potential to completely change the industry, it is doubtful that they will do so in the next five years. In areas where conventional bottles have a track record of success, such as durability, leakage, and shelf life, there are still a number of design and functioning issues that need to be resolved. More research and development efforts are required to improve the orb's membrane's physical characteristics.

Critics have also expressed concerns regarding hygiene issues associated with the unique design of water orbs. Furthermore, skepticism surrounding food safety poses a challenge to consumer acceptance. Although these consumer-related challenges can be overcome, surpassing the established legacy of bottled water at a significant scale remains a daunting task. Additionally, raising consumer awareness and addressing ergonomic issues present additional obstacles. Given these factors, while water orbs hold promise, it will require substantial efforts to overcome these barriers and establish themselves as a viable alternative to conventional bottled water.

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THE ROLE OF ANNUAL FLOWERS IN LANDSCAPING

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Introduction

Landscaping is an art form that involves transforming outdoor spaces into aesthetically pleasing and functional environments. Among the various elements that contribute to an outstanding landscape, the use of annual flowers plays a vital role. These seasonal blooms offer a plethora of benefits, making them an essential component for gardeners, landscapers, and homeowners alike. This essay explores the multifaceted role of annual flowers in landscaping, highlighting their ability to enhance beauty, provide versatility, and promote sustainability in outdoor spaces.

1. Enhancing Beauty

The most apparent role of annual flowers in landscaping is their capacity to enhance beauty and add vibrancy to outdoor spaces. Annual flowers are known for their wide array of colors, shapes, and sizes, making them versatile and easy to incorporate into any design scheme. From vibrant reds and yellows to calming blues and purples, annuals offer a kaleidoscope of hues that can transform an otherwise dull landscape into a picturesque haven.

One of the most striking features of annual flowers is their ability to bloom profusely for a single growing season. They offer an ever-changing display of colors, from delicate pastels in spring to vibrant hues in summer and autumn. This seasonal transformation adds a dynamic aspect to the landscape, capturing the attention of viewers and creating a sense of excitement.

Moreover, these blooms have the unique ability to be planted en masse, creating stunning floral displays that catch the eye from afar. Flowerbeds filled with marigolds, petunias, zinnias, or pansies create a visual spectacle that elevates the overall aesthetic appeal of the landscape.

2. Versatility in Design

Annual flowers are a landscaper's dream due to their versatility in design. Unlike perennial plants that remain in place for several years, annuals have a short life cycle, typically blooming for one growing season. This transient nature allows landscapers to experiment and refresh the design annually, adapting to changing trends, seasons, or preferences.

2.1 Container Gardening: Annual flowers are perfect for container gardening due to their relatively short

lifespan. This flexibility allows gardeners to experiment with various combinations of colors, textures, and heights within a single season, making container gardens a focal point on patios, balconies, or any small outdoor space.

2.2 Seasonal Themes : Landscapers often utilize annual flowers to create themed gardens that reflect different seasons or events. For instance, spring gardens may feature tulips and daffodils, while summer gardens burst with sunflowers and zinnias. This seasonal variation adds an ever-changing dimension to the landscape, ensuring constant visual interest.

2.3 Annual Bedding Displays : Public parks, commercial spaces, and municipal gardens frequently feature annual bedding displays, showcasing creative arrangements of flowers. Designers can use annual flowers to craft various themes, such as cottage gardens, modern landscapes, or naturalistic plantings. Whether used as borders, focal points, or as part of elaborate mixed planting schemes, the adaptability of annuals ensures they can seamlessly fit into any landscape design.

3. Long-Lasting Blooms:

While annual flowers may complete their life cycle within a single year, they reward us with prolonged and continuous blooms throughout the growing season. Unlike many perennials that have a short flowering window, annuals provide an extended period of color and fragrance, enriching the landscape with their splendor.

Their long-lasting blooms also serve as a haven for pollinators, such as bees, butterflies, and hummingbirds, supporting biodiversity and ecosystem health within the landscape.

4. Cost-Effectiveness:

In landscaping projects with budget constraints, annual flowers offer a cost-effective solution. Unlike perennial plants that require long-term investment, annuals are generally more affordable, allowing for impactful displays without breaking the bank. Their low initial cost makes them accessible to a broader range of gardeners and landscapers.

Moreover, annuals can be grown from seeds, further reducing expenses. This aspect is particularly beneficial for community gardening projects, where a sense of camaraderie and involvement is fostered while keeping costs manageable.

5. Fillers and Transition Plants:

Annual flowers play a crucial role in bridging the gap between seasonal transitions. In regions with harsh winters, perennial plants often go dormant, leaving gaps in the

landscape. Annuals can fill these voids, ensuring that the garden remains vibrant and appealing throughout the year. Similarly, they can be used to transition between different phases of the garden. For instance, during the spring-to-summer transition, annuals can provide bursts of color while perennials are still maturing.

6. Easy to Grow and Maintain:

One of the key reasons annual flowers are so popular in landscaping is their ease of cultivation and maintenance. Many annuals are hardy and tolerant, making them suitable for both beginner gardeners and seasoned horticulturists. With the right soil, water, and sunlight conditions, annuals thrive and reward the effort with abundant blooms.

Furthermore, annuals often have relatively fewer pest and disease issues compared to some perennial plants, reducing the need for extensive interventions and chemical treatments.

7. Improving Soil Health:

Incorporating annual flowers in the landscape contributes to improving soil health and fertility. As annuals grow and bloom, they draw nutrients from the soil. When the growing season ends, gardeners can choose to leave the spent plants to decompose on the soil's surface or turn them into the earth, enhancing organic matter and nutrient content.

Additionally, certain annual flowers, such as legumes like clover, have the unique ability to fix nitrogen into the soil, enriching it for other plants in the garden.

8. Supporting Sustainable Landscaping:

Annual flowers can play a vital role in promoting sustainability in landscaping practices. Firstly, the short lifespan of annuals allows for the constant reinvention of the landscape, which can foster a more dynamic and adaptable approach to gardening. This adaptability is particularly valuable in the face of climate change, enabling gardeners to experiment with drought-resistant or heat-tolerant varieties as needed.

Secondly, many annuals are well-suited for container gardening, making them an excellent option for urban landscapes and small spaces. Container gardening reduces water usage, prevents soil erosion, and limits weed growth.

Moreover, selecting native annual flowers can enhance the ecological value of the landscape. Native annuals are well-adapted to the local climate and soil conditions, requiring minimal inputs such as water and fertilizers.

9. Environmental Benefits

9.1 Pollinator Attraction: Many annual flowers are rich in nectar and pollen, attracting bees, butterflies, and other pollinators. By incorporating these plants into landscapes, we support local ecosystems and contribute to the overall health and biodiversity of the environment.

9.2 Erosion Control: The quick growth and dense foliage of certain annual flowers, such as marigolds and petunias, make them excellent choices for erosion control on slopes or disturbed areas. Their robust root systems help stabilize soil, preventing erosion and promoting vegetation growth.

9.3 Soil Health: Some annual flowers, like legumes, have nitrogen-fixing properties that improve soil fertility by enriching it with essential nutrients. When these flowers are used in rotation or

incorporated into the soil after blooming, they contribute to the long-term health and productivity of the landscape.

Conclusion

In conclusion, annual flowers play a multifaceted and indispensable role in landscaping. From enhancing beauty with their striking colors to providing versatility in design and bridging seasonal transitions, annuals have much to offer in the outdoor spaces we cherish. Their cost-effectiveness, ease of cultivation, and ability to improve soil health make them a favorite among gardeners and landscapers alike. Moreover, the use of annual flowers contributes to sustainable landscaping practices by fostering adaptability, supporting biodiversity, and reducing the environmental impact. As we continue to value the beauty and practicality of annuals, these seasonal blooms will undoubtedly continue to shape the landscapes of today and tomorrow.

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CHALLENGES AND STRATEGIES IN RESERVOIR FISHERIES MANAGEMENT: A FOCUS ON INDIA

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Introduction

A reservoir is a man-made ecosystem without analogues in nature. Although the biotope is fundamentally a synthesis of lacustrine and fluviatile systems, closer inspection reveals that it has certain distinctive characteristics of its own. The riverine and lacustrine characters coexist in reservoirs, depending on the temporal and spatial variations of certain habitat variables. For example, the lotic sector of the reservoir sustains a fluviatile biocoenosis, whereas the lentic zone and the bays harbour lentic communities. During the months of heavy inflow and outflow, the whole reservoir mimics a lotic environment whereas in summer, when the inflow into and outflow from the reservoir dwindle, a more or less lentic condition prevails in most parts of it. Another unique feature of reservoirs that makes them distinctly different from their natural counterparts is the water renewal pattern marked by swift changes in levels, inflow, and outflow.

The ecology of reservoirs is radically different from that of the Parent Rivers. Dams alter river hydrology both up and downstream of the river. The obstruction of river flow and the consequent inundation trigger off the sudden transformation of a lotic environment into a lentic one. The riverine community is subjected to changes akin to the secondary community succession. A number of organisms perish, some migrate to more hospitable environments, and the more hardy ones adapt themselves to the changed habitat. There is usually an initial spurt of plankton and benthic communities due to the increased availability of nutrients released from the decay of submerged vegetation.

The need for reservoir fishery management

The goals of reservoir fisheries management are to maintain a steady-state fish harvest at a level that is close to the reservoir's maximum productivity while also increasing production. The three main kinds of management techniques for reducing fish population fluctuations and boosting production are as follows. They are the modification of ecosystems, the control and regulation of fisheries, and the management of fish populations and their food sources. The changing patterns of fish populations in reservoirs, such as the dynamics of fish populations, the number of fish in stocks and their biomass, and the maximum yield that the reservoirs could support, must be understood in order to meet management objectives.

Reservoir fisheries management in India

The present low level of fish production in Indian reservoirs can be attributed to inadequate management inasmuch as many of them have high propensities of production from a limno-chemical point of view. In many of the reservoirs, the high rate of primary and secondary productivity is not channeled to fish production. Insufficient understanding of the reservoir ecosystem often comes in the way of adopting effective management measures.

Table-01. Present and potential production from reservoirs of India

Category	Yield (kg ha^{-1})	Area (ha)	Present Production	Potential Production
Small	49.90	1 485 557	74 129	148 556
Medium	12.30	527 541	6 488	39 565
Large	11.43	1 140 268	13 033	57 013
Total	**73.63**	**3 153 366**	**93 650**	**245 134**

Since fish production from reservoirs is essentially extractive in nature, the essence of management strategy lies in the exploitation of natural stocks. Nevertheless, ecosystem management provides different degrees of freedom for stock manipulations, depending on the size and class of the water body. One of the possible criteria that can be used to differentiate between capture and culture fisheries is the extent of human intervention in ecosystem management. While aquaculture systems provide maximum avenues for man to monitor and change the habitat variables and the biotic communities at will, this freedom attenuates as we proceed from aquaculture to culture-based and capture fisheries. In a large water body, managed on capture fishery norms, there is little room for altering the habitat variables, and the scope for effecting change in biotic communities is limited to stocking and ranching, which have uncertain chances of success. Various management processes involved in reservoir fisheries are the following:

Environmental Management

A conducive habitat for primary producer organisms to flourish and produce carbon at a high rate, and maintain the habitat at an optimal level to suit the life-cycle of all organisms including fishes. Eco-degradation of reservoirs has been on the increase due to the rapid pace of industrialization, poor environment management in the catchment, and a variety of other factors. Apart from the direct entry of industrial, municipal such as chemical plants, textile mills, Heavy engineering plants, paper mills, iron, and steel factories are often dumped into the reservoirs causing hazards. It also hampers recruitment by destroying the breeding grounds and retards the overall productivity of the ecosystem**.**

Fish stock monitoring

This is primarily due to stock monitoring/management measures. It is essential to ensure that the stocked fishes grow to maturity and breed naturally and that the juvenile achieves the desired level of survival so that natural recruitment takes place. Steps needed are:- Protection of brood stock, Protection of breeding grounds, Protection of feeding ground of juveniles, and Enforcement of mess regulations to prevent catching of young ones.

Fig. 1 : Fish stocking in reservoir

Stocking

Inducting fast-growing extraneous species into the ecosystem to colonize diverse niches is a necessary prerequisite of reservoir management. Since one of the primary aims of stocking is to ensure the utilization of the enhanced food reserves, the ideal time to stock new species is the period of the trophic burst. Any lapse in this important management measure causes the proliferation

of trash fish by taking advantage of the increased availability of fish food organisms, which in turn, may provide a forage base for catfishes. Nagarjunasagar, Tungabhadra, Hirakud, and a number of other large reservoirs in India are examples where the minnows, catfishes, murrels, and other uneconomic fishes gained grounds in the early years, leading to the establishment of long food chains. These reservoirs harbour good-standing crops of plankton and benthos, which are not reflected in the fish output. Even intensive stocking at a later stage has failed to reverse the situation.

Since large and medium reservoirs are to be developed on the principles of capture fisheries, it is desirable to stock the species that may breed and ultimately get naturalized in the system through auto-stocking. This is imperative to meet the long-term objective of obtaining a sustained yield rate. The most important objective of stocking, i.e., to augment the yield, can be achieved only if the stocked fishes survive, grow, and get caught in the fishing gear. This is achieved, to a large extent, in small reservoirs where the management centers round the stocking and recapture system. However, in larger water bodies, the recapture is uncertain on account of many reasons as mentioned earlier.

Impact of stocking in medium and large reservoirs

Experience in a number of medium and large reservoirs prompts us to conclude that the stocking program can be termed as successful, only when the stocked fishes breed in the reservoir and contribute towards autostocking. In many cases, despite persistent stocking, the transplanted species did not show up in the catch, thereby rendering the expenditure incurred in stocking as waste. Only in a few instances, the resources mobilized for stocking operations were compensated by the generation of income through the recapture of the stocked fish.

Impact of stocking in small reservoirs

In sharp contrast to the large and medium reservoirs, stocking has been more effective in improving the yield from small reservoirs as success in the management of small reservoirs depends more on recapturing the stocked fish rather than on their building up a breeding population. The smaller water bodies have the advantage of easy stock monitoring and manipulation. Thus, the smaller the reservoirs, the better the chances of success in the stock and recapture process. In fact, an imaginative stocking and harvesting schedule is the main theme of fisheries management in small, shallow reservoirs. The basic tenets of such a system involve the Selection of the right species, depending on the fish food resources available in the system. Determination of a stocking density on the basis of production potential, growth, and mortality rates. Proper stocking and harvesting schedule including staggered stocking and harvesting, allowing maximum grow-out period, taking into account the critical water levels.

Removal of predators and weed fishes

The presence of predatory and weed fishes poses impediments to the survival and growth of economic species in many Indian reservoirs. Keeping these unwanted populations under check is a very difficult management problem, especially in large reservoirs. A small population of predators helps to crop the trash fishes which compete for food with the economic species. A small predator population of Gobindsagar which keeps the minnows under check is a good example. However, no scientifically sound methods are available to keep a limited population of predatory species. Repeated use of gill nets of appropriate mesh size, use of long lines, traps, etc. are suggested for

control of the uneconomic and undesirable populations. Manipulation of reservoir levels with a view to checking the breeding and destruction of the young ones of predators and minnows has been tried in several countries. However, this is not practicable in many Indian reservoirs since the water release pattern is dictated by priority sectors like irrigation and power generation.

Cage and pen culture

The unconventional production systems, such as cage and pen cultures have not become very popular in India, although they have a definite role to play in augmenting fish production from open water, especially the reservoirs. It is now widely accepted that the pen enclosures erected in the reservoir margins can be used as nurseries to raise stocking material to obviate the necessity for constructing concrete nursery farms which are cost-intensive. Similarly, the rearing of fish in cages and pens up to marketable size enables easier stock manipulation and total harvesting. Species selection: Main criteria for the choice of candidate species for cage and pen culture are: Fast growth rate, Adaptability to the stresses in enclosures due to crowded conditions, Ready acceptance of artificial feeds consisting mainly of cheap agricultural byproducts, High feed conversion rates, Resistance to diseases, and Good market demand. The candidate species should preferably not breed in the cages and upset the population balance. Under the Indian conditions, the Gangetic major carps *(C. catla, L. rohita, C. mrigala*), the chinese carps (*Hypophthalmichtys molitrix, Ctenopharyngodon idella*), common carps (*Cyprinus carpio*), the magur (*Clarias batrachus*) and tilapias satisfy these requirements to a great extent.

