Open Access Multidisciplinary Online Magazine

Agri-India TODAY

Monthly e-Newsletter

ISSN : 2583-0910

Volume 04 | Issue 04 | April 2024

www.agriindiatoday.in

Editorial Board

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ISSN : 2583-0910
Agri-India TODAY
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Peer reviewed
monthly newsletter

Article ID : 04/IV/01/0424

MODERN METHODS FOR FOOD BIO-PRESERVATION

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Abstract
The Agri-food industries encounter a significant challenge in preserving their products, aiming to thwart spoilage and prevent or hinder pathogenic attacks. The practice of chemical preservation has a longstanding history, yet there is a contemporary shift in consumer preferences towards natural products for food preservation. Biopreservation emerges as a sustainable solution, utilizing microorganisms or their metabolic products to extend the shelf life. This method, also known as living preservation, safeguards efficacy, safety, and quality while exhibiting antimicrobial properties and contributing to distinctive flavours and textures in food products. While lactic acid bacteria (LAB) is widely utilized, various other microbial and non-microbial products find application in food preservation. A more profound comprehension of both microbial and non-microbial products enables us to address health and environmental concerns arising from the use of chemical preservatives.

Keywords : Bio preservation, sustainability, antimicrobials, enzymes.

Introduction

The Food and Agriculture Organisation (FAO) estimates that 14% of the food produced worldwide is lost during the period spanning from harvest to reaching the market. Food spoilage occurs due to chemical, physical, or microbiological actions across the entire supply chain. The ingestion of contaminated food is a substantial contributor to morbidity and mortality worldwide, with the World Health Organization (WHO) estimating that approximately 600 million individuals become ill each year due to the consumption of tainted food. These damages can modify the texture, odour, flavour, or appearance of food, frequently reducing their nutritional value and making them undesirable for consumers (Knorr, 1999).

The preservation of food can be achieved through various methods: physical methods include thermal processing like pasteurization, chilling, or drying, chemical preservation involves the use of chemical preservatives; and biological preservation encompasses the use of beneficial microorganisms, their by-products like bacteriocins and enzymes, or naturally derived substances from animals, plants, bacteriophages along with their lytic enzymes. These biological preservation techniques are collectively known as bio preservation (Tucker, 2008).

Throughout time, individuals have used a variety of techniques to increase the shelf life of food include drying, chilling, freezing, salting, smoking and fermenting. Eat treatments, freezing, pasteurisation, and canning were introduced on a wider scale with the arrival of industrialization. Chemical additives eventually made their way onto the market. Consumer preferences today tend to favour foods that are fresh, natural, little processed, and additive-free. In this context, bio preservation techniques provide new directions in the field of food preservation.

Protective cultures vs starter cultures

Protective cultures and starter cultures are commonly referenced in the realm of food preservation, specifically in the crafting of fermented or cultured foods. Table 1 illustrates the

differences between protective cultures and starting cultures, explaining their individual purposes and providing instances.

PROTECTIVE CULTURES	STARTER CULTURES
Intentionally adding microorganisms to food, such as yeast, moulds and lactic acid bacteria (LAB), is known as protective cultures. Their objective is to impede the growth of rotting organisms or pathogens while maintaining the food's sensory qualities.	Microorganisms intentionally added to food initiate fermentation, introducing distinct nutritional and sensory qualities. Fermented foods, containing beneficial bacteria, offer a healthy addition to a balanced diet. Though starter cultures are common in fermented foods, the use of protective cultures for preservation, newer development.

Biopresrvation using microbial products and non- microbial products

Given their capacity to generate compounds with antibacterial and antifungal characteristics, microorganisms show promise as bio-preservation agents. Bioactive compounds from plant or animal defence systems and antimicrobial chemicals derived from natural sources, like proteins or peptides from animal secretions, have also been applied in a variety of methods for food bio-preservation**.** For bacteria to be deemed protective cultures, they must meet specific criteria such as regulatory approval, stability, and proven effectiveness against targeted pathogens. These protective cultures find application in diverse food sectors, including dairy and meat products, bakery items, fish, beverages, vegetables, fruits, and even extend to medicinal use, safeguarding cells, tissues, gametes and embryos, providing and protects against microbial risks (Nikravan et al., 2024).

Table 2: comprises a list of microbial and non-microbial products utilized in the practice of bio preservation

Microbial derived products	
Organic acids (OA)	Lactic acid and acetic acid, derived from carbohydrate fermentation are the commonly used organic acids in biopreservation. These acids inhibits the growth of the bacteria and fungi. They lower the medium's pH, creating unfavourable conditions for spoilage and pathogenic microorganisms. Homofermentative LAB (*Leuconostoc, Lactococcus, Lactobacillus, Pediococcus*) metabolize sugar via glycolysis to produce lactic acid as the only byproduct. Heterofermentative LAB (*Oenococcus, Leuconostoc,* some *Lactobacillus*) metabolize sugars via phosphogluconate pathway generating carbon dioxide, ethanol, lactic acid, or acetic acid .Commercial production of organic acids involves fermentation or chemical synthesis, with fermentation gaining attention for lower costs, high productivity, and potential for genetic engineering.
Bacteriocins	Antimicrobial peptides produced by bacteria, known as *bacteriocins,* effectively kill or inhibit the growth of other bacteria and are widely studied for food preservation and considered potential alternatives to antibiotics.While various *bacteriocins* are recognised and unquestionably effective as antimicrobials, only nisin and pediocin PA-1, produced by *Lactococcus lactis* and *Pediococcusacidilactici* respectively, are commercially available for food preservation.Nisin inhibits various foodborne bacteria,

Microbial derived products	
	including *Listeria, Staphylococcus*, and spore-forming *Bacillus* and *Clostridium*. Pediocin exhibits strong antimicrobial activity against *Listeria monocytogenes*, *Staphylococcus aureus*, and other foodborne pathogens, as well as certain LAB such as *Lactococcus, Lactobacillus, Pediococcus, Leuconostoc,* or *Enterococcus* (Garcia et al., 2024).
Bacterial enzymes	Microbial enzymes enhance the technological properties of food, leading to improved flavour, aroma, bread quality, beer-making efficiency, and meat tenderization. Some enzymes contribute to extended shelf life by degrading toxic substances or breaking down complex molecules, reducing susceptibility to spoilage. Certain enzymes, like catalase and glucose oxidase, work together to reduce hydrogen peroxide and glucose levels in food production, Laccases play a preservative role in beer production while lipases prolong the shelf life of bakery goods.
Non -microbal products	
Plants	Essential oils and spices contain bioactive compounds like phenolic compounds, isoflavonoids, aliphatic alcohols, terpenes, aldehydes, ketones and isoflavonoids. These chemicals' kind and concentration dictate how antibacterial they are. Guar gum from leguminous plants and antimicrobial peptides from plants are recommended for food preservation.
Animals	Lactoferrin, derived from milk, exhibits antimicrobial activity against bacteria, viruses, and fungi, making it suitable for use in dairy and meat products. Lysozyme, found in various biological fluids and extracted from eggs, disrupts the peptidoglycan of Gram-positive bacteria, finding applications in meat, cheeses and wine. Chitosan, derived from the polysaccharide chitin, is recognized for its antimicrobial properties in food preservation. Its antifungal activity involves suppressing sporulation and spore germination, and it is primarily researched as an edible coating for protecting food.
Bacteriophages	Bacteriophages are viruses widely present that infect and replicate in bacteria, exhibiting species-specific or even strain-specific behavior. Phages intended for food preservation should be lytic and stable in their application environment. Their specificity enables targeting specific foodborne pathogenic bacteria. Commercialized phage cocktails effectively target bacteria like *Escherichia coli*, *Listeria monocytogenes*, *Salmonella,Shigella*, and *Campylobacter* in foods(Bhat et al., 2012).
Endolysins	Endolysins, are enzymes from lytic phages that break down the bacterial cell wall peptidoglycan, facilitating the release of new viral particles. This capability is exploitable for food preservation, particularly targeting Gram-positive bacteria due to their vulnerability to external lysin action. Research recommends utilizing endolysins to regulate bacteria such as *S. aureus, L. monocytogenes*, and *Clostridium* perfringens in the dairy industry.

Conclusion

The process of preservation is essential not only to guarantee food safety but also to foster sustainability by minimizing food loss and waste, enhancing food accessibility, and conserving natural resources. Chemicals have historically been used to prolong food's shelf life, frequently with no thought given to how these actions may affect human health or the environment. The use of natural products is rapidly gaining popularity as an alternative. While some of these techniques are already accessible in the market, further research is needed to evaluate their safety and effectiveness on an industrial scale. Advancements in understanding microbial dynamics, facilitated by technologies like next-generation sequencing and nanotechnology, are poised to revolutionize our approach to addressing food contamination. This progress will involve developing targeted strategies against specific undesirable microorganisms, ultimately expanding the availability of bio preservatives for consumers.

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ISSN : 2583-0910
Agri-India TODAY
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Peer reviewed
monthly newsletter

Article ID : 04/IV/02/0424

ANTIOXIDANT DEFENSE SYSTEM IN MICROALGAE

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Abstract
Free radicals and their derivative compounds called reactive oxygen species (ROS) are synthesized in microalgae or plants triggered by abiotic stress. At a lower concentration these ROS species play a very pivotal character in signal transduction processes while due to excessive accumulation of these molecules, they become toxic and cause several types of oxidative damage to various cellular organelles which are detrimental to their survival. Microalgae have developed two types of antioxidative defense mechanisms against them namely enzymatic antioxidative defense mechanisms and non-enzymatic antioxidative defense mechanisms each of which includes various components. The article seeks to provide fundamental knowledge on the antioxidant defense mechanism in microalgae to cope with toxic ROS species generated as a result of abiotic environmental stress.

Keywords : Antioxidant, Defense, Free radicals, Microalgae, ROS.

Introduction

Microalgae are autotrophic microbes with an astounding attribute to metabolize light and inorganic compounds to meet their energy requirements. They are enriched with valuable biomolecules such as polyunsaturated fatty acids (PUFA), carotenoids, phycobiliproteins, and polysaccharides. They thrive in dry and aquatic habitats, with a broad range of application sectors ranging from nutritional food to biofuel production. Oxygen is burned by aerobes in respiration for energy needs and leakage of electrons during this process in the cell membrane, mitochondria, and chloroplasts leads to reactive oxygen species (ROS) generation(Rezayian et al 2019).Higher concentrations of ROS result from abiotic stress conditions cause extensive oxidative damage and have several detrimental effects. ROS species interact with biomolecules altering or inactivating them, causing malfunctioning of organelles, cell structure changes, and mutations. To survive the damaging consequences of ROS, microalgae have been bestowed with antioxidant defense systems (Vranová et al 2002). Non-enzymatic and enzymatic antioxidants are used for the detoxification of ROS species. They play the role of secondary messengers to environmental fluctuations, and their role is determined by the preserving equilibrium between generation and suppression. (Lim et al 2002). The article comprehends the overview of types of ROS species and oxidative damage caused by them along with antioxidant defense mechanisms in combating its effects in microalgae.

Types of damaging ROS species

During the process of respiration, ROS are synthesized as a by-product of this process in chloroplasts, peroxisomes, cytosol, and mitochondria. In the chloroplasts, when the light absorption limit exceeds the requirement, ROS are generated in membranes of the thylakoid. The

activity of ROS is a function of 2 factors: first, the type of ROS species produced, and second conditions of reaction. For instance, the chemical activity of HO* is enormous and can oxidize several organic molecules as compared to H_2O_2 which shows average chemical activity. In biological systems, $HO^{\cdot} > {}^1O_2 > H_2O_2 > O_2^{\cdot -}$ is the order of activity of ROS species (Asada 2006).

i) Singlet oxygen

Compounds present in membrane lipids such as unsaturated fatty acids are countered by the singlet oxygen ($^1O_2$) that is electrophilic in nature. In photosynthetic cells, the molecule of oxygen reacts with another molecule of pigment in a singlet or triplet state of excitation and synthesizes $^1O_2$. Carotenoids and tocopherols are examples of two scavengers of singlet oxygen (Triantaphylidès et al 2008).

ii) Hydrogen peroxide

The reduction of oxygen molecules by two electrons generates hydrogen Peroxide (H_2O_2). This molecule is generated by superoxide dismutase by dismutating $O_2^{\cdot -}$ and is suppressed by enzymes peroxidases and catalases (Ruzzi et al 2013).

iii) Superoxide anion

It is generated by the reduction of oxygen molecules in PSI and is dismutated via superoxide dismutase (Pospíšil 2009).

iv) Hydroxyl radical

Hydroxyl radicalscause oxidative destruction of proteins and lipids and are formed by splitting water molecules into $HO^- + H^+$(Halliwell 2006).

Damages caused by ROS species

ROS causes damage to the metabolism of cells through alteration to membranes, lipid peroxidation, and oxidation of DNA and protein molecules(Naveed et al 2020).Lipids are the major compounds present in cellular membranes that are oxidatively damaged by the ROS by electron or hydrogen removal from them producing several types of toxic products such as malondialdehyde (MDA) and aldehydes. In proteins, it causes oxidation of amino acids, altering the electric charge, splitting the peptide chain, formation of cross-linkages, oxidation of cysteine and methionine residues in protein chains producing disulfide bonds which eventually destroy the final structure and activity of the protein, which if not removed by proteosomal complexes will change the cell function. ROS species cause damage to base and sugar moiety in the DNA molecule and strand break which are more fatal than the former (Rezayian et al 2019).

Antioxidant defense strategies employed by microalgae

Two types of defense mechanisms are employed by algae against damage caused by ROS 1). Enzymatic antioxidant defense system consisting of enzymes with antioxidant properties like superoxidedismutases, glutathione reductase, catalases, and ascorbate peroxidasehaving detoxifying functions. 2). Non-enzymatic defense system with repairing properties and preventing the generation of ROS molecules. Some instances include ascorbate, vitamin E, carotenoids, glutathione,and phenolic components (Pikula et al 2019). A brief overview of the components of each system is presented below:

Enzymatic antioxidant defense system

i) Superoxide dismutase

Thismetalloprotein produces oxygen and hydrogen peroxide by the dismutation reaction of superoxide radicals and is considered the frontline shield for coping with the oxidative damage

caused by the ROS species. For normal physiology and functioning of cells and management of ROS, it is contemplated as the foremost enzyme (Ologundudu 2021).

ii) Catalase

Catalase enzymes exist as tetramers with heme attached to each monomeric unit as a prosthetic group. They are primarily connected to peroxisomes where fatty acid β-oxidation, photorespiration, and purine catabolism occur that produce generous amounts of H_2O_2 (Mittler 2002)**.** Catalase convertsthe disproportionation of hydrogen peroxide (H_2O_2) molecules into water(H_2O) andoxygen (O_2) (Zamocky et al 2008).

iii) Ascorbate peroxidase

They belong to the heme peroxidase superfamily and catalyze the splitting ofH_2O_2 into H_2O involving ascorbate moleculesas donors of electrons (Caverzan et al 2012). Five types of isomeric forms of ascorbate peroxidase prevail in the cytosol, mitochondria, peroxisomes, and chloroplast of microalgae (Sharma and Dubey 2005).

iv) Glutathione reductase and glutathione peroxidase

They are regarded as the collection of peroxidase enzymes that are phylogenetically related and contain nonheme and thiol groups. It induces the decomposition of H_2O_2 molecules into water (H_2O) and oxygen (O_2). It has a primary function in the antioxidant defense mechanism as it is the chief enzyme of the ascorbate-glutathione cycle for maintaining the glutathione in its reduced state (Sharma et al 2022).

Non-enzymatic antioxidant defense system

i) Ascorbate or Vitamin C

Ascorbic acid or Vitamin C is a widely prevalent molecule with anti-oxidizing characteristics and exists in various reduced and oxidized forms as ascorbic acid and mono- and dehydroascorbic acid and it is oxidized to reduced ratio are the primary elements affecting the oxidative stress resistance (Cruz-Rus et al 2012). Ascorbate is kept in its reduced form by the activity of monodehydroascorbate reductase, glutathione reductase, and dehydroascorbate reductase (Foyer and Noctor 2011). In the aqueous phase, it is a very crucial molecule to combat the toxic effect of ROS. It can eliminate O_2^-, OH^-, and $^1O_2$ and decompose H_2O_2 to H_2O by employing ascorbate peroxidase mechanism (Blokhina et al 2003).

ii) Glutathione

Glutathione is a tripeptide antioxidant involving the amino acids glycine, glutamate, and cysteine. In the ascorbate-glutathione cycle, ascorbic acid is regenerated by converting glutathione molecules from reduced to oxidized form. It acts as a cofactor for enzyme-catalyzed reactions, combating oxidative damage, H_2O_2, and ROOH suppression, *etc.* Oxidation of Glutathione (GSH) by ROS produces GSSG, both of which together help in maintaining the balance of redox potential (Sharma et al 2022).

iii) Vitamin E or tocopherols

Vitamin E or tocopherols are the most potent free radical scavengers. Along with their function as antioxidants, they also perform some other functions. *E.g.* α-tocopherol detoxifies the peroxy radicals in in bilayers of lipid molecules (Lide 2006). In the chloroplast, α-Tocopherols act as the most powerful bioactive antioxidants and prevent the photooxidative effect. α-, β, ϒ, and ϐ-tocopherols are the four categories of tocopherols. The most potent among α-tocopherol is the

major key antioxidant and hasa role in the suppression of $^1O_2$and reduction of $O2^-$ and completion of lipid peroxidation reaction (Sharma et al 2022).

iv) Carotenoids

Carotenoids or tetraterpenoids are natural compounds in plants and some microbial species (Otles and Cagindi 2008). They comprised carotenes like lycopene, α- carotene and β-carotene, and xanthophylls. They have antioxidant activities that prevent cellular damage against free radicals and lipid peroxidation inhibition, and maintain the integrity of cellular membranes (Sharma et al 2022).

v) Phenols

Microalgae contain phenolic compounds lower than or equal to minimal concentrations present in plants. They are secondary metabolites endowed with multiple phenol rings *e.g.* tannins, flavonoids, lignins, and stilbenes. Microalgae produce certain types of complex phenols and molecules of flavonoids, such as isoflavones, flavanones, flavonols, and dihydrochalcones. Polyphenols such as phlorotannins found in marine microalgae have antioxidant properties.

Conclusion

Free radicals generated have lethal effects on lipids, proteins, and DNA and halt normal cellular metabolism. They act as signalling agents at lower amounts while their accumulation at higher levels becomes detrimental to the cells. To combat the oxidative damages caused by these potent ROS species, microalgae have evolved two types of defensive strategies namely enzymatic and non-enzymatic defense mechanisms.

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ISSN : 2583-0910
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Article ID : 04/IV/03/0424

AGRIVOLTAICS: PIONEERING SUSTAINABLE AGRICULTURE AND ENERGY

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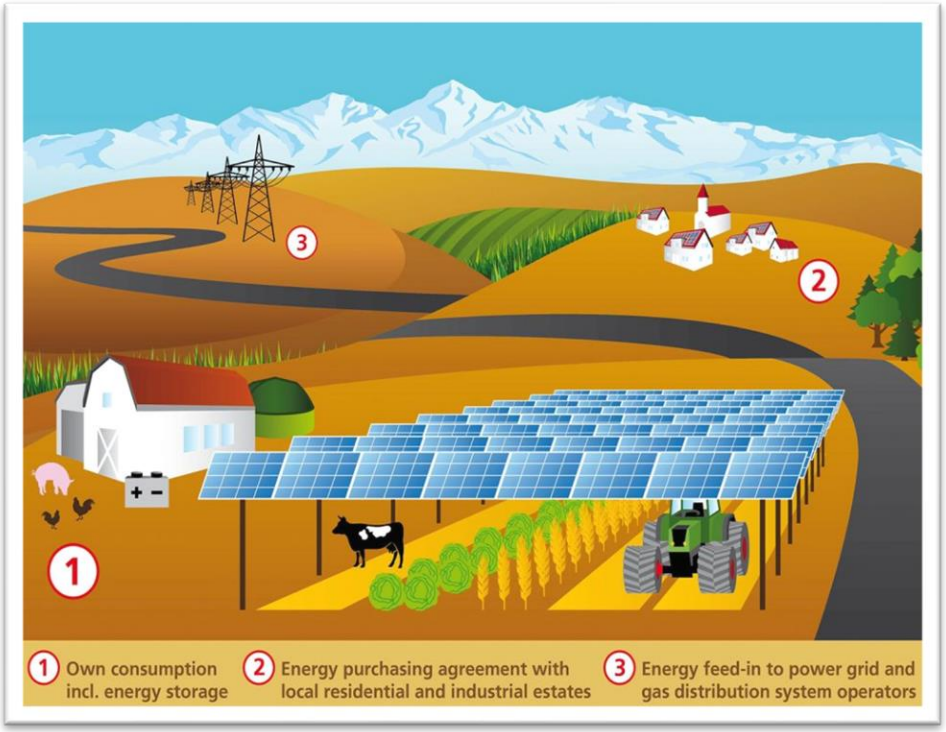
Abstract
Agrivoltaics, the harmonious integration of agriculture and solar photovoltaic (PV) systems, maximizes land use efficiency while enhancing crop productivity and generating renewable energy. Technical advancements drive system optimization, empowering rural communities and addressing climate challenges. However, overcoming policy, technological, and stakeholder engagement hurdles is crucial for unlocking agrivoltaics' full potential. Ultimately, agrivoltaics represents a pioneering approach to sustainable land management, blending environmental stewardship with economic resilience in the pursuit of a brighter, more sustainable future.
Keyword: Agrivoltaics, Renewable energy, Solar panel, Crop Production.

Introduction:
A team of French scientists lead by Christophe Dupraz were the first to use term agrivoltaic. It basically means when solar panels and food crops are combined on the same land to maximize the land use. It's an idea which could bring food producing to the next level. Their research field in Montpellier, France, indicated that agrivoltaic systems may be indeed very efficient: the increase of global land productivity can be from 35 to 73 percent.



Setting the Stage: Agriculture and energy production are fundamental pillars of human civilization. However, traditional practices in both sectors often lead to land use conflicts, resource depletion, and environmental degradation.

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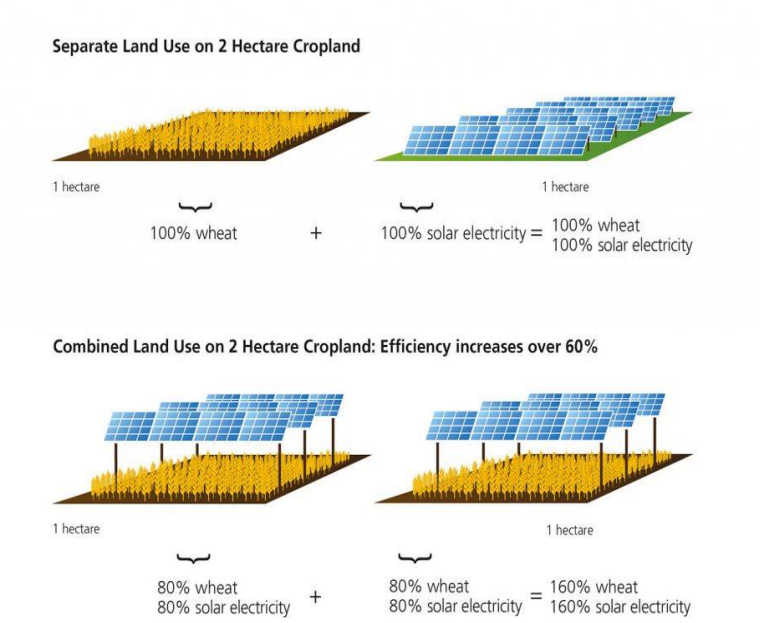
Enter Agrivoltaics: Agrivoltaics presents a revolutionary solution by harmonizing agricultural and energy production on the same land, offering multiple benefits that could redefine the future of farming.

Benefits of agrivoltaics:

Maximizing Land Use Efficiency: By co-locating solar panels above crops, agrivoltaics optimize land use, allowing farmers to generate renewable energy without sacrificing valuable agricultural land.



Enhanced Crop Productivity: Studies show that crops grown under solar panels in agrivoltaic systems often exhibit improved yields, reduced water requirements, and enhanced resilience to climate extremes due to moderated microclimates.

Diversification of Revenue Streams : Agrivoltaics provide farmers with additional sources of income through renewable energy generation, helping to stabilize farm incomes and mitigate financial risks.

Technical innovations in agrivoltaics:

Optimized System Design: Advanced modeling techniques and field experiments are refining agrivoltaic system designs, optimizing parameters such as panel orientation, spacing, and crop selection to maximize energy production and crop yield.

Smart Irrigation and Monitoring: Integration of precision agriculture technologies, such as sensor networks and automated irrigation systems, enables efficient water management and real-time monitoring of crop health within agrivoltaic systems.

Real-world applications and success stories:

Global Adoption: Agrivoltaic projects are gaining traction worldwide, from arid regions in Australia to temperate climates in Europe and North America.

Community Empowerment: Agrivoltaics empower local communities by providing clean energy access, creating jobs, and fostering sustainable development while preserving agricultural heritage.

Overcoming challenges and barriers:

Policy Support: Governments and policymakers play a crucial role in incentivizing agrivoltaic adoption through supportive policies, subsidies, and regulatory frameworks that recognize the dual benefits of agriculture and renewable energy.

Technological Advancements: Continued research and development are needed to address technical challenges, such as optimizing light distribution, managing soil health, and integrating energy storage solutions.

Looking ahead:

Towards a Sustainable Future: Agrivoltaics represent a paradigm shift towards integrated land management approaches that prioritize environmental sustainability, food security, and energy independence.

Collaboration and Innovation: Collaboration between farmers, researchers, industry stakeholders, and policymakers is essential to unlock the full potential of agrivoltaics and accelerate the transition to a regenerative agriculture and renewable energy future.

Conclusion

A New Dawn for Farming : Agrivoltaics hold immense promise as a transformative solution that transcends the boundaries between agriculture and energy, offering a blueprint for sustainable development that benefits both people and the planet. As we embrace the challenges and opportunities of the 21st century, agrivoltaics stand poised to lead the way towards a brighter, more resilient future for farming and beyond.