Timber clearance

Opinion is divided on the wisdom of removing timber from the reservoir bed. While it is mostly appreciated that a reservoir bed free from obstructions facilitates the use of active fishing gear and leaves room for many other management options, many workers feel the necessity to leave at least the non-commercial timber intact for a variety of purposes such as, reducing wave action, flocculating the colloidal clay turbidity, providing habitat for fishes and substrata for periphyton deposition (Bhukaswan, 1980). Timber clearance has been tried in a number of reservoirs in India, both before and after the impoundment.

Exploitation systems

Fisheries being a state subject, management of reservoir fisheries vests with the State Governments. There is a great deal of divergence in the management practices followed by individual States which vary from outright auctioning to almost free-fishing. Cooperative societies and the State level Fisheries Development Corporations are also involved in the fishing and marketing operations. Involvement of the above agencies and their role in fishery operations and market interventions often vary from one reservoir to another within the same State. Some sort of uniformity in fishery regulations among various categories of reservoirs as well as the need to monitor the socio-economic aspects of reservoirs fisheries. Commercial exploitation systems followed in different States can be broadly classified under four headings viz., departmental fishing, and lease by auctioning, issue of licenses to cooperative societies or individuals and fishing on a royalty basis (crop sharing).

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ROLE OF SELF HELP GROUP IN FISHERIES SECTOR

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Abstract
Development is the improvement of the poorest of the poor in society's level of living. Self Help Groups (SHGs) will play a transparent role in the poverty eradication activities that will realise the development of the Indian fishing sector in a larger sense. The Self Help Groups can be extremely important to the growth of the fisheries industry. The most important prerequisite for this is making sure that fishermen, particularly women, are included in the planning and execution of various site-specific resource-oriented development programmes. For the purpose of making this study thorough, data on SHG women's roles in fisheries and aquaculture around the world were gathered from 82 research articles that were published in various peer-reviewed national (26) and international (56) journals, books (6), technical papers (15), and other useful scholarly study materials (12), and they were then grouped, analysed, and summarised in line with the study's goals.

Introduction
Women only begin to participate in the fishing industry once the catch has been landed. This custom may have developed as a result of the men's need for relaxation and repose following a protracted period of laborious work in the water. Up until a decade ago, women predominated in both the inland and marine sectors of fish selling across the nation. Fisherwomen in the coastal belts contribute significantly to the sorting, grading, processing, etc. following the fish haul and make up a sizable portion of the workforce in the export-focused marine products processing facilities. With the administration of male animals and the production of fodder, women can perform indoor tasks like milking, feeding, cleaning, etc. Women haven't historically felt the effects of pond production due to their lack of involvement in farming husbandry or other cultivation inputs, but there is growing understanding of the importance of other input components, such as monitoring water quality in addition to seed release and harvesting. A wise use of pond embankments is now necessary as per capita land availability in the farming sector is continuously decreasing. Rural women can help maintain the livestock being raised on the embankments or the plants being grown on the ponds' banks, and they can also lend a hand with the pond fish culture practises that are integrated with livestock rearing and horticultural cultivation.

A useful way to enhance information access, women's empowerment in agriculture, better agricultural practises, and production diversification is by promoting women's self-help organisations (Raghunathan et al., 2019). A redistribution of social power and resource management in favour of women was the definition of empowerment as initially stated at the International Women's Conference in Nairobi in 1985. Women's development in recent years has

concentrated on giving women equal opportunity through eradicating gender bias, empowering women, and developing self-reliance in them. 'Empowerment' is a multifaceted, multilayered notion (Ghosh, 2015).

Culture of Fresh Water Pearls

A variety of activities are involved in freshwater pearl cultivation in aquaculture systems. At the Central Institute of Freshwater Aquaculture in Bhubaneswar, this cutting-edge technique was created. The three species of pearl mussels that have been identified are *Parreysia corrugata*, *Lamellidens marginalis*, and *L. corrianlis*. Different forms of pearls are grown using three different surgical techniques. The technology is currently attracting a number of rural, artisanal, and entrepreneurial communities, especially women. This skill-based technology is linked to a number of ancillary activities, including the gathering of pearl mussels, the fabrication of culture units and culture platforms, surgical implantation and postoperative care, the preparation and supply of nuclei, the harvest of pearls, and pearl processing. The technology is gaining relevance because to its operational simplicity, eco-friendliness, ability to create jobs and boost the local economy, efficient use of local natural resources, and potential for long-term outcomes like import substitution and export revenues.

Integrated aquaculture

Through the use of contemporary aquaculture techniques, inland fish production can be greatly improved. The capacity to obtain seed and food has become a significant barrier to the adoption of aquaculture practises. Women business owners can be trained in induced breeding methods and fish seed production, and they can play a significant role. Through a participatory approach, appropriate production models for freshwater prawn farming that are both economically viable and environmentally safe have been shown to women self-help groups (SHGs). Freshwater prawn farming was converted to a low external input sustainable aquaculture with adequate management practises using farm-produced diets incorporating local ingredients and compatible environmental parameters. In addition to fish yields, this method produced a prawn yield of 1 tonne/hal culture in 6 months. It was determined that an integrated farming system involving paddy-fish culture, poultry, piggery, turkey, and cattle was both economically and environmentally sound.

Neighborhood Pond Aquaculture

Environmental issues are brought about by the widespread usage of small and backyard ponds as dumping grounds, bathing, and washing facilities in coastal areas. Recognising that women could be employed in using such underutilised bodies of water to raise short-term crops of fish fry, fingerlings and even table-size fish at very low operational costs, planned to show the practical viability and the range of benefits in terms of economic gains, labour efficiency, self-employment opportunity and multiple choice of vocabularies that aquaculture could offer to rural women. This plan would assist meet the need for protein, improve sanitation, and create a more favourable climate for women's empowerment in addition to giving people the chance to find productive employment. Community ponds are tightly linked to the customs and cultures of the surrounding areas. By adding fingerlings of fast-growing, suitable fish species with various feeding patterns, the production capacity of these ponds is intended to be increased. Silver carps, Common carps, Grass carps, and Freshwater Prawns are stocked alongside Indian Major Carps such Calla calla (Catla), Labeo rohita (Rohu), and Cirrhinus mrigala (Mrigal).

Culture of Freshwater Prawns (*Macrobrachium rosenbergii*)

The programme adheres to the Low External Input Sustainable Aquaculture (LElSA) principles. One of the main prospective species for freshwater aquaculture is the Macrobrachium rosenbergii, also known as the "scampi." Despite the fall in catch, there has been an increase in commercial interest in raising freshwater prawn production. The distinctive characteristics of freshwater prawns, such as their large size and fast growth rate even without a specific feed, inherent ability to be cultured in both fresh and low-saline waters, lower incidence of disease outbreaks, and potential for polyculture methods, offer significant economic potential as far as the species' suitability. The program's main goal is to improve the competitiveness of women participants. The participants have been active in stocking, managing feed, and educating the farmers of the nearby communities, and they are encouraged to do so.

Paddy-Cum-Fish Culture

Paddy-cum-fish culture is only a co-activity of an agricultural enterprise in which fish farming is prudently conducted with the paddy farming's drained out water. Carps are raised in rectangular trenches that range in size from 20 to 100 m2, with a water depth of roughly 1.8 m and a width of 1.5 m. It has already been demonstrated that raising common carps exclusively is successful. Results indicate that in order to get the most out of these systems as a source of supplementary income, the water flow into them should be carefully managed and it is preferable to have a steady water flow during the culture period. In agriculture, women have a significant role, notably in paddy cultivation activities including planting, weeding, and harvesting. When it comes to post-harvest and marketing tasks, women may be better able to absorb labour if fish culture is introduced into paddy agriculture.

Fattening of Crabs, Mussel and Oyster Culture

The location is rich with crabs (Porlunus pelagialS and P. sanguinolentus), which are a high-value resource. Each small crab only brings in Rs. 5 whereas the larger ones can bring in up to Rs. 200. It takes about three months to fatten them up. The crabs can be fed molluscan meat or offal as they grow larger in cages instead of swimming in the creek. You may even use fish that you've collected from the creek as trash. Infrastructure COSIs are relatively low, but profits are adequate. Mussels and oysters are abundant throughout the Konkan coast's rocky shores and sandy beaches, indicating the suitability of these locations for their culture. The technology for growing mussels and oysters is now accessible, and it will initially be spread at selected areas through women's cooperatives and group management. These would also, whenever possible, be raised in prawn ponds where they would serve as biofilters and lower the amount of suspended particulates. Additionally, this would result in higher income.

Conclusion

In the fisheries sector, some successful micro enterprises developed based on the location-specific resource availability and experience, and some alternate vocations as subsidiary entrepreneurial ventures successfully undertaken by Self Help Groups in coastal sectors and related areas are identified. This is done for the upliftment of fisherfolk below the poverty line. Freshwater pearl cultivation, integrated aquaculture, prawn cultivation, pond culture in the neighborhood, crab fattening, and paddy cum fish cultivation. Mussels and edible oysters are both grown. Clam collecting and other activities are crucial.

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ENTREPRENEURSHIP OPPORTUNITIES FOR FISHERIES GRADUATES

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Abstract
Under the negative effects of climate change, entrepreneurship in rural areas may be one of the most important projects for the nation's economic development. Contrarily, the lack of basic facilities in rural areas causes a number of issues for the majority of rural businesses in developing countries, including India. Fish is currently regarded as a healthy food and a valuable source of animal protein. As a result, consumer demand has soared. Initiatives to Promote Entrepreneurship in the Fisheries Sector the fishing industry, which has a significant impact on the socioeconomic development of the nation, has developed into a significant source of income and employment. It also encourages the expansion of several related small, medium, and large-scale companies.

Introduction
Many of the world's underprivileged kids, whose numbers are steadily increasing, reside in rural locations where a poor economy gives them less options to find civilized job. Over the next 30 years, it is expected that 300 million young people would enter the workforce, 195 million of them will reside in rural regions (IYF 2014). It is vital to create sustainable economic opportunities in order to retain the rural population and fishery graduates. At the same time, the current prominence of young people presents an extraordinary opportunity for practitioners and governments to make use of the zeal, enthusiasm, and innovative mindset of these young people to advance socioeconomic development and address pressing food security needs.

Entrepreneurship is a common occurrence in business and is a component of the entrepreneurial spirit. It shows that where entrepreneurial skills are present and management is used for wisdom, business is healthy. Therefore, it will be useful for every business organisation to understand what entrepreneurship is, how it works, and the many types of entrepreneurship (Diandra & Azmy 2020).

An innovation-based Business Incubation Centre (BIC) has been established at the ICAR-Central Institute of Fisheries Technology (CIFT), Cochin, in order to convert research findings from the fisheries and other agricultural sectors. The Zonal Technology Management - commercial Planning and Development (ZTM-BPD) Unit oversees BIC, which intends to build food commercial businesses using IPR-enabled ICAR technology. As a means of strengthening the base for new technology-based businesses and developing a knowledge-based economy, BIC supports operations on business projects. It focuses on opening doors to untapped markets in order to discover new ways to conduct business in the fisheries and related agricultural areas. The Centre assists aspiring entrepreneurs by offering proactive and value-added business support in the form

of technical consulting, infrastructure, professional mentoring, and training to create technology-based company concepts and long-lasting businesses. Through a networking and interface mechanism between research institutes, companies, and financial institutions, it serves as a platform for the quick commercialization of ICAR technology. The ICAR-CIFT incubator is different from conventional business incubators in that it is operational in a region with a high concentration of fish production and is designed primarily for technology-based companies. This industry-specific incubator also enables emerging businesses to make use of established local business networks and knowledge bases. Through virtual incubation, BIC provides their services to enterprises not only in Cochin but also throughout all of India. The Centre aims to serve all Indian fisheries communities in addition to fostering economic success. This distinctive business incubator is now referred to as a "One Stop Shop" where entrepreneurs can receive proactive, value-added support in the form of technical consulting and access to essential tools like entrepreneur ready technologies, vast infrastructure, and other resources that may otherwise be unaffordable, inaccessible, or unknown. The ZTM-BPD Unit has established a setting where technology-based company ventures can receive the timely scientific and technical advice and support needed for establishment. This is done with the intention of turning the incubator into a symbol of innovation and entrepreneurship. The ZTM-BPD Unit's efforts are focused on coming up with original and creative solutions to connect public resources and private sector initiatives both inside and across regional and national boundaries to support economic growth. The Centre identifies and analyses the limits and barriers preventing the growth of a firm, develops appropriate strategies, and does so using the required knowledge in pertinent domains. It examines the many frameworks and tactics that can support small businesses in expanding and securing a bright future on the international market. In addition to fostering productive government-research-business partnerships, it encourages corporate and community collaboration.

Land-based pond: semi-intensive and intensive

It entails maintaining fish-stocked ponds or water reservoirs. It accounts for about 66% of production and is the semi-intensive system that is most commonly employed. It is the primary farming method employed by businesses for the production of prawns (Aldridge et al., 2008). By employing aerated flowing water and getting rid of fish metabolic waste, intense technology boosts fish output. According to Cremer et al. (2014), this method enables increased fish longevity, lower costs per pound of weight gained, lower energy costs per generated unit, and lower labour and waste product costs.

Floating cage system

To retain and safeguard fish until they can be harvested, it can be suspended in freely flowing water, such as sizable reservoirs, lakes, lagoons, dams, rivers, or seas. It uses simple technology, little infrastructure investment, and high planting densities (Botero and Fernando Ospina, 2003; Carrera and Villarreal, 2015). Its maintenance is very straightforward.

Recirculating Aquaculture System

The fish are kept in tanks with water that is continuously recirculated and treated by a filtering system as part of a closed system to provide ideal growing circumstances. Since it takes up little space, the grower can stock fish at high densities and get high yields per square foot.

Biofloc

Its foundation is the employment of bacterial, algae, or protozoan aggregates along with particulate organic matter to enhance water quality, manage waste, and prevent disease in intensive aquaculture systems. It requires less equipment and water treatment units, which results in a lower setup cost. It is conducive to the development of a wide range of microorganisms that can help fish nutrition (Brordero et al., 2017). This system produces no more than 10% of the nation's output.

Conclusion

Fisheries entrepreneurship is crucial in India because it has the potential to directly affect farmers and their capacity while also stimulating the development of entrepreneurial abilities. Therefore, it is necessary to refocus fisheries education in India to foster youth entrepreneurship. We have identified the important technological elements of this industry and the major issues in the research on fisheries entrepreneurship from which entrepreneurship academics can learn more about entrepreneurship. We have thoroughly examined various technologies with potential for entrepreneurship in the fisheries sector, provided scholars with recommendations for revising and refocusing their research in the farm sector, and included background information on the suggested entrepreneurship pathways. Therefore, the entrepreneurship alternatives outlined and assessed in this study will assist rural youth and fishery graduates in starting and establishing small-scale businesses, which would ultimately boost rural population prosperity and ease unemployment problems.

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FROM POND TO PROFIT: SPIRULINA CULTIVATION AS A MICROENTERPRISE VENTURE

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Abstract
Spirulina is a type of blue-green microalgae, known for its rich nutritional profile and potential health benefits. It is an excellent source of plant-based protein, essential vitamins, minerals and antioxidants. The scope for spirulina cultivation as a microenterprise venture, focusing on setting up a small-scale production system, cultivation techniques, quality control measures and value-added product development are always inspiring. Microenterprises can leverage spirulina's eco-friendly cultivation methods and versatile applications to establish a successful venture. Effective marketing strategies and understanding market demand will enhance profitability and contribute to sustainable food production and human health promotion. As consumer awareness about spirulina's benefits increases, microenterprises have the opportunity to play a vital role in sustainable agriculture practices and food security while reaping profitable returns.