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ISSN : 2583-0910
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Article ID : 04/IV/04/0424

WOMEN EMPOWERMENT: PLAY THE CRUCIAL ROLE IN EMPOWERING FRAMING COMMUNITY

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Introduction

Women have key roles in the rural economy, including farming, wage earning, and entrepreneurship. They are also responsible for the well-being of their family members, which includes providing food and caring for youngsters and the elderly. Rural women's unpaid employment, especially in poor homes, sometimes includes gathering wood and water. Women from indigenous and grassroots groups are frequently the stewards of traditional knowledge, which is critical to their communities' livelihoods, resilience, and culture. However, women in rural regions confront barriers to economic participation due to gender-based discrimination and societal norms, disproportionate engagement in unpaid work, and uneven access to education, healthcare, property, and financial and other services.

They are also more sensitive to the effects of natural calamities and climate change. Promoting and ensuring gender equality, as well as empowering rural women through decent work and productive employment, not only helps to drive inclusive and sustainable economic growth, but also improves the effectiveness of poverty reduction and food security initiatives, as well as climate change mitigation and adaptation efforts.

Women and Empowerment

Women and empowerment develop a mutually beneficial and revolutionary partnership.

- Empowering women requires more than just eliminating gender gaps. It also means creating an atmosphere where women can take charge of their life and make decisions that determine their future.
- Empowerment include education, economic independence, healthcare access, and breaking down cultural preconceptions.
- As women develop knowledge and skills, they can drive change in their communities, tearing down barriers and motivating others.
- Empowerment recognizes and respects varied objectives and potentials, rather than being a one-size-fits-all idea.
- Empowering women leads to greater cultural advancement, economic prosperity, and community well-being.
- Women's strength and resilience drive empowerment, producing a positive feedback loop that promotes equality, justice, and prosperity.
- Women's empowerment is essential for creating a more inclusive and harmonious world.

Focus Area Needs of Women Empowerment

While everyone talks about women's empowerment, it's important to understand the many types of empowerment. We will address the numerous ways in which women in rural India might be empowered.

How to Empower Women in Rural India?

Empowering women in rural India necessitates a multifaceted strategy that tackles the many problems they encounter. Here are seven measures for empowering women in rural India:

Promoting education

Promoting education is a top priority. Women's lives in rural places can be considerably improved if they have access to a decent education. Focus on developing and maintaining rural schools that are accessible and inviting to females.

Vocational Training

Improve Vocational Training for Rural Women by introducing programmes tailored to their requirements. These programmes can teach a variety of skills, such as agricultural practices, animal husbandry, handicrafts, and small-scale entrepreneurship.

Access to Healthcare

Improve rural healthcare infrastructure by establishing clinics and educating local healthcare personnel. Launch health awareness initiatives centered on mother and child health, family planning, and cleanliness.

Facilitate Economic Opportunities

Encourage women to participate in local marketplaces by organizing training courses on entrepreneurship, marketing, and financial management. Set up women's cooperatives to combine resources and exchange information. Microfinance programmes that offer women with small loans to help them establish or develop their enterprises can also be highly beneficial.

Address Land Rights

Women in many rural communities typically struggle to defend their land rights owing to established patriarchal traditions. Land ownership not only gives economic stability, but it also increases women's decision-making authority in their homes and communities.

Technology Inclusion

Introducing technology in rural regions may greatly empower women by increasing their access to information, marketplaces, and educational opportunities. Initiatives should include digital literacy training programmes, the introduction of mobile agricultural information applications, and increased access to online learning platforms.

Community Awareness Programmes

Cultural conventions and prejudices frequently undermine women's empowerment in rural India. Community awareness programmes are critical to breaking these practices. Engage with local leaders, influencers, and community members to promote gender equality and the value of women's participation in a variety of fields.

Conclusion

Incorporating these subtle tactics alongside the other stages outlined above can result in a comprehensive strategy to empowering women in rural India, addressing different aspects of their

life and fostering long-term positive change. Collectively, these approaches can create an atmosphere favorable to women's empowerment in rural India, supporting good change at both the individual and communal levels.

ISSN : 2583-0910
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Article ID : 04/IV/05/0424

AGRICULTURE, PESTICIDE AND ENVIRONMENT : A COMPREHENSIVE OVERVIEW

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Abstract

Pesticides have been utilized for centuries as an indispensable aspect of agricultural production, serving to protect crops from pests and insects that can cause damage and significantly reduce yields. They have played a significant role in improving human welfare by reducing losses of stored grains and increasing agricultural production. However, the excessive use of pesticides can result in undesirable residues that act as trace contaminants in food, living tissue, and the environment. This can have severe negative impacts on the ecosystem, as overuse of pesticides can lead to the destruction of biodiversity. Moreover, the contamination caused by pesticides can extend beyond the target plants and cause environmental pollution, which can have adverse effects on human health through environmental and food contamination. Additionally, climate change-related factors can impact pesticide application, resulting in increased pesticide usage and pesticide pollution. In summary, while pesticides are vital for crop protection, their use requires careful monitoring to ensure that their benefits are not outweighed by their negative effects on human health, the environment, and the ecosystem.

Keywords: Pesticide, Environment, Toxicity, Residual effects, Biomagnification, Fate of Pesticides, Hazardous effect of Pesticides

Introduction

When a pesticide is applied, it undergoes various transformations in the environment. In some instances, certain herbicides may permeate into the root zone, potentially leading to more effective weed control. Nonetheless, the release of pesticides into the environment can also pose risks, as not all of the applied chemical reaches its intended target site. Environmental risk assessment is a crucial process aimed at identifying potential harm or damage that products, like pesticides, might inflict on the environment. To conduct a comprehensive and reliable environmental risk assessment, it is essential to meticulously evaluate all potential problems, exposure scenarios, and possible adverse effects that could result from the use of such products. By examining specific hypotheses regarding the likelihood and severity of adverse effects, a more accurate understanding of the actual risk posed by a particular product can be achieved.Ultimately, risk managers, policymakers, and regulators make the final decision on whether a pesticide or feed additive is safe to be commercialized, based on the results of the environmental risk assessment. The environmental risk assessment also provides various options to accept, minimize, or reduce the risks associated with such products (Devos et al. 2015).

The nexus between pesticide application, agricultural practices, and environmental health is complex and multifaceted. Current projections estimate global pesticide usage to exceed 4 million tons annually, a trend exacerbated by unregulated distribution worldwide (FAOSTAT, 2010). In contemporary agriculture, chemical pesticides and insecticides are prevalent for pest control.

Integrating these chemicals with natural pest management strategies can enhance integrated pest management efforts, offering both preventive and curative benefits (Gentz et al., 2010). Nevertheless, the indiscriminate application of pesticides within aquatic environments threatens various species, including significant declines in fish populations such as salmon, alongside adverse effects on primary producers and macroinvertebrates (Macneale et al., 2010).

A pressing issue in modern agriculture is the diminishing populations of pollinators, leading to a potential global food crisis. This decline is largely attributed to the rampant use of pesticides in agricultural ecosystems. Pollinators encounter pesticides through several routes: direct exposure during spraying, contamination via residual pesticides and systemic insecticides in pollen and nectar, polluted nesting materials and water sources, and indirectly through the consumption of aphid honeydew (Vaughan et al., 2014).

The widespread adoption of chemical pest control methods in the early 20th century, aimed at addressing agricultural pests, public health concerns, and nuisance organisms, led to significant unintended consequences. These include the development of pesticide resistance among target species, collateral damage to non-target species, contamination of food and water supplies, ecological harm, and a variety of public health challenges. This historical perspective underscores the urgent need for a more sustainable and environmentally conscious approach to pest management in agriculture and beyond.

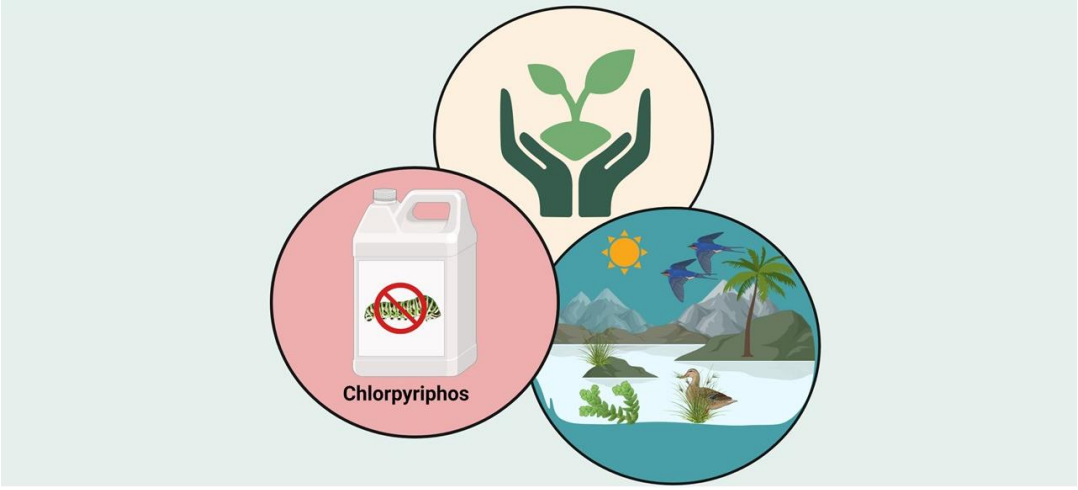

Figure 1: Interaction between Agriculture, Pesticide and Environment

Fate of Pesticide

The presence of pesticides in aquatic environments and sources of potable water represents a notable hazard to both aquatic life and the safety of drinking water supplies. The introduction of pesticides into aquatic systems can occur through both dispersed and localized mechanisms. Dispersed, or non-point, sources of pesticide contamination in aquatic environments often stem from agricultural practices. Such sources encompass a range of pathways including outflows from tile drainage, seepage of baseflow, runoff from both surface and subsurface areas, and soil erosion in areas where pesticides have been applied, as well as the drift of pesticides during spraying and their subsequent deposition following volatilization. Conversely, localized, or point, sources of pesticide entry into water bodies are characterized by specific, limited points of discharge. These primarily involve runoff from agricultural premises, effluent from sewage treatment facilities, sewer system overflows, and incidents of accidental spillage.

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Non-agricultural use of pesticides also has point sources, e.g. from application on roads, railways, or urban sealed surfaces such as parking lots (Reichenberger et al. 2007).Pesticides can enter surface waters in various ways such as through run-off, waste water discharges, atmospheric deposition, and spills (Cessna 2009). Water and dissolved pesticides can penetrate deep into the soil through two different mechanisms: matrix flow and preferential flow. Matrix flow is a slower process, where the physical-chemical properties of the pesticides determine their movement alongside the water. This movement depends on factors such as the pesticide's solubility in water, vapor pressure, K_h and K_{oc} (Cessna 2009).

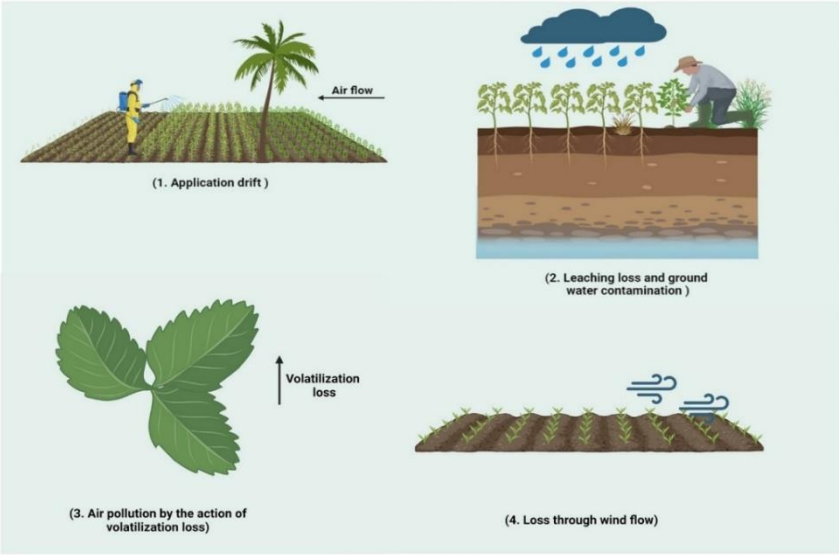

Figure 2: Fate of Pesticide in Ecosystem

Distribution of Pesticide

According to statistics from Dppqs, the use of pesticides has been distributed among different commodities from 2018-2019 to 2022-2023. The figures indicate that 41% of pesticide consumption was used for cereal crops, 10% for vegetables, 9% for pulse crops, 7% for oilseeds, 4% for fruit, 1% for plantation crops, 15% for cash crops, 5% for fiber crops, and the remaining 8% was used for other crops.

Hazardous Effects of Pesticides

The infiltration of pesticides into environmental matrices can manifest through dual channels of contamination: direct (point-source) and indirect (nonpoint-source). Direct contamination originates from distinct, identifiable sources including leaks from pesticide storage facilities, the rinsing water from pesticide application equipment, spillages, and the incorrect disposal of both pesticides and their packaging. Conversely, indirect contamination disperses over broader areas, entailing the aerial dispersion of pesticides, their runoff into aquatic systems, and their percolation into subterranean water reserves (Toth and Buhler, 2009).

The deployment of pesticides, while intended to target specific pests, invariably casts a broader net of detriment, adversely affecting species not originally targeted, diminishing the diversity of both fauna and flora, and disrupting aquatic and terrestrial ecosystems and food chains. Research by Majewski and Capel (1995) elucidates that a significant proportion, estimated at 80–90%, of pesticides applied can evaporate within days post-application, underscoring the pervasive nature of pesticide dispersion in the environment.

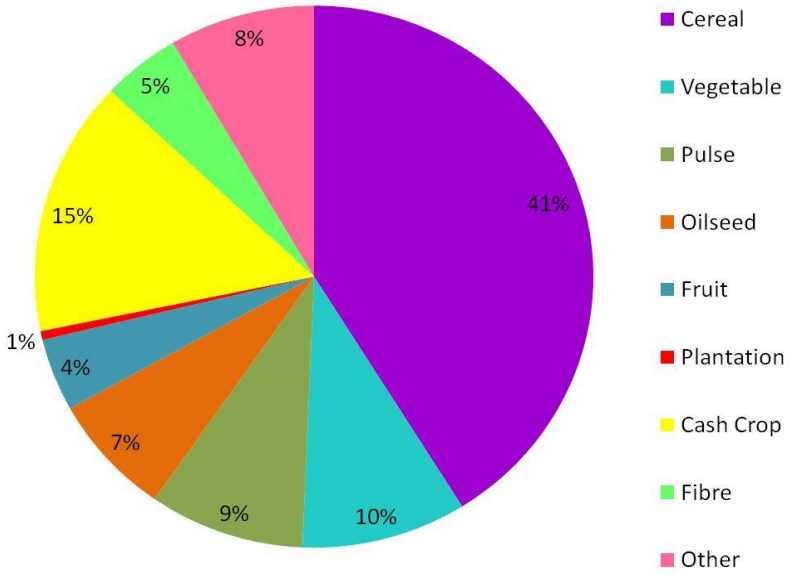

Figure 3: Commodity-Wise Consumption of Chemical Pesticides during 2018-19 to 2022-23
[Source Directorate of Plant Protection Quarantine & Storage
https://ppqs.gov.in/statistical-database]

Threats to Aquatic Biodiversity and Water Ecosystem

The infiltration of water bodies by persistent organic pollutants and currently used pesticides (CUPs) may occur through several pathways, including deposition from the atmosphere or the discharge of untreated chemical wastes by the pesticide and chemical manufacturing sectors into flowing freshwater systems like rivers. Such pollutants can be transported over extensive distances, adversely affecting aquatic ecosystems (Socorro et al., 2016). These substances are prone to bioaccumulation and biomagnification within aquatic food chains, posing direct threats to the health of aquatic plants and animals. Additionally, they present risks to human health through consumption and other forms of exposure (Woodrow et al., 2018).

Pesticides also have the capability to permeate into groundwater, a scenario often prompted by agricultural runoff or the direct use of these chemicals on agricultural lands. The detection of pesticides in aquatic sources represents a significant concern due to their toxicological implications for human health. Given that groundwater serves as a crucial drinking water resource globally, the contamination of both surface and groundwater by pesticides from unregulated agricultural activities and practices compromises the quality and safety of the drinking water supply (Khatri and Tyagi, 2015).

Threats to Terrestrial Biodiversity

Earthworms play a pivotal role in the sustenance of a vibrant soil ecosystem, acting as vital indicators of soil health and contamination. They are extensively utilized in evaluating soil toxicity, thereby underscoring their significance in ecological studies. In addition to their role in monitoring environmental health, earthworms significantly enhance soil fertility, contributing to the nutrient cycling process. However, their populations and health are jeopardized by the presence of pesticides in the soil. These chemicals, especially when they infiltrate the soil pore water, can exert

detrimental effects on earthworms. Research by Schreck et al. (2008) has highlighted that exposure to insecticides and fungicides can lead to neurotoxic outcomes in earthworms, causing physiological impairments after prolonged exposure periods. This underscores the critical impact pesticides have on earthworms, thereby affecting the overall health and functioning of soil ecosystems.

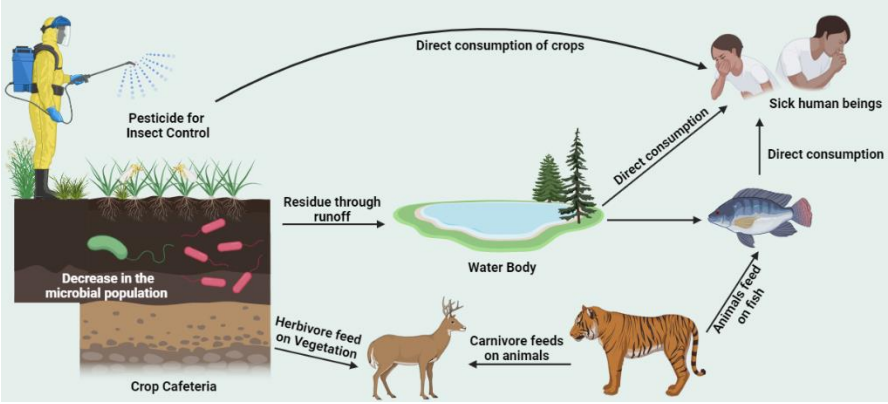

Figure 4: Detrimental Effects of Pesticide on Ecosystem

The application of pesticides has negatively impacted terrestrial wildlife, notably beneficial insect species such as bees and beetles. The deployment of broad-spectrum insecticides, including carbamates, organophosphates, and pyrethroids, has been linked to marked reductions in their populations. Research indicates that insect populations are more abundant on farms that practice organic agriculture as opposed to those that do not. Specifically, the combined use of pyrethroids with triazole or imidazole fungicides has been found to be especially detrimental to honey bees, as reported by Pilling and Jepson (2006).

Organochlorine pesticides (OCPs) represent another class of pesticides that have seen extensive global use in agriculture for pest management and in public health for the control of vector-borne diseases such as malaria and dengue fever. These pesticides are characterized by their non-volatile nature, meaning they do not readily evaporate into the atmosphere. The challenge associated with OCPs lies in their persistent nature within environmental systems, leading to long-term repercussions. The indiscriminate application of these chemicals poses significant threats to environmental integrity, potable water sources, and human health. Prolonged exposure to OCPs has been linked to a spectrum of health issues, including but not limited to cancer, birth defects, neurological disorders, reproductive health problems, and immune system dysfunctions (Agbeve et al., 2014; Fosu-Mensah et al., 2016).

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ISSN : 2583-0910
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Article ID : 04/IV/06/0424

BETTA FISH BREEDING UNIT ECONOMICS : AN OVERVIEW

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Introduction

In this guide, we will go through the basics of betta fish breeding step by step making it easy for beginners and hobbyists to start their own betta fish breeding venture. This article will help you to analyze the profit ofa betta fish breeding startup. But before diving into the nitty-gritty of betta fish breeding let's begin by getting to know this incredible aquatic companion a bit better. The Siamese fighting fish is found not only in Thailand but also in other neighbouring countries in Southeast Asia (Monvises, 2009). They are most popular aquarium fish in the world, due to their diverse colouration, fin morphology (including veil tail, delta tail, Halfmoon tail, crown tail and double tail) and body size.The most recent classification of bettas from phylogenetic evidence places them in the Osphronemidaefamily (whose freshwater members are *Anabas* spp.,*Trichogaster* spp., and *Trichopsis* spp.), Macropodusinae subfamily and genus *Betta*. It has more than 72 recognized species worldwide. The Siamese fighting fish, *Betta splendens* (Regan, 1910)is a popular fish in the aquarium trade and was declared on 5 February2019 as Thailand's National Aquatic Animal. *B. splendens* is listed as vulnerable by the IUCN, due to increasing pollution and habitat destruction. Bettas have adapted to diverse aquatic habitats including rice paddies, shallow ponds, canals, and even drainage ditches. Their natural habitats have low levels of oxygenation, they have evolved with specialized respiratory organs called labyrinth organs which help them to respire directly through the water surface from the atmosphere (Peters, 1978; Lichak, 2022).Bettas are highly valued for their breathtaking beauty. They are low-maintenance pets, making them ideal for those new to fishkeeping. These little swimmers are known for their inquisitive behaviour and often display their vibrant colours when they see you. Male bettas are highly territorial in behaviour and defend their own territories (Lichak, 2022). Most of the males create bubble nests on the surface of the water. When it comes to territorial disputes between male bettas, aggressive displays such as fin flaring and combat can occur (Sermwatanakul, 2019). Female bettas are quite less aggressive as compared to males. Bettas are diurnal creatures which means they are most active during daylight hours (Lichak, 2022).

Creating and maintenance a breeding setup

According to the Ornament Aquatic Trade Association, an aquarium should contain at least 4 litres of water to prevent the accumulation of toxic products. At a breeding unit level, we can keep bettas from 100ml to 300ml. It is important to have a lid that prevents bettas from jumping out and to maintain stable humidity levels. The temperature of the water should be maintained within the optimum range of 24-28°C. pH levels should be kept between 6.0-7.5.however, they can tolerate a pH range of 5.0-9.0. It is crucial to have a heater and regular water changes in place for the well-being of bettas. The intensive metabolism of the growing young fish necessitates frequent cleaning of the tank and regular water replacement.

Sexual dimorphism

Characteristic	Males	Females
Appearance	Vibrant colors, elongated fins, vail-tailed dorsal fins	Rounded fins, less colorful, bulgy abdomen with white belly spot
Size	Larger	Smaller
Operculum Size	Large	Small
Territorial behaviour	Highly territorial and aggressive	Less territorial and less aggressive
Compatibility	Cannot coexist with other bettas	Can coexist with other female bettas
Breeding Behavior	Create bubble nests	Less involvement in nest-building
Parental Care	Guard eggs in bubble nests	Limited or no parental care

Selection of breeding pair

Selecting the perfect betta pair is the cornerstone of your breeding venture. Before you choose your betta pair, it is essential to ensure they are in the best possible health. Healthy parents are more likely to produce healthy fry. Here is how to perform a basic including; Vibrant Colors, Fins, signs of illness (white spots, faded patches, or lethargic behavior), Compatibility (Ensuring compatibility is key to peaceful coexistence and successful breeding.), Less aggressive female etc. It is important to avoid inbreeding to maintain the health and vitality of your betta population.

Fig 1: Male

Fig 2: Female

Fig 3: Male building bubble nest

Mating and spawning

Male builds bubble nest usually under or adjacent to floating almond leaf. It was found that the bubbles contain bacteriostatic substances and substances that have a beneficial effect on the vicinity of the eggs. When a male start building a nest, or even a few bubbles, it indicates that it is ready to breed. Initially, male and female are kept separately by keeping a glass curtain in the aquarium. When both are excited and the male starts bubbling glass curtain should be removed. The male proceeds to court the female with splashing movement towards the nest and if all goes well, the male will wrap himself around her and fertilize the eggs as they are released. The male will collect the eggs and plant them in a nest. The average fecundity of an adult female is around 252 eggs (Jindal et al, 2009). Once the spawning is over, the female should be shifted to another tank because of cannibalistic feeding behaviour.

Caring for Fry

Once they become free swimming the male must be removed. Otherwise, he will forget all the care and attention. Once the larval fish have absorbed their yolk sacs (about 3 days old hatchling), they are removed from the spawning tanks and placed into grow-out tanks. They are initially fed with live feeds such as infusoria (*Brachionus* spp.) and brine shrimp (*Artemia* spp.). Bettas are reared together as a group until they reach 3 to 4 months old, at which point the males become distinguishable from females and must be separated into individual containers to avoid damage due to aggression. Females are reared together rin separate tanks but males are grown individually.

No.of offspring can be produced

Let's consider, 90% fertilization rate, 90% hatching rate and 95% survival rate. From each breeding pair around 194 offsprings can be produced.