Spirulina, the green microalgae has garnered considerable interest owing to its nutritional and potential health benefits. It is known for its vibrant green colour and spiral-shaped appearance, hence the name "spirulina." Spirulina is considered a nutritional powerhouse due to its rich content of essential nutrients. It is an excellent source of protein, containing all the essential amino acids, making it a valuable plant-based protein source for vegetarians and vegans. Spirulina also contains vitamins (including B vitamins and vitamin K), minerals (such as iron, magnesium and potassium) and antioxidants like beta-carotene and phycocyanin. It is believed to offer several health benefits with its high protein content which can support muscle growth and repair. It is also a rich source of antioxidants, which help to combat oxidative stress and protect against cellular damage. Some studies suggest that spirulina may have anti-inflammatory properties, support immune function and improve lipid profiles by lowering cholesterol levels.

Spirulina cultivation and potential benefits
Spirulina is cultivated in freshwater or saltwater ponds and is known for its high photosynthetic efficiency. It has a lower ecological footprint compared to traditional livestock production and requires significantly less land, water and resources. Its cultivation can contribute to sustainable food production and reduce pressure on land use. Spirulina is available in various forms, including powder, capsules and tablets. It can be consumed as a dietary supplement or incorporated into food and beverages. Spirulina powder is often used in smoothies, energy bars and baked goods for added nutritional value and vibrant colour as a natural food colouring agent. While spirulina is generally safe for consumption, it is essential to choose high-quality sources and ensure proper cultivation and processing practices. Contamination from environmental pollutants or toxins can occur if spirulina is not sourced from reliable producers. As with any dietary supplement, it is advisable to consult a healthcare professional before starting any new supplementation. Spirulina

continues to be an area of active research, exploring its potential applications in various fields, including food, medicine, and environmental sustainability. Studies are ongoing to evaluate its effects on different health conditions, such as allergies, diabetes and cardiovascular health.

Spirulina cultivation as microenterprise

Spirulina cultivation offers a unique opportunity for microenterprises to thrive while contributing to sustainable food production and promoting human health. From its nutrient-rich composition to its eco-friendly cultivation methods, spirulina presents a promising venture for individuals seeking to establish a microenterprise.

Spirulina, a photosynthetic microorganism, is typically cultivated in large-scale open ponds or closed systems like raceways or photobioreactors. As a microenterprise, starting with a small-scale production system is recommended. Basic knowledge of the growth requirements, cultivation techniques and quality control measures is essential for successful spirulina cultivation. Establishing a microenterprise for spirulina cultivation requires careful consideration of infrastructure and production setup. This includes selecting a suitable site with access to clean water sources, adequate sunlight and temperature control. Constructing the cultivation ponds or setting up closed systems like photobioreactors is crucial to maintain optimal growing conditions.

Microenterprises can employ various cultivation techniques for spirulina, such as open pond culture or closed systems with controlled environmental conditions. Open pond culture involves preparing the cultivation medium, inoculating the spirulina starter culture and monitoring and adjusting the growth parameters to ensure optimal growth and productivity. Closed systems provide more control over environmental factors, allowing for enhanced quality and productivity. Maintaining quality control is vital in spirulina cultivation. Regular monitoring of water quality parameters, pH levels, temperature and nutrient concentrations is essential to optimize growth and prevent contamination. Harvesting techniques involve the separation of spirulina biomass from the culture medium, typically through filtration or centrifugation. Efficient harvesting ensures high-quality spirulina biomass for further processing.

Microenterprises can explore value-added product development to diversify their offerings and maximize profitability. Spirulina can be processed into various forms such as powder, tablets, or capsules, suitable for dietary supplements, functional foods or cosmetic applications. Developing innovative and marketable spirulina-based products can differentiate the microenterprise and attract a broader customer base. A well-defined marketing strategy is essential for the success of a spirulina microenterprise. Identifying target markets, understanding customer preferences and highlighting the unique qualities and benefits of spirulina products can help create a compelling brand image. Developing distribution channels, including online platforms, local markets, health stores or collaborations with health professionals, will aid in reaching the target market effectively. The profitability of a spirulina microenterprise depends on various factors, including production costs, market demand, pricing strategies and operational efficiency.

Spirulina is an impressive microalgae with a range of potential health benefits. Its rich nutritional profile, environmental sustainability and versatile applications make it an attractive option for those seeking plant-based protein sources and a natural nutritional supplement. By carefully planning the infrastructure, implementing appropriate cultivation techniques, maintaining quality control and focusing on value-added product development and effective marketing,

microentrepreneurs can establish a successful venture in the spirulina industry. As consumer awareness about the nutritional benefits and sustainable nature of spirulina grows, the microenterprise can contribute to improved food security, sustainable agriculture practices, and the promotion of human health while generating profitable returns.

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SUCCESS STORY OF ARUNACHAL PRADESH FARMERS UNDER ATMANIRBHAR BHARAT THROUGH BROILER FARMING

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Background

Mr. Wangro Wangsu was class five drops out youths of Samsathan village Longding Arunachal Pradesh, details of farmers is shown in table No.1. He was rearing 10-20 numbers of local chickens for meat and egg purpose but it could not support family through rearing small numbers of local chicken. However, he was having tea plantation of 2 acre from where additional income was generated for maintaining daily essential needs. After knowing KVK-Longding has newly started functioned, he came to seek technical help regarding broiler farming after looking the local market demand. On enquiry regarding economics, cash flow analysis of earlier local bird farming, it was found to be very low income and which may really not be able to support the family, as shown in table No.2.

Table No.1. Farmer details

Name of farmer : Mr. Wangro Wangsu
Address : Samsathan village
Age : 35
Education : 5 pass
Size of land holding (in acre) : 4

Table No.2. Economic analysis of 20 local chickens

Components	Benchmark (Baseline period 2018-19)				
Names	**Number**	**Production (No./kg)**	**Expenditure (Rs)**	**Gross Income (Rs.)**	**Net Income (Rs.)**
Poultry (Local)	20	a) 70 egg/year/bird b) 1.3kg adult bwt (meat)	1. Feeds = 20x50Rsx12kg= 12,000.00 2. Medicine= 20x20=400.00 3. Equipments= 200.00	**Rs 22,770** a. 70x15x15=15,750 b.1.3kgx18x 300=7,200)	**10,175**
Total	**20**		**Rs 12,600**	**Rs 22,770**	**Rs 10,175**

Interventions

A vocational course of 7 days training entitles “Entrepreneurships development through poultry farming” was organized for 10 rural youths, in which his name was included. Where, hands on

training on poultry farming right from housing management, feeding, vaccinations and other bio-security was taught from 24th June to 30th June 2020.

He was advice to construct a broiler shed with locally available, low cost material and asks him to come to office once, poultry shed is complete. 100 numbers of broiler chicks was provided to Mr. Wangro Wangsu, under the banner of ATMANIRBHAR BHARAT as a token of encouragement from KVK-Longding office along with inputs like feederer and drinker along with pre-starter feeds for 7 days and advised him to purchase rest of the feeds and gave him the feeding schedule when to introduce Starter, Grower and finisher feeds along with vaccination scheduled and vitamins supplements charts. However, routine vaccination for Ranikhet and infectious bursal disease (IBD) was done by SMS Animal science, in first batch of broiler productions. A detail of production is shown in figure No.1 and 2. However, from second batch of broiler production by Mr Wangro Wangsu, has done by himself in close supervision on KVK officials. The economic analysis is deficit in table No. 3 & 4 for each 100 and 400 numbers of broiler productions respectively.

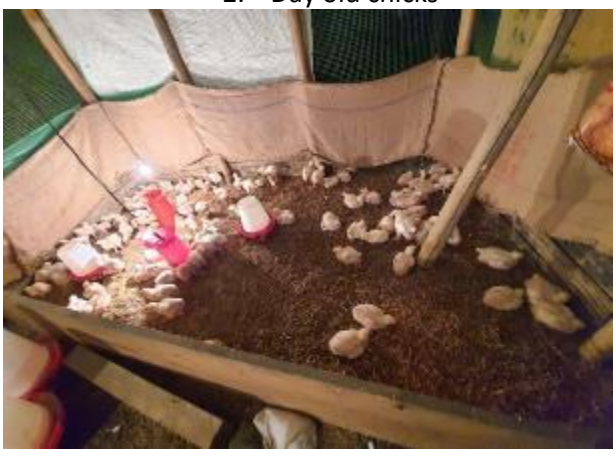
Earlier he uses to earn a net profit of Rs 10,175 (Ten thousand one hundred seventy five) only. After taking over broiler farming in first year, he reared two batches of 100 numbers in each batch and earned a net profit of Rs 28,100 (Twenty eight thousand one hundred). In the subsequent year he started rearing 400 numbers per batch and could able to produce 8 batches in a year with a net profit of Rs 4,16,000 (Four lakhs sixteen thousand).

Fig.1. Training and management of day old chicks (DOC) to Marketable age at 45 days

1. Training

2. Day old chicks

3. Vaccination of Ranikhet disease at 5th day



4. 10 days old chicks

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5. Ready for sale of broiler at 45 days

6. Whole sales purchaser of broiler

Table No.3. Economic analysis of 100 numbers of broiler chicks per batches

Component Description	**Period 2021-22**				
Names	**No**	**Production (No./kg)**	**Cost of productions Net Income (Rs.)**	**Gross Income (Rs.)**	**Income Net**
Poultry (Broiler – Vancob strain)	100	2.5 kg /bird in 45 days	1. Feed cost @ 50/kg. in 45 days 4.5 kg feed/ birds (4x90x50= Rs 18000) 2. Medicine =Rs 700 3. equipments =Rs 1000 Total = 19,700.00	**Rs 33,750** (2.5kgx90 no. x Rs150=Rs 33,750 Rs 33,750/batches in a year,2 batches= 2x33,750= Rs 67,500	**Rs 28,100**
	2x100 = 200		Rs 19700/batches in a year two batches= 2X19700= Rs 39,400		
Total	**200**		**Rs 39,400**	**Rs 67,500**	**Rs 28,100**

NB: considering 10% as mortality

After two batch of rearing broiler Mr Wangro Wangsu gained confidence and started to rear 400 numbers of broiler per batches and total of 8th batches in a year

Table No.4. Economic analysis of 400 numbers of broiler chicks per batches

Component Description	**Period 2020-21**				
Names	**No**	**Production (No./kg)**	**Expenditure (Rs)**	**Gross Income (Rs.)**	**Income Net**
Poultry (Broiler – Vancob strain)	400	2.5 kg /bird in 45 days	1. Feed cost @ 50/kg. in 45 days 4.5 kg feed/ birds (4.5x380x50= Rs 85500) 2. Medicine = Rs 2000	**Rs 1,42,500** (2.5kgx380 no. x Rs150= Rs 1,42,500	**Rs 4,16,000**

			3. Equipments = Rs3000 Total= Rs 90500		
	400x8= 3200		Rs 90500/batches in a year,8 batches= 8x90500= 7,24,000	Rs 1,42,500/batches in a year,8 batches= 8x1,42,500= 11,40,000	
Total	**3200**		**Rs 7,24,000**	**Rs 11,40,000**	**Rs 4,16,000**

NB: considering 10% as mortality

Fig.2. Management of 400 chicks per batch from DOC to Marketable age at 45 days

1. 400 broiler day old chicks

2. 10 days old chicks

3. 35 days old broiler

4. 45 days old broiler ready for sale

Impact

1. His income from broiler farming has significantly improved in contrast to earlier local poultry rearing and manages to save Rs 5000 per month for social security, apart from spending for schools free for their children and other daily expenses of day to day life.
2. Now the villagers of Samsathan need not required to travel 7 km to town for purchase of broiler meat, instead from town people come to purchase broiler in village.

Acknowledgement

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LANDSCAPING IS AN ART

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Land refers to the soil and scep refers to land reclamation and creation. So, the landscape is organized land. Landscaping is the art of transforming an outdoor area into a beautiful and functional area by using various elements and principles of landscaping. It involves the careful planning and designing of the visible features of the land, including plants, hardscaping elements such as wood, walls, paths, and other decorative features. Landscaping can enhance the aesthetic appearance of an area, improve its functionality, and even increase its value. When landscaping an area, it is important to start with a clear vision of the purpose of landscaping. This may involve creating a detailed plan or sketch of the space, taking into account factors such as the size and shape of the area, the existing features, and the desired style. It is also important to consider practical considerations such as drainage, irrigation, and maintenance. Select the plants and other elements that will bring our vision to reality. This may involve selecting plants that will thrive in the local climate and soil conditions and incorporating hardscaping elements such as wood, stone or concrete.

When selecting plants for your landscape, it is important to consider not only their aesthetic appeal but also their practicality. Choose plants that are well-suited to the local climate and soil conditions, and that will require minimal maintenance. Consider factors such as the mature size of the plants, their growth rate, and their water and sunlight requirements. In addition to plants, hardscaping elements such as wood, stone or concrete can play an essential role in the overall design of the landscape.

Softscape (plants) material use for landscaping:

- Plants can be used to create beautiful flower beds, shrubbery borders and lush green lawns.
- Plants in the landscape controls the microclimate.
- They help to improve air quality and reduce soil erosion along with providing habitat for wildlife.
- Large trees by controlling solar radiations provide shade and cool the surrounding area.

Hardscape material for landscaping:

- Hardscapes can also help to increase property values. A plant or softscape can turn brown or die due to extreme weather conditions like frost or extreme heat, whereas a hardscape is non-living material that will maintain its appearance during extreme weather conditions.
- Unlike living plants, hardscaping elements do not require water, mowing, pruning, sun exposure etc. In short, there is very little to no maintenance required for hardscapes. Hardscaping elements like pathways and walkways can greatly increase the accessibility of any property.

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Elements of landscaping

1. **Colours**: Colour is an important element of landscaping for creating variety and interest in the landscape. Cool colours tend to recede and are perceived as being farther away, making a space feel larger. Cool colour include blue, purples and pale pastles. Whereas warm are perceived as being closer making a space feel smaller. Warm tones of red and orange came under warm colours.

Vertical line

2. **Lines**: line is related to eye movement. Horizontal line move the eye along the ground plane and can make a space feel larger. These lines can divide a space or tie a space together. Similarly, vertical lines move the eye up and make a space feel large

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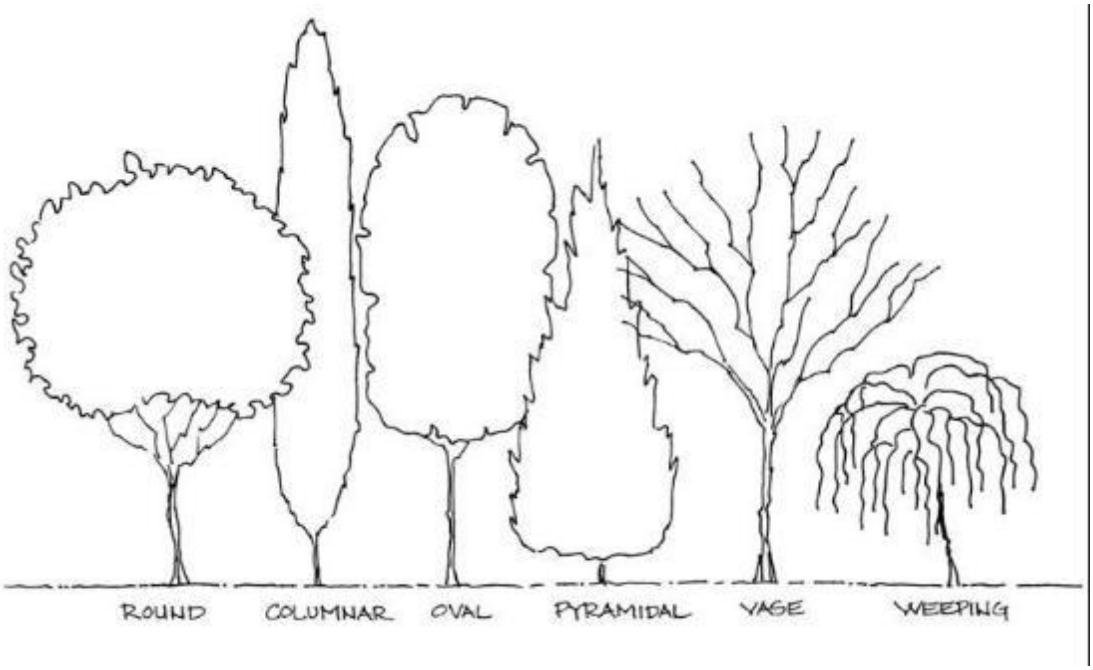
3. **Form**: form is the outline or three dimentional shape of an object. Plant form includes upright, oval, columnar etc.