Cost and Profit considerations

Materials	Description	₹Estimated Cost
Breeding Tanks and Setup	Tub, buckets, nets, and related equipment	1500
Water Supply System	Motors, Syphon pipes, top-up pipes, and plumbing	1000
Aeration &Filtration Equipment	Air Pumps, air stones etc.	6590
Water Test Kit	Equipment for monitoring water quality	1450
Brine Shrimp Hatching Unit	Hatching equipment for fry food production	750
Fry Grow Out Tank	Plastic tanks for growing out fry in batches	12500
Website Development	Online marketing	5000
Social Media Promotion	Budget for promoting your venture on social.	2000
Bottles from Scrap	Glass bottles for male Betta housing	2000
Broodstock Purchase	Initial purchase of Betta breeding pairs	1100
Oxygen cylinder	For transportation and packaging	9000
Miscellaneous Expenses	Unforeseen expenses and contingencies (10%)	4289
	Total :	**47,179rs**

Operation cost (culture period: 4 months)

Materials	Description	₹Estimated Cost
Electricity	Electricity bill for maintaining the equipment	1337rs
Maintenance	Regular upkeep and potential equipment repairs	250
Feed for Fry	Ongoing expenses for Betta fry food and nutrition (brine shrimp)	3000
Feed for Brood Fish	Live. Commercial and DIY homemade feed	2000
Packaging	Materials for packaging Betta fish (plastic bag rubbers,O2)2.5rupees per packing	5000
Miscellaneous Expenses	Unforeseen expenses and contingencies (10%)	2809
	Total :	**14,396rs**

(Estimated cost is calculated from current online prices)

Total Expenditure = Total Capital Cost + Total Operating Costs + Total Depreciation = ₹66,293
Where, Total Depreciation (10% of Capital Cost) = 0.10 * ₹47,179 = ₹4,717.90 (rounded to ₹4,718)

Price of betta fish at different markets:

Cost	Farm rate	Wholesale rate	Retail rate
Male	35	75	220
Female	15	**35**	**100**

- **Retail Prices:** The retail price is the price that a customer will pay when purchasing a product at a retail store.
- **Wholesale Prices:** The price charged for a product sold in bulk to retailers or distributor groups.
- **Farm Cost:** The farm gate prices are in principle the prices received by farmers for their produce at the location of the farm

  Total revenue

  Now as above calculation, we will have 1940 betta fish offspring from that let's assume 50% are male and 50% female. If we sell 50% male at farm price, 25% at wholesale price and the remaining 25 % at retail price likewise 50% female at farm price 25% at wholesale price and the remaining 25 % at retail price, you can calculate the total revenue as follows:

Sex	Revenue		
	50% male at farm price	**25% at wholesale price**	**25 % at retail price**
Male (970)	₹16,022.50	₹18,562.50	₹53,185.00
Female (970)	₹7,275.00	₹8,516.25	₹24,250.00
Total Revenue = ₹128,811.25			

Total Profit = Total Revenue - Total Expenditure = ₹128,811.25 - ₹66,293 = ₹62,518.25
Benefit-Cost Ratio (BCR) : Total Revenue / Total Expenditure = ₹128,811.25 / ₹66,293≈ 1.945

A BCR of approximately 1.945 indicates that, for every unit of expenditure, you are generating approximately 1.945 units of revenue, which is a positive sign for the profitability and potential benefits of your Betta fish breeding venture.


Fig 4: Spawning tanks


Fig 5: Mating


Fig 6: Free swimming larvae

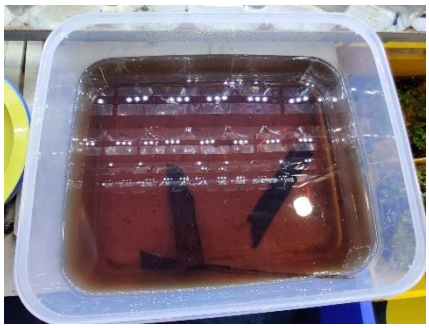

Fig 7: grow-out tanks

Fig 8: 4 week old fries

Fig 9: 9 week old fries

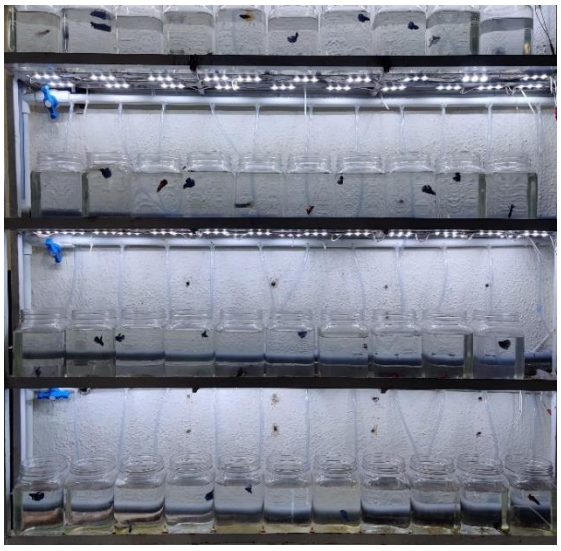

Fig 10: 13 week males raring individually

Fig 11: Females are reare together

Fig 12: 17 week old males

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ISSN : 2583-0910
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Article ID : 04/IV/07/0424

COMPOSTING: ITS DIFFERENT TYPES AND PROCESS INVOLVED

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Abstract

Composting refers to the natural process of decomposing organic materials, such as food scraps, yard waste, and other biodegradable substances, into a nutrient-rich soil amendment known as compost. This process involves the breakdown of organic matter by microorganisms like bacteria, fungi, and worms, under controlled conditions of moisture, temperature, and aeration. Composting helps reduce waste sent to landfills, improves soil health, and provides a sustainable way to recycle organic materials for gardening, agriculture, and landscaping purposes.

Introduction

Composting: Conversion of substances containing higher content of organic matter into highly stable, decomposed form from which plants can uptake nutrient through roots when applied to soil. Nutrient composition of compost is more than that of FYM.

Types of Composting:

1. On the basis of source:
   a) Rural Compost
   b) Urban Compost
2. On the basis of process involved:
   a) Aerobic decomposition process
   b) Anaerobic decomposition process
   c) ADCO N-enriched composting

FYM: Farm Yard Manure includes manure produced by decomposition of dung and urine of farm animals like cow, buffalo, sheep, goat, horse, pig. Nutrient composition of FYM is slight less than compost.

Material and method

Composting

a) Rural composting: Includes all crop residues, cotton sticks, cattle farm upper wet urinated soil, vegetable and fruit residues, plant leftover leaves.

b) Urbancomposting: Mainly includes MSW (Municipal solid waste) including sewage and sludge, Kitchen waste, Garden residues.

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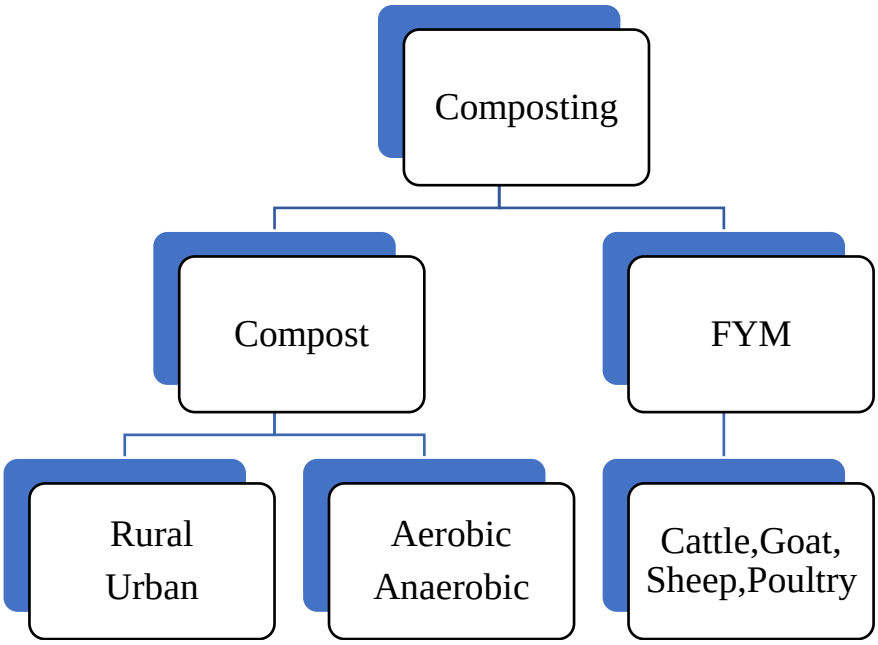

Fig 1: Different types and process of Compost and FYM

Common Composting Methods or process:
Important composting methods are

a) **Indore method (Aerobic)**
b) **Bangalore method (Anaerobic)**

a) **Indore method process:**
Known as: Heap or Aerobic method
Developed by: Albert Howard and Y.D. Wad b/w 1924 and 1931
Developed at: Institute of Plant industry, Indore

Catalytic agent: Animal dung
Trench or Pit size: 3m * 1.5m * 1m

Site selection: Elevated area near cattle shed having water source

Precaution: Rain water must not enter pit to avoid leaching losses

Process of composting:
First layer: Well mixed Organic waste from different sources at base and cow-dung slurry and water sprinkled over it.

Thickness of first layer: 30cm

Second layer : Waste from crop residues, dry and wet fodder waste followed by cow-dung slurry and water over it.
Thickness of first layer: 30cm
Repeat layer 1 and 2 till 50cm thickness is achieved.
Total Height of heap: 50cm above ground covered with a soil layer.
Moisture content: Add water to maintain moisture content 60-80%
Filling time of trench: $3/4^{th}$ within 6-7 days, left $1/4^{th}$ for turning.
Turning duration: 15,30 and 60 days of pit filling.

Time for Composting: 4-5 months with 2-3 turnings.

b) Bangalore method:

Known as: Anaerobic method
Developed by: C.N. Acharya (1939)
Developed at: Indian Institute of Science, Bangalore

Process of composting:

Pit filling up to 50cm above ground is similar to Indore method of composting.
Plastering: 2-5cm layer with mixture of Cow dung and mud.
Time for Composting: 6-8 months with no turning required.
Advantage: Control fly nuisance, kill harmful pathogens and prevents foul smell, less labour required, more nutrient enrichment (0.8-1% N)

MSW: Municipal Solid Waste includes metro-cities highly organic rich garbage, sewage and sludge, household waste including kitchen waste. This huge quantity of waste which is released on daily basis is a major problem that's why MSW management is must for Urban areas. Diversion of water to canals and rivers must be done after prior treatment through STP (Sewage Treatment Plants which reduce their organic matter load and BOD (Biological Oxygen Demand) that may not cause any respiratory and metabolic problem to aquatic animals and plants. Compost from MSW contains 0.7% N, 0.5% P_2O_5, 0.4% K_2O.

STP components

a) Aeration tank: Have aerobic microbes with supply of Oxygen.
b) Activated sludge recirculation
c) Excess sludge recirculation
d) Aeration for Oxygen supply
e) Secondary sedimentation tank: To separate and concentrate activated sludge

Table 2: Nutrient content of different Manure and Compost:

	N	P	K
FYM	0.5	0.25	0.5
Town Compost	1.5	0.4	1.4
Vermi-compost	3.0	1.0	1.5
Night Soil	5.5	4.0	2.0
Sheep and Goat Manure	3.0	1.0	2.0
Poultry manure	3.03	2.63	1.40

Enrichment of compost and FYM

a) N- enrichment process:

Known as: ADCO process
Developed by: Hutchinson and Richards (1921)
Material used: Ammonium sulphate or Urea @ 0.7-0.8%
Purpose: To reduce C:N ratio to fasten decomposition
Enrichment of N: 1.8-2.5 %

b) Phosphorus enrichment:

Material used: Rock Phosphate, Superphosphate, Di Calcium Phosphate
Material used for 1 tonne phospho-compost (6-8% P_2O_5):

800kg organic material, weeds, residue, leaves + 100kg biogas or cow dung slurry + 100kg soil + 50kg FYM/Compost + 265kg low-grade Rock Phosphate.
Time for Composting : 3 months

Composition of enriched compost:
0.5-1.0% N, 0.2-0.5% P_2O_5 and 0.5-1.0% K_2O

Precautions during composting:

a) Pit must be above ground level to avoid rain water from entering.
b) Floor below must be Pakka to avoid leaching losses.
c) If possible cover the above ground portion with teen shed for better nutrient enrichment.
d) Maintain adequate moisture content to maintain favourable condition for microbes proliferation.
e) Turning must be done timely in aerobic method of composting.
f) Enrichment with fertilizers must be done with adequate doses.

Conclusion

In conclusion, composting is a vital process that transforms organic waste into a valuable resource. Through the action of microorganisms, organic materials decompose into nutrient-rich compost, which can enhance soil health and fertility. By diverting waste from landfills and promoting sustainability, composting plays a crucial role in environmental conservation efforts. Its benefits extend to gardening, agriculture, and landscaping, offering a natural and eco-friendly solution for recycling organic materials. Embracing composting practices can contribute to healthier ecosystems and a more sustainable future for generations to come.

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ISSN : 2583-0910
Agri-India TODAY
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Article ID : 04/IV/08/0424

THE ECOLOGICAL BASIS FOR FOREST REGENERATION: KEY CONCEPTS AND IMPLICATIONS

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Abstract

Forest regeneration is essential for sustaining ecosystem health and resilience, yet its success hinges upon understanding and applying ecological principles. This article delves into the interaction between the factors driving forest regeneration, emphasizing the pivotal role of early management decisions. Key elements include succession dynamics, seed ecology, microsite conditions, disturbance regimes, species interactions, and climate change impacts. By integrating this knowledge, managers can develop informed strategies to promote resilient and biodiverse forest ecosystems. Sustainable forest management practices, informed by ecological integrity and adaptability, are crucial for ensuring long-term forest vitality in the face of environmental change.

Keywords : Disturbance regimes, Microsite conditions, Seed ecology and Succession dynamics.

Introduction

Trees, like all living organisms, have a finite lifespan. There comes a point when they either need to be replaced naturally or through intentional management. The early stages of tree regeneration are remarkably adaptable, and the actions taken during this critical period play a substantial role in shaping the future development of both individual trees and entire stands. The decisions and treatments implemented in the initial weeks or months can exert a more significant influence on future tree characteristics than any subsequent efforts. The success or failure of silvicultural practices is often determined during the establishment of the stand. Regenerating a forest stand is such a pivotal undertaking that it should remain a central consideration throughout the entire rotation period. Furthermore, understanding the ecological basis for regeneration is paramount in ensuring the successful replacement of aging trees, as it directly influences the methods and strategies employed during the early stages of tree establishment and stand development.

Ecological basis for forest regeneration

The ecological basis for forest regeneration encompasses the complex web of natural processes that drive the renewal and growth of forest ecosystems. Forest regeneration, vital for maintaining ecosystem health and resilience, involves the interaction of various ecological factors. Understanding these fundamentals is crucial for guiding sustainable management practices and ensuring the long-term viability of forests. Key elements include the dynamic processes of seed dispersal, germination, and establishment, as well as the interactions between plants, animals, and their environment. Moreover, factors such as soil fertility, climate conditions, and disturbance regimes significantly influence forest regeneration dynamics. By comprehending these ecological

principles (Fig. 1), we can develop effective strategies to support natural regeneration processes, enhance biodiversity, and mitigate the impacts of disturbances.

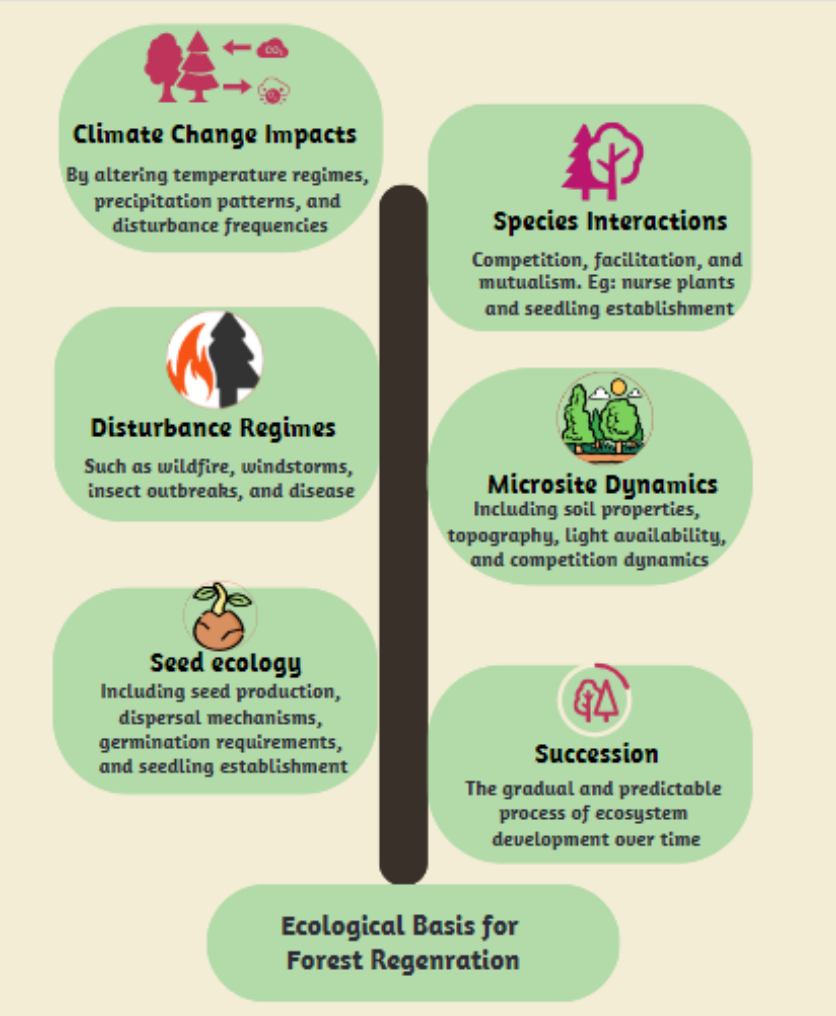

Figure 1: Ecological Principles of Forest Regeneration

1. Succession : Forest regeneration occurs within the broader framework of ecological succession, which is the gradual and predictable process of ecosystem development over time. Succession involves a series of stages, starting from bare ground or disturbed sites and progressing towards the establishment of stable forest communities. Understanding the dynamics of succession helps managers anticipate and facilitate the regeneration process by recognizing the species composition, structural changes, and ecological interactions that occur during different stages (Derroire *et al.,* 2016).

2. Seed Ecology : Seeds play a fundamental role in forest regeneration, serving as the primary means of dispersal and establishment for many plant species. Knowledge of seed ecology, including seed production, dispersal mechanisms, germination requirements, and seedling establishment, is crucial for predicting regeneration outcomes and designing effective management strategies. The distribution of seeds by various mechanisms, such as wind, animals, or water, plays a crucial role in initiating the regeneration of forests. Seeds must reach suitable locations for germination and growth. In particular, the process of natural regeneration is

significantly shaped by seed dispersal, a phenomenon influenced by a combination of biological factors (such as seed properties like wing loading, seed yield, and distance from seed to ground) and environmental variables (including wind conditions, topography, and climate) (Kim *et al.,* 2022). Once seeds reach the forest floor, they need the right environmental conditions, including moisture, light, and nutrient availability, to germinate and establish as seedlings. Additionally, factors such as seed viability, dispersal distance, and microsite conditions influence the success of seedling recruitment and colonization in forest ecosystems.

3. Microsite Dynamics : Microsite conditions, including soil properties, topography, light availability, and competition dynamics, strongly influence the regeneration process. Different plant species exhibit varying preferences for microsite characteristics, and understanding these preferences is essential for promoting successful regeneration. Managers can manipulate microsite conditions through techniques such as site preparation, soil amendment, and vegetation control to create favorable environments for target species regeneration. Healthy soils with suitable nutrient levels are essential for the growth of forest vegetation (Dyderski *et al*., 2018). Nutrient cycling processes, involving decomposition and nutrient release, support forest regeneration. Additionally, microclimatic conditions, including temperature, humidity, and light levels, can significantly impact the regeneration of understory plants and tree seedlings in the forest (Baker *et al*., 2014).

4. **Disturbance Regimes :** Natural disturbances, such as wildfire, windstorms, insect outbreaks, and disease, play a crucial role in shaping forest regeneration dynamics. Disturbances create openings in the forest canopy, promote species turnover, and create opportunities for seedling establishment and growth. Sustainable forest management recognizes the importance of natural disturbance regimes and seeks to mimic their effects through prescribed burning, selective harvesting, and other silvicultural practices to maintain ecosystem resilience and diversity. Sturtevant and Fortin (2021) opined that variability in tree regeneration following disturbance has the potential to mitigate and postpone future disturbances by disrupting spatial and temporal synchrony across the landscape. This stresses the significance of promoting landscape variability within ecosystem management frameworks, particularly considering evolving disturbance patterns.

5. Species Interactions : Forest regeneration is influenced by complex interactions among plant species, including competition, facilitation, and mutualism. The relationships between different plant species, as well as between plants and animals, can influence forest regeneration. For example, mutualistic interactions with mycorrhizal fungi may enhance nutrient uptake by tree seedlings. Understanding these species interactions helps managers anticipate community dynamics and select appropriate regeneration strategies. For example, nurse plants can provide shelter and microsite conditions conducive to seedling establishment, while allelopathic species may inhibit the growth of competitors (Callaway, 2007). By considering species interactions, managers can promote the coexistence of diverse plant communities and enhance ecosystem resilience.

6. Climate Change Impacts : Climate change poses significant challenges to forest regeneration by altering temperature regimes, precipitation patterns, and disturbance frequencies. Shifts in climate conditions may affect the distribution and abundance of plant species, disrupt phenological synchrony, and increase the frequency and intensity of extreme weather events.

Sustainable forest management strategies should incorporate climate change adaptation measures, such as assisted migration, genetic diversity conservation, and flexible management regimes, to enhance the adaptive capacity of forest ecosystems. Maintaining genetic diversity within tree populations is crucial for long-term forest regeneration, as it can enhance adaptability and resilience to changing environmental conditions.

The ecological fundamentals of forest regeneration encompass a diverse range of processes and interactions that influence the dynamics of forest ecosystems. By integrating knowledge of succession dynamics, seed ecology, microsite dynamics, disturbance regimes, species interactions, and climate change impacts, managers can develop informed strategies for promoting resilient and biodiverse forest regeneration. Sustainable forest management practices that prioritize ecological integrity, adaptability, and diversity are essential for ensuring the long-term health and vitality of forest ecosystems in the face of environmental change.

Conclusion

Understanding and applying the ecological basis for forest regeneration is essential for sustainable forest management and conservation. It helps ensure that forests can recover and thrive after disturbances and continue to provide important ecological, economic, and social benefits. This knowledge can assist in formulating approaches to strengthen natural regeneration processes and enhance forest resilience in the face of environmental pressures.

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ISSN : 2583-0910
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Article ID : 04/IV/09/0424

EXPLORING ECONOMIC TRAITS IN CATTLE AND BUFFALOES

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Introduction

Dairy cattle and buffaloes play an indispensable role in the global agricultural market, providing a important source of milk and dairy products essential for human nutrition and sustenance. The economic significance of these animals is influenced by their diverse traits, which impact productivity, profitability, and sustainability within the dairy industry. The economic traits of dairy cattle and buffaloes, focusing on five primary categories: production, reproduction, growth, type and conformation, disease resistance, and longevity are discussed. By examining and understanding these economic traits, dairy farmers and industry stakeholders can implement targeted breeding, management, and health strategies to optimize productivity, profitability, and sustainability within the dairy sector.

Economics Traits

Economic traits refer to those characteristics of an animal that directly impact its productivity and, consequently, its economic value. These traits are typically measurable or easily identifiable and have a discernible effect on either income generation or production costs. They are predominantly quantitative in nature and are influenced by multiple genes, reflecting the complex interplay of genetic and environmental factors in determining an animal's performance.

Economic Traits of Dairy Cattle and Buffaloes

1. Production Traits
2. Reproduction Traits
3. Growth Traits
4. Type and Conformation
5. Disease Resistance
6. Longevity

Production Traits

1. Lactation Yield: Lactation yield stands as one of the primary indicators of a dairy animal's productivity, referring to the total volume of milk produced during a single lactation period. This trait is influenced by various factors such as the number of calving events, frequency

of milking sessions, and the persistency of milk yield throughout the lactation period. Research indicates a notable increase in milk yield from the first to the third lactation, typically ranging from 30 to 40%. However, beyond the third or fourth lactation, a decline in milk yield is commonly observed. Lactation yield is a heritable trait, with estimates of heritability typically ranging from 20 to 30%.

2. Lactation Period: The lactation period refers to the duration from calving until drying off, a critical phase that directly influences milk production. An optimal lactation period typically spans around 305 days. Shorter lactation periods may result in reduced milk yield, highlighting the importance of managing lactation duration to maximize productivity.
3. Persistency in Milk Yield: Persistency in milk yield characterizes the ability of a dairy animal to maintain high milk production levels over an extended period following the peak milk yield phase. High persistency is crucial for sustaining milk production throughout the lactation period, contributing to overall productivity. Achieving and maintaining high levels of persistency requires careful management practices and genetic selection.
4. Milk Fat Content/ Yield: Aside from milk volume, the fat content or fat yield of milk also holds significant economic value for dairy producers. Total fat production in milk, from the sixth day post-calving until drying off, is an essential determinant of milk quality and pricing. Milk yield and fat content often exhibit a negative correlation. Heritability estimates for fat percentage range from 50 to 60%, while fat yield typically exhibits heritability estimates of 20 to 30%.
5. Production Lifespan: The production lifespan of a dairy animal denotes the total duration over which it remains productive in terms of milk production. This trait, while crucial for long-term profitability, exhibits relatively low heritability estimates ranging from 0 to 10%.

Reproduction Traits

1. Age at First Calving: Age at first calving represents the age at which a dairy animal gives birth for the first time. This trait significantly influences subsequent productivity and reproductive efficiency. Optimal age at first calving varies among different breeds, with early calving associated with challenges such as weak calves and difficult calving, while delayed calving may result in reduced lifetime production due to fewer calving events. However, despite its importance, age at first calving exhibits relatively low heritability.
2. Calving Interval: Calving interval, the duration between successive calving events, plays a crucial role in determining the reproductive efficiency and productivity of dairy animals. An optimal calving interval is typically around 12 months for cows and 14 months for buffaloes. Prolonged calving intervals can lead to reduced lifetime production due to fewer calving events, emphasizing the importance of managing this trait for optimal herd performance.
3. Dry Period: The dry period refers to the period between drying off and the subsequent calving event. An optimal dry period duration, typically around 60 days, is essential for ensuring the health and productivity of dairy animals in the subsequent lactation cycle. Inadequate dry periods may result in stress, reduced lactation yield, and weakened calves, underscoring the importance of effective management practices in optimizing reproductive performance.

4. Service Period/Days Open: The service period, also known as days open, represents the duration between calving and conception. An optimal service period, typically ranging from 60 to 90 days, allows dairy animals to recover from calving stress and return to normal reproductive function, contributing to efficient reproductive performance and overall herd productivity. However, prolonged service periods can result in extended calving intervals and reduced lifetime production, highlighting the importance of managing this trait to optimize reproductive efficiency.

Growth Traits

Growth traits in dairy cattle and buffaloes encompass various characteristics related to the rate and pattern of physical development from birth to maturity. These traits play a significant role in determining the future productivity and profitability of dairy animals. The rate of growth during early stages of development often correlates with later production traits such as milk yield and reproductive performance. Additionally, growth traits such as age at first calving are positively correlated, with animals exhibiting superior growth rates typically achieving earlier age at first calving and vice versa. Effective management practices and genetic selection strategies can help optimize growth traits to enhance overall herd productivity and profitability.

Type and Conformation Traits

Type and conformation traits in dairy cattle and buffaloes encompass physical characteristics that influence overall structural soundness, functional efficiency, and performance. While the relationship between physical traits and production may vary among different breeds, these traits play a crucial role in determining milk production, udder health, and overall longevity. While certain traits such as udder characteristics exhibit moderate to high heritability, others may have lower heritability estimates. Effective selection strategies targeting desirable type and conformation traits can contribute to improved productivity, health, and profitability within dairy herds.

Udder Traits

Udder traits represent a subset of type and conformation characteristics that specifically influence milk production, udder health, and milking efficiency. Development of the udder and proper placement of teats are essential considerations in dairy animal selection and management, as they directly impact milk yield, udder health, and ease of milking. Traits such as teat placement exhibit heritability estimates, highlighting the potential for genetic improvement through selective breeding strategies targeting desirable udder characteristics.

Disease Resistance

Disease resistance is a critical aspect of dairy cattle and buffalo management, influencing overall herd health, productivity, and profitability. Healthy animals are more resilient to diseases, exhibiting higher milk production levels and reproductive efficiency. Indigenous breeds often demonstrate greater resistance to a variety of diseases compared to exotic breeds, emphasizing the importance of genetic selection and management practices in optimizing disease resistance and overall herd health.

Longevity

Longevity refers to the lifespan of dairy cattle and buffaloes in productive use within a herd. Animals with increased longevity contribute to herd profitability by producing more calves, undergoing more lactation cycles, and providing additional opportunities for genetic selection and

improvement. Longevity is a desirable trait in dairy production systems, as it allows for the accumulation of genetic progress over time and enhances overall herd sustainability and profitability. Effective management practices, including proper nutrition, healthcare, and reproductive management, play a crucial role in maximizing the longevity of dairy animals within a herd.

Conclusion

Economic traits play a pivotal role in determining the productivity, profitability, and sustainability of dairy cattle and buffalo operations. Understanding and effectively managing these traits through appropriate selection, breeding, and management strategies are essential for optimizing herd performance, maximizing resource utilization, and ensuring long-term success within the dairy industry.

Acknowledgement:

The ChatGPT, an AI-powered chatbot (https://www.openai.com/chatgpt) was used for language modulation.

ISSN : 2583-0910
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Article ID : 04/IV/10/0424

HARNESSING THE POTENTIAL OF MARINE PLANKTON : A BIOPROSPECTING PERSPECTIVE

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Abstract
A growing area called marine bioprospecting looks into the ocean's rich biodiversity to find novel natural products that could be used in biotechnology, cosmetics, pharmaceuticals, and agriculture, among other industries. The importance of marine bioprospecting in utilising the abundance of biological resources found in marine habitats is emphasised in this abstract. The methods used to find and create bioactive compounds from marine animals, such as microbes, algae, invertebrates, and marine plants, are covered in this article. It also looks at the difficulties and moral issues of marine bioprospecting, such as fair benefit sharing with local communities and conservation concerns. Lastly, it highlights the promise for marine bioprospecting as a sustainable drug discovery strategy in the future as well as the continuous efforts to protect marine biodiversity and realise its medicinal and economic potential.

Keywords : Marine Plankton, Fucoxanthin, PUFA, Astaxanthin, Anti-Cancer, Cosmeceuticals

Introduction

At the stands of scientific research, marine bioprospecting makes use of the rich biodiversity found in the world's seas to find new biologically active substances. With more than 70% of the Earth's surface is covered up my marine waters and home to a wide variety of rare and frequently undiscovered species, there is an enormous chance that important bioresources may be found there. The foundation for comprehending the importance of marine bioprospecting in relation to medicine development, sustainable development, and environmental protection is laid forth in this introduction. Scientists have been looking more closely at these varied environments over the past several decades in an effort to find molecules that may have use in medicine, industry, or agriculture. In order to survive in harsh marine habitats, marine species have developed special metabolic pathways that have produced bioactive compounds with amazing qualities. However, there are moral, legal, and environmental issues that come up when marine biodiversity is explored for profit. We may gain a better understanding of the significance of protecting marine biodiversity while utilising it for human benefit by illuminating the complexities of this sector.

General phases in Bioprospecting:

Generally Bioprospecting involves four phases. Phase I deals with collection of samples from the marine environment. In Phase II the collected sample is identified and isolated. Characterization and specification of particular compound from the sample will be carried out. Phase III involves screening of the compound for its bioactivity. The final step i.e., Phase IV involves product development and testing. Later the product will be commercialized.

Need for Bioprospecting of Plankton:

Algae are also called the “treasure from the god of the sea” in ancient periods due to their unique composition. The planktonic compartment represents 95% of marine biomass and yet the extent of its diversity remains largely unknown and underexploited. Immense opportunities: new resources for medicine, cosmetics and food, renewable energy. Research programs aiming to exploit culture collections of marine micro-organisms as well as to prospect the huge resources of marine planktonic biodiversity in the oceans are now underway, and several bioactive extracts and purified compounds have already been identified. This review will survey and implies to better explore the potential of marine plankton for drug discovery and for dermo-cosmetics.

Potential Fucoxanthin from Diatom

Fucoxanthin is a specific non-provitamin Acarotenoid found as an accessory pigment in the chloroplast of brown algae, giving them a brown or olive-green color. Generally, diatoms contain up to 4 times more Fucoxanthin than seaweed, making diatoms a viable source for fucoxanthin industrially. Diatoms can be grown in controlled environments (such as photobioreactors). Researchers screened 13 naturally occurring diatom (strains from several culture collection centers and identified a promising strain, with regard to growth and fucoxanthin production (Fung et.al, 2013) i.e., *[C. cryptica, C. gracilis, C. meneghiniana, N.incerta, N. laevis, N. pelliculosa, P. tricornutum, S.polycystum, S.horneri, T. weissflogii, , T. pseudonana, I.galbana, O. aurita,]*

Cyclotella cryptic had a higher biomass concentration than the other five strains. In addition, *C.cryptica* had the highest fucoxanthin content, which was 0.77% of dry weight and comparable to that under photoautotrophic conditions. Its unique structure endows fucoxanthin with a variety of biological activities, including Anti-obesity and anti-diabetes, Anti-cancer, Anti-allergic, Anti-inflammatory, Anti-osteoporotic activities, Inhibit the growth of *Mycobacterium tuberculosis*. (Guo *et.al*., 2013).

Alternate source of PUFA in Marine Microalgae

Microalgae species with potential to accumulate lipids in high amounts and to present elevated levels of n-3 LC-PUFA are known in marine phytoplankton. Seafood originating from contamination factors may be hazardous for humans, particularly pregnant or lactating women and young children.According to recent reviews of total lipid extracts, Bacillariophyceae (diatoms) and *Chrysophyceae* species may be rich sources of EPA and DHA. EPA sources - *Cryptophyceae, Prasinophyceae, Rhodophyceae, Xanthophyceae, Glaucophyceae* and *Eustigmatophyceae*. DHA sources - *Dinophyceae, Prymnesiophyceae,* and *Euglenophyceae.* (Mortia et.al.,2006).Thedevelopment of commercial processes for microalgal oil production, particularly oils rich in DHA, has benefited more recently.It isbecause of the fact that a number of microalgae organisms can accumulate high lipid contents in biomass (up to 50% biomass dry weight), including 30%–70% of this fatty acid (Goldberg et.al.,2011).

Bio-Economy from Marine Phytoplankton

Chaetoceros calcitrans (family Bacillariophyceae) contains high amounts of lipids, natural antioxidant pigments (carotenoids and chlorophylls) and PUFAs. *Chaetoceros muelleri* and *Chaetoceros lauderi* displayed antimicrobial and antibacterial effects due to elevated amounts of eicosapentaenoic acids. It also used as valuable feed supplement or substitute for conventional animal feed sources. There was a dynamic range of detectable metabolites between acetone, chloroform, methanol, 70% ethanol and hexane extracts from the diatom, *C. calcitrans*.29

metabolites were identified from various solvent extracts and Chloroform extract has been shown to be very effective at recovering antioxidant compounds. The microalgae *C. calcitrans* could serve as important functional food ingredient in the mariculture industry. It has been proven that other species under the same genus such as *Chaetoceros gracilis* is capable of producing high quality of fatty acids for lipid industry. *Chaetoceros muelleri* is one of the most extensively used microalgae in aquaculture. Proviron Chaetoprime, a Freeze Dried *Chaetoceros muelleri product* is commercially available as feed for shrimp, sea cucumber and oyster. (Azizan *et.al*., 2018)

Astaxanthin from Green Microalgae

Astaxanthin is a red keto-carotenoid with high commercial value in functional food, cosmetics and nutraceuticals industry due to its high anti-oxidative activities. The natural product serve as additives to food and pharmaceutics.Unicellular green microalga, *Chlorella zofingiensis*, is considered a promising producer of natural astaxanthin.*C. zofingiensis* has a high growth rate and it is easy to achieve high cell density in the presence of organic substrates and it accumulates astaxanthin under stress conditions. Microalgae derived astaxanthin is being used as a pigment in food and feed production and also in cosmetic and pharmaceutical products. The major market for astaxanthin is as a pigmentation source in aquaculture, primarily in salmon and trout. Astaxanthin price - US$2500 /kg; with an annual worldwide market estimated at US$200 million (Chen *et.al*., 2017).

Anti-Cancer property from Diatom

Different solvent extracts of diatoms have also exhibited potent anticancer activities with the induction of apoptosis. *Chaetoceros calcitrans*ethanol extracts (EEC) show anti-cancer activity against MCF-7 and MCF-10A. The *C. calcitrans* ethyl acetate extract (CEA) has exhibited cytotoxic activity against MDA-MB-231 cancer cell line. *Cocconeisscutellum* diethyl ether extract, especially the fraction rich in EPA, can reduce the viability of BT20 cells and induce apoptotic activities.(Martínez et.al., 2018).

Anti-oxidant property from Diatom

Under specific culture conditions, the marine diatom *Odontella aurita* can accumulate chrysolaminarin, which has antioxidant and anti-inflammatory functions, to improve immunity and regulating lipid metabolism.Recent study investigated the use of *O.aurita* as an immune stimulant in the diet of juvenile golden pompano *Trachinotus ocatus.* Three experimental diets containing 0%, 1% and 5% *O. aurita* were used to feed *T. ovatus* for 6-week. The results indicated that diet supplementation with *O. aurita* powder boosted the growth of *T. ovatus* by decreasing the feed conversion ratio, increasing the activities of lipase and pepsin in the intestine, and improving intestinal villi structure. (Xia *et.al*., 2013).

Anti-microbial compounds from Eukaryotic Microalgae

Short chain fatty acids from *H. pluviali s* and long chain fatty acids from *Scenedesmus obliquus exhibited* antibacterial activity against *E. coli* and *S. aureus.* The polyunsaturated fatty acids from *Chlorococcum* strain and *Dunaliella primolecta* demonstrated antibacterial activity against the methicillin-resistant *S. aureus* (MRSA), a bacterium causing infections that kill thousands of people per year and which can be highly resistant to conventional antibiotics. Fatty acids from the diatom Phaeodactylumtricornutum with a very potent antibacterial activity against the MRSA (Bratchkova *et al.,* 2020).

Cosmeceuticals from Plankton

"Cosmeceutical" is a combination of cosmetics and pharmaceuticals and indicates that a specific product contains active ingredients (Fernandoet. al., 2019). According to EU regulation (No. 1223/2009 on cosmetic products) seaweed is classified as a plant extract and there is no restriction for cosmetic use. Algalbiomass provides a rich source of biologically active compounds with a broad range of physiological and biochemical properties that are rare or absent in other taxonomic groups. Biologically active algal compounds are known to have anti-aging, antiphotoaging, antioxidant, antimicrobial, photoprotective, skin conditioning, moisturizing, protecting, smoothing, soothing, viscosity controlling, lipolytic and whitening properties. They can also be used in anti-cellulite and slimming treatments, as well as in the treatment of skin problems, such as tanning and pigment disorders (Wang *et.al.,* 2017).

Cosmeceuticals from Seaweed

The most frequently used extracts in cosmetic formulations are derived from: Brown macroalgae: *(Fucus serratus, Fucus vesiculosus, Laminaria angustata, Laminaria digitata, Pelvetiacanaliculata, Undaria pinnatifida, Sargassum muticum)* Green macroalgae: *(Ulva compressa, Ulva lactuca, Ulva ramulosa, Codium tomentosum.)*Red macroalgae: *(Kappaphycus alvarezii, Jania rubens, Halopteris scoparia, Chondrus crispus, Gelidium cartilagineum, Asparagopsis armata, Palmaria palmata)* (Bedoux *et al.,* 2014). Among the red algae, Algotherm pays special attention to *Palmaria palmata*, which is rich in vitamins A and B12, regulates flows and encourages elimination of water and toxins, which cause sensations of tired legs.

Marine Phytoplankton Capsules and Powder

Phytoplankton are a highly bioavailable source of nutrients, which can be directly absorbed into the bloodstream. They are now available in the form of capsule and powder to best suit your lifestyle needs. *Nannochloropsis gaditana*is the Hero Ingredient of ocean phytoplankton*"* - *Daniella Hunter*. *Nannochloropsis gaditana*supplementation in high fat diet induces reduction in weight gain, plasma, and tissue lipids and attenuates oxidative stress and improves the metabolic status. Bioactive compounds of *Nannochloropsis gaditana* have a hypoglycemic, hypolipidemic nature and improves the redox status of the subject, which could prevent some metabolic disorders associated with obesity. (Bendaoud *et. al*., 2019).

Conclusion

This article covered the bioprospecting potential marine plankton and their qualities, economic relevance, aiming the production of cosmeceutical products with industrial interest. It is of great need to use all the knowledge presented and apply it in the different branches of science, aiming the discovery of new products from least explored areas for the wellness of environment and the human being. If mass culture of marine algae having bio-prospecting potential could be carried out, then potential of marine algae can be benefitted in large scale in future.

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ISSN : 2583-0910
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Peer reviewed
monthly newsletter

Article ID : 04/IV/11/0424

PROTECTING ANIMAL HEALTH: NAVIGATING THE IMPACT OF PESTICIDES IN AGRICULTURE

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Introduction

In the intricate tapestry of agricultural practices, pesticides play a pivotal role in safeguarding crop yields and ensuring food security. These chemical defenders stand as a bulwark against the relentless assault of pests, offering farmers essential protection for their harvests. However, amidst their efficacy in controlling pests, lies a concern often overlooked—the potential impact on the health of our beloved domestic animals.

As pesticides permeate agricultural landscapes, concerns regarding their impact on animal health become increasingly pertinent. While the primary targets are crop-damaging pests, the consequences extend beyond the intended targets. Domestic animals, such as cattle, sheep, poultry, and pets, are inadvertently exposed to these chemical compounds through contaminated food, water, or direct contact with treated surfaces. The ramifications of pesticide exposure on domestic animals can be profound and multifaceted. From acute poisoning to chronic health issues such as neurological disorders, reproductive complications, and weakened immune systems, the toll on animal health can be severe. Furthermore, the potential for pesticide residues to accumulate in animal products such as meat, milk, and eggs raises concerns about food safety and human health implications. Raising awareness about the impact of pesticides on domestic animal health is imperative.

By shedding light on the hidden risks associated with pesticide use, we can empower animal owners, farmers, and consumers to make informed decisions that protect the well-being of our cherished animal companions. Join us as we explore the intricate relationship between pesticides and the health of domestic animals. Delve into the obstacles, dangers, and possible remedies to reduce the negative impacts of pesticide exposure on our beloved pets and farm animals. Let's collaborate towards a future where sustainable agricultural practices coexist with safeguarding the well-being of domestic animals.

How Pesticides Enter the Animal System:

Pesticides find their way into the bodies of domestic animals through various pathways, each presenting unique risks to their health and well-being.

1. **Direct Ingestion:** One of the most common ways animals are exposed to pesticides is through the consumption of contaminated feed or water. Foraging animals, such as cattle and sheep, may inadvertently ingest pesticides sprayed on crops or present in water sources. Similarly, pets may consume pesticide-laden plants or contaminated food left accessible in outdoor settings.

2. **Inhalation:** Animals can also be exposed to pesticides through inhalation of residues present in the air. Aerosolized pesticides, such as those applied via spray drift or aerial spraying, can be inhaled by animals grazing nearby or housed near treated fields. This route of exposure poses a particular risk to respiratory health, especially for animals with sensitive airways.
3. **Dermal Absorption:** Pesticides can be absorbed through the skin or mucous membranes of animals, particularly those with direct contact with treated surfaces. Livestock, such as dairy cows, may come into contact with pesticides sprayed onto crops during grazing or through direct application for pest control. Similarly, pets may absorb pesticides through contact with contaminated surfaces or grooming activities.

Examples of specific pesticides:

a. Organophosphates, pyrethroids, and neonicotinoids. Organophosphates, known for their neurotoxic effects, can enter animals' bodies through all three pathways, making them particularly hazardous.
b. Pyrethroids, commonly used in household insecticides and agricultural pest control, can be ingested, inhaled, or absorbed through the skin.
c. Neonicotinoids, systemic pesticides widely used in crop protection, are primarily absorbed by plants and can be ingested by animals consuming treated vegetation.

Understanding these pathways of exposure is crucial for assessing the risks posed by pesticides to animal health and implementing effective mitigation strategies to minimize their impact.

Adverse Effects of Pesticides on Animal Health

Pesticide exposure poses significant risks to the health and well-being of domestic animals, manifesting in a range of acute and chronic effects, as well as sublethal impacts.

1. **Acute Toxicity:** Animals may experience immediate adverse effects upon exposure to high levels of pesticides. Symptoms of acute toxicity include vomiting, diarrhoea, tremors, convulsions, respiratory distress, and, in severe cases, death. These effects are often observed shortly after ingestion, inhalation, or dermal contact with concentrated pesticide formulations.
2. **Chronic Toxicity:** Long-term exposure to pesticides can result in chronic health issues, including reproductive abnormalities, developmental disorders, immune system suppression, and increased susceptibility to diseases. Pesticides may disrupt hormonal balance, leading to infertility, miscarriages, or birth defects in animals. Additionally, chronic exposure to certain pesticides has been linked to an elevated risk of cancer and other chronic diseases in animals.
3. **Sublethal Effects:** Even at low levels of exposure, pesticides can exert sublethal effects on animals, impacting behaviour, reproduction, and growth. Sublethal effects may include altered feeding and foraging behaviours, reduced reproductive success, delayed growth and development, and compromised immune function. These subtle yet significant changes can have profound implications for individual animals and populations over time.

Case Studies or Examples:

1. **Birds:** Pesticide exposure has been implicated in the decline of bird populations worldwide. For example, the use of organophosphate pesticides in agricultural areas has been linked to acute poisoning and reproductive failure in raptors such as eagles and hawks. Additionally,

neonicotinoid insecticides have been associated with neurological impairment and decreased foraging success in songbirds.

2. **Fish:** Aquatic ecosystems are particularly vulnerable to pesticide contamination, with fish being exposed to waterborne pesticides and contaminated prey. Studies have shown that exposure to pesticides like atrazine and glyphosate can disrupt fish reproduction, impairing fertility and spawning success. Moreover, chronic exposure to pesticides has been linked to developmental abnormalities and decreased survival rates in fish larvae.
3. **Livestock:** Dairy cattle and other livestock can suffer adverse health effects from pesticide exposure, particularly through contaminated feed and water sources. Chronic exposure to organochlorine pesticides, such as DDT, has been associated with reproductive disorders and milk contamination in dairy cows. Additionally, the use of pyrethroid insecticides in livestock facilities has been linked to respiratory problems and skin irritation in animals.

Cows Died of Pesticide Poisoning

Elephant Died of Pesticide Poisoning

Pea fowls died of Pesticide Poisoning

These case studies underscore the diverse and far-reaching impacts of pesticides on different animal species, highlighting the urgent need for improved pesticide management practices to protect animal health and biodiversity.

Vulnerable Populations and High-Risk Scenarios

Certain animal groups are particularly susceptible to pesticide exposure due to their living environments and behaviours. These vulnerable populations face increased risks of adverse health effects from pesticides, often exacerbated by specific scenarios or practices.

1. **Livestock Animals in Intensive Farming Systems:** Livestock raised in intensive farming systems, such as cattle, sheep, pigs, and poultry, are at high risk of pesticide exposure due to their close confinement and reliance on pesticide-treated feed and water. In these environments, animals may be exposed to pesticides through contaminated feed, water sources, or direct application for pest control. Additionally, the use of pesticide-based veterinary treatments and disinfectants further increases the risk of exposure in intensive farming operations.
2. **Companion Animals in Urban or Suburban Areas:** Companion animals, including dogs and cats, living in urban or suburban areas are often exposed to pesticides used for lawn and garden maintenance, pest control, and mosquito abatement. Pesticides applied to lawns, gardens, or public spaces can be tracked indoors on pets' fur or paws, leading to dermal exposure through grooming or direct contact. Moreover, pets may ingest pesticides through licking or chewing treated surfaces, posing risks to their health.
3. **Wildlife Species in Agricultural Landscapes:** Wildlife species inhabiting agricultural landscapes or areas with heavy pesticide use face significant risks of exposure to

pesticides. Birds, mammals, amphibians, and insects may come into contact with pesticides through contaminated food, water sources, or direct application for crop protection. Additionally, pesticide residues can accumulate in soil, waterways, and vegetation, posing secondary exposure risks to wildlife through ingestion or inhalation.

High-Risk Scenarios and Practices:

1. **Grazing on Treated Fields:** Livestock grazing on recently treated fields or pasturelands are at high risk of pesticide exposure. Pesticides applied to crops or forage may contaminate grazing areas, leading to direct ingestion or dermal exposure in animals. Inadequate grazing management practices and improper application techniques can exacerbate the risk of exposure in grazing livestock.
2. **Living Near Pesticide Application Sites:** Companion animals residing near pesticide application sites, such as agricultural fields, orchards, or golf courses, face heightened risks of exposure to pesticide drift and runoff. Wind dispersal of pesticide droplets or particles can carry pesticides over long distances, contaminating neighbouring residential areas and posing risks to pets and wildlife. Additionally, living in areas with heavy pesticide use for vector control or mosquito abatement increases the likelihood of exposure in companion animals.

Identifying vulnerable animal populations and high-risk scenarios for pesticide exposure is essential for implementing targeted mitigation strategies and protective measures to safeguard animal health and well-being in diverse environments.

Mitigation Strategies and Best Practices

To minimize the adverse impact of pesticides on animal health, a combination of proactive measures and best practices is essential. These strategies aim to reduce pesticide exposure in vulnerable animal populations and promote sustainable agricultural practices.

1. **Integrated Pest Management (IPM) Strategies:** Implementing IPM strategies reduces reliance on chemical pesticides by incorporating a holistic approach to pest management. This includes practices such as crop rotation, habitat diversification, biological pest control, and the use of pest-resistant crop varieties. By integrating multiple pest control methods, farmers can effectively manage pests while minimizing the use of pesticides, thereby reducing the risk of exposure to animals.
2. **Proper Pesticide Application Techniques:** Employing proper pesticide application techniques is critical to minimizing off-target drift and contamination of animal habitats. This includes using precision spraying equipment, adjusting application rates and timing to minimize environmental exposure, and adhering to buffer zones to protect sensitive areas. By following recommended application practices, farmers can minimize the risk of pesticide exposure to livestock, wildlife, and companion animals.
3. **Monitoring and Surveillance Programs:** Establishing monitoring and surveillance programs helps detect pesticide residues in animal products and the environment, ensuring compliance with safety regulations and identifying potential risks to animal health. Regular testing of animal feed, water, soil, and animal products for pesticide residues provides valuable data on exposure levels and enables timely intervention measures to protect animal health and food safety.

4. **Education and Training Initiatives:** Providing education and training initiatives for farmers, veterinarians, and pet owners on safe pesticide use and handling is essential for promoting responsible pesticide management practices. Training programs should cover topics such as pesticide selection, application techniques, storage and disposal guidelines, and recognition of signs of pesticide toxicity in animals. By raising awareness and promoting best practices, stakeholders can reduce the risk of pesticide-related incidents and protect animal health.

Success Stories and Examples:

1. **Organic Farming Practices:** Transitioning to organic farming practices, which prioritize natural pest control methods and avoid synthetic pesticides, has been shown to significantly reduce pesticide-related risks to animal health. Organic farming systems promote biodiversity, enhance soil health, and minimize pesticide residues in animal feed and products, resulting in healthier livestock and wildlife populations.
2. **Community-Based Pest Management Programs:** Community-based pest management programs, such as farmer cooperatives and integrated pest management networks, have successfully reduced pesticide use and exposure in agricultural communities. By pooling resources, sharing knowledge, and adopting collaborative pest control strategies, farmers can effectively manage pests while minimizing reliance on chemical pesticides, thereby protecting animal health and environmental quality.
3. **Veterinary Outreach Programs:** Veterinary outreach programs that provide education and training on pesticide safety and toxicity to livestock producers and veterinarians have proven effective in reducing pesticide-related incidents and promoting responsible pesticide use. By equipping stakeholders with the knowledge and tools to identify and mitigate pesticide risks, these programs contribute to improved animal health and welfare in agricultural settings.

By implementing these mitigation strategies and best practices, stakeholders can reduce the adverse impact of pesticides on animal health and promote sustainable agricultural practices that benefit both animals and the environment.