4. **Texture**: texture describes the surface quality of an object that can be seen or felt. Course, medium or fine terms can be used to describe texture. Fine texture: Eye move easy, Course texture: focused eye
5. **Scale**: scale refers to the size of an object in relation to its surrounding.

Principles of landscaping

1. **Unity**: Unity means components are placed in such a way that they appear to have a sense of oneness. Repetition of pattern can be used to create unity. E.g. use of same type of rock throughout the area.

2. **Balance**: Balance is achieved when one side of the design is mirror image of the other side.

3. **Proportion**: refers to the size of parts of design in relation to each other. It is requirement that size of individual component fit into the whole landscape harmoniously. E.g. tall tree is not in proportion in small courtyard.
4. **Focalization**: it includes the leading of visual observation towards the feature.

5. **Rhythm**: Rhythm is the repetition of similar components in a landscape. It is achieved when elements creates a feeling of motion.
6. **Contrast**: Occasional contrasts are used to create eye catching feature in a garden.
7. **Simplicity**: it is reduction of unnecessary things in design which avoids unnecessary cost and maintenance. Too much of variety in design creates confusion in design.

   In conclusion, landscaping is a powerful tool for transforming an outdoor space into a beautiful and functional area. By carefully planning and designing a landscape, selecting appropriate plants and hardscaping elements, and considering long-term maintenance requirements, we can create a stunning outdoor space that will provide years of enjoyment. Landscaping helps manage air pollution, helps clean the air, improves people's health and plays an important role in sustainability.

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THE IMPORTANCE OF FUNCTIONAL TRAITS IN AQUACULTURE

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Introduction

In recent year trade of aquatic product has grown significantly and this trade generates revenue, employment, global food security as well as total gross domestic product (GDP). There are several functional traits that are valuable for aquaculture research and management. The Traits oF Fish (TOFF) database developed to focuses on fish functional traits, including behavioral, morphological, phenological, and physiological traits, coupled with environmental context. Economic values can be used to determine the importance of traits in aquaculture breeding programs. Marker-assisted selection (MAS) is a way to enhance fish production by improving important traits. However, there are still major traits that have not been utilized and their respective genes need to be explored for MAS. Tolerance to temperature fluctuations and low dissolved oxygen, as well as growth capacity, are important traits for mariculture species. There may be a trade-off between tolerance ability and growth, with larger, slower-growing species having wider temperature ranges and lower minimum dissolved oxygen levels. Genetic technologies have advanced the genetic improvement of aquaculture animals, with significant progress in understanding the molecular basis of economically important traits such as reproduction, growth, and disease resistance.

Quantitative Traits

Quantitative traits, also known as polygenic traits, are characteristics in fishes (and other organisms) that are controlled by multiple genes and exhibit a continuous range of variation. These traits are influenced by both genetic and environmental factors, making their study complex but essential in understanding the diversity and adaptability of fish populations. These traits are usually determined by a larger number of genes. These traits can change under the influence of the environment and they are spread over a range of values, cannot be analyzed by counts and ratios, but must be analyzed statistically.

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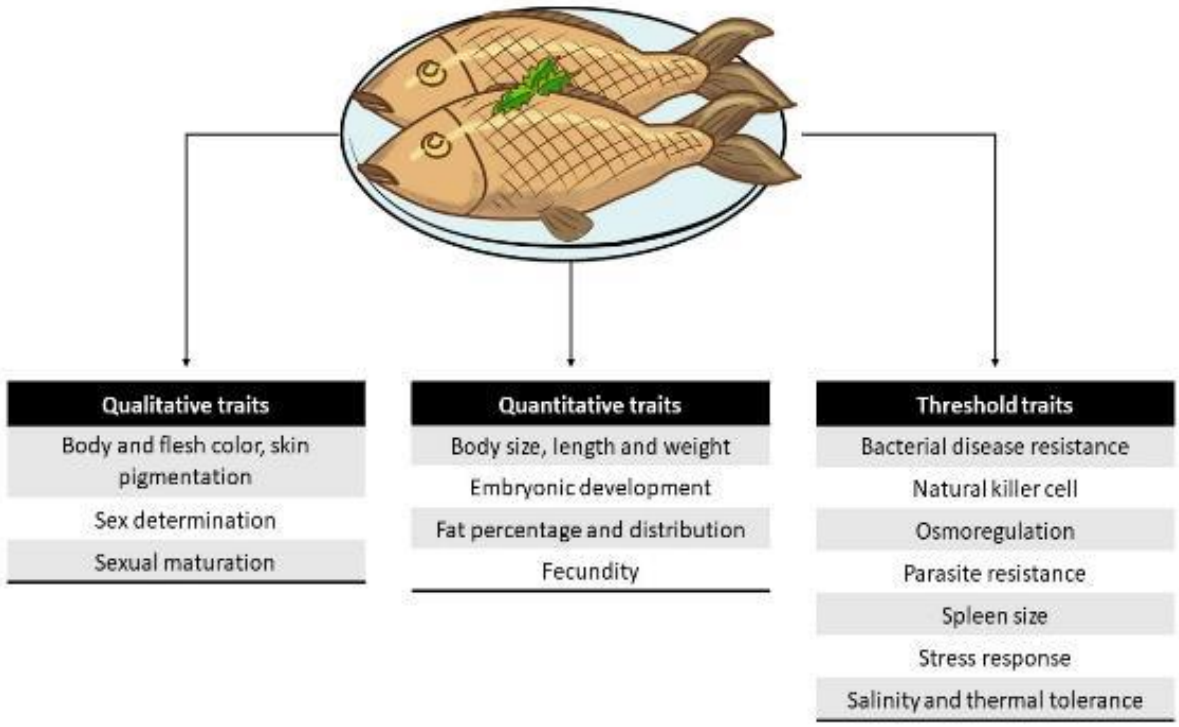

Fig 1. Function important different traits

I. Body size (weight and length)

Many factors affect aquatic organisms to different extents, leading to changes in body sizes in various ecosystems and subsequently altering food webs. In aquaculture growth related traits such as body weight, length and size play a crucial role in selecting the culture economical beneficial species. By understanding these trait controlling genes, we can increase survival, reduce food competition in farming as well as increase aquaculture production, sustainability and profitability. A quick rise in weight in a time increases the profitability and meets the market demands. Therefore, the majority of experts have focused on this valuable trait and several studies on various cultures species have been reported. QTL for weight have been mapped in several aquaculture species, such as Arctic charr, Asian seabass, Atlantic salmon, Brook charr, Catfish, Coho salmon, Common carp, European sea bass, Gilthead Sea bream, Japanese flounder, Rainbow trout, Tilapia, Tongue sole, and Turbot.

II. Fat percentage and distribution

Fish flash contains a polyunsaturated fatty acid, and fat-soluble vitamins. Omega 3 fatty acid in aquatic products is a major factor determining consumer preference because of their beneficial effects on human health (cardiovascular disease prevention). The fat percentage of fish fillet plays a critical role in flesh quality and consumer preference based on color, texture, and fat content of the flesh. 18% or above flesh content can lead to detrimental effects on fillet quality such as texture and flavor as well as excessive deposited fat could reduce the growth of fish and effect on the fecundity and production. Genes responsible for fat content of body composition and dietary quality of fish fillets have rarely been investigated.

III. Feed conversion ratio

Feed conversion ratio (FCR) trait, primary economical trait of interest, needs great attention in aquaculture species. It's efficiency with which an aquaculture production system converts feed into fish biomass. Determining the FCR could increase profitability, cutting stoking expenses as well as reducing rearing time for faster growth rate in commercial important species. Single sequence repeats (SSR), Expressed sequence tags (EST) and Single nucleotide polymorphism (SNP) markers were used to investigate the QTL responsible for FCR trait in common carp and many aquaculture species by several researchers.

IV. Fecundity

Knowledge of the fecundity of a species is an important factor in fish stock management as well as aquaculture aspects. It's a potential reproductive capacity of an individual or population. The reproductive rate of a fish is measured by the number of gametes (eggs). In the biology and population dynamic of fish species, strategies and assessment of fecundity have fundamental importance. Its estimation helps to better understand the relationship between reproductive potential and environmental variation. In Japanese flounder SNP marker associated with reproductive trait for fecundity investigated by He and other researcher.

Qualitative Traits

Qualitative traits, also known as categorical traits, are characteristics in fishes (and other organisms) that exhibit discrete, distinct categories or phenotypes rather than continuous variation. These traits are typically controlled by one or a few genes with distinct alleles, making their inheritance more straightforward compared to quantitative traits. A qualitative trait is a feature, that is either present, or not present, depending on whether the gene responsible for that trait is present (or functional) or absent (or non-functional). Here are some common qualitative traits in fishes:

I. Color

1. Body color
   It's an important impressive morphological trait and important during the life cycle of fishes. Camouflage and disguise are the purpose of this large variety of designs/color to be found among the fish: blending with the environment and masking the fish's body is hidden from predators. This trait increases the market value of fish such as atlantic salmon, tilapia and molluscs also have color related important traits.
2. Flesh color
   Its important economical trait helps to identify market acceptance and fetch good price of fish's flesh.so that it is essential to find out the QTL that affects the flesh color in aquaculture species such as SCAR marker for predicted breeding values (PBV) in coho salmon.
3. Skin pigmentation
   It's an adaptive trait which is not only commercially important but also gives protection from predators and some fishes could change their body color to surrounding environment. This trait could be beneficial for survival and conservation purposes in natural habitat.

II. Lateral line, Fin rays, Gill rakers and vertebrae numbers

These are meristic traits with importance in taxonomy as well as biological activities (migration, feeding, swimming and protection) of fish. All these traits are not studied widely due to limited application and unavailability of detailed information of utilization.

III. Sex determination

This biological system determines the development of sexual characteristics in organisms. All species does not have similar sex determining pattern and differ according to different variables. Sex determination in aquaculture species is not fully understood hence sexual dimorphism in male and females such as growth rate, maturation, color pattern and size could be used as marker to improve production of commercial important species. Various fish species such as Arctic charr, Atlantic salmon, Catfish, Gilthead Sea bream, Oyster, Rainbow trout, Shrimp, Tilapia, Tongue sole and Turbot species were studied for the traits.

IV. Sexual Maturation time

Sexual maturation time is controlled by several genetic, environmental and epigenetics factors and it can occur prematurely when physiological thresholds for maturation exceed certain control in fish weight and lipid reserves. Certain aquaculture species male and female have different growth rate in early stage hence maturation may be affects the development of fish growth utilize energy reserve for gonadal development. Various researchers studied the QTL responsible for sexual maturation in Arctic charr, Eastern oyster and Rainbow trout.

Threshold traits

I. Bacterial, Viral and Parasitic disease resistance

Fishes have two types of defence mechanism against diseases such specific (inflammatory immune response) and nonspecific (skin, mucus layer and scales). Bacterial, viral and parasitic diseases cause significant stock loss and economical loss to the aquaculture industry. Several vaccines are available for the all the mentioned disease but it is not feasible to apply on the small fish and caused mass mortality. Scientists and researchers have paid serious attention find out genes associated with disease traits during the initial infection phase. Therefore, analysis of genetic characteristics and QTL markers are essential to produce disease resistance strain by using molecular markers (SSR, AFLP, SSR, single-strand conformation polymorphism (SSCP) and SNP) in various commercial importance aquaculture species.

II. Natural killer cell

Natural Killer (NK) cells play a fundamental role and constantly protect an individual from life-threatening infections. They are third type of lymphocyte which produce cytotoxicity and cytokines help to recognize and kill the infected cells. This trait was only studied in Rainbow trout using AFLP and SSR marker for identifying QTL for NK cells.

III. Osmoregulation

Osmoregulation is considered as an essential trait for those aquaculture species which have a life cycle in the two waterbodies or are cultured in hypertonic conditions. In a hyperosmotic environment (Sea Water), fishes lose water through osmosis and gain ions (NaC and Cl¡) through diffusion mechanism. Several authors mentioned that fish reared in saline environments have a better growth rate than freshwater environments. For that

QTL analysis was done in two migratory fish species such as atlantic salmon and rainbow trout.

IV. Spleen size

The cellular composition, development, and function of the spleen are less known in fish. Several authors reported that large spleen in fish has a greater filtering capacity and thus increases the immune system, and strong correlation has been observed between spleen index value and survival during the challenge studies. Therefore, it is important to produce the population with such strong trait and identify trait using QTL analysis in aquaculture species.

V. Stress response

The stress response in fish concerns the principal messengers of the brain-sympathetic chromaffin cell axis (equivalent of the brain-sympathetic-adrenal medulla axis) and the brain– pituitary–interregnal axis (equivalent of the brain–pituitary– adrenal axis), as well as their functions, involving stimulation of oxygen uptake and transfer, mobilization of energy substrates, reallocation of energy away from growth and reproduction, and mainly suppressive effects on immune functions.

a. Salinity tolerance resistance
   This trait controlled by genetic factor and fluctuation salinity modulate the growth performance, survival as well as mortality. Therefore, species with salt tolerance is essential to commercial farming. In Arctic charr, Atlantic salmon, Rainbow trout, and Tilapia salinity tolerance QTL were recorded by many researchers.
b. Thermos tolerance resistance
   Temperature has a great role in the growth and survival of the fish. It affects the FCR, growth rate, as well as food intake, that are directly related to production. There is a range of temperatures that encourage maximum growth. Temperature tolerance is an important trait in aquatic farming and has a great environmental threat to aquaculture, especially in the temperate regions. Temperature fluctuation, in the aquatic atmosphere, generates environmental stress indicated by the organism, such as appetite, reductions in immune function, growth, reproduction, susceptibility to disease and ultimately death. While minor temperature fluctuation may cause severe physiological disruption. Hence, temperature tolerance trait is highly required due to climate change and other factors.