Conclusion

The extensive application of pesticides in farming has significant implications for the health and welfare of animals in various ecosystems. Whether it is livestock in intensive farming, pets in urban areas, or wildlife in agricultural landscapes, the dangers associated with pesticide exposure are widespread and multifaceted. This article has highlighted that pesticides can cause both immediate toxicity and long-term reproductive and developmental issues for animals. Additionally, their sublethal effects on behaviour, reproduction, and immune function emphasize the intricate relationship between pesticides and animal physiology.

To tackle these challenges effectively, stakeholders within agriculture, veterinary services, and regulatory bodies must prioritize animal well-being when managing pesticides. Implementing integrated pest management strategies along with proper application methods, monitoring schemes, and educational campaigns are vital to minimize exposure risks and safeguard animal health. However, this journey does not conclude here. Continued research and advocacy efforts are necessary to enhance our understanding of the complex interactions between pesticides and animal health. Also, it's important to find innovative solutions that balance agricultural

productivity with environmental considerations and animal welfare factors. In conclusion, we must answer the call to action and unite our efforts to ensure that pesticides can benefit with out compromising animal well-being. Through collaboration, elevating awareness, and implementing evidence-based strategies, we can forgea future where animals flourish alongside sustainable agricultural practices.

Acknowledgement : I acknowledge the use of ChatGPT, an AI-powered chatbot (https://www.openai.com/chatgpt) for language modulation. The images used in this article are collected from the various internet sources.

ISSN : 2583-0910
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monthly newsletter

Article ID : 04/IV/12/0424

IN-SITU MOISTURE CONSERVATION PRACTICES FOR SUSTAINABLE DRYLAND AGRICULTURE

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Introduction

Dryland agriculture, characterized by limited and erratic rainfall, poses significant challenges to farmers seeking sustainable and productive cultivation in arid and semi-arid regions (Chimwamurombe and Mataranyika, 2021). One of the critical issues faced in these areas is water scarcity, which necessitates innovative and efficient approaches to manage and conserve moisture for optimal crop growth (Ingrao et al., 2023).In this context, the integration of in-situ moisture conservation practices, including both traditional and mechanical measures, is essential to address the unique challenges posed by dryland environments.

As farmers grapple with the impacts of climate change and diminishing water resources, adopting comprehensive strategies becomes imperative for enhancing agricultural productivity while safeguarding the delicate balance of the ecosystem (Malhi *et al.,* 2021). Among these strategies, in-situ moisture conservation practices play a pivotal role in mitigating the adverse effects of water scarcity (Choudhary *et al.,* 2017). In this article, we will explore the significance of various in-situ moisture conservation practices, including mulching, contour ploughing, rainwater harvesting, conservation tillage, and cover cropping. Furthermore, mechanical measures such as ridge and furrow systems, broad bed furrow systems, and intensive cropping systems, highlighting their contributions to optimizing water use and fostering sustainable agricultural practices in dryland regions. The synergy of these approaches not only ensures efficient water management but also promotes soil health, biodiversity and the overall resilience of dryland agriculture systems.

1. Mulching

Mulching is a widely adopted in-situ moisture conservation practice that involves covering the soil surface with a layer of organic or inorganic materials. Organic mulches, such as crop residues, straw, or compost, act as a protective barrier, reducing evaporation and preventing soil moisture loss. Inorganic mulches, like plastic sheets or gravel, also help in minimizing water evaporation from the soil surface. Mulching not only conserves moisture but also improves soil structure, regulates temperature, and suppresses weed growth, thereby enhancing overall crop yield (Prajapati and Subbaiah 2019; Satasiya *et al.,* 2022).

2. Contour Ploughing

Contour ploughing is a soil conservation technique that involves ploughing along the contour lines of the land. By creating furrows and ridges perpendicular to the slope, water runoff is slowed

down, allowing it to infiltrate the soil. This prevents soil erosion and promotes water retention in the root zone (Farahani *et al.,* 2016). Contour ploughing is particularly effective in hilly or sloping terrains where water runoff can be a significant challenge.

3. Rainwater Harvesting

Rainwater harvesting is a crucial in-situ moisture conservation practice that involves collecting and storing rainwater for future agricultural use. This can be achieved through the construction of ponds, check dams, or small reservoirs. Harvesting rainwater helps recharge groundwater levels and provides an additional source of moisture during dry periods. Integrating rainwater harvesting into dryland agriculture systems contributes to increased water availability for crops and enhances the overall sustainability of farming practices.

4. Conservation Tillage

Conservation tillage practices involve minimal soil disturbance, leaving crop residues on the field after harvest. This helps create a protective cover on the soil surface, reducing evaporation and preventing soil erosion. Conservation tillage methods include no-till, strip-till, and reduced tillage. These practices not only conserve moisture but also improve soil structure, enhance nutrient retention, and promote biodiversity, contributing to the long-term health of the agricultural ecosystem. Also, it is expected to have a positive effect on soil physical properties, soil carbon, and storage (Zurovec*et al.,* 2017).Moreover, it reducing fuel, labour and machinery costs.

5. Cover Cropping

Cover cropping involves planting specific crops during fallow periods to cover the soil surface and protect it from moisture loss. These cover crops, often legumes or grasses, contribute organic matter to the soil when incorporated after their growth cycle. The organic matter improves soil structure, moisture retention, and nutrient content (Ward*et al.,* 2013; Zurovec*et al.,* 2017). Additionally, cover crops act as living mulches, suppressing weed growth and reducing evaporation.

6. Ridge and Furrow Systems

Ridge and furrow systems are mechanical measures designed to conserve moisture by altering the topography of the field. In this practice, raised ridges and sunken furrows are created along the contour lines of the land. The raised ridges act as barriers that reduce water runoff, allowing it to infiltrate the furrows and percolate into the soil. This design facilitates better water distribution across the field, minimizing soil erosion and maximizing water retention in the root zone (Vekaria *et al.,* 2020). Ridge and furrow systems are particularly effective in regions with low rainfall, as they optimize the utilization of available moisture and contribute to increased crop yields.

7. Tied and Ridge system

The tied-ridge method is an effective in-situ moisture conservation technique designed to optimize water distribution and retention in agricultural fields, particularly in areas with limited and erratic rainfall. This method involves the creation of tied ridges along the contour lines of the land. These ridges act as barriers to water runoff, slowing it down and allowing for better infiltration into the soil. Simultaneously, small trenches or furrows are often constructed on the lower side of the tied ridges to capture and channel water into the root zones of crops. The tied-ridge method serves multiple purposes, such as minimizing soil erosion, enhancing water retention, and promoting a more uniform distribution of moisture across the field (Wiyo *et al.,* 2000). This approach proves

particularly valuable in dryland agriculture where water scarcity is a constant challenge. It helps maximize the utilization of available moisture and contributes to increased crop yields.

8. Broad Bed Furrow Systems

Broad bed furrow systems involve the creation of broad, flat-topped beds with furrows on either side. These beds help to concentrate rainfall or irrigation water into the furrows, promoting efficient water infiltration and reducing surface runoff. The broad bed design enhances water retention within the root zone and provides a conducive environment for plant growth. Additionally, broad bed furrow systems contribute to better soil aeration, improved drainage, and reduced soil compaction. Farmers adopting this mechanical measure can benefit from enhanced water-use efficiency, ultimately leading to increased agricultural productivity in dryland areas (Vekariya *et al.,* 2015).

Integration of Mechanical Measures

Combining mechanical measures such as ridge and furrow systems and broad bed furrow systems with other in-situ moisture conservation practices, like mulching and conservation tillage, creates a comprehensive approach to water management in dryland agriculture. These mechanical measures help reshape the landscape, directing water where it is needed most and minimizing wastage through runoff. Integrating these mechanical measures into the farming system not only conserves moisture but also contributes to soil health, erosion control, and overall sustainability.

Conclusion

In-situ moisture conservation practices are essential for ensuring the sustainability of dryland agriculture in the face of water scarcity. By adopting these practices, farmers can enhance water-use efficiency, reduce soil erosion, and improve overall crop resilience. A combination of mulching, contour ploughing, rainwater harvesting, conservation tillage, and cover cropping can create a holistic approach to moisture conservation, providing a pathway to increased agricultural productivity and long-term environmental sustainability in dryland regions. As the global population continues to grow, the importance of these practices becomes even more evident in securing food production for future generations in arid and semi-arid areas.

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Article ID : 04/IV/13/0424

WILD COLLECTION AND TRANSPOTATION OF INDIAN SPINY LOACH – A FIELD BASED EXPERINECE

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Introduction

Loach fish are very small, and they inhabit in the canal, paddy fields, small streams, swamps, riverine areas, *etc*. Loach fish have high market demand in the southern states of India, especially in Tamil Nadu, because of their taste.From historical point of view, this species was served as subsistence food source for many tribal people. Moreover, it has nutraceutical potential with good nutritional value, and they are rich in calcium which is equal to milk's calcium level. On the other side, some of the loach fish species in Southeast Asia are mostly used for ornamental trade and aquarium purposes due to their good ornamental value based on the small size, bright bands, dots or blotches, coloration, hardiness and peaceful nature.Among them, one important species called as *L. thermalis*which is widely distributed in peninsular India and Sri Lanka and reported that the species population differs within the Indian region. IUCN has categorized this species under the least concern category.

To further threaten this species, their wild population is decreasing in some regions due to various reasons such as subsistence fisheries, aquatic pollution, climate change, deforestation, construction of a dam across the river, *etc*. On the other hand, wild collection is playing an important role in loach fishery in India. To till date, rehabilitation of this species is not propagated due to lack of culture technology. Therefore, wild stocks of loach were recklessly exploited, as they fetch good market price. Moreover, a very few steps were taken to initiate their captive breeding and rearing to diversify this species aquaculture activity, as a new culture species in fish farming. Again, wild collection plays a significant role in raising loach species under captive conditions. Therefore, through a successful collection method, we could study their many of the concealed things related to their biology, food and feeding habitat, breeding and farming techniques, etc.

In India, there is no standard wild collection methods or techniques for the collection of *L. thermalis*for successful propagation of loach under captivity. Hence, through this article, we share our field knowledge, that we gained during wild collection, for the benefit of researchers, farmers, students,*etc*., to develop either breeding or farming techniques of loach fish. Wild collection of loach was carried out to develop the broodstock and to standardize their captive breeding protocol. For these wild collections were carried out in two different irrigation channels with the help of different fish collection nets such as fine meshed nylon net, hand net and dragnet. Generally, the collection sites had a narrow channel with a water depth of less than 25cm and mild water flow. Moreover, sites with sandy and vegetative or decaying matter are ideally chosen for collection. Additionally, an Eighteen-liter capacity tank was used in which approximately more than 200 numbers of loach can be kept for transportation. The following things were observed during our field collection trips.

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Loach fish identification

We had identified the loach fish by their movement and hiding nature. Further the collected fish sex was identified with a help of earlier study by Manoharan et al., (2019) who reported morphometric sexualdifference between the male and female. In general, female fish have a slightlygreater body with heavier weight, clearer color of the body than male fishes. Further, Havirdand Page, (2010) reported that the males of genus Lepidocephalichthys, has modified rays (7^{th}& 8^{th} rays) in pectoral fin which was observed in the collection site itself. Whereas in o2nd ray in the pectoral fin has modifications.

Indian spiny loaches preference on natural habitatand their ecology

Generally, loach fish prefer inhabitants likecanal, paddy field, small stream,*etc*., with mild water flow. Keeping this in mind, we frequently had visited the various places in and around the Kanniyakumari District, Tamil Nadu. With our field visits, we have identified regions such as Parakkai, Suchindram, Velladichivilai, Nagercoil and Vetha Nagar where the availability of loach fish was confirmed. Then we studied loach fish availability and their ecology characteristics.

The following general habitats were observed during our collection trips. The availability of the speciesis subjected to locality as they are very sensitive to humans andother aquatic organisms. If they identify such kind of disturbance, then they quickly swim away and starts to hide under the mud or sand or any other vegetative areas. Mostly this species is found in channels, where mildwater flows with a depth of less than 25cm, which signifies that low water depth with mild water flow is their preferred place in natural ecosystem. Additionally, they prefer a place where the decaying and vegetative matters are rich.

Loach fish in wild conditions

Collection site identification based on field knowledge

Collection sites were identified with our frequent field visits and discussion with the identified local people, who were familiar with fish collection. Initially, collections sites like small pools or ponds and canals situated in and around the Parakkai region of Kanyakumari district were

identified where presence ofloach fish were noticed. Generally, these sites receive water from Thamirabarani river. The interesting thing about collection site is that they are perennial, as they receive more rainfall from both seasons of north-east and southwest monsoon which makes the water available year-around. Therefore, this perennial water sources are acting as home for various indigenous fish. The presence of bird, a white crane, is the best indicator for locating the availability of loach fish in the various collections sites such as canals and small streams.

We had identified two riverine systems with our field trips as loach species resource and collection sites and they are lower stretch of Pechiparai reservoir and a small stream of Kalakad riverine area. Periodically, we have observed the collection sites and recorded the following ecological characteristics. Among the two sites, Kalakand stream has a very narrow and mild water flow whereas Pechiparai's lower stretch has a wider channel area, however, its width shrinks when less water is released from the reservoir or dam. Therefore, the width of the water channel area may be affectedby the water released from the reservoir. In general, *Lepidocephalichthys thermalis* is a very fast-moving fish and they hide under substratum in the natural ecosystem. Therefore in Pechiparai's lower stretch, areas with a wider water spread area or channel with more water flow is not suitable for collection. Based on our observation, we had always chosen the ideal collection sites with very narrow flow of water supported by vegetation or any other substrates. Whereas the Kalakad stream is small and narrow with modest rate of water flow,there isno vegetative production area which resulted in poor loach yield. Further we had identified that, the paddy field is considered an ideal place for collection of loach brood fish, especially when the paddy is ready to flower. Overall, it has been well understood thatloach collection sitesshould be narrow, with mild water flow, sandy bottom and supported by vegetative or decaying matters.

Table 1. The geographical location and area of the loach fish collection sites.

S. No.	Name of collection site	North latitude	East longitude
1	Kalakad riverine area (Tirunelveli Dist.)	$8^0$30’58’’	77^0 32’ 21’’
2	Pechiparai reservoir (Kanyakumari Dist.)	$8^0$23’12’’	77^0 17’ 50’’

Loach fish collection at Pechiparai reservoir catchment area

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Loach fish collection at Kalakad riverine area

Loach collection technique

In general, suitable times for loach fish collection are preferably late evening and early morning. Interestingly, we have noticed the presence of loach was noticed along the paddy field canal area throughout the day. However, collection could not be accomplished during afternoon time or sunny time or heavy rain times, as this species hides under shelters to avoid temperature fluctuations during sunny time and visibility is the major issue during rainy season which makes very difficult to see this species.

Around the different parts of the country, variouscollectionmethods have been adopted for loach fish collection. In a few places, people have used traditional fishing gear, drag net, for catching loach fish species (Keskar et al., 2015). In some riverine areas, dip nets were used for collection. For a collection of loaches, it is better to usea fine nylon meshed net (length should be chosen according to the width of the collection site), to avoidluminous time because it is used to hide under rocks or dense vegetative areas.

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During our field trips and collections, in a narrow water body we had closed one side of the canal or stream with finely meshed nylon net and then with the help of two people, the net was dragged against the water flow. While dragging the net, whatever substratum available in the collection area were disturbed to aggregate the loach inside the net. Another method we employed forloach fish collection was using a hand net and it's a very feasible one. In this method, the net was kept near the vegetative areas and the substrate and then they were disturbed to enter intothe handnet. Since loach species are autochthonic and endemic, a minimum number of fish were collected during each fish collection trips. However, collection of loach fish was avoided during heavy rain and high temperature during the day times in the regular collection sites.

Transportation

After collection, the wild fish were immediately placed in a separate tank which is going to be used for transportation purposes. In an eighteen-liter capacity tank, approximately more than 200 numbers of loach can be stocked for transportation. Prior to transportation, the collection tank bottom was packed with fine sand, gathered from the collection site, and then water was filled in the tank. The sand helps in providing the natural substratum as well as maintain the water temperature during transportation. Generally, collection site natural water is used for transportation. The use of natural water reduces stress during transportation. If the collection is continued for lengthier duration, the at periodic intervals water must be changed and refilled. Based on the distance between collection site and farm facility, usage of aeration advised, however, provision of mild aeration is recommended for better transportation conditions. The wild collected loach fish were maintained in heterosexual grouping and separate tanks were provided for individual sexes. Also, the collected fish can be transported and maintained separately as per collection site to study their stock variations.

Wild collected loach ready for transportation

Conclusion

L. thermalis is a small indigenousfreshwater fish and it contains better nutritional profile than the other commercially farmed fish. Similarly, Indian spiny loaches arefetching high market prices than the other food fish available in the market. However, the domestic market of loach fish is heavily relying on wild collection, which subsequently categorized this fish under IUCN threatened list. However, the absence of standardized breeding and rearing practices for loach is limiting wild seed ranching and commercializing its farming practices in inland sector. Therefore, the information on filed based experience on collection and transportation would help the scientist to initiates its captive broodstock development and seed production. Further, this information would help the fisherman to optimally exploit the natural stocks which in turn minimize the pressure on loach capture fishery.

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ISSN : 2583-0910
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Article ID : 04/IV/14/0424

EXPLORING PROBIOTIC APPLICATIONS IN FOOD

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Abstract
Probiotics, live microorganisms beneficial for health, have garnered significant attention for their potential in food applications. This article explores the diverse applications of probiotics in food, emphasizing their role in enhancing nutritional value and promoting gut health. From fermented dairy products like yogurt to functional foods like probiotic-infused beverages and snacks, probiotics offer promising avenues for improving digestive health and overall well-being. Additionally, advancements in food technology have enabled the development of innovative probiotic formulations, expanding their incorporation into various food matrices. Understanding these applications facilitates the creation of functional foods that promote consumer health and satisfaction.

Introduction

The word "probiotic" comes from the Latin word's "pro" meaning "for" and "bios" meaning "life," indicating that it helps to sustain life. The term "probiotics" describes a class of helpful microorganisms that may have an impact on the health of humans and other animals when taken in sufficient quantities. The idea of probiotic bacteria has been around for thousands of years, closely linked to humans' use of fermented foods, even if the acronym is more modern. People have been preparing and eating foods that are high in probiotics for a very long time. Some of the earliest instances of fermentation processes are lactic acid bacteria (LAB) and fungal fermentation of milks and cheeses, and yeast fermentation of leavened bread. Probiotics have always played an important role in human diets, and the fact that fermented foods have been known to provide health advantages since ancient times is proof of that.

Over the course of the last twenty years, there has been an increasing interest among consumers in functional foods, especially those that include probiotics. Incorporating probiotics into a wide range of commercial food items is becoming more common as probiotics are being lauded for the possible health advantages they provide. This development has prompted businesses to investigate various uses of probiotics in food products, which has resulted in the emergence of a new generation of foods that are marketed as "probiotic health" foods.

Dairy-based probiotic food products

The inherent characteristics and chilled storage conditions of food items, such as milk and its derivatives, make them ideal carriers for probiotic bacteria. Yogurt and cheese are only two examples of the many commercial dairy products that contain probiotics, which are essential for providing people with good bacteria. Many people still like dairy drinks, especially those made from fermented milk or drinkable fresh milk, which were among the earliest commercialized probiotic goods. Fortified dairy beverages and whey-based beverages are the two main types of these functional dairy drinks. Because of its resilience to acid and bile, *Lactobacillus rhamnosus GG* is the probiotic bacterium of choice for industrial uses in the manufacturing of dairy beverages.

Yogurt is made using a blend of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* bacteria. Sometimes, other *lactobacilli* and *bifidobacteria* are also added during or after the culturing process. Adding fruit to yogurt may hinder the viability of probiotics due to potential antimicrobial properties in fruits and berries. However, encapsulating probiotics or adding prebiotics or cysteine to yogurt can improve probiotic viability and stability.
Cheese possesses a multitude of merits in comparison to yoghurt and fermented milks, including but not limited to its elevated pH, buffering capability, nutritional value, energy content, solid consistency, lipid content, and extended expiration life. It has been demonstrated that probiotics present in cheese can traverse a simulated human gastrointestinal tract and proliferate probiotic cells in the intestines by a significant margin. In contrast to yoghurt, cheese necessitates a greater density and viability of probiotic cells in order to impart comparable health advantages. In contrast to yoghurt, semi-hard and hard cheeses have a comparatively modest daily recommended quantity of probiotics, necessitating a greater frequency of probiotic inoculation (approximately four to five times).

Additional dairy-derived goods may function as efficient vehicles for probiotics, such as chocolate mousse, quark, sour cream, frozen fermented dairy desserts, and ice cream.

A fresh dairy product known as **quark** is produced by first curdling sour milk and then filtering the resulting mixture. It is classified as a fresh acid-set cheese and may be enhanced with probiotic cultures to improve its nutritional profile. This can lead to an increase in the utilization of fat, protein, lactose, and phosphorus, particularly in skim milk.

Sour cream may serve as a means of delivering probiotics, demonstrating the ability to function as a carrier.

Ice cream has significant promise as a medium for probiotics since the inclusion of probiotic cultures does not change the sensory qualities of the ice cream product.

Non-dairy based probiotic products
According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) of the US National Institutes of Health, the development of innovative non-dairy probiotic food products provides a significant challenge. This is particularly true when considering the fact that Lactose intolerance affects around 75 per cent of the world's population. Not only must these items provide health benefits, but they must also be in accordance with the desires of the consumers.

Fermented veggies are used as a suitable medium for the delivery of probiotics in products that are based on vegetables. *L. rhamnosus, L. casei,* and *L. plantarum* are examples of strains that are better able to adapt to their environment. The fast development of probiotic bacteria on plant-based substrates is assisted by adjusting the temperature to 37 degrees Celsius.

Carrot juice enhances the metabolic functions of Bifidobacteria, even in the absence of other nutrients. Tomato juice promotes the creation of probiotics by different strains such as *L. acidophilus, L. plantarum, L. casei,* and *L. delbrueckii*. These bacteria effectively use tomato juice for cell synthesis and the formation of lactic acid.

Kimchi and sauerkraut, which are fermented using strains such as *L. plantarum,* provide sufficient amounts of probiotics. In addition, red beets may be used as a base for generating probiotic beet juice, since some types of lactic acid bacteria quickly consume it to create new cells and produce lactic acid.

The fermentation of **soymilk** with bifidobacteria results in the creation of a novel functional food that has the potential to help in the prevention of chronic illnesses such as cancer, menopausal disorders, osteoporosis, and atherosclerosis. Soymilk is already well-known for its positive effects on health. Probiotic fermentation of soy products may lead to a reduction in the amounts of specific carbohydrates, an increase in the amount of free isoflavones, and the promotion of favourable changes in the populations of bacteria that live in the gut.

Fruit-based probiotic products provide delicious and nutritious choices for individuals of all age groups, including an abundance of essential elements such as vitamins, minerals, antioxidants, and dietary fibres. These products are devoid of dairy allergies, making them appropriate for a diverse array of customers. Adding *L. plantarum* to orange juice might result in diverse scents and flavours that may not be favoured by customers unless they are educated about the health advantages. Probiotics-induced off-flavours may be concealed by using minute quantities of tropical fruit liquids such as pineapple, mango, or passion fruit.

Cereal-based probiotic products provide health advantages by introducing helpful microorganisms and perhaps prebiotic fibers. Cereals provide an optimal habitat for the growth of probiotic strains, and their indigestible components may function as prebiotics. Specific strains derived from a traditional Bulgarian cereal-based fermented beverage demonstrated probiotic characteristics, such as the ability to withstand the harmful effects of bile, which is important for surviving the digestive system. Several methods have been investigated, including the use of malt hydrolysate to make probiotic beverages or the addition of whole grains like oats to generate drinks containing both probiotics and prebiotic beta-glucan. Yosa is a product created from oat bran pudding that has been fermented with LAB (lactic acid bacteria) and Bifidobacteria. It is a nutritious and low-fat alternative to yoghurt, appropriate for vegetarians and lactose-free. Yosa is high in beta-glucan, a beneficial compound. Fermented maize products, renowned for their delectable fruity profiles, with the capacity for worldwide recognition.

Table 1: Non-dairy based probiotic foods and beverages

Category	Product
Fruit and vegetable based	Vegetable-based drinks, fermented banana, cabbage juice, beets-based drink, tomato-based drink, many dried fruits, green coconut water, , onion probiotic banana puree, noni juice nonfermented fruit juice beverages, peanut milk cranberry, pineapple, and orange juices, fermented banana pulp, ginger juice, grape and passion fruit juices, carrot juice and black currant juice
Soy based	Nonfermented soy-based frozen desserts, soy-based stirred yogurt-like drinks and fermented soymilk drink
Cereal based	Rice-based yogurt, oat-based drink, cereal-based puddings, oat-based products, mahewu (fermented maize beverage), yosa (oat-bran pudding), maize-based beverage, wheat, rye, millet, maize, and other cereals fermented probiotic beverages, malt-based drink boza (fermented cereals) millet or sorghum flour fermented probiotic beverage
Other non-dairy foods	Probiotic cassava-flour product, starch-saccharified probiotic drink, dosa (rice and bengal gram) and meat products

Probiotics are mostly used in fermented meats, such as dry sausages, for their uses in the food industry. It is standard practice to utilize lactic acid bacteria (LAB) as starting cultures in these meats in order to generate lactic acid from carbohydrates such as glucose or lactose. When making dry sausages, the ingredients that are combined are as follows: frozen pork, pig fat, beef, salt, sugars, ascorbates, nitrite, nitrate, and spices. After being filled into casings, the mixture is then placed in fermentation and ripening chambers for a period of several weeks. Bacteriocins, which are able to fight against dietary pathogens in the stomach, might be produced by the LAB that is present in the banger. Dry sausage seems to be an appropriate carrier for probiotics, since LAB strains such as *Lactobacillus plantarum, Lactobacillus lactis,* and *Enterococcus faecium* have shown the capacity to exhibit probiotic characteristics.

Conclusion

Probiotics have extended their usage beyond plant-based foods to include dairy products and even fermented meats over the course of the previous two decades, demonstrating the potential qualities of probiotics. During this time period, there has been a notable increase in the level of interest among consumers associated with functional foods that include probiotics. There has been a substantial increase in the number of non-dairy alternatives, which cater to a broader variety of dietary requirements, despite the fact that dairy products continue to be the most popular. The contemporary consumer attitude places a greater emphasis on gut health and general wellbeing, as seen by the wide variety of probiotic options available across a variety of food categories.

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Article ID : 04/IV/15/0424

NATURAL FARMING : CULTIVATING HARMONY WITH NATURE

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Abstract
Natural farming, also known as sustainable agriculture or agroecology, represents a paradigm shift in agricultural practice, prioritizing principles and practices that work in harmony with nature. It emphasizes minimal tillage, organic inputs, biodiversity, and traditional knowledge integration. Natural farming aims for sustainable, resilient, and culturally connected agricultural systems. Its adoption brings environmental benefits like reduced carbon footprint and biodiversity conservation, alongside economic gains from cost-effective practices and higher market value. Socially, it empowers small-scale farmers and preserves traditional knowledge. Challenges include knowledge gaps, market access barriers, and policy constraints. Future efforts should focus on refining techniques, advocating for supportive policies, and mainstream integration. Prioritizing natural farming principles can build a more sustainable, resilient, and equitable food system for generations to come.

Keywords : Natural farming, sustainability, biodiversity, resilience, integration.

Introduction

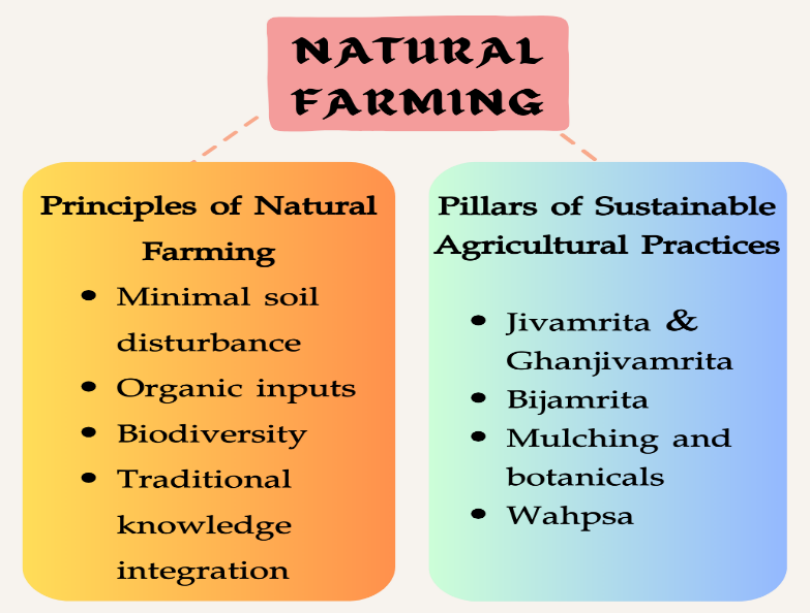
In the current agricultural landscape, a significant shift towards methods that harmonize with nature, rather than dominate it, is underway (Devarinti, 2016). This shift is epitomized by natural farming, also known as sustainable agriculture or agroecology (Gliessman 2018). At its core, natural farming is about a philosophy that values the symbiotic relationships between farming practices, the environment, the well-being of farmers, and the quality of food.

Natural farming is a holistic approach that recognizes the interdependence of all components within agricultural systems. It is dedicated to preserving the health and integrity of ecosystems, aiming to grow crops in ways that support environmental sustainability and resilience. By enriching the soil, safeguarding biodiversity, and reducing reliance on external inputs, natural farming aims to ensure the long-term health and productivity of the land (Chappell & LaValle2011).

Moreover, this approach is deeply committed to the well-being of farmers and the vitality of rural communities. It advocates for methods that lessen dependence on synthetic inputs and decrease exposure to hazardous chemicals, thereby creating safer, healthier working conditions for those in agriculture. Furthermore, by encouraging community involvement and empowerment, natural farming seeks to bolster social bonds and economic stability in rural locales. Numerous states in India are championing natural farming practices, with Andhra Pradesh, Gujarat, Himachal Pradesh,

Rajasthan, and others leading the charge. Andhra Pradesh's Community-Managed Natural Farming (APCNF) program, for instance (Jaacks et al., 2023), exemplifies the state's commitment to eco-friendly agriculture. Similarly, Gujarat's initiatives like Sat PagalaKhedutKalyaan and Himachal Pradesh's PrakritikKhetiKhushhalKissan (PK3) Yojana demonstrate concerted efforts towards sustainable farming practices (Chandel et al., 2021; Biswas & Pakhira 2023).

Natural farming also underscores the vital connection between farming practices and the quality of food produced. By focusing on soil health, biodiversity, and the natural cycles of nutrients, the goal is to harvest foods that are not only nutritious but also rich in flavor, nourishing both the body and spirit. This attention to quality encompasses the entire journey of food from the seed to the table, ensuring a sustainable and enriching food production process.



Principles and Practices of Natural Farming

Natural farming is guided by fundamental principles that shape its approach to agriculture and is supported by practices that align with these principles (Xu, 2001).

Natural farming advocates minimal soil disturbance to preserve soil structure, fertility, and ecosystem health, reducing erosion and carbon footprint. It relies on organic inputs like compost and cover crops to promote nutrient cycling, soil fertility, and reduced chemical pollution. Adoption of diversified cropping systems enhances biodiversity, while recycling naturally available nutrients and on-farm biomass further sustains soil health. Moreover, natural farming integrates locally developed and refined practices based on plant, animal, and microbial sources, fostering adaptive innovation tailored to local conditions such as cropping patterns, climate, altitude, soil quality, and pest severity (Bhati et al., 2022).

Natural farming revolves around four essential pillars that form the backbone of sustainable agricultural practices:

1. Jivamrita & Ghanjivamrita: These natural fertilizers, derived from Desi cow inputs, nourish the soil and plants, promoting healthy growth and vitality without relying on purchased inputs. Jivamrita and Ghanjivamrita foster soil fertility and microbial activity, enhancing the natural balance of nutrients.

2. Bijamrita: Another key aspect of natural farming, Bijamrita, involves the preparation of seed treatments from Desi cow inputs. This practice ensures that seeds are fortified with essential nutrients and beneficial microbes, facilitating robust germination and plant establishment.
3. Mulching and use of botanicals for plant protection: Natural farming emphasizes the use of mulching techniques and botanical extracts for plant protection, reducing the reliance on synthetic pesticides and chemical interventions. Mulching conserves soil moisture, suppresses weeds, and improves soil health, while botanicals offer natural alternatives for pest and disease management.
4. Wahpsa: Excluding all purchased inputs, natural farming relies solely on resources derived from Desi cows to meet agricultural needs. Wahpsa, which stands for 'Waste Decomposer Solution,' exemplifies this principle by utilizing indigenous microorganisms to break down organic matter and enrich the soil, fostering nutrient cycling and soil health.

Implications of Natural Farming

The adoption of natural farming practices brings profound implications for environmental sustainability, economic viability, and social well-being, highlighting its transformative potential for a more sustainable and equitable agricultural system. Environmentally, natural farming significantly lowers carbon footprints, conserves biodiversity, and mitigates soil and water pollution. It reduces reliance on synthetic inputs, thus promoting ecological balance, helping to sequester carbon, reduce greenhouse emissions, and combat climate change. Natural farming also preserves natural habitats and biodiversity while minimizing chemical use, contributing to wildlife, soil organisms, and ecosystem services conservation. Additionally, it enhances soil health, reducing erosion and runoff, thereby protecting water quality and aquatic ecosystems.

Economically, natural farming proves to be cost-effective, offering potential savings by reducing the need for chemical fertilizers, pesticides, and fossil fuels. This aspect is particularly beneficial for small-scale and resource-limited farmers. Tapping into the growing consumer demand for organic and sustainably produced food, natural farming can fetch premium prices, providing economic incentives for farmers to adopt sustainable practices. It also fosters diversified and resilient farming systems, enhancing farmers' capacity to withstand environmental shocks and market fluctuations, promoting economic sustainability over the long term.

Socially, natural farming brings significant benefits by empowering small-scale farmers, preserving traditional knowledge, and building community resilience. It emphasizes farmer autonomy, knowledge sharing, and participatory decision-making, enabling farmers to take control of their livelihoods. By preserving indigenous knowledge and cultural heritage, natural farming strengthens local identities, fosters intergenerational learning, and preserves cultural diversity. Moreover, it encourages community collaboration and collective action, building social capital, enhancing social cohesion, and making communities more resilient to environmental and economic challenges.

Challenges and Limitations of Natural Farming

Despite its many benefits, natural farming faces challenges that slow its adoption. These include gaps in farmers' knowledge and skills, limited market access and consumer awareness, and obstacles created by policy and regulatory frameworks.

1. **Knowledge and Skills**: A key issue is that many farmers don't know enough about natural farming methods or lack the training to use them. To tackle this, providing training programs, extension services, and platforms for sharing knowledge is critical.
2. **Market Access and Consumer Awareness**: Despite a rise in interest for organic and eco-friendly products, many consumers are still not fully aware of natural farming's advantages, often choosing cheaper or more convenient options. Natural farmers also struggle to enter mainstream markets, making it hard to reach more customers. Strategies to improve this situation include educating consumers and advocating for policies and infrastructure that support easier market access for natural products.
3. **Policy and Regulatory Barriers**: Policies and regulations often favor conventional farming, offering little support for sustainable practices. Complex regulations and a lack of financial incentives can also discourage farmers from switching to natural farming. To change this, it's important to work on policy reform, lobby for laws that support sustainability, and engage with policymakers to highlight natural farming's benefits.

Overcoming these challenges requires a united effort from everyone involved in agriculture, including farmers, policymakers, researchers, consumers, and advocacy groups. By focusing on education, awareness, and policy reform, we can create a more sustainable and resilient food system that embraces natural farming.

Future Directions and Recommendations for Natural Farming

As interest in sustainable agriculture grows, natural farming is increasingly recognized as a viable and eco-friendly approach. To enhance its adoption and effectiveness, it is crucial to focus on research, supportive policies, and efforts to integrate these practices more broadly into agriculture. Research should aim to improve natural farming methods, concentrating on areas like soil health, nutrient management, pest control, and the importance of crop diversity. It's also vital to assess the broader impacts of natural farming on the environment, economy, and society, seeking ways to boost farm productivity without harming nature (Korav et al., 2020).

Policy-wise, there's a need for advocacy for measures that encourage farmers to adopt natural farming. Financial incentives, such as grants or subsidies, can make a significant difference, as can regulations and standards that favor sustainable practices and the use of organic, local produce. Collaboration among policymakers, farmers, and advocacy groups is key to crafting policies that support the transition to natural farming.

For natural farming to become a mainstream part of agriculture, pathways must be found to integrate it into existing systems. This means improving access to education and training for those in the farming sector, from farmers themselves to extension agents and agricultural professionals. Encouraging partnerships among a wide range of stakeholders, including farmer cooperatives, research bodies, NGOs, and the private sector, will be essential for scaling up natural farming. By promoting knowledge exchange and innovation, and incorporating natural farming principles into agricultural education, we can nurture a new generation of farmers and agricultural leaders committed to sustainability.

Conclusion

Natural farming stands as a beacon of hope in the quest for sustainable and harmonious coexistence with nature within the realm of agriculture. As articulated throughout this discourse, its principles and practices represent a fundamental shift towards agricultural methodologies that

prioritize the preservation of ecological integrity, community well-being, and the cultivation of nutritious and flavorful food.

The multifaceted implications of natural farming extend far beyond mere agricultural production. Embracing this holistic approach holds the promise of mitigating environmental degradation, fostering economic resilience, and nurturing social cohesion within rural communities. From reducing carbon footprints and conserving biodiversity to empowering small-scale farmers and preserving traditional knowledge, the benefits of natural farming resonate across various dimensions of sustainability. As we embark on this journey towards a more sustainable future, let us heed the lessons of natural farming and strive to cultivate a world where ecological integrity, economic prosperity, and social well-being flourish in unison.

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ISSN : 2583-0910
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Article ID : 04/IV/16/0424

MILK: IMPORTANCE AND COMPOSITION

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Introduction

India is the largest producer of milk. Milk production is increasing at a CAGR of 6.2% from 146.31 million tonnes (MT) in 2014-15 to 209.96 MT in 2020-21 (PIB, 2022).According to OECD-FAO (2020), world milk production is projected to grow at 1.6% p.a. to 997 MT by 2029.Indian dairy industry is rising high. Milk contributes nutrition and health to the growing population of India (Arora, 2017). It provides excellent source of protein particularly to the large lacto-vegetarian segment of the society (Arora, 2022).

Composition of Milk

Milk is a complex fluid composed of various macronutrients, micronutrients, and water. Its composition can vary slightly depending on factors such as the species of animal, the animal's diet, and the stage of lactation. However, the basic composition of cow milk, which is the most commonly consumed type of milk, is as follows:

1. **Water**: Water makes up the largest proportion of milk, typically comprising about 87-88% of its total volume. It provides hydration and serves as the solvent for the other components of milk.
2. **Proteins**: Milk contains various proteins, with the most abundant being casein and whey proteins. Casein accounts for approximately 80% of the total protein content, while whey proteins make up the remaining 20%. These proteins are rich in essential amino acids and has very high digestibility and bioavailability (Arora, 2023a).
3. **Lactose**: Lactose is the primary carbohydrate found in milk, comprising about 4-5% of its total volume. It is a disaccharide composed of glucose and galactose and serves as the main source of energy in milk.
4. **Fats**: Milk contains lipids in the form of triglycerides, which consist of fatty acids and glycerol. The fat content of milk varies depending on factors such as the breed of the cow and its diet. Whole milk typically contains around 3-4% fat, while reduced-fat or skim milk has lower fat content.
5. **Vitamins**: Milk is a good source of various vitamins, including vitamin A, vitamin D, vitamin B12, riboflavin (vitamin B2), and niacin (vitamin B3). These vitamins play essential roles in metabolism, vision, bone health, and overall health.
6. **Minerals**: Milk is rich in minerals such as calcium, phosphorus, potassium, magnesium, and zinc. Calcium and phosphorus are particularly abundant and are essential for maintaining bone health, muscle function, and other physiological processes. Bioavailability of milk calcium is very high in comparison to the commonly used calcium fortificants in the food industry, for example calcium carbonate and remain unaffected if incorporated with suitable functional ingredients at certain levels (Arora and Patel, 2019).

7. **Dietary fiber**: Milk essentially lacks dietary fiber and thus is highly digestible. Some individuals may however be unable to digest lactose due to the deficiency of the enzyme lactase and may develop the problem of lactose intolerance. Due to the increased popularity of the health benefits of dietary fiber, some fortified milk products can also be developed with the addition of fiber-rich food ingredients (Arora, and Patel, 2017; Arora and Patel, 2015).
8. **Other Components**: Milk also contains smaller amounts of other bioactive components, such as enzymes (e.g., lactase, lipase), hormones (e.g., insulin-like growth factor 1, IGF-1), and immune factors (e.g., immunoglobulins), which contribute to its nutritional and functional properties (Muehlhoff, Bennett and McMahon,2013).

The composition and bioavailability of nutrients from milk and other foods can vary depending on factors such as the processing methods (e.g., pasteurization, homogenization), the presence of additives (e.g., fortification with vitamins and minerals), and the removal or modification of certain components (e.g., skim milk, lactose-free milk) (Arora *et al*., 2022). Additionally, milk from other animals, such as goats, sheep, and buffalo, may have slightly different compositions compared to cow milk. Also, the various plant-based milk alternatives available in the market are not really 'milk' (Arora, 2023b).

How Cow milk is different from buffalo milk?

Cow milk and buffalo milk differ in several aspects, including nutritional composition, taste, texture, and fat content (Muehlhoff, Bennett and McMahon, 2013).Indian dairy industry relies on the mixing of the two type of milk and the success story of cooperative societies and dairy entrepreneurs in India depend on the utilization of milk produced from these two types of milk (Arora, 2021). Here's a comparison of the key differences between cow milk and buffalo milk:

1. **Nutritional Composition:**
   - **Cow Milk**: Cow milk typically contains lower fat content compared to buffalo milk. It is also lower in protein and minerals such as calcium and phosphorus compared to buffalo milk (De, 1980).
   - **Buffalo Milk**: Buffalo milk is higher in fat, protein, and minerals, particularly calcium and phosphorus, compared to cow milk. It also tends to have a creamier texture due to its higher fat content.
2. **Fat Content:**
   - **Cow Milk**: Cow milk generally contains around 3-4% fat, although this can vary depending on factors such as breed and diet.
   - **Buffalo Milk**: Buffalo milk typically has a higher fat content, ranging from 6-8%, making it creamier and richer in texture compared to cow milk.
3. **Protein Content:**
   - **Cow Milk**: Cow milk contains approximately 3-4% protein, with casein and whey proteins being the primary types.
   - **Buffalo Milk**: Buffalo milk has a higher protein content, typically around 4-5%, making it a richer source of protein compared to cow milk (De, 1980).
4. **Calcium and other Minerals:**
   - **Cow Milk**: Cow milk provides essential minerals such as calcium and phosphorus, although in slightly lower amounts compared to buffalo milk (De, 1980).

- **Buffalo Milk**: Buffalo milk is richer in calcium and phosphorus compared to cow milk, making it a better source of these minerals.

5. **Taste and Texture:**
   - **Cow Milk**: Cow milk has a milder flavor and lighter texture compared to buffalo milk. It's often preferred by individuals who prefer a lighter taste and consistency.
   - **Buffalo Milk**: Buffalo milk has a richer, creamier texture and a slightly tangy flavor compared to cow milk. It's favored by those who enjoy a more robust and flavorful milk.
6. **Digestibility:**
   - **Cow Milk**: Some individuals find cow milk easier to digest compared to buffalo milk, particularly if they have lactose intolerance or sensitive stomachs.
   - **Buffalo Milk**: Buffalo milk may be more difficult to digest for some people due to its higher fat and protein content, although individual tolerance varies.
7. **Cultural Preference:**
   - **Cow Milk**: Cow milk is more widely consumed globally and is the primary type of milk in many Western countries. It is commonly used for drinking, cooking, and making dairy products such as cheese, yogurt, and ice cream.
   - **Buffalo Milk**: Buffalo milk is more commonly consumed in certain regions of the world, particularly in South Asia and parts of the Mediterranean. It is favored for its rich flavor and nutritional benefits, and is often used to make traditional dairy products such as paneer, ghee, and kulfi.

Conclusion

Milk is a nutritive food item rich in protein, calcium and other minerals and vitamins. Its composition varies depending on several factors such as the species of animal. Human colostrum is a complex fluid that provides essential nutrients, immune factors, growth factors, and bioactive compounds necessary for the health, growth, and development of newborn infants. Both cow milk and buffalo milk have their own unique characteristics and nutritional profiles. Both types of milk can be part of a healthy diet, providing valuable nutrients such as protein, calcium, and vitamins. The choice between the two types of milk often depends on individual preferences, cultural traditions, and dietary needs.

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ISSN : 2583-0910
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Article ID : 04/IV/17/0424

EXPLORING NON-PROBABILITY SAMPLING: METHODS, ADVANTAGES, AND LIMITATIONS

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Introduction

A sample is a subset of a population and survey the units from the sample with the aim to learn about the entire population. However, the sampling theory was basically developed for probability sampling, where all units in the population have known and positive probabilities of inclusion. This definition implicitly involves randomization, which is a process resembling lottery drawing, where the units are selected according to their inclusion probabilities. In probability sampling the randomized selection is used instead of arbitrary or purposive sample selection of the researcher, or, instead of various self-selection processes run by respondents. Within this context, the notion of non-probability sampling denotes the absence of probability sampling mechanism.

What is non probability sampling?

Non-probability sampling is defined as a sampling technique in which the researcher selects samples based on the subjective judgment of the researcher rather than random selection. It is a less stringent method. This sampling method depends heavily on the expertise of the researchers. It is carried out by observation, and researchers use it widely for qualitative research.

In contrast to probability sampling methods where each element in the population has a calculable probability of being selected, non-probability sampling methods rely on the subjective judgment of the researcher or other factors unrelated to the population's characteristics.

Types of Non-Probability Sampling

1. **Purposive sampling**: This is also called judgemental sampling. In this method, the researcher selects individuals based on their judgment or specific criteria relevant to the research question. This approach is useful when the researcher seeks to include specific characteristics or expertise in the sample. Soil surveys in many countries have traditionally been based on 'purposive sampling' at points or along transects, in which the surveyor chooses sample locations based on knowledge of the survey area with some restriction to ensure a balanced sample.
   E.g.- You want to know more about the opinions and experiences of disabled students at your university, so you purposefully select a number of students with different support needs in order to gather a varied range of data on their experiences with student services.
2. **Convenience sampling:** This method involves selecting individuals who are readily available or easily accessible to the researcher. Convenience sampling is quick and inexpensive but may not be representative of the entire population. It is the prevailing nonprobability approach where units at hand are selected. Convenience sampling is applied by brands and organizations to measure their perception of their image in the market. Data is collected from potential

customers to understand specific issues or manage opinions of a newly launched product. In some cases, it is the only available option.

E.g. - You are researching opinions about student support services in your university, so after each of your classes, you ask your fellow students to complete a survey on the topic. This is a convenient way to gather data, but as you only surveyed students taking the same classes as you at the same level, the sample is not representative of all the students at your university.

3. **Volunteer sampling**: This is a type of convenience sampling, where the decision to participate strongly relies on respondents due to the non-individualized nature of invitations (e.g. general plea for participation appears in media, posters, leaflets, web, etc.)

   E.g.- You send out the survey to all students at your university and a lot of students decide to complete it. This can certainly give you some insight into the topic, but the people who responded are more likely to be those who have strong opinions about the student support services, so you can't be sure that their opinions are representative of all students.
4. **Snowball Sampling**: If population is hard to access, snowball sampling can be used to recruit participants via other participants. The number of people you have access to as you get in contact with more population.

   E.g. — You are researching experiences of homelessness in your city. Since there is no list of all homeless people in the city, probability sampling isn't possible. You meet one person who agrees to participate in the research, and she puts you in contact with other homeless people that she knows in the area.
5. **Quota sampling :** In quota sampling, the researcher selects individuals to meet predetermined quotas based on certain characteristics (e.g., age, gender, occupation). Quota sampling ensures diversity in the sample but may not be representative of the population.

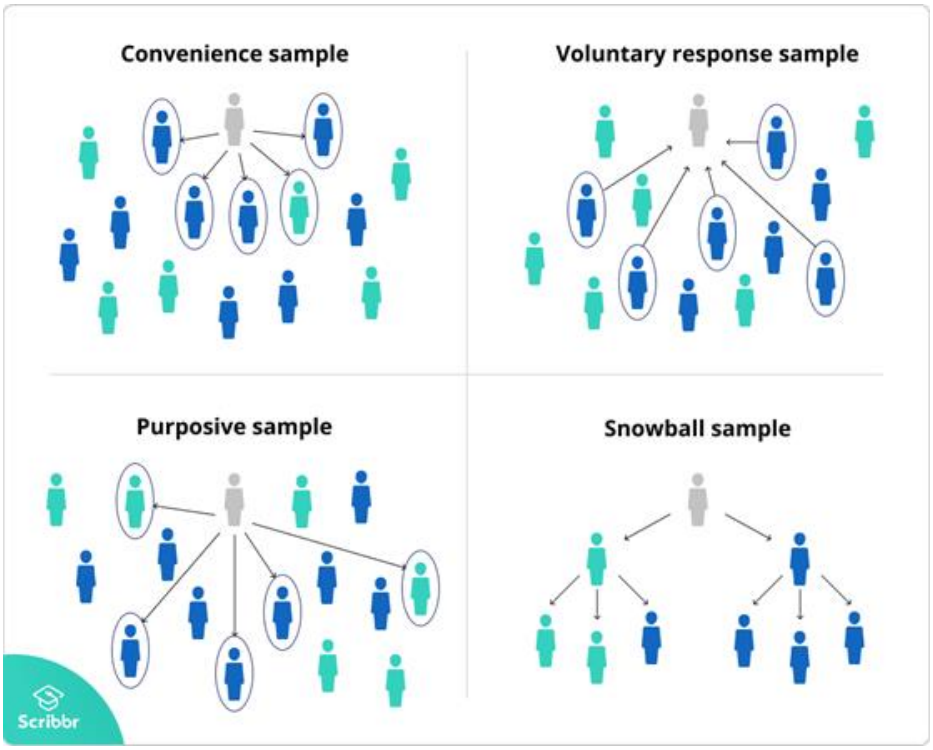

Figure 1: *Types of Non-Probability Sampling*

Advantages of Non-Probability Sampling

- **Quick and convenient:** As a general rule, non-probability samples can be constituted quickly, which allows the survey to be launched, executed and finished in shorter times.
- **Inexpensive:** It usually only takes a few hours to an interviewer to conduct such a survey. As well, non-probability samples are generally not spread out geographically, therefore travelling expenses for interviewers are low. In web panels or crowdsourcing, no interviewers are necessary. Tracing and persuasion of non-respondents are not required or less demanding.
- **Reduce respondent burden:** In the case of volunteer sampling or crowdsourcing, respondents volunteer to participate in the survey without being solicited personally.
- **Flexibility:** Non-probability sampling methods provide flexibility in selecting samples based on specific criteria or objectives. Researchers can tailor their sampling approach to suit the research question or objectives, allowing for targeted and purposive sampling strategies.