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WAX COATED SAND: A BOON TO ARID REGIONS

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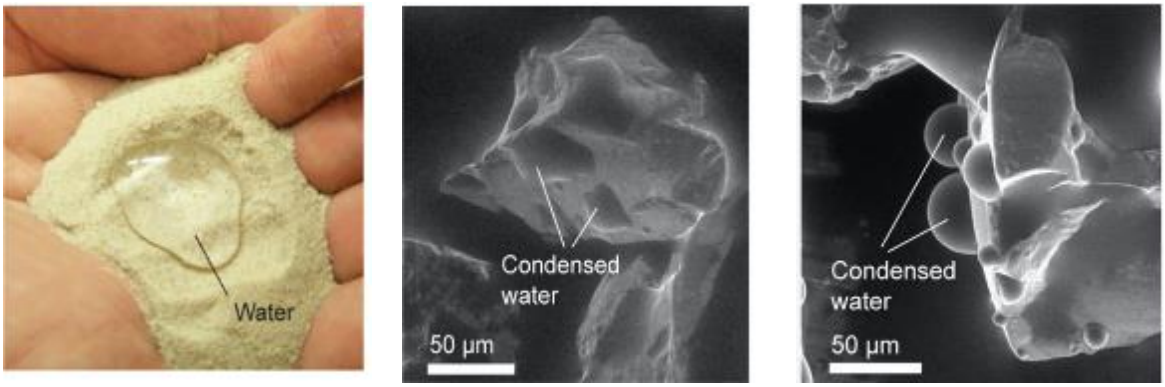
Introduction

A region is arid when it severely lacks available water, to the extent of hindering or preventing the growth and development of plant and animal life. Regions with arid climates tend to lack vegetation and are called xeric or desertic. The soil is categorized according to the amount of annual precipitation: ultra-dryly (less than 100 mm), with almost no or no water in this soil, and dry (100–250 mm) and semiarid areas (200-500 mm) other definitions and criteria are used for the classification of soils (Verheye, 2009). The earth's land surface is covered by drylands forming about 41 per cent which is inhabited by 2 billion people (about one third of world population) (Roshni, 2016). In a country like India, where 44 per cent of the total food production being supported by drylands and thereby playing a critical role in nation's food security (Roshni, 2016). A real need to second green revolution has been envisioned, which can be achieved by improving the dryland agriculture. Geographically dryland agriculture area in India includes the north western desert regions of Rajasthan, the plateau region of central India, the alluvial plains of Ganga Yamuna river basin, the central highlands of Gujarat, Maharashtra and Madhya Pradesh, the rain shadow regions of Deccan in Maharashtra, the Deccan Plateau of Andhra Pradesh and the Tamil Nadu highlands (Rao and Ryan, 2004 and Singh *et al*., 2004). Soils are highly diverse in the drylands of India. In semiarid regions, the alfisols and vertisols predominate, whereas in river basins inceptisols and entisols (alluvial soils) are seen and in desert regions, aridisols (Peterson *et al*., 2006). Alluvial soils of arid regions have low soil fertility, but respond well to inputs and are highly productive under irrigated conditions. Wind erosion predominates in aridisols (Roshni, 2016). Sand, an abundant natural resource, is the cause behind the harsh environmental conditions of the desert, such as water shortages and sand storms. Because of the strong hydrophilicity of sand itself, water can be quickly absorbed by sand, which greatly impedes desert greening, water storage and transportation projects (Chen *et al.,* 2017). In sandy soil, the moisture conservation is a tedious effort, because water holding capacity of sandy soil is the least. In such regions, wax coated sand is a boon. Gallo *et al*. (2022) developed Super Hydrophobic Sand (SHS) and they found that application of 5 mm thick SHS mulch reduced evaporation and increased yield of crops.

Characteristics of Super Hydrophobic Sand (SHS)

A large number of plants and animals naturally have micro/ nano textures to achieve water repellance and is known as superhydrophobicity. Likewise, the SHS comprises common sand grains coated with a nanoscale layer of paraffin wax. It is produced by and dissolving common

paraffin wax in hexane and this solution is mixed with common sand. Afterwards, hexane is evaporated from the mixture at 100 mbar pressure and 55°C. Then, hexane was simultaneously condensed and collected in a separate container for reuse during the process. The sand comprised silica particles 100–700 µm in diameter. Paraffin wax was a mixture of hydrocarbons with 27–37 carbons in length. This process led to the formation of a 20 nm-thick wax coating onto the sand grains (Gallo *et al*.,2022). The surface area of our sand to be 0.11 m2/g. In addition to hexane, pentane, octane, cyclohexane, diethyl ether, dichloromethane, methyl-tert-butyl ether, petroleum ether (ligroin), chloroform, tetrahydrofuran, and triethyl amine can also be used as solvents (Gallo *et al*.,2022). Gallo *et al*., 2022 found that that when placed on moist topsoil, SHS would create a capillary and diffusion barrier for soil moisture and insulate it from direct exposure to solar radiation, wind, and dry air (Gallo *et al*.,2022). Gallo *et al*.,2022 found that that adding a superhydrophobic material on top of soil would reduce evaporative losses, increase the soil moisture content, and possibly benefit crops grown in water-scarce environments as well as increased yield of crops. Furthermore, the superhydrophobic sand demonstrates a great water-holding capacity, such that a sand layer with a thickness of 2 cm can sustain a water column height of 35 cm (Chen *et al.,* 2017).



Super Hydrophobic Sand Common sand Wax coated sand

Source: Gallo *et al*., 2022

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A DESCRIPTION OF WHOLESALE FISH MARKETS OF DELHI & NCR

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Abstract

Rasing population growth, changes in dietary pattern and increased awareness about health benefits of fish consumption among consumers have increased the fish consumption of Delhi and NCR over the years. To fulfil the increased demand for fish, many markets were developed in Delhi and NCR. These fish markets were surveyed and interpreted that Gazipur fish market is one of the major fish markets in India. Chittaranjan fish market, INA market, Gole market, Bristol fish market and Laxmi Nagar fish market were also serving to meet the fish consumption needs. Majority of the fish sold in these markets are freshwater fishes.

Introduction

The national capital Delhi is situated on right bank of river Yamuna at the periphery of the Gangetic plains. National Capital Region (NCR) usually share borders with Uttar Pradesh, Haryana and Rajasthan. The tourist places in the NCR region attract consumers from different geographical areas, therefore exhibit a variety of consumption pattern which in turn led to increase consumption of different food and non-food items including fish.

As far as consumption of fish is concerned, Delhi and NCR have great importance due to size of the market. The meagre fish production in Delhi and NCR provides a big market for fish producing states like Andhra Pradesh, West Bengal, Kerala, Karnataka, Uttar Pradesh, Haryana, and Rajasthan. There are several wholesale markets in Delhi and NCR to meet the consumer demand for fish. The major wholesale markets are Ghazipur, Chittaranjan, INA, Gole, Bristol and Laxmi Nagar fish markets.

1. Ghazipur Fish Market

The name of Ghazipur fish market is Shaheed Ashfaqueullah Khan Fish Market. It is known as a hub from which a bulk quantity of fish is traded. This market is performing extremely well due to increased demand for seafood in restaurants of the town, and it is the go-to place for buying fish in bulk. This market is regulated by *fish poultry & egg marketing committee* (Govt. of NCT of Delhi).

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Fig: Gazipur Fish Market

The entire area of NCT of Delhi was stated as market area for animal husbandry products and pisciculture. Later Jama Masjid area was declared as principal market for fish poultry & egg and a committee was constituted to regulate the market activities. Subsequently FP and EMC, Ghazipur was declared as principal market for fish, poultry and egg during 2001.

Till September 2001 fish trading was carried out from Jama Masjid area of Gali Khan Khana, Union Fish Market, Urdu Bazar, Katra Nizamul Mulk, Gali Nal Wali etc. Due to over congestion Jama Masjid fish market was relocated at Ghazipur in 15 acres of land. A total of 252 shops in various sizes were installed in the mandi in which 238 were allotted to the fish commission agents. At present, 195 valid licences are provided to wholesalers of Ghazipur fish market. Fish trade has been shifted from Jama Masjid and the new market is renamed as Shaheed Ashfaqullah Khan Fish Market, Ghazipur. Fish traded in this market is majorly arrive from West Bengal, Odisha, Maharashtra, Andhra Pradesh, Gujarat, Rajasthan, Haryana and Punjab. Since Ghazipur fish market is a distribution center hence it dispatches fish to Haryana, Himachal Pradesh, West Bengal, U.P, Assam and Chandigarh.

Market committee provides security, sanitation and other primary requirement such as drinking water, maintenance of roads, green area, traffic control and spray of medicine/ fumigation in the slaughter house without any cess.

2. Ina Fish Market

INA Market is situated right across Dilli Haat with a few stalls selling fresh seasonal fish. A variety of seafood such as shrimp, prawn, lobsters, crabs, fresh water fish like Rohu, Catla and Pangas are available. The availability of different dried fishes and fish pickles in few shops represents the consumers' demand for fish and fishery products. There are 8 wholesalers and they have permanent shops. The total sale in a day is about 500 - 1000 kg fish. However, market is located in a small place and market premises are not maintained hygienically.

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Fig: INA Market

The market is dominated by marine fish species which contribute nearly 60% and it comes mainly from Gazipur fish market. Some of the wholesalers are also having shops in Gazipur fish market. Prices are determined by the freshness and availability of fish species.

3. Chittaranjan Park Fish Market

Market is located 3 km away from Govindpuri metro station near Kalkaji in South Delhi and it is listed in the top just after Gazipur fish market. It is one of the well-known fish markets where a variety of fishes are sold. The consumer can choose any fish and vender will cut fish according to his/her choice. Surmai (King Fish), Hilsa, pomfret, cat fish, crabs, shellfish, prawns & other seafood are stacked in bulk here. Chittaranjan park fish market has two parts and they are 1 km from each other.

Fig- Chittaranjan Park Fish Market

In Chittaranjan park fish market- 2, only one wholesaler operates and sells nearly 75 kg- 100 kg/day. Market is dominated by fresh water specie mainly Rohu and Pangas along with some marine fish and shrimp. He also sells chicken along with fish.

In Chittaranjan park fish market -1, about 8- 10 wholesalers are operating. A daily sale of 300- 400 kg is observed in this market. It mainly deals with Rohu, Pangas, marine fishes and shrimp.

4. Bristol Fish Market

Bristol Market is a congested evening fish market, located at the entrance of the Sikanderpur Metro Station, Gurgaon. It is known for selling both marine and freshwater fishes for all fish lovers at affordable rates. Gazipur fish market is the supplier for this market.

Fig: Bristol Fish Market

The market makes a sale of 100-200 kg/ day with fresh water species such as Rohu, catla, Pangas along with few marine fish and shrimp. Market infrastructure is poorly developed and wholesalers sell fish just like in village hat.

5. Gole Fish Market

Gole Market is one of the oldest serving colonial markets in Delhi known for a variety of things such as its architecture, stores, sweet shops, post office, nearby religious centres etc. Also, its butcher shops are selling freshly-made frozen meat, chicken and a variety of fresh fish in raw form.

Fig: Gole Fish Market

It is located about <1 km from R.K Ashram Marg metro station. It is a small fish market with 7 wholesalers. Total sales of the in this market is around 150-200 kg/day. The dominant species are Rohu along with Pangas and Catla. Few marine species are also available.

6. Laxmi Nagar Fish Market

Market is located in laxminagar region of Delhi. There are about 8 – 10 wholesalers handling approximately 200-300 kg/day. A variety of freshwater and marine fishes are available and mostly dominated by Rohu and Pangas. Other species such as shrimp, tilapia, salmon, catla and tuna are also available. Live fish available in small quantity. This market also deals with Chicken. Price is fluctuating according to the freshness of the fish and demand.

Conclusion

A renowned wholesale fish markets of Delhi and NCR were studied. It was found that Gazipur fish market is the biggest regulated fish market in the region. About 195 licenced fish shops were present in the Gazipur fish market. Ghazipur fish market acts as a distribution centre and it dispatches fish to Delhi, Haryana, Himachal Pradesh, West Bengal, U.P, Assam and Chandigarh. Other markets namely Chittaranjan fish market, INA market, Gole market, Bristol fish market and Laxmi Nagar fish market are also significantly serving to meet the consumer demand for fish in Delhi and NCR region.

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DIAGNOSING AND AMELIORATING MACRONUTRIENT DEFICIENCIES IN CROPS

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Abstract
In order to create greater awareness among the farmers and the extension personals to understand the problem of emerging plant nutrient deficiencies in the standing crops, this paper aims at highlighting the pattern of appearance of nutrient deficiencies and corrective measures for amelioration of plant nutrient deficiency disorders in two parts. Herein, discussions on characteristic symptoms of deficiencies and remedial measures related to Macronutrients (N, P, K, S, Mg and Ca) are being presented while in the second part details related to micronutrients will be provided.

Introduction
Farmers of high productivity zones invariably apply excessive N to get the same or higher yield. Such indiscriminate use of N not only aggravates soil fertility depletion, but also results poor nutrient use efficiency, poor produce quality, higher incidence of nutrient deficiencies biotic and abiotic stresses, and a potential threat to ground water quality. Nutrient mining is being observed even with current state fertiliser recommendations. For development of pragmatic fertilization schedules, a thorough understanding of soil fertility problems well beyond NPK in the soils of different farming situations is a pre-requisite. Equally important is to redefine the soil fertility evaluation criteria, as economic yield increases to nutrient inputs are frequently reported on the soils conventionally classified in medium-high or high category. However, there is a mismatch between the soil test values and the plant nutrient deficiency problems usually seen in the field in respect of potassium, sulphur, iron and few other nutrients. Inadequate and unbalanced nutrient use is considered as one of the major reasons for incidence and expansion of multi-nutrient deficiencies in the soils and plants. Studies conducted in India have clearly established that most Indian soils are suffering from widespread deficiencies of multiple nutrients (N, P, K, Sulphur, zinc and boron) along with Ca and Mg in alkali and acid soils and so the crops grown in fields which are deficient in specific nutrients show the deficiency symptoms in the standing crop. Farmers and extension staff are unable to precisely identify the plant problems insight and to correct these disorders so they fully depend on the advice of local agri-input dealers who very often suggest to use pesticides to correct disease as they suspect instead of correcting the nutrient deficiencies in absence of expert advice. Therefore, farmers and extension personals need to be trained to identify and correct these deficiencies in the standing crops to get desired yield.

Essential Nutrients
An element is considered essential only if it is necessary for a plant to complete its life cycle, and no other element can substitute for it. Seventeen chemical elements are essential to the growth

of a plant (**Table 1**). Most of these essential elements are found in the soil. Carbon, hydrogen, and oxygen are obtained from the atmosphere and water during photosynthesis. If any one of these 17 elements is deficient or limited, plant growth will be reduced and plants may not achieve their genetic yield potential—even if all other 16 essential elements are fully available. These nutrients are classified in to three categories as primary nutrients, secondary nutrients and micronutrients.

Table 1. Essential elements needed for plant growth

Nutrients Essential for Plant Growth			
Nutrients from Atmosphere & Water	**Nutrients from Soil & Amendments** ***(Soil, Compost, Manure, Fertilizer, Organic Matter…)***		
Structural Elements	**Primary Nutrients**	**Secondary Nutrients**	**Micronutrients**
Carbon (C) Hydrogen (H) Oxygen (O)	Nitrogen (N) Phosphorous (P) Potassium (K)	Calcium (Ca) Magnesium (Mg) Sulfur (S)	Boron (B) Chlorine (Cl) Copper (Cu) Iron (Fe) Manganese (Mn) Molybdenum (Mo) Nickel (Ni) Zinc (Zn)

* Elements listed on the left are taken up in the highest quantities; those on the far right are needed only in minute quantities.

Diagnosing Nutrient Deficiency in crop plants

Nutrient mobility is a key aspect of plant nutrition that's often overshadowed by more basic information about NPK formulas and fertilisation. Understanding how plants move nutrients around their organism, however, can come in super handy when it comes to diagnosing plant health, nutrient deficiencies, and more.

The difference between mobile and immobile plant nutrients is quite simple; once they've been assimilated by a plant, ***mobile nutrients can be translocated to other parts of the plant's organism, while immobile nutrients cannot.*** In that sense, plants are able to use assimilated mobile nutrients in ways that most favour their growth, such as to address a nutrient deficiency in younger foliage by using nutrients stored in older leaves, for example. Immobile nutrients, on the other hand, cannot move around once assimilated into a plant, and usually remain in the areas of the plant where they were initially stored.

The primary, secondary, and micronutrients classified as "mobile" are:

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)
- Magnesium (Mg)
- Chlorine (Cl)
- Molybdenum (Mo)
- Nickel (Ni)

While all of the above nutrients serve different individual purposes, they do share some commonalities. In general, the aforementioned mobile plant nutrients:

- Will move towards areas where there is active plant growth
- Can move in all directions
- Are transported via the 2 main vascular plant tissues (the xylem and phloem)
- Can be effectively administered with both soil and foliar fertilisation (except nitrogen, which is best applied to the soil)

Unlike mobile nutrients, immobile nutrients cannot be relocated within a plant's organism and typically stay in the areas of the plant where they were stored. If a plant suffers from a deficiency of immobile nutrients, it will typically develop symptoms of this deficiency in areas of new growth. In most cases, nutrient deficiencies take time to develop into symptoms, especially if the lacking nutrient is immobile and the affected plant is growing slowly.