Disadvantages of Non-Probability Sampling:

- **Selection bias**: In order to make inferences about the population, it requires strong assumptions about the similarity between the sample and the population even though the respondents are self-selected. Due to the selection bias presented in all non-probability samples, these are often dangerous assumptions to make. When generalization to the whole population is to be made, probability sampling should be performed instead.
- **Noncoverage (under coverage) bias**: Since some units in the population can have no chance of being included in the sample, it results noncoverage bias. For example, people without the internet at home might never be selected for a web panel and may differ from those with the internet.
- **Difficulty of assessing the quality**: It is impossible to determine the probability that a unit in the population is selected for the sample, so reliable estimates and estimates of sampling error cannot be computed.
- **Limited generalizability:** Due to the lack of random selection, findings from studies using non-probability sampling methods may not be generalizable to the broader population. The sample may over represent or underrepresent certain characteristics or subgroups, limiting the external validity of the research findings.

Conclusions

Non-probability sampling is a quick and adaptable method for certain types of research. It's important to recognize the limits, though, and refrain from extrapolating the results to a larger population. When conducting exploratory research, gaining preliminary ideas, or focusing on certain groups where random sampling might not be feasible, it works well.

It is imperative for researchers to meticulously evaluate the pros and negatives of various sampling techniques when choosing ones for their research projects. In some research situations, such as qualitative or exploratory studies, where the focus is on understanding particular phenomena or viewpoints rather than drawing statistical conclusions for the larger population, non-probability sampling approaches may be acceptable. It is imperative for researchers to exercise caution when utilizing non-probability sampling, as there are potential limitations and biases. To address these concerns, researchers should carefully plan, analyse, and interpret their findings. Researchers should also be open about any limits or potential biases in their research findings, as well as the

sample strategies they used. In general, non-probability sampling techniques are useful in research, but they should only be applied sparingly and in concert with other sampling techniques.

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ISSN : 2583-0910
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Article ID : 04/IV/18/0424

PHYTO-REMEDIATION THROUGH ORNAMENTAL PLANTS – A NECESSARY APPROACH IN THE ERA OF CLIMATE CHANGE

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Abstract
With time, as the population is increasing, the greed and exploitation of natural resources has also been escalated, which become a prominent reason for inclination of greenhouse gases and bring the threat of climate change. During COP26 in Glasgow (2021), India set an ambitious goal of achieving net-zero emissions by 2070, demonstrating its commitment to addressing climate change. However, as India is still in the race for becoming developed country, it is hard to reduce the consumption and production of pollution causing substances and other approaches to rectify this problem are quite expensive and not applicable to all the location. Therefore, Phyto-remediation can become a better alternative approach which can be adopted be adopted indoor as well as outdoor especially with the use of ornamental plants which can gives the benefits of beauty, peace and pollution free environment. This technique has the potential for gaining the target of net-zero by 2070.

Keywords : Degradation, Ornamental plants, Phyto-remediation, Sequestration

Introduction

Phyto-remediation is made up from two different words phyto (Greek) means plant and remedium (Latin) means restoring balance. Therefore, it is a bioremediation-based technology where plants can be used for controlling or removing the concentration of pollutants from soil, water and air. Almost all the plants possess the capability to assimilate, degrade or modify toxic pollutants such as heavy metals, pesticides, volatile compounds, dust and oil etc into less or non-toxic form which ultimately leads to reduction in concentration of pollutants not only of air but also of soil, water and noise.It is eco-friendly and in-situ technology which has the ability of absorbing impurities that can be organic and inorganic, available in solid (soil), liquid (water) and the air. Also, it is cost-effective and provides aesthetic peace and prevents syndromes like nausea, cold and headache *etc*.

Mechanism of Phyto-Remediation

Phyto-remediation can be achieved by several methods that are specific to type of pollutants and plants. However, roots and leaves play significant role in uptake and accumulation of contaminants. The different mechanisms adopted by plants for phyto-remediation are depicted below in figure 1.

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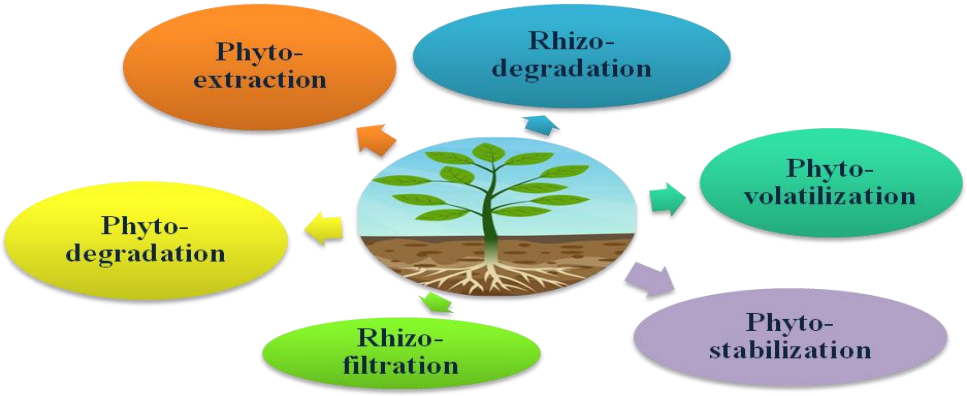

Figure 1: Mechanisms for phyto-remediation

1. Phyto-extraction

It is also called as phyto-accumulation, a process by which plants root absorb pollutants especially heavy metal from soil and transfer upper part for concentrating them at metabolically inactive parts in plant tissues *i.e.*, vacuole, cell membrane, cell wall or intercellular space or in broad in harvestable part. Plants can accumulate heavy metals like Mn, Fe, Cu, Cd, Mg, Mo, Zn, Se, Cr, Co, Ag, Pb and Hg *etc* (Ali *et al.,* 2013). Phyto-extraction achieved by majorly four steps given below in figure 2.

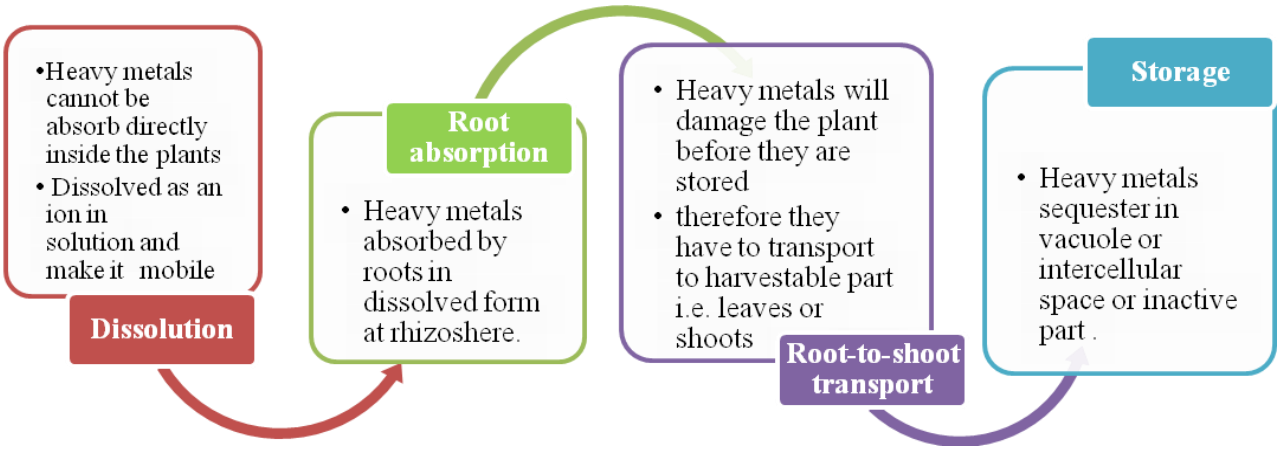

Figure 2: Diagrammatic representation of mechanism of phyto-extraction

The Effectiveness of phyto-extraction depends on the canopy of plants, root depth and leaf area. Also, depends upon physiological adaptability of plans towards varying climatic conditions and field practices.

2. Phyto-Degradation

Also known as phyto-transformation, involves the use of autotrophs and associated microorganisms for breaking down the organic pollutants into simpler, less or non-toxic form through metabolic processes inside or surrounding the plants by producing several enzymes that can catalyze and accelerate the process. This technique can also be used to remove a wide range of substances including solvents in groundwater, volatile compounds in the air. Several enzymes like nitro-reductases, phosphatases, glycosyl, oxidases, glutathione transferases, nitrilases and dehalogenases *etc*. released by bacteria and different plant species plays crucial role.

3. Phyto-Volatilization

Phyto-volatilization refers to the uptake of the pollutants from soil or water and converts it into volatile compounds and release into the atmosphere through transpiration (Salt *et al.,* 1998). Mainly organic compounds, such as phenol, acetone, chlorinated ethenes, chlorinated benzenes, toluene, ethyl benzene and xylene can be degraded through this process.

4. Rhizo-Degradation

Rhizo refers to rhizosphere (zone of soil surrounding the plant roots that generally considered extending 1-5 mm from the root surface where microbial activities occurs). It is a mutual metabolism of both microorganisms (fungi and bacteria) and plant root exudates (organic compounds within the rhizosphere excreted by plant roots, *i.e.*, sugars, acids, organic acids, sterols, fatty acids, growth factors, nucleotide, flavanone and enzymes) for breakdown of certain pollutants. The exudates from the roots allow the pollutants degrade in their natural habitat (Gerhardt*et al.,* 2009). That's why, it also known as plant-assisted degradation, microbe-assisted phyto-remediation or phyto-stimulation.

5. Phyto-Stabilization

It is also referred as in-place inactivation or phyto-immobilization. It is a useful approach for amendment of soil, sludge and sediment by which root exudates of plants immobilize pollutants within the soil matrix or in groundwater and reduce the bioavailability of pollutants by their accumulation and absorption by roots or precipitation within root zone. This approach has high potential to re-establish the pollutant land into green by choosing suitable plants. Metal tolerant species can be the better alternative for regenerating vegetation.

6. Rhizo-Filtration

Rhizo-filtration or phyto-filtration is a technique through which pollutants are adsorbed, concentrated and precipitated from contaminated groundwater onto the plant roots and later can be harvested after saturation and extracted from water. It is basically used to clean ground water. Thus, limiting its effectiveness to area where low concentrations and large volumes of water is present. It can be used in ex-situ remedial process also. Plants with high root biomass or high absorption surface, which have greater accumulation capacity and pollutant tolerance, can produce remarkable results.

Importance of Ornamental Plants in Phyto-Remediation

Due to change in climatic conditions and busy schedule, everyone wants peaceful place to breath and ornamental plants are their first choice to be get surrounded. Moreover, consumable crops even though have the potential for phyto-remediation; however, their consumption can have adverse effects on human body. Therefore, ornamental plants are better option for phyto-remediation as they are non-consumable and provide aesthetic peace and can amend not only outer environments but also can be used for indoor atmosphere. Examples of few suitable plants are mentioned in table 1 and 2.

Table 1: Suitable trees and annual for phyto-remediation

S. No.	Trees	Pollutant	Annual	Pollutant
1.	*Leucaena leucocephala*	Cd	*Zinnia elegans*	Pb, Cr and As
2.	*Morus alba*	Cd, Cu and Pb	*Tagetes erecta*	Cd, Ni and As
3.	*Azadirachta indica*	Pb	*Salvia splendens*	Cd

S. No.	Trees	Pollutant	Annual	Pollutant
4.	*Cinnamomum camphora*	Zn	*Gomphrena globosa*	As
5.	*Acacia mangium*	Pb	*Calendula officinalis*	Cd, Cr and Cu

Table 2: Suitable bulbous and herbaceous plants for phyto-remediation

S.No.	Bulbous plants	Pollutant	Herbaceous	Pollutant
1.	*Canna indica*	Pb, Zn Cr, Ni and Cd	*Sedum alfredii*	Zn
2.	*Polianthe tuberose*	Cd	*Alternanthera bettzickiana*	Cd and Pb
3.	*Iris lacteal*	Cd	*Mirabilis jalapa*	Cr
4.	Gladiolus	Cu and As	*Chlorophytum comosum*	Cd and Zn
5.	Nymphaea aurora	Cr	*Syngonium sp.*	As

As population is increasing and land is decreasing, space for plantation is considered to less but still there is lot of space where phyto-remediation can be achieved, such as by using pubic place, highways and bus stops, railway station and railway lines, rivers and ponds *etc*. Phyto-remediation can be also be achieved at our surrounding by adopting indoor or outdoor gardening, vertical gardening and roof gardening. Few examples of indoor plants are figure 3.

Figure3 : Examples of indoor plants for phyto-remediation

Conclusion

As country is trying hard to be a developed nation, unwillingly producing pollution, that uplifting the threats of climate change. Therefore, phyto-remediation by using ornamental plants can be proved as a better, easy and cost-effective in-situ method of removal of pollutants not only from outside but indoor also and can provide peaceful healthy atmosphere for work.

Acknowledgment

The authors acknowledge Department of Science and Technology (DST), Government of India [Sanction number-DST/INSPIRE/ Fellowship//IF210024) dated 8th August 2022] for their financial support in carrying out this work.

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Article ID : 04/IV/19/0424

EDUCTION: A SUSTAINABLE MULTIPLICATION TECHNIQUE FOR STINGLESS BEES

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Abstract
Hiving and multiplication of natural feral colonies of stingless bees, *Tetragonula iridipennis*, is the highly challenging task for beekeepers as there is a loss of robust wild foragers of the colony. Education is the well suited non- destructive sustainable technique employed, which helps in successful multiplication of feral colonies of stingless bees without any damage to the original colony and loss of brood.

Introduction
Stingless bees are a large group of bees closely related to common honey bees, orchid bees, and bumblebees. These bees do have stings, but they are rudimentary and cannot be used for defense purposes. These bees exhibit other defensive behavior by biting painfully with their strong mandibles. Indian stingless bees or Dammer bees" are one of the rarest and smallest forms of honey bee colonies in the world. Honey is stored in pot-shaped structures built with the help of propolis (natural resinous material collected from plant parts by the bees). These bees collect nectar and pollen from important medicinal plants. Its honey is known as the "Mother of Medicine" possessing higher medicinal properties than all other honeys. The honey is darker, thicker, tastes sour and sweet.

Multiplication of stingless bees, *Tetragonula* spp is a challenging task for beekeepers and scientists in India. Even though some methods are available to increase the colony numbers, refinement is essential to reduce the time taken and increase the success rate. During the hiving of wild colonies, colonies are destroyed with the complete loss of robust wild foragers and built-in storage reserves over the years. Eduction or budding is a sustainable technique to multiply the colonies of stingless bees by connecting a new empty box to an existing wild colony and forcing them to enter and exit via the new box without any damage to the bees and colony.

Steps involved in eduction process of stingless bees

1. **Locating the wild colonies:** This is the initial step in eduction process, we have to locate the wild colonies of stingless bees in their habitats and find the hive entrance to place the bee box.
2. **Box placement/position:** After locating the wild colony of stingless bees, gently remove the nest entrance of the colony by using a fine needle. A transparent polyethylene tube of inner diameter (1.0 cm) was taken, and one end of the tube was gently inserted into the nest entrance and tightly fastened with tape to prevent its further movement and serve as

an entry/exit for foragers. The hole on the hive's other side was applied with resin collected from the wild colonies.

3. **Shifting of the educted colony:** we have to observe the moving foragers carrying any resource from the wild parent colony through the connecting polyethylene transparent tube and monitor the movement of the foragers into and out of the hive. After a certain period i.e., a minimum of 3 months,the bees will start building structure, and hopefully create a new Queen cell and start with the brood. The presence ofa good amount of brood and bees in the annexure hives is a sign of the successful establishment of the colony in the annexure hive. Once the new colony is well established, disconnect the annexure hive from the wildhive and shift to the meliponiary.

Flow chart for steps involved in eduction process shown in Fig 1 and eduction setup is shown in Fig 2.

Advantages of eduction over splitting the colony

- The eduction method is found to be a safer alternative than general method of multiplication of the colony.
- The eduction method more naturally mimics how native stingless bees multiply and spread in nature.
- There will be no damage and no disturbance to the brood and bees in the wild colonies.
- Brood development of educted colony is good when compared to the manual destructive splitting of the colony.

Conclusion

Eduction is a successful non-destructive multiplication technique, with negligible disturbance to the wild colonies of stingless bees. This technique will be the limelight in future, used to train the enthusiastic beekeepers for sustainable eduction of feral colony in view of prolific multiplication of stingless bee colonies.

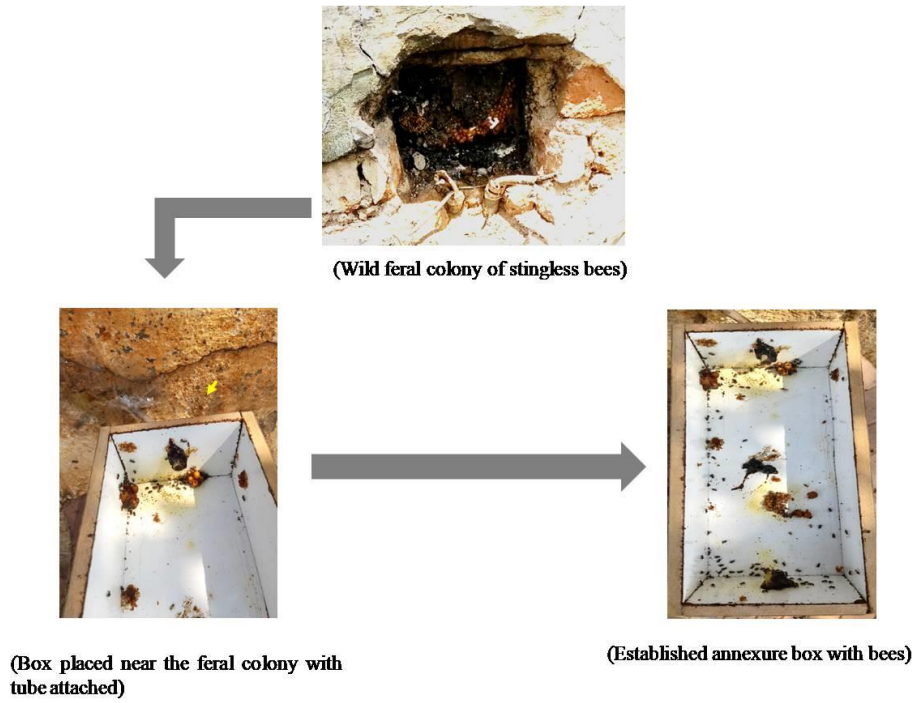

Fig 1: Steps involved in eduction of stingless bees

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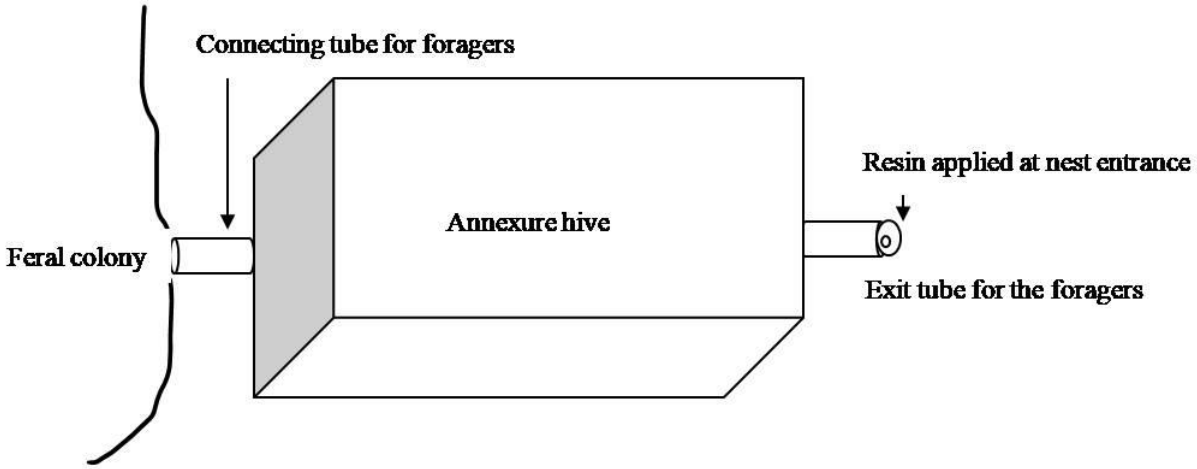

Fig 2: Eduction set up to hive the wild colony

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Article ID : 04/IV/20/0424

BEYOND CONVENTIONAL FEEDS: MILLETS PAVING THE WAY FOR A SUSTAINABLE DAIRY FUTURE

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Abstract
In light of growing environmental concerns and the need for sustainable agricultural practices, the dairy industry is looking into alternative feed options. Millets, which are frequently overlooked in favour of traditional feeds such as corn and soybeans, are emerging as a promising alternative. This article investigates the viability of millets as a sustainable feed source for dairy cattle. Millets have many benefits, including drought resistance, low water requirements, and high nutritional value. Incorporating millets into dairy cattle diets not only lowers the industry's environmental impact, but it also improves animal health and product quality. Furthermore, millet cultivation promotes biodiversity and benefits small-scale farmers, thereby contributing to overall agricultural sustainability. By embracing millets as a viable feed option, the dairy industry can transition to a more environmentally responsible and resilient future.

Key Words : Dairy Farming, Feeds, Millets, Sustainability

Introduction

Dairying, as a subset of agriculture, has exhibited remarkable growth over the past 75 years of Indian independence. India has consistently held the position of the world's leading milk producer since 1998, with a total output reaching 230.58 million tonnes in 2023. The annual increase in milk production, standing at 5.29 percent, surpasses the global average of 1.34 percent. From 2010-11 to 2021-22, the Compound Annual Growth Rate (CAGR) for milk products has been recorded at 5.57 percent (DAH&D, 2022-23).Growing consumption of dairy products is bringing important nutritional benefits to large segments of the population of developing countries (Jaiswal *et al.*, 2018). Despite India being the world's largest milk producer, productivity (production/animal) of dairy animals remains relatively low. The global average milk yield per cow is 7.2 kg, whereas India's average is 4.87 kg. According to the Government of India's estimate, the average daily milk yield in the country is 5.15 kg for cows and 5.9 kg for buffaloes. Enhance the productivity of dairy animals requires the effective management of their feed (Chand, 2023). It is crucial to redirect attention to the feed management of dairy animals at this juncture, aiming for an eventual boost in productivity. One potential strategy could be integrating millets into the diet of dairy animals to enhance feed management.

Why Millets Stand Out for Optimal Feed Management in Dairy Animals?

A high-milk-producing dairy animal requires a variety of nutrients, including amino acids, carbohydrates, minerals, vitamins, water, and fatty acids. Millets, along with other compound feed mixtures, are an excellent source of high-quality dairy feed (Pashudhanpraharee, 2024).Millets, characterized by their rich nutritional composition, serve as a key catalyst in enhancing various facets of milk quality (Sujith *et al.,* 2023). They provide a wide range of essential nutrients, such as

proteins, vitamins, and minerals, promoting a balanced diet for dairy cows. This nutritional richness translates directly into higher milk quality and quantity, as the cow's diet influences the composition of the milk it produces.

Millet Magic Unleashed: A Nutrient-Rich Feast for Dairy Animals

Millet grains are considered unique crops because they are rich in valuable nutrients such as calcium, dietary fibre, polyphenols, and protein (Devi *et al.,* 2014). Millets are known for their high fiber content, which promotes proper digestion and rumen function. They also contain essential vitamins (such as B-complex) and minerals, such as iron and zinc, which contribute to the fodder's overall nutritional value. The gluten-free nature of millets makes them suitable for animals with dietary sensitivities (Tong *et al.*, 2023).

Various types of millets are used as fodder for dairy cattle, each with its own nutritional profile and benefits. Sorghum is an excellent fodder grass that can be used for grazing as well as making silage and hay. During normal seasons, it accounts for 20-45% of the total dry weight of dairy animal feed, but during lean summer and winter seasons, it can reach 60%.A study conducted on cows found that pearl millet grain could completely replace maize in high-supplement diets (Hassan *et al*., 2021).Green Bajra contains 6-20% crude protein, and the fresh forage is highly digestible for ruminants, with a digestibility percentage (DMD) of 66-69%. Ragi straw can be used as forage in diets for crossbred dairy cows supplemented with a balanced concentrate mixture (energy and protein), which gives an 8-9 kg milk yield (Wang *et al*., 2023).In India, finger millet grain is used as an energy supplement for dairy cows during early to mid-lactation, resulting in an increase in milk yield (average increase of 1.9 litre/cow/day), fat, and solids-not-fat content of milk (average increase of 0.2-0.3%). It's economically profitable (Gowda *et al*., 2009).

Fig. 1 (Source: Tribune Today)

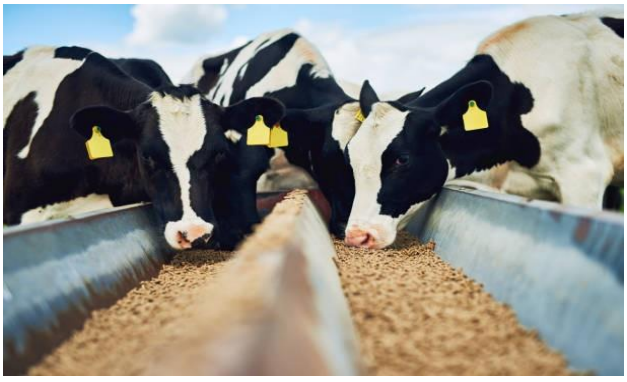

Fig.2 (Source: Food and Agriculture news)

Positive impacts of Millet inclusion in feeding practices for Dairy animals

Incorporating millets into dairy animal feeding practices can help with sustainability due to their resource-efficient cultivation and positive impact on animal health.

Economic benefits of millets as a component of fodder

Millets cultivation for fodder offers farmers an appealing economic opportunity. Millets, known for their adaptability and resource efficiency, are a low-cost alternative that requires fewer inputs like water and fertilizers. Millets, with their rapid growth rates and high nutritional content, help to increase fodder availability while reducing reliance on conventional and potentially more expensive feed sources. This strategic diversification not only improves livestock management's

economic resilience, but it also aligns with sustainable farming practices, ensuring farmers' long-term financial viability.

Reduced Dependency on Conventional Fodder Crops

Diversifying fodder sources with millets reduces the economic risks associated with relying on conventional crops. Farmers can adjust to fluctuations in the availability and price of specific feeds, ensuring a consistent supply of affordable fodder. This strategic diversification promotes financial stability and resilience in the face of fluctuating market conditions.