The nutrients classified as "immobile" include:

- Calcium (Ca)
- Sulphur (S)
- Boron (B)
- Copper (Cu)
- Iron (Fe)
- Manganese (Mg)
- Zinc (Zn)

Unlike mobile nutrients, immobile nutrients are only transported via the xylem. Because they cannot be redistributed within a plant, they do not move to areas of new growth. A deficiency of one of the immobile nutrients listed above will usually manifest as symptoms in new foliage first and only affect older foliage if left untreated. Immobile nutrient deficiencies typically don't respond well to foliar fertilisation and are best treated with soil-based fertilisers, where they can be absorbed via the roots and transported directly via the xylem to the areas they are needed most.

Herein discussions related to primary and secondary nutrients which collectively called as Macronutrients are being presented.

Oldest leaves affected first: Nitrogen (N), Phosphorus (P), Potassium (K) and Magnesium (Mg).
Youngest leaves affected first: Calcium (Ca) and Sulphur (S)

Precautions in identifying nutrient deficiency symptoms

Interpreting visual nutrient deficiency and toxicity symptoms in plants can be difficult and plant analysis or soil testing is necessary to confirm nutrient stress. Precautions in identifying nutrient stress symptoms include the following:

- **Many symptoms appear similar :** For instance, nitrogen (N) and sulfur (S) deficiency symptoms can be very alike, depending upon placement, growth stage, and severity of deficiencies. However, nitrogen deficiency symptoms first appear on older/lower leaves and of sulphur on the younger/upper leaves
- **Multiple deficiencies and/or toxicities :** Multiple deficiencies and/or toxicities can occur at the same time. More than one deficiency or toxicity can produce symptoms, or possibly a deficiency of one nutrient can induce the excessiveness of another (i.e., excessive P causing Zn deficiency).

- **Efficient species/cultivars :** Crop species, and even some cultivars of the same species, differ in their ability to adapt to nutrient deficiencies and toxicities. For example, maize is typically more sensitive to a Zn deficiency than barley.
- **Pseudo (false) deficiency symptoms :** Visual symptoms appearing similar to nutrient deficiency symptoms are known as Pseudo (false) deficiency. Potential factors causing pseudo deficiency include, but are not limited to, disease, drought, excess water, genetic abnormalities, herbicide and pesticide residues, insects, and soil compaction.
- **Hidden hunger:** Plants may be nutrient deficient without showing visual clues.
- **Field symptoms appear different than 'ideal' symptoms :** Many of the plants shown in this module as photographs were grown under controlled nutrient conditions, and deficiency/toxicity symptoms observed in the field may or may not appear as they do here. Experience and knowledge of field history are excellent aids in determining causes for nutrient stress.

  In addition to the above precautions, visual observation is also limited by time. Between the time a plant is nutrient deficient (hidden hunger) and visual symptoms appear, crop health and productivity may be substantially reduced and corrective actions may or may not be effective. Therefore, regular soil or plant testing is recommended for the prevention and early diagnosis of nutrient stress.

Issues related with diagnosis, correction and prevention of nutrient deficiencies

The way crops deal with deficiency depends on whether the nutrient is mobile or immobile in the plant. If the nutrient is mobile, like nitrogen, phosphorus or magnesium, the plant can 'strip it' from the old leaves to protect the younger growth and reproductive organs. However, if it's immobile like calcium or boron, deficiency will occur throughout the entire plant.

Poor growing conditions make plants unable to fully utilize soil nutrients and thus shortages in plants. Extremely dry or waterlogged soil, extreme acidity or alkalinity can all hinder plants' ability to absorb nutrients from the soil. For example, high pH levels in soil restrict availability of zinc, copper, manganese and iron, and dry top soil can limit the uptake of calcium and boron early in the season. In acid soils, calcium and magnesium is a common problem due low base saturation. The problem of phosphorus fixation due high Al, Fe and Mn content and also the toxicity of these nutrients are the major problems of nutritional disorder. Leaf browning or yellowing is an indication of nutritional deficiencies and can take many different forms. It can lead to fruiting or flowering being poor as well as decreased development. Deficiencies can occur even when the nutrient is in optimal supply due to these adversities which often affect the soil's ability to transfer the nutrient or the plant's ability to access it.

When correcting nutrient deficiencies, one should keep in mind that interactions between nutrients can influence uptake. Too much of one nutrient can restrict the crop's ability to take in another. If the crop is displaying potassium deficiency symptoms, it may indicate a shortage of potassium, but it may also be related to over application of nitrogen, calcium or magnesium, or it may also be caused by saline soil. Excessive application of phosphorus very often causes zinc deficiency. In potato crop this a general problem.

In saline soils, crops can take in excess chloride, which greatly reduces phosphorus uptake. Likewise, high potassium and/or calcium often trigger magnesium deficiency in plants. If there is

too great an abundance of certain nutrients in the soil, a crop may also turn on its natural toxicity prevention mechanisms, which could lead to reduced nutrient uptake.

Although abiotic and biotic stresses are the biggest causes of nutrient deficiencies, some practices used on the farm can contribute a great deal. Compaction is likely going to induce early-season deficiency of potassium. The chemistries used to control weeds, diseases and pests also have chelating properties that prevent crops from accessing certain nutrients at critical times.

In addition, some weed species are very competitive, sequestering key nutrients from the root zone and preventing crops or their beneficial microbes from accessing them.

If a nutrient deficiency is being suspected but are not certain, check with the specialist local extension officer/scientist. They can provide information and assistance to confirm nutrient deficiencies and then the necessary action should be taken to restore nutrient balance to the plants. Choosing a foliar fertilizer application is an excellent way to supply crops with necessary nutrients and to prevent or correct deficiencies. When the cause of deficiency is not clearly identified, foliar application of such fertilizers developed with balanced NPK formulations with key secondary nutrients and a full micronutrient package, would be a better option than highly concentrated solutions of single nutrients. When nutrient deficiencies go unchecked, symptoms spread. Expect poor plant vigour, stunted growth, reduced lateral branching, weak flower and fruit development, poor root growth, terminal bud death and disappointing harvests.

Roles, deficiency symptoms and corrective measures of Macronutrients

Treating nutrient deficiencies in plants involves several steps. First, identify the specific nutrient lacking in the plant through visual symptoms or soil and tissue testing. Next, provide the deficient nutrient through fertilizers or organic amendments tailored to the plant's needs. Improve the pH levels of the soil if necessary to enhance nutrient availability. Finally, monitor the plant's response and make any necessary adjustments to ensure it receives balanced nutrition for healthy growth. Characteristic symptoms of the deficiencies of primary and secondary nutrients ie. macronutrients and the corrective measures are described below:

Nitrogen

Roles and deficiency symptoms : The main role of nitrogen in plants is to stimulate vegetative growth and maximize crop potential. The effects of nitrogen shortage in plants can be identified with characteristic symptoms such as yellowing typically begins at the leaf margins and progresses inward (**Pictures 1**). Because N is a part of the chlorophyll molecule, a major deficiency symptom is chlorosis of oldest or lowest leaves, stunted and slowed growth, reduced size of new leaves, shorter internodes, less tillering in small grains and other grasses, reduced fruit set, reduced yield potential and finally insufficient protein content.

Corrective measures : Nitrogen fertilizers such as urea, IFFCO nano urea (liquid), ammonium sulphate or calcium nitrate, organic manures can help in correcting nitrogen deficiency in plants.

2. Phosphorus

Roles and deficiency symptoms : As a primary nutrient for plants, phosphate supports root development, initiates flower, develops seed and fruit, and builds reserves in roots. Symptoms generally appear on older leaves first as purple or reddish coloration and brown veined leaves and grey luster, overall stunting, reduced tillering and slightly darker color of leaves in small grains and

reduced yield potential (**Pictures 2**).

Corrective measures : Apply a phosphorus-rich fertilizer or amendment viz. DAP, single superphosphate and NP/NPK complexes at the recommended rate to solve this problem to the soil. Work it into the soil around the plant's root zone. Foliar spray of IFFCO nano DAP (liquid) is a better option for quick recovery. Additionally, ensure proper soil pH, as phosphorus availability is optimal in slightly acidic to neutral soil. Avoid over-fertilization, as excessive phosphorus can interfere with other nutrient uptake. Regularly monitor the plant's progress and make adjustments as needed to address the deficiency effectively.

3. Potassium

Roles and deficiency symptoms : Plants need Potassium to boost the size of grains and seeds, and produce high-quality fruits and vegetables, in addition, to increasing drought tolerance and improving disease resistance. Lack of Potassium in plants can be identified by mild chlorosis progressing into dry and leathery burns, veins become scorched or necrosis and leaves tend to curl and crinkle (**Pictures 3**). The plants produce fewer blossoms and fruit.

Corrective measures : Apply a potassium-rich fertilizer or organic amendment to the soil like muriate of potash, natural potash, potassium sulphate and 100% water soluble NPK. Ensure proper watering practices and adequate drainage, as excessive moisture can hinder potassium uptake. Regular soil testing can help determine the effectiveness of the treatment and guide further adjustments.

4. Calcium (Ca)

Roles and deficiency symptoms : Ca is a component of plant cell walls and regulates cell wall construction. Ca deficiency is uncommon in most areas due to the presence of calcium carbonates and gypsum in most agriculture soils. However, crops grown in acid and alkali soils may face the problem of Ca deficiency. Insufficient Ca can cause young leaves to become distorted and turn abnormally dark green. Leaf tips often become dry or brittle and will eventually wither and die. Stems are weak and germination is poor. To learn more, look for these nutrient deficiency symptoms as displayed in **Pictures 4.**

(**Pictures 4).**

Corrective measures : To correct Ca deficiency in plants incorporate calcium-rich amendments, such as gypsum or lime into the soil. This helps raise Ca levels over time. Additionally, maintain consistent moisture levels to prevent Ca deficiency caused by irregular water uptake. Lastly, consider foliar sprays containing Ca to provide a direct supply to the leaves.

5. Magnesium (Mg)

Roles and deficiency symptoms : Plants require Mg to keep enzymes that produce carbohydrates, sugars, and lipids working and to manage nutrient absorption. Symptoms include older leaves Symptoms of Mg deficiency include interveinal chlorosis and leaf margins of older leaves becoming yellow or reddish-purple while the midrib remains green. Leaves become chlorotic between the veins, a condition known as interveinal chlorosis. In severe deficiency, the plant's growth rate slows, leaf size decreases, and lower leaves die. In wheat, distinct mottling as yellowish-green patches will occur, and red clover (Egyptian clover)/ alfalfa leaves may curl and have reddish undersides. Leaves of Mg deficient sugar beets and potatoes are stiff and brittle and veins are often twisted. Reduced Mg concentrations in forage can lead to grass tetany (low blood serum Mg) in

animals. Magnesium is a component of the structure of the chlorophyll molecule. To learn more, look for these nutrient deficiency symptoms as displayed in **Pictures 5 and 5A.**

Corrective measures - Apply a magnesium-rich fertilizer like Epsom salt/ magnesium sulphate to treat magnesium deficiency in plants or amendment to the soil.

6. Sulphur (S)

Roles and deficiency symptoms : As S is an essential constituent of certain amino acids and proteins, S deficiency results in the inhibition of protein and chlorophyll synthesis.

S deficiency symptoms can be difficult to diagnose as effects can resemble symptoms of N and Mo deficiencies. In contrast to N or Mo deficiency, however, S deficiency symptoms initially occur in *younger* leaves, causing them to turn light green to yellow (chlorosis) (In later growth, the entire plant may be pale green. Characteristic spots or stripes are generally seen on the younger leaves. To learn more, look for these nutrient deficiency symptoms as displayed in the **Pictures 6.**

Pictures 1. Nitrogen Deficiency Symptoms in maize, sorghum, wheat, potato, cotton and sugarcane

Pictures 2. Phosphorus deficiency symptoms in maize, sorghum, sugarcane, wheat, mustard and tomato

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Pictures 3. Potassium deficiency Symptoms in rice, wheat, soybean, maize, maize cobs, arum, potato, cotton, tobacco, cucumber, onion, garlic and cabbage.

Pictures 4. Calcium deficiency symptoms in tomato, wheat, pineapple and Egyptian clover

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Pictures 5. Magnesium deficiency symptoms in maize, rice, wheat, cotton, arum, tomato, broccoli, soybean and sugarcane

Pictures 5A. Magnesium deficiency symptoms in okra, grape, mango, mung bean, rice and potato

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Pictures 6. Sulphur Deficiency Symptoms (peanut, pea, chickpea, wheat, turmeric, maize, Rice, brinjal, coriander, okra, potato and sweet potato)

The keys for diagnosing and correcting Macronutrients deficiency are provided in **Table 1**.

Table 1. Keys for diagnosing and correcting macronutrients deficiency

Macronutrient Deficiency Symptoms	Fertilizer Sources
Nitrogen (N) – Entire leaves show general yellowing, starting in older leaves and progressing through the plant.	Any nitrogenous fertilizer, IFFCO Nano urea (Liquid)
Phosphorus (P) – Older leaves take on an unnaturally dark green or reddish-purple coloration. Leaf tips brown and die.	Anything with the words "phosphates, IFFCO Nano DAP, Water soluble NP/NPK fertilizers

Macronutrient Deficiency Symptoms	Fertilizer Sources
Potassium (K) – Leaf margins on older leaves turn bright yellow, then look scorched. Brown speckles may cover leaves.	Anything with the words "potassium or potash including natural potash of sugar factories.
Calcium (Ca) – Younger leaves turn light green or yellow between veins, new tips may look brown or black, fruiting vegetables may rot at the blossom end.	Anything with the word "calcium" or gypsum.
Magnesium (Mg) – Older leaves develop yellow patches between leaf veins. Veins stay green as chlorosis expands.	Anything with the word magnesium or Epsom salts.
Sulphur (S) – General, uniform yellowing of entire leaf starts with young leaves.	Anything with the word "sulphate."

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DIAGNOSING AND CORRECTING MICRONUTRIENT DEFICIENCIES IN AGRONOMIC CROPS

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Abstract
In the first part of the paper published in this issue, the diagnostic and corrective measures for macronutrient deficiencies in agronomic crops have already been discussed. Herein, the diagnostic and corrective measures for micronutrient deficiencies are being presented in this second part in this issue itself.

Introduction
Essential micronutrients involved in plant nutrition are: zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), boron (B), molybdenum (Mo), chlorine (Cl), and nickel (Ni); for animals Zn, Fe, Mn, Cu, selenium (Se), iodine (I) and cobalt (Co) have been identified as being essential; and list for humans includes Zn, Cu, Fe, Mn, Mo, Co, I, Se, fluorine (F), and chromium (Cr). Micronutrients are required in very small quantities for overall growth of plants. India has larger prevalence of micronutrient deficiency in soils and plants so the problem of malnutrition as 50% of children and women are suffering from one or more essential micronutrient deficiency. Widespread multi-nutrient deficiencies in soil are resulting in low yield and poor quality products leading to malnutrition. This paper highlights the ways to identify the symptoms of micronutrient deficiency in standing crops and measures to correct them are also suggested.

Diagnosing Micronutrient Deficiency in Crop Plants
Like macronutrients, some micronutrients are mobile and others immobile. The mobile micronutrients are molybdenum (Mo), zinc (Zn) (intermediate mobility) and Chlorine (Cl) while boron (B), iron (Fe) manganese (Mn) and copper (Cu) are immobile. Mobile nutrients may be moved from one areas of the plants to another if availability becomes growth limiting or say from “less important” to “more important” areas. Mobile nutrients manifest deficiency symptoms first on the older tissues because of their movement from older to newer tissues. Plant unable to move nutrients from older tissues to newer tissues, the deficiency symptoms first appear on newer leaves or say leaves to flowers/apical meristems, etc.

Roles, Deficiency Symptoms and Corrective Measures of Micronutrients
Roles, characteristic symptoms and corrective measures of the deficiencies of micronutrients are described below:

Boron (B)
Roles and Deficiency Symptoms : Plants take boron as borate from the soil. Primary functions of B in plants are related to cell wall formation and reproductive tissue. Plants suffering from B deficiency exhibit chlorotic young leaves and death of the main growing point (terminal bud). Whitish-yellow spots may also form at the bases of leaves. Boron is required for cell differentiation at plant growth tips, where cell division occurs. Deformed and stunted vegetation are indicators of a

deficiency. As the main stem dies, 'witches broom' side shoots appear to ensure that the lateral shoot's growth remains dormant. This is referred to as apical dominance loss. Due to disturbances in cell wall growth, leaves and stems of B deficient plants will become brittle and distorted and leaf tips tend to thicken and curl. The leaves tend to be thickened and may curl and become brittle (**Pictures 1**). In many crops, the symptoms are well defined and crop-specific, such as: alfalfa and canola: rosette (the clustering of leaves in crowded circles); peanuts: hollow hearts; celery: crooked and cracked stem, beets: black hearts, sugar beets: crown and heart rot; papaya: distorted and lumpy fruit carnation; Chinese cabbage: midribs crack, turn brown; cabbage, broccoli, and cauliflower: pith in hollow stem.

Corrective Measures : Boron shortages can be avoided by staying hydrated. Furthermore, borax (14% or 20% boron) are excellent fertilizers for increasing soil boron levels. Foliar application (0.2%) is more effective than soil application. Soil application of borax @ 4 to 6 kg/acre may be sufficient. However, be cautious not to overapply boron, as it can be toxic in excessive amounts.

Some Examples of Boron Deficiency in Crops

Pictures 1. Symptoms of boron deficiency in red clover, tomato, cabbage, sugarcane, tomato plant, tomato fruits, mango (bud necrosis), mango (resetting) and cracking of edible parts sweet potato and beet roots (Below)

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Copper (Cu)

Roles and Deficiency Symptoms : Copper is needed for chlorophyll production, respiration, and protein synthesis. Cu deficient plants display chlorosis in younger leaves, stunted growth, delayed maturity (excessively late tillering in grain crops), lodging, and, in some cases, melanosis (brown discoloration). In cereals, grain production and filling is often poor, and under severe deficiency, grain heads may not even form (**Pictures 2**). Cu deficient plants are prone to increased disease, specifically ergot, a fungus causing reduced yield and grain quality. The onset of disease-caused symptoms may confound the identification of Cu deficient symptoms. Wheat and other small grains are the most sensitive crops to Cu deficiency. Similar to Zn, forage that is deficient in Cu can cause a reduction in the reproductive efficiency of cattle. Cu deficient citrus tree show severe incidence of citrus canker.

Corrective Measures : In standing crop two foliar spray of copper sulphate (0.25-5% solution) at fortnightly interval can correct Cu deficiency. If the deficiency is confirmed with experiences in previous crop or in trees showing symptoms of Cu deficiency, both soil application @ 6 to 8 kg/acre of copper sulphate and foliar spray (0.25-5% solution) is recommended.

Picture 2. Symptoms of copper deficiency symptoms in maize, wheat, wheat II, barley, sugarcane and citrus

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Iron (Fe)

Roles and Deficiency Symptoms: Iron plays an important role in plant respiratory and photosynthetic reactions. Fe deficiency reduces chlorophyll production and is characterized by interveinal chlorosis with a sharp distinction between veins and chlorotic areas in young leaves (**Pictures 3**). As the deficiency develops, the entire leaf will become whitish-yellow and progress to necrosis. Slow plant growth also occurs. Distinct yellow or white areas appear between veins of younger leaves and veins eventually become chlorotic. Symptoms are rare on mature leaves.

Corrective Measures- As iron under dry condition is converted into unavailable form (Ferric form), this condition can be reversed by irrigation. In standing crop two foliar spray of ferrous sulphate (1% solution) at fortnightly interval can correct Fe deficiency.

Picture 5. Symptoms of iron deficiency symptoms in maize, sugarcane, peanut, sorghum, soybean and tomato

Manganese (Mn)

Roles and Deficiency Symptoms: Chloroplasts (plant organelles where photosynthesis occurs) are the most sensitive of cell organelles to Mn deficiency. Symptoms of Mn deficiency first appear as chlorosis in young tissues because manganese is not mobile (**Pictures 4**). However, unlike Fe, there is no sharp distinction between veins and interveinal areas, but rather a more diffuse chlorotic effect. Unlike Fe chlorosis symptoms, in dicots chlorosis shows up as tiny yellow spots. In monocots, greenish-grey specks appear at the lower base of younger leaves. The specks may eventually become yellowish to yellow-orange. Chlorosis is less marked near veins. Some mottling occurs in interveinal areas. Chlorotic areas eventually become brown, transparent, or necrotic. Symptoms may appear later on older leaves. Two well known Mn deficiencies in arable crops. In legumes, necrotic areas develop on the cotyledons, a symptom known as marsh spots particularly in peas. The other is grey speck in oats. White streak in wheat and interveinal brown spot in barley are also symptoms of Mn deficiency.

Corrective Measures : Manganese deficiency is easy to cure preferentially with the foliar spray of manganese sulphate (0.5-1% solution). Manganese oxide may be used as soil application in acid soils.

Pictures 4. Symptoms of manganese deficiency in peanut, rice, soybean, cucumber, cowpea, potato, sweetpotato, apple and citrus

Molybdenum (Mo)

Roles and Deficiency Symptoms: Mo is needed for enzyme activity in the plant and for nitrogen fixation in legumes. Due to this interrelationship, Mo deficiency symptoms often resemble N deficiency symptoms with stunted growth and chlorosis occurring in legumes. Other symptoms of Mo deficiency include pale leaves that may be scorched, cupped, or rolled. Leaves may also appear thick or brittle, and will eventually wither, leaving only the midrib (**Pictures 5**).

Corrective Measures : Mo deficiency can be corrected by foliar sprays of commercial grade sodium/ammonium molybdate (0.1-0.2% solution).

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Pictures 5. Symptoms of molybdenum deficiency in cauliflower and sugarcane.

Zinc (Zn)

Roles and Deficiency Symptoms: Zinc is needed by plants for growth hormone production and is particularly important for internode elongation. Zn deficient plants generally exhibit severe stunting. Flowering and seed set is also poor in affected plants. Zn has intermediate mobility in the plant and symptoms will initially show up in middle leaves. Zn deficiency causes interveinal, light striping or a whitish band beginning at the base of the leaf and extending towards the tip. The margins of the leaf, the midrib area, and the leaf tip usually remain green. Plants are stunted because internodes are shortened. Chlorotic areas can be pale green, yellow, or even white. Severe Zn deficiencies will cause leaves to turn grey, white and fall prematurely or die. Crop specific symptoms include smaller leaf size in alfalfa, grey or bronze banding in cereal leaves, reduced tiller production in wheat and other small grains, and abnormal grain formation. In rice - wheat cropping system in India, rice is more vulnerable to Zn deficiency as compared to wheat mainly because of high moisture regime and high availability of nutrients in particular, P, Ca, Fe, Cu etc. which have antagonistic relationship with Zn. Zinc deficiency in rice is known as *Khaira* disease matching with reddish brown coloration on middle leaves New leaves of maize under severe deficiency are nearly white, an effect termed “white bud.” (**Pictures 6**). Zinc deficiency is favored by high soil pH; light texture; low organic matter; cool, wet soil; and high phosphorus fertilizer applications on soils that are marginal in zinc availability (although high soil phosphorus levels alone don’t create zinc deficiency but do create problem to hidden hunger as we see in potato growing areas due to over dosing of P fertilizers. Zn deficiencies in forage have been reported to reduce reproductive efficiency in cattle. Zn deficiency generally does not affect whole fields uniformly and deficient areas are scattered due to soil and moisture variations.

Corrective Measures : Zn deficiency can be corrected by soil application of zinc sulphate, heptahydrate @ 5 to 8 kg/acre as basal application to enhance availability of Zn and to prevent Zn deficiency. in soil depending on the severity of deficiency In case, Zn deficiency is seen in the standing crop, 2 foliar sprays of zinc sulphate, monohydrate (0.3% solution) at weekly/fortnightly interval should be done depending on the magnitude of deficiency.

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Pictures 6. Symptoms of zinc deficiency in maize, rice, wheat, tomato, potato, citrus and mango

Chloride (Cl)

Roles and Deficiency Symptoms: Chloride (Cl) is required by the plant for leaf turgor and photosynthesis. Until recently, little information was documented on Cl deficiencies, as symptoms were often misdiagnosed as physiological leaf spot. However, recent studies have shown Cl deficiencies to exist in western countries with visual symptoms observed in winter wheat and durum wheat cultivars. Plants with insufficient Cl concentrations show chlorotic and necrotic spotting along leaves with abrupt boundaries between dead and live tissue. Wilting of leaves at margins and highly branched root systems are also typical Cl deficient symptoms, found mainly in cereal crops. Cl deficiencies are highly cultivar specific and can be easily mistaken for leaf diseases. In India, Cl deficiency is not a problem.

Cobalt

Cobalt has proven to be beneficial to at least some plants although it does not appear to be essential for most species. It has, however, been shown to be essential for nitrogen fixation by the nitrogen-fixing bacteria associated with legumes and other plants.

Nickel (Ni)

Nickel is required by plants for proper seed germination. Additionally, Ni is the metal component in urease, an enzyme that catalyzes the conversion of urea to ammonium. Research has shown

Ni to be beneficial for N metabolism in legumes and other plants in which ureides are important in metabolism. Though Ni deficiency symptoms are not well documented and believed to be non-existent in India, symptoms include chlorosis and interveinal chlorosis in young leaves that progresses to plant tissue necrosis. Other symptoms include poor seed germination and decreases in crop yield.

Summary

These nutrients are called “micro” because plants need only small amounts of them. Earlier they were even called “trace elements”. Though they all have to play a vital role in plant life. Boron is a boss (or regulator) of other nutrients. Plants need it for seeds and fruit. To correct boron deficiency powdered boron is added. Copper helps plants reproduce and boosts metabolism in roots. Copper is needed for chlorophyll production, respiration, and protein synthesis. Iron assists in producing chlorophyll. Manganese breaks down carbohydrates, cooperating with enzyme systems. Molybdenum aids nitrogen use by plants. Zinc helps change carbohydrates into sugars, and it’s in plant growth enzymes too. Add it via zinc oxide, zinc sulphate, and zinc chelate. Chloride is another aid to plant metabolism. Nickel is required by plants for proper seed germination. Additionally, Ni is the metal component in urease, an enzyme that catalyzes the conversion of urea to ammonium. We should always be cautious if our crops are suffering from deficiency of anyone of these micronutrients, otherwise neglect of applying few grams of specific micronutrient to correct existing deficiency will not allow the bags of applied NPK to work well.

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MUD CRAB: CULTURAL TECHNIQUES AND MANAGEMENT

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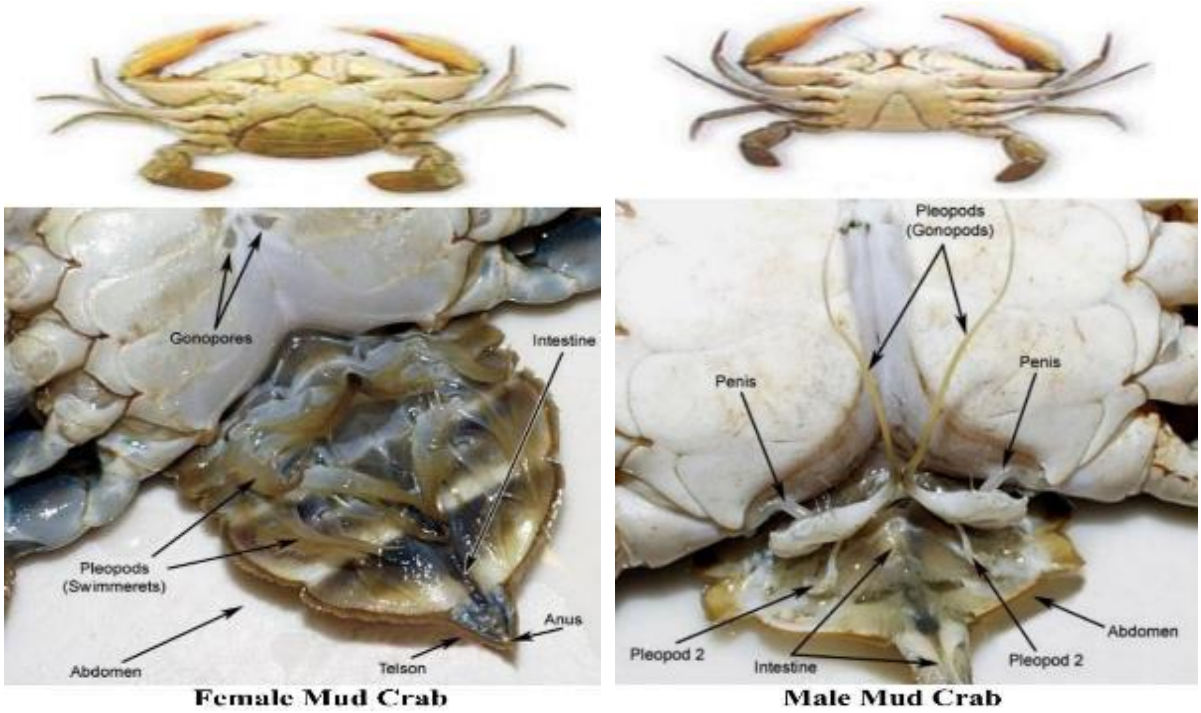
Abstract
The four major mud crab species *Scylla serrata, S. tranquebarica, S. paramamosain*, and *S. olivacea* are among of the most valuable crab species since the bulk of their commercial production is delivered live to market. Each of the four Scylla species has a somewhat distinct biology, which results in changes in the best methods for aquaculture production. The use of formulated feeds for them is still in its infancy, and little work has yet been done to improve stock performance through breeding programs, making mud crabs still considered to be in an early stage of development compared to many other species that are the subject of industrial-scale aquaculture.

Introduction
Throughout their range, commercial fisheries and aquaculture production are centered on four species of mud crab: *Scylla serrata, S. tranquebarica, S. paramamosain*, and *S. olivacea*. *Scylla serrata*, sometimes known as mud crab, is the species that is most widely regarded as being ideal for coastal aquaculture. They are one of the costliest crab species in the world since the majority of their commercial output is supplied live to markets. When compared to other forms of aquaculture, mud crab farming still has a lot of variations, such as the use of wild and hatchery-produced seed stock, farming systems that range from very extensive to intensive, monoculture to polyculture, and farm locations that range from mangrove forests to well-constructed aquaculture ponds or fattening cages. The habitat preferences of *S. paramamosain* of various sizes have been documented to differ noticeably. Crablets that are just 0.5 cm in carapace width (CW) begin to live on the surface of mangroves and subsequently move deeper into the woods (CW 1.5 cm). While the majority of the adult crab population lives offshore, subtidally (CW 12.5 cm), bigger crabs construct burrows or reside in the subtidal zone, moving in to eat in the mangroves at high tide (CW 4.5 cm). Mud crab distribution within local populations is marked by strong ontogenic variations, with some studies indicating that juveniles are more prevalent in seagrass and algal beds connected to mangroves. A region that can support larger crab populations is the border between the mangroves and the mud crab flats. The subtle biological differences among the four species of Scylla lead to variances in the most effective methods of aquaculture production. Farmers, researchers, and extension workers may all need to adapt findings from other species to their preferred species of mud crab and local environmental factors

where variances are known and documented. The use of formulated feeds for them is still in its infancy, and little work has yet been done to improve stock performance through breeding programs, so mud crabs can still be considered to be in an early stage of development when compared to many other species that are the focus of industrial-scale aquaculture.