Crop Rotation Benefits

Integrating millets into crop rotation systems improves soil health while also providing economic benefits. Improved soil health reduces the need for excessive fertilizers, resulting in long-term cost savings to farmers. Sustainable farming practices, such as millet cultivation, encourage environmental stewardship and economic efficiency in resource management.

Dual-Purpose Cultivation

Some millets have a dual-purpose cultivation model, producing both grains for human consumption and fodder for animals. Diversification increases farmers' income. Farmers can increase their economic returns and build a more resilient agricultural enterprise by participating in both the food and fodder markets.

Supporting Livestock Productivity

The provision of nutrient-rich millet-based fodder improves the health and productivity of dairy animals. Healthy animals are more likely to produce more milk, which directly benefits dairy farmers. The economic benefits extend beyond the cultivation phase into the entire value chain of milk production.

A Call to Action: Embracing Millets for a Sustainable Dairy future

To summarize, incorporating millets into dairy farming practices is a revolutionary shift rather than a trend. Millets are proving to be the driving force behind a new era of sustainable, efficient, and economically viable dairy farming. As we say goodbye to traditional norms, the era of millets in dairy promises a future in which productivity is balanced with nutrition, sustainability, and economic prosperity. It is more than just a dietary change; it is a transformative journey toward a better, healthier future for dairy farming.

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Article ID : 04/IV/21/0424

DIGGING DEEPER: COAL MINING, INJUSTICE, AND HEALTH

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Abstract
With the ever-growing global demand for coal to fuel the rapid expansion of urban centres, the discourse surrounding the social, environmental, and health injustices stemming from coal mining remains profoundly relevant. It scrutinizes and dissects the mechanisms underlying coal mining-related injustices, highlighting the inherent conflicts and power imbalances between political and industry interests and the inhabitants of mining communities. Moreover, the paper explores the fundamental question of what measures would be necessary for health considerations to outweigh economic interests.

Key Words : Coal, Mining, Injustice and health

Introduction

Throughout the course of modern history, coal has played a pivotal role in human progress, fuelling both the industrial revolution and the ongoing wave of globalization. Despite the emergence of alternative energy sources such as natural gas, nuclear, wind, and hydroelectric power, coal's perceived affordability has ensured its continued prominence as a primary energy source. It has facilitated the development and advancement of a vast array of technologies that profoundly influence our daily lives, from how we access information and communicate to how we transport ourselves and conduct our work. Even the significant gains in human longevity witnessed over the past century can be largely attributed to advancements made possible by coal-powered technologies. However, this reliance on coal comes with inherent drawbacks, primarily manifesting in environmental degradation and adverse impacts on health and well-being. These impacts extend not only to those directly involved in the coal industry but also to communities residing in proximity to coal mines or coal-burning facilities.

The recent surge in coal demand has heightened the politicization and contention surrounding mining-related health and well-being in many countries. This stems from the conflicting priorities between promoting health and social justice versus sustaining a profitable mining sector and fostering robust economic growth. Despite predictions of a decline in coal demand, ongoing coal mining activities necessitate comprehensive research into their health and social impacts. Moreover, even nations without a local mining industry find themselves entangled in the negative environmental, health, and social repercussions of coal extraction, combustion, and their by-products, driven by the perceived necessity of coal for powering urbanization and modern technologies worldwide. Consequently, the age-old debate concerning social injustices and health hazards linked with mining remains as pertinent as ever, if not more so, given the increasing automation of labour practices and lifestyles. Furthermore, despite variations in national resources and political systems, the fundamental issues surrounding coal mining's impacts appear

universally consistent. These issues encompass environmental repercussions such as landscape degradation, soil erosion, habitat depletion, and the generation of greenhouse gases during coal combustion. For instance, despite coal contributing only 25 per cent of global energy consumption in 2005, it accounted for a disproportionate 41 per cent of carbon dioxide emissions. Additionally, coal mining operations generate various pollutants, including heavy metals and potential carcinogens such as poly-aromatic hydrocarbons, sulphur dioxide, and nitrogen oxides, which pose significant risks to respiratory health. Furthermore, the disposal of coal combustion waste products like fly ash can pose serious health hazards if not managed properly, while the use of coal combustion by-products in building materials can lead to secondary health impacts such as injuries and fatalities associated with coal transport vehicles. (Epistein *et al.,* 2011).

I. Health and Injustice

In the World Health Organization (WHO) constitution, health is characterized as "a state of complete physical, mental, and social well-being, not merely the absence of disease." This definition encapsulates health as a holistic amalgamation of physical, mental, and social dimensions, as emphasized by Rapport and Mergler (2004). There were a range of adverse health consequences spanning from minor respiratory issues to more severe conditions such as birth defects, cancers, heart and kidney diseases, and increased mortality rates. For instance, certain studies have identified heightened levels of heavy metals in children residing near coal mines (Yapici *et al.,* 2006), while individuals living in proximity to coal-fired power stations have shown elevated rates of non-melanoma skin cancers (Pesch et al., 2002). The severity and frequency of these effects may vary depending on national disparities in mining techniques and the quantity of coal extracted. Studies conducted in the Appalachian coal mining region of Kentucky, USA, suggest that mountain-top mining has a more detrimental impact on the health of local communities compared to non-mountain top mining (Esch and Hendryx, 2011). Additionally, the effectiveness of local or national regulations, or their absence, concerning the operation of coal mines and coal-fired power stations may significantly influence the potential mitigation or exacerbation of health risks. More recently, psychological distress associated with adverse environmental change has been encapsulated by Albrecht (2005), in the term ‘solastalgia’. Albrecht uses this concept to describe the feelings of powerlessness and homesickness that can result from damage, destruction or loss of ‘place’. This phenomenon has been reported in mining communities by Higginbotham et al. (2006) and Connor et al. (2004).

II. Economic Inequalities

Coal mining often exacerbates economic inequalities within and among communities. While the industry may provide employment opportunities, these jobs frequently come with low wages, poor working conditions, and limited job security. Moreover, the economic benefits derived from coal mining tend to disproportionately accrue to corporations and affluent individuals, widening the wealth gap. Small-scale miners and local residents, particularly those in developing regions, often bear the brunt of economic hardships associated with coal mining, facing displacement, loss of livelihoods, and diminished access to resources and services.

III. Environmental Injustices

Coal mining operations contribute significantly to environmental injustices, perpetuating disproportionate harm to marginalized communities and ecosystems. These injustices manifest in various forms, including pollution of air, water, and soil, destruction of habitats, and disruption of natural landscapes. Marginalized communities, such as indigenous populations and low-income neighbourhoods, are often situated in close proximity to coal mines and coal-fired power plants, bearing the brunt of pollution and environmental degradation. This unequal distribution of environmental burdens exacerbates existing social inequities and undermines the right to a clean and healthy environment for all.

IV. Social Divides

Coal mining can deepen social divides within affected communities, fostering tensions and conflicts over resource allocation, land rights, and decision-making processes. Displacement of communities to make way for mining operations, coupled with disruptions to traditional livelihoods and cultural practices, can fracture social cohesion and erode community resilience.

V. Power Imbalances

Coal mining perpetuates power imbalances between industry stakeholders and affected communities, leading to unequal distribution of benefits, risks, and decision-making authority. Multinational corporations and government agencies often wield significant influence over mining operations, regulatory processes, and resource allocation, sidelining the voices and interests of local residents and indigenous groups. This imbalance of power limits community participation in decision-making, undermines accountability mechanisms, and perpetuates social injustices.

VI. Occupational Impacts on Water Quality:

In this context, Blakeney and Marshall (2009) define 'occupation' as all human activities not just employment. From their qualitative study in a mining community in Kentucky, USA, these authors proposed three key themes of

(i) Occupational injustice/occupational deprivation,
(ii) Occupational imbalance and
(iii) Occupational alienation. This indicates that local residents experienced occupational injustice in a multifaceted way. The findings from them includes:
   a) Garden produce rendered unsafe for human consumption due to irrigation with contaminated water.
   b) reduced ability to gain income by growing and selling local produce
   c) Unpleasant odour and dingy appearance of clothes washed in the local water supply occasioning discomfort, inconvenience and embarrassment

Conclusion

In conclusion, the discourse surrounding coal mining reveals a complex interplay of health, economic, environmental, and social injustices, highlighting the urgent need for comprehensive policy interventions. To address these multifaceted challenges, policymakers must prioritize the health and well-being of communities affected by coal mining activities, while also promoting sustainable economic development and environmental conservation. This requires implementing stringent regulations to mitigate health hazards associated with coal mining and combustion, ensuring equitable distribution of economic benefits, and fostering community participation in

decision-making processes. Moreover, addressing power imbalances and promoting social cohesion are essential for achieving justice and sustainability in coal-dependent regions. Effective policy measures should encompass a holistic approach that considers the interconnectedness of health, economic, environmental, and social factors, ultimately striving for a just transition away from coal towards cleaner, more equitable energy alternatives.

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Article ID : 04/IV/22/0424

HARNESSING RNA INTERFERENCE (RNAi) FOR PEST MANAGEMENT IN INSECTS: MECHANISMS, METHODS, AND SUCCESSFUL APPLICATIONS

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Abstract

RNA interference (RNAi) has emerged as a promising technology for insect pest management due to its specificity, effectiveness, and environmentally friendly nature. This article explores the mechanisms of RNAi in insects, methods of delivery, and successful applications in pest control. RNAi operates through the introduction of double-stranded RNA (dsRNA) molecules, triggering a sequence-specific degradation of target messenger RNAs (mRNAs) and subsequent gene silencing. This mechanism, conserved across insects, offers a potent means to disrupt vital physiological processes in pests without harming non-target organisms. This also enables to understand about the efficacy and specificity factors of RNAi in insects and successful examples of insect control using RNAi.

Introduction

RNAi is a biological process in which RNA molecules inhibit the expression of specific genes. It has revolutionized our understanding of gene regulation and function across diverse organisms, including insects. Discovered over two decades ago, RNAi is a conserved cellular process that regulates gene expression through sequence-specific degradation of target messenger RNA (mRNA). In insects, RNAi aids as a crucial machinery for controlling expression of endogenous genes, viral defense, and developmental processes. However, the manipulation of RNAi pathways has also emerged as a promising strategy for managing insect pests, which pose significant threats to agriculture, human health, and biodiversity. Conventional pest management strategies, such as chemical pesticides, have raised concerns about environmental pollution, non-target effects, and the development of pesticide resistance. Therefore, there is an imperative requirement for sustainable and eco-friendly alternatives to mitigate the negative impacts of insect pests. RNAi technology offers a promising avenue for precisely targeting pest insects while minimizing collateral damage to beneficial organisms and the environment.

Background of RNAi

In 1990, Napoli et al. made a groundbreaking discovery by identifying RNA interference (RNAi) and demonstrated its potential by transferring the chalcone synthase gene into petunia plants, aiming to intensify the color of their flowers. Surprisingly, instead of deepening the purple hue as intended, many flowers turned white or floral white. This phenomenon, known as co-suppression, occurs when the introduction of an exogenous gene closely related to an endogenous gene leads to the suppression of both genes' expression.

Fire et al. (1998) further elucidated the RNAi process by confirming that double-stranded RNA (dsRNA) is more effective in suppressing target gene expression compared to single-stranded RNA (ssRNA) in *Caenorhabditis elegans*. This post-transcriptional gene silencing mechanism was officially termed RNA interference (RNAi). Over the past two decades, significant advancements have propelled RNAi technology, particularly in agricultural pest control. Researchers have engineered RNAi-based approaches to target genes involved in agricultural diseases, insect infestations, and weed proliferation, thereby disrupting their expression.

The immense potential of RNAi-based biopesticides has spurred considerable investment from research institutes and agrochemical companies, including Bayer (Monsanto), Corteva, and Syngenta. These entities have actively pursued the development of innovative RNAi-based products, resulting in the acquisition of major patents for RNAi applications. Notably, the transgenic maize SmartStax® Pro, engineered to produce dsRNA targeting *Diabroticavirgiferavirgifera* Dvsnf7, received approval in Canada in 2016 and the United States in 2017.Bayer's announcement regarding their insecticide "ledprona," designed for controlling *Leptinotarsa decemlineata*, signals a significant milestone in RNAi technology. Expected to be submitted to the Environmental Protection Agency (EPA) in 2022, ledprona represents a pioneering non-PIP (Plant-Incorporated Protectant) insecticide. This development underscores the growing recognition and adoption of RNAi-based solutions in modern agriculture, promising pest management strategies that are environmentally effective and sustainable.

Mechanism of RNAi

The mechanism of RNA interference (RNAi) in insects involves a series of intricate molecular processes that ultimately lead to the degradation or silencing of specific target messenger RNA (mRNA) molecules. This process is initiated by the introduction of double-stranded RNA (dsRNA) into the insect cells, either exogenously or through endogenous production. The detailed process as follows;

1. **dsRNA Uptake**: Insects can take up dsRNA through various routes such as ingestion, injection, or absorption through the cuticle. Once inside the cell, dsRNA molecules are recognized as foreign by the intracellular machinery.
2. **Dicer Cleavage**: The ingested or produced dsRNA is processed by an enzyme called Dicer, which cleaves it into smaller fragments known as small interfering RNAs (siRNAs). Dicer is part of the RNA-induced silencing complex (RISC).
3. **siRNA Incorporation**: One strand of the siRNA duplex is loaded onto the RISC, guiding it to complementary target mRNA molecules. The other strand is typically degraded.
4. **Target mRNA Cleavage or Suppression**: The RISC complex, guided by the siRNA, binds to target mRNA molecules with complementary sequences. Depending on the degree of complementarity, the target mRNA is either cleaved by the endonuclease activity of the Argonaute protein within the RISC complex or subjected to translational repression, ultimately leading to the degradation or reduced expression of the target mRNA.
5. **Amplification Cascade**: In some cases, the cleaved mRNA fragments generated by RNAi can serve as substrates for further amplification of the RNAi response, leading to enhanced silencing effects.
6. **Spread of RNAi Signal**: In certain insects, RNAi signals can spread systemically through the organism, allowing for the propagation of the silencing effect to tissues distant from the site of dsRNA uptake.

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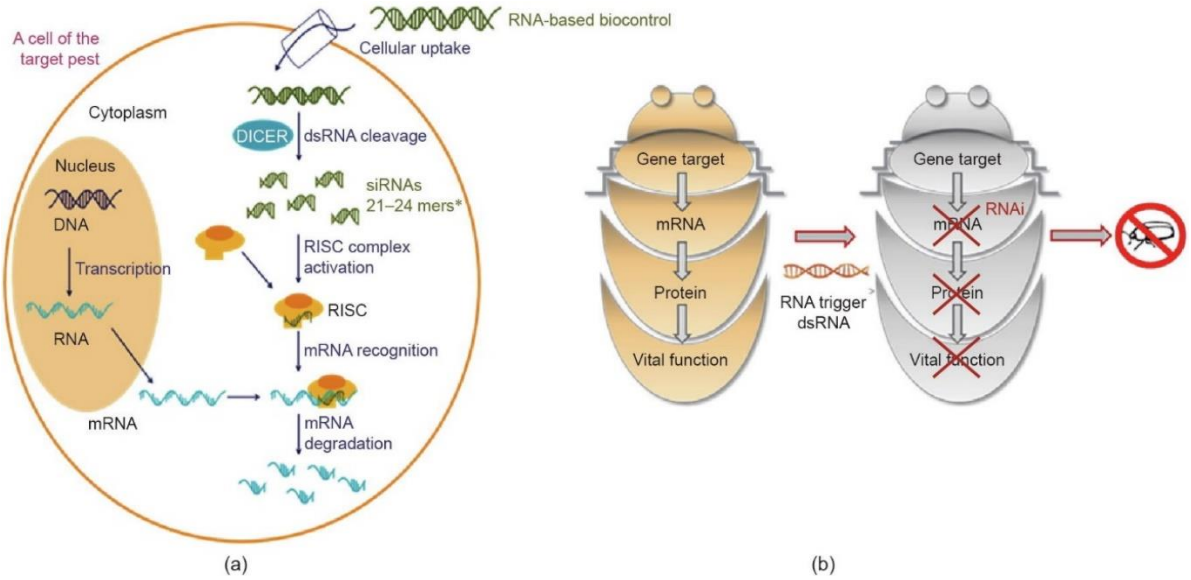

Fig. 1. (a) Molecular mechanism of RNAi; (b) principle of using RNAi for insect control.

Methods of administering the dsRNA to insects

1. Microinjection

Double-stranded RNA can be introduced directly into target tissues or hemolymph, through microinjection. This method allows bypassing physical barriers (integument or gut epithelium). Double-stranded RNAs used in this are commonly synthesized in vitro using T7 RNA polymerase.

2. Ingestion/Oral feeding

Orally administereddsRNA may face degradation by midgut endonucleases, a portion can still be absorbed by midgut cells, with some dsRNA even reaching other tissues. RNAi triggered by ingestion is particularly effective for genes expressed in the midgut compared to those in other tissues. Common non-transgenic methods for delivering oral dsRNA include incorporating it into artificial diets via mixing, spraying, or coating, immersing or coating plant leaves with dsRNA. These non-transgenic delivery approaches can involve in vitro synthesis of dsRNA or utilize microbes like *E. coli*, yeast, and entomopathogenic fungi for dsRNA production.

3. Soaking

The cells or tissues are soaked in dsRNA solution for a particular time. Soaking is done using insect cell lines by introducing dsRNA into the culture medium. Several insect cell lines, including S2, Bm5, Sf21, and CiE1, have been established for inducing RNA interference responses. Transfecting agents (Lipofectamine 3000, Lipofectamine RNAiMAX) increase the RNAi efficacy by assisting the uptake of dsRNA from the solution.

4. Topical application

topical application of double-stranded RNA (dsRNA) or small interfering RNA (siRNA) has the ability to penetrate the cuticles of various insect species and induce lethal effects. This phenomenon has been observed in several insects, including *Aphis glycines, Aedes aegypti, Leptinotarsa decemlineata, Anastrephafraterculus,* and *Spodoptera frugiperda*.

5. Nanoparticle-Mediated dsRNA Delivery

Nanoparticle-mediated delivery of double-stranded RNA (dsRNA) represents a promising strategy for enhancing the efficacy and specificity of RNA interference (RNAi) in insects. Several nanoparticle-based formulations have been developed and investigated for their potential in delivering dsRNA to insect pests. These formulations often involve the encapsulation of dsRNA within biocompatible and biodegradable nanoparticles, such as liposomes, polymeric nanoparticles, or lipid nanoparticles. These nanoparticles can be engineered to improve stability, cellular uptake, and intracellular trafficking of dsRNA. Additionally, surface modifications of nanoparticles enable specific targeting of tissues or cells within the insect.

6. Host-induced gene silencing (HIGS)

HIGS in insects is a strategy aimed at utilizing the natural defense mechanisms of plants to confer resistance against insect pests. In HIGS, plants are genetically engineered to express double-stranded RNA (dsRNA) targeting essential genes in invading insect pests. When insects feed on these transgenic plants, they ingest the dsRNA, which triggers RNA interference (RNAi) in the insect's digestive system, leading to the suppression of target gene expression and ultimately causing mortality or reduced fitness.

7. Virus-induced gene silencing (VIGS)

Viral vectors can be engineered to express dsRNA targeting specific insect genes. These viral vectors can infect insect cells, delivering dsRNA and inducing RNAi responses. Virus-mediated dsRNA delivery methods are particularly useful for studying gene function or conducting RNAi-based pest control in insects.

8. Spray-induced gene silencing (SIGS)

The SIGS process typically involves formulating dsRNA into spray solutions that can be applied directly onto plant foliage or other surfaces where insect pests are present. Upon contact with the sprayed dsRNA, the insects ingest or absorb the dsRNA, which then enters their cells and triggers RNA interference (RNAi) pathways.

Factors influencing the efficacy and specificity of RNA interference (RNAi) in insects

1. **Sequence Specificity**: The degree of sequence complementarity between the double-stranded RNA (dsRNA) or small interfering RNA (siRNA) and the target mRNA influences RNAi efficacy and specificity. Greater sequence complementarity typically results in more efficient target mRNA cleavage and gene silencing.

2. **Length and Structure of dsRNA/siRNA**: The length and secondary structure of dsRNA or siRNA molecules can affect their stability, cellular uptake, and ability to induce RNAi. Optimal lengths for dsRNA or siRNA molecules can vary depending on the target gene and insect species.

3. **Delivery Method**: The method of delivering dsRNA or siRNA to insects can significantly impact RNAi efficacy and specificity. Different delivery methods, such as oral ingestion, microinjection, topical application, or nanoparticle-mediated delivery, can influence the efficiency of dsRNA uptake and intracellular processing.

4. **Cellular Uptake and Intracellular Trafficking**: The ability of insect cells to uptake and process dsRNA or siRNA molecules is critical for RNAi efficacy. Factors such as the presence of dsRNA uptake receptors, endocytic pathways, and intracellular trafficking mechanisms can affect the efficiency of RNAi induction.

5. **Off-Target Effects:** Off-target effects occur when dsRNA or siRNA molecules inadvertently silence unintended genes with partial sequence homology to the target gene. Minimizing off-target effects requires careful design of dsRNA or siRNA sequences and validation of specificity through bioinformatics analysis and experimental validation.

6. **Persistence and Stability of RNAi Response**: This can influence the duration of gene silencing and the effectiveness of RNAi-based pest control strategies. Factors like degradation rate of dsRNA or siRNA molecules, turnover of RNAi machinery components, and systemic spread of RNAi signals can affect the longevity of RNAi effects.

7. **Insect Species and Developmental Stage:** RNAi efficacy and specificity can vary among different insect species and developmental stages due to differences in physiological, biochemical, and genetic factors. Understanding species-specific differences in RNAi response mechanisms is essential for optimizing RNAi-based pest management strategies.

RNAi-based products for pest control.

Several RNAi-based products have been developed and commercialized for managing insect pests in agriculture, horticulture, and public health. Here are some examples mentioned in Table 1 of RNAi-based products for pest control (Lu *et al.,* 2023).

RNAi Event	Products	Company	RNAi Gene	Target Pest	Approval
MON87411 (GM corn)	SmartStax Pro, Vorceed™ Enlist®, VT4PRO™…	Bayer, Corteva, Pioneer Hi-Bred	*DvSnf7*	*D. v. virgiferaD. v.zeae D. barberi*	2015–2017
DP23211 (GM corn)	**unknown**	DAS	*DvSSJ1*	*D. v. virgifera*	2021
Ledprona	Calantha	GreenLight	*PSMB5*	*L. decemlineata*	2021

Examples of insect control using RNAi

i. **Corn Rootworm** (*Diabroticavirgiferavirgifera*): Transgenic maize expressing dsRNA targeting essential genes in the western corn rootworm has been developed to control this destructive pest. The RNAi-based maize provides protection against root damage caused by rootworm larvae, reducing the need for chemical insecticides (Baum *et al.,* 2007).

ii. **Asian Tiger Mosquito** (*Aedes albopictus*): RNAi has been explored as a potential strategy for controlling mosquito populations that transmit diseases such as dengue fever, Zika virus, and chikungunya virus. Targeting genes involved in mosquito development, reproduction, or pathogen transmission can disrupt mosquito populations and reduce disease transmission (Whyard *et al.,* 2015).

iii. **Colorado Potato Beetle** (*Leptinotarsa decemlineata*): The biopesticide, known as ledprona, inhibits the expression of an enzyme in the beetles that facilitates the breakdown of proteins. With this enzyme inhibited, metabolites accumulate, which, if allowed to continue, eventually leads to mortality (John 2023).

iv. **Citrus Psyllid** (*Diaphorinacitri*): RNAi has been explored as a potential strategy for controlling the citrus psyllid, an insect vector of citrus greening disease (huanglongbing). Targeting genes involved in psyllid development or disease transmission could help reduce psyllid populations and mitigate disease spread in citrus orchards (Hajeri*et al.,* 2014).

Conclusion

RNA interference (RNAi) represents a powerful tool for controlling insect pests, offering targeted and environmentally friendly solutions for agricultural and public health challenges. Understanding the mechanism of RNAi in insects, including the processing of double-stranded RNA (dsRNA) into small interfering RNAs (siRNAs) and the subsequent degradation of target messenger RNAs (mRNAs), is essential for harnessing its potential. The development and commercialization of RNAi-based products for pest control demonstrate the practical applications of this technology. These RNAi products offer targeted and sustainable alternatives to chemical pesticides, with potential benefits for crop protection and integrated pest management strategies.

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ISSN : 2583-0910
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Article ID : 04/IV/23/0424

ROLE OF FISH FARMER PRODUCER ORGANIZATIONS (FFPOS) IN THE OVERALL DEVELOPMENT OF THE FISHERS AND FISHERMEN

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Highlight of FFPO: An FFPO is an organization made up of fishermen, fish farmers, or other fisheries stakeholders that is registered under any current law or that is supported by a scheme or program run by the federal or state governments with the primary goal of carrying out sustainable fisheries value chain business activities.

What is FFPOs?

Fish Farmer Producer Organizations (FFPOs) is one of the innovative approaches to increase and provide end-to-end support and services with respect to technical inputs (feed and seed supply, training), processing, marketing, and provide access to financial advice and services for small-scale fishers and fish farmers.

FFPOs have been aggressively promoted by the Indian government through programs like the Pradhan Mantri Matsya Sampada Yojana (PMMSY). FFPOs may be registered under the Companies Act or the Cooperative Societies Act. Which refers to an organization or association of fishermen, fish growers, or other fisheries stakeholders whose main goal is to conduct sustainable fisheries value chain business, whatever its name may be. The Central Sector Scheme component of PMMSY will be used to form and promote FFPOs, with 100% central support.

Who can be a member for FFPOs?

Fishers, fish farmers, fish workers, fish vendors, fisheries entrepreneurs, and other individuals connected to the fisheries industry may be included in the FFPOs, depending on what the Dept. of Fisheries, Government of India, decides. Moreover, at the District and State levels