Female Mud Crab **Male Mud Crab**

Why the Importance of Mud Crab Farming?

- Commercial significance as food organisms.
- The crab meat is having high export value and is highly relished by foreigners.
- Resistance to diseases in culture.
- Survival outside the water in case of emergency.
- Tolerance to a wide range of temperatures & salinity.
- Scylla serrata is mainly cultured for its meat-rich chelate legs.
- Crab meat is sweet and tasty.
- It also has medicinal value and is used to cure various protein deficiency diseases.
- Crab meat has 20% protein, 5% fat, 2% Minerals, vitamins A and D, glycogen, and free amino acids so it has high demand as a table food all over the countries.

Habit and Habitat

Female crabs bearing eggs are scarce in southern Asia during the winter, while they are nearly always present in tropical areas. They consume the leftovers of crustaceans, mollusks, fish, and plants, as well as debris that naturally forms as food. Mud crabs consume fish voraciously because they are omnivorous eaters. Reproduction season varies depending on the temperature of the water around. *S. tranquebarica* is estimated to lay 2.5 to 7.0 million eggs in the backwaters of Cochin and 0.05 to 2.0 million eggs in Karwar. According to the captive broodstock induction of maturity, the fecundity range of *S. tranqueharica* is from 2.0 to 5.0 million eggs while *S. serrata* ranges from 1.0 to 3.0 million.

Culture Parameters

Site selection is an important process in farming as it decides the success or failure of mud crab farming. The crabs are boreholes along the dykes and cause leakage so coastal ponds with numerous mounds and un-submerged regions are more suitable for crab culture. Because there is less margin for error in site selection, cage, and pen-based aquaculture systems suffer in contrast to operators that use land. If a cage or pen farm's location turns out to be excessively exposed, the water exchange is subpar, or the water quality declines, there isn't much that can be done.

It is good to use silty clay, clay loam, or clayey soil with a sufficient layer of clean mud. When mud crabs are eating, moulting, or in their post-molt soft state, this type of soil can adapt well to their biological needs. Additionally, mud crabs may thrive in this type of soil by retaining the ideal depth of water. In general, mud crabs can tolerate a broad range of salinity and temperature. The species' ideal temperature and salinity parameters should be reached since, even just a little outside of these ideals, feeding, food conversion, and growth are negatively impacted. Crabs may use the oxygen in the air for their own purposes. They can survive water temperatures of 12 to 35 °C, but when the temperature drops below 20 °C, their activity and feeding drastically decrease. They can endure in the salinity range of 2 to 43 ppt. The availability of stocking materials, an adequate supply of inexpensive garbage fish, and storage facilities for fresh, unprocessed feed are among other considerations. Water of good quality should be adequate throughout the culture period, coming directly from the water sources.

Types of Farming

There are mainly two types of crab farming adapted for the commercial systems;

a). Grow out System (in Pond)

Young crabs are raised using this farming technique for a total of six months until they are of marketable size. This kind of crab farming setup often uses ponds. Construction, administration, feed, and other pond-related technical requirements must be satisfied.

b). Fattening System

i. Pond Fattening System: In this method, mud crab fattening, one can select the size of the pond from 0.025 to 0.2 ha. The suitable tidal pond depth is about 1.5 m. All the proper technical parameters are required for pond construction, management, feed and other sources.

ii. Cage or Pen Fattening System: Floating cages, pens, and capes constructed of bamboo can be used in shallow rivers and inside sizable prawn ponds with strong tidal water flow in addition to pond fattening. The ideal cage dimensions for fattening crabs are 3 m by 2 m by l m. HDPE or bamboo splits are utilized as the netting material in cage culturing. It is advised to have 9 to 10 crabs per square meter in the cage and 4 to 5 crabs per square meter in the pen when it comes to stocking density. This method of fattening is only effective for small-scale farming; pond fattening is preferable for commercial mud crab fattening on a big scale.

Stocking Density and Feed Management

For a higher output, ponds with dense populations of crabs are desirable. Soft-shelled crabs with carapace widths more than 9 cm or crabs weighing more than 575 grams should be stored in general. The ideal stocking density is 1 to 3 crabs/m2. To avoid cannibalism and death, employ similar-sized crabs and divide the pond into sections or compartments. It is recommended to pet

soft-shelled crabs from certified hatcheries or nurseries for pond stoking. Male and female crabs can be kept separately.

Mud crabs are fed 5-10% of their body weight in bivalve meat/trash fish, brackish water clams, or cooked chicken feces on a daily basis (10% of body weight in the first week). Typically, fattening takes place for 20 to 21 days. If you intend to feed your pet twice a day, be sure to feed them more in the evening than in the morning. For greater growth and to prevent cannibalism, be careful throughout the feeding period.

Management of Mud Crab Farming

Mud crab cultivation involves a lot of pond preparation. Small tidal ponds are available in sizes ranging from 0.025 to 0.1 h, with a water depth of around 0.5 m to l m. The process of rearing mud crabs often takes place in ponds, pens, or cages. Building a pond shape should be done with the appropriate attention. Sand should be present in the pond's bottom to prevent any burrowing. As crabs can escape by tunneling through the bunds, ensure sure the top of the bunds is at least l m wide. They even climb over the bunds, which may be avoided by installing overhanging fences on dykes, in addition to this risk. Utilizing materials like asbestos sheets, bamboo sticks, or glass panels, fencing should be placed between the dyke and a height between 0.5 and 1 meters. The flow of tidal water should be controlled by sluice gates. Bamboo screens should be installed on the sluice gates since they also stop crabs from escaping. To avoid cannibalism or mortality, "hideouts" made of hollow bamboo pieces, cement pipes, or stones should be positioned inside the pond. Before liming the pond, drain the water and make sure it is totally dried out. This helps shield crabs from dangerous diseases. Water in the pond should always be kept at a maximum height of 1.5 meters.

Harvesting

Crabs may go through six fattening cycles in a pond in a year and have an anticipated survival rate of 75 to 80%. It is important to regularly inspect the crabs for hardness. It is advised to collect the crabs in the early morning or late at night. After the shell has hardened and before the subsequent moulting, the crabs should be collected. The crabs may be gathered with scoop nets. Even hand-picking can be effective. Clean the crabs to get rid of any filth, then bind the legs without hurting or breaking them.

Production and Returns

This is only a preliminary estimate, but one may anticipate that a crop would produce between 240 and 250 kilograms per acre. This output brings in roughly Rs. 80,000. These numbers might, however, vary from time to time and place to place.

Conclusion

There are two ways to cultivate mud crabs. With this technique, newborn crabs are raised for 5 to 6 months until they reach the ideal size. Ponds with or without mangroves are often the basis of mud crab grow-out systems. The pond has suitable bunds and tidal water exchange, and its size ranges from 0.5-2 hectares. Crabs with soft shells are raised for a few weeks until their exoskeleton hardens. These 'hard' crabs, often known as "mud" (flesh) in the area, sell for three to four times more than soft crabs. Small tidal ponds between 0.025 and 0.2 hectares with a water depth of 1 to 1.5 m can be used for fattening.

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INFLUENCE OF PROTECTED STRUCTURE IN BROCCOLI CULTIVATION

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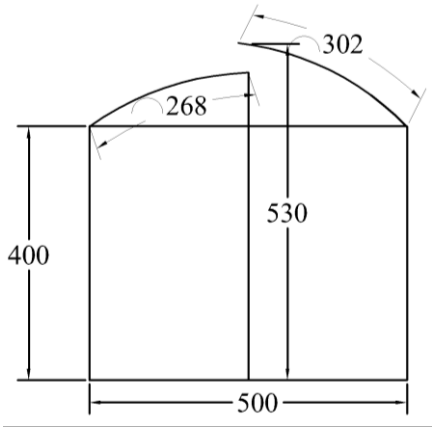
Abstract
This study was investigated the influence of protected structures (shadenet house and natural ventilated net-cum-poly house) on the growth and yield of broccoli. Various crop parameters, including stem diameter, plant height, plant canopy, number of leaves per plant, curd weight, and curd yield were measured. The results revealed that the shadenet house recorded lower temperature (28.7 ^{0}C) and higher humidity (40%) at 15:00h compared to other structure which resulted better crop performance followed by the natural ventilated net-cum-poly house except plant stand and number of leaves per plant. The light intensity (lux) was also recorded as 32582 and 26335 in natural ventilated poly-cum-shadenet house and shadenet house respectively while it was observed 76773 lux in open field at 12:00 h. Overall, the research suggests that structures like shadenet house and natural ventilated net-cum-poly house can be beneficial for growing broccoli for promoting taller plants, bigger heads and reduced insect pest occurrences thereby resulting in higher marketable yield by altering micro climatic parameter inside the structure.

Keywords: Shadenet house, Natural ventilated net cum poly house, Broccoli, climatic parameter, crop parameter

The production of vegetables in India has increased from 101.2 million tonnes to 184.40 million tonnes from 2004-05 to 2017-18 (Anon., 2018) which is sufficient per capita availability of fruit and vegetable consumption. However, green leafy vegetables are the least consumed by peoples. The world population is increasing continuously and it is difficult to feed the entire population through traditional farming. The fruit and vegetable production could be manifold through the protected cultivation (Sojitra *et al*., 2023). In addition to mulch helps to regulate soil temperature, protecting crops from extreme heat or cold further it enhances the yield (Prajapati and Subbaiah, 2015, Prajapati and Subbaiah, 2019). The vegetables from the brassica family are good source of minerals vitamin, dietary fibres and lipids. The yield and production of vegetables, fruits and flowers are highly affected by climatic conditions. Heavy rain, thunderstorms, excessive solar radiation, temperatures and humidity levels are the constraint of open field cultivation of vegetables (Max *et al*., 2009). Sometimes crop are completely vanished by external factor that could not be controlled in open field. It can be optimized through protected cultivation. Insect and pest attack could be reduced in protected structures which improved crop growth parameters and yield (Prado *et al.*, 2008). In arid and semi-arid regions, irrigated agriculture stands as the largest

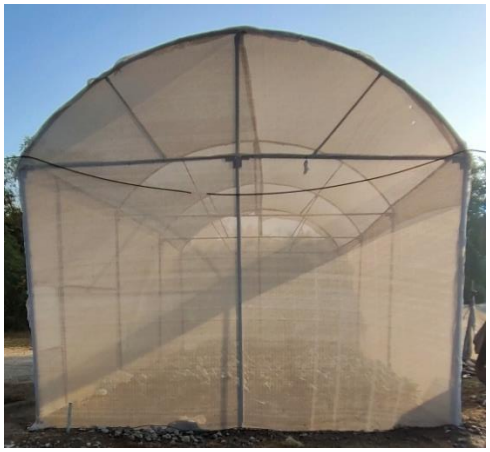
consumer of water (Parmar *et al.,* 2023; Kunapara *et al.,* 2016) and the protected cultivation also optimizes the natural resources.

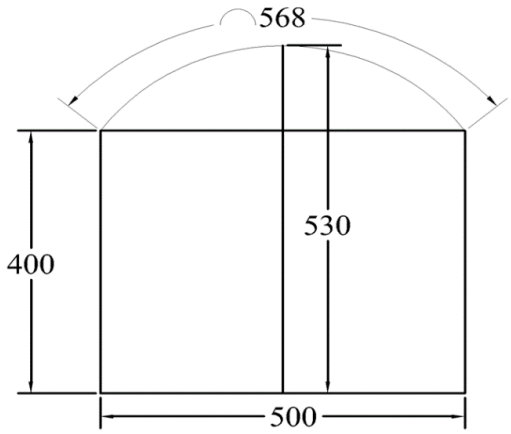
The experiment was conducted to study the effect of protected structure on crop parameter like; stem diameter, plant height, plant canopy, no of leaves per plant, curd weight, curd yield of broccoli. The details of natural ventilated net-cum-poly house and shadenet house are given in Fig. 1 and Fig. 2 respectively. The research result of crop parameters was found significantly highest inside the shadenet house followed by natural ventilated net-cum-poly house except for plant stand and number of leaves per plant that might be due to lower level of light intensity and high humidity inside the natural ventilated net-cum-poly house. The light intensity (lux) was recorded highest as 76773 in open field followed by 32582 and 26335 in natural ventilated poly-cum-shadenet house and shadenet house respectively at 12:00 h. The relative humidity was observed highest (40%) inside shadenet house followed by open field (36%) and shadenet house (31%) at 15:00 h. However temperature recorded lower of 28.62 °C inside the shadenet house followed by 30.07 °C and 31.40 °C in open field and natural ventilated net-cum-poly house respectively at 15:00 h. Thus the structure provides better favourable climatic condition for promote higher crop yield and yield attribute. The curd yield of broccoli was recorded highest as 43.19 t/ha in shadenet house followed natural ventilated net-cum-poly house (42.58 t/ha) and open field (24.57 t/ha).



(All the dimensions are in cm)

Fig.1: Natural ventilated net-cum-poly house





(All the dimensions are in cm)

Fig.2: Shadenet house

Prado *et al.* (2008) revealed that plants raised in two and three layer shading nets were least attacked by insect pests, matured earlier, had more leaves, were taller plants at heading and harvesting, bigger and heavier heads and higher yield per treatment. From these findings, it is implied that shade nets can be utilized to protect sensitive plants from adverse environmental conditions and their results are completely in line with present research. The broccoli was grown under the shading for the lower light intensity and lower temperature and the higher relative humidity compared to the full sunlight which might have supported the higher growth and yield. Karistsapol *et al.* (2013) also revealed that the shadenet house, increased the seedling survival rate, plant height and plant width, head diameter, head weight and yield which was significantly better than full sunlight which also in line with present result. Yasoda *et al.* (2017) reported a great influence on the number of leaves, plant height, curd weight, curd diameter and curd circumference of cauliflower growing under different shade levels.

Nooprom *et al.* (2014) also revealed that the broccoli grown under a green shade net or a plastic sheet had higher growth and yield compared to those grown in the open field and also broccoli grown under the plastic sheet could be harvested 13.25 days and 2.50 days earlier than those grown in the open field or under green shade net. Their results revealed that broccoli should be grown under a plastic sheet or a green shade net to achieve higher yields than that of grown in the open field The similar results were also obtained from the present study. Martin and Sideman (2012) also revealed that the use of a secondary low tunnel covered with heavy row cover significantly increased the survival, yields, and earliness during winter. In a general protected structure like a poly house, shadenet house and low tunnels covered with raw cover also influence the crop parameter and crop yield.

The curd yield was found higher in the natural ventilated poly house in the present study which is also supported by Kanthaswamy *et al.* (2000). Thapa *et al.* (2013) also responded that the plants grown in the poly house were superior to those grown in the field and added that the quality of marketable curd yield was highest in poly house condition as compared to plants grown in open field. Thakur *et al.* (2016) also obtained higher curd yield, plant spread, and stem diameter in natural ventilated poly house than the open field. Ayas *et al.* (2011) found a significant effect structure on yield, head height, head diameter, head weight and dry matter under unheated greenhouse conditions. Structures like; poly house, shadenet house and low tunnel or raw cover on plant growth have directly affected the crop parameters due to favourable climatic conditions. Therefore, it is to be confirmed that shadenet house and natural ventilated net-cum-poly house can be used in growing broccoli to produce taller plants, bigger heads and to reduce the occurrence of insect pests thus resulting in earlier and higher yield.

Summary

The present study examined various crop parameters of broccoli inside different structures like; shadenet house, natural ventilated net-cum-poly house and open field. The yield and yield attribute were found significantly higher in the shadenet house followed by natural ventilated net-cum-poly house. Light intensity and solar insolation inside the structures was found lower compared to the open field and humidity was recorded higher which might be contributing to better crop conditions. Reviewed research results also supported that shade nets can protect sensitive plants such as broccoli from the adverse environmental conditions which resulted higher

yields and improved growth parameters. Results indicated that growing broccoli under shading resulted in taller plants, bigger heads, and reduced occurrences of insect pests. The use of shadenet house and natural ventilated net-cum-poly house can be effective in producing broccoli with enhanced growth and yield.

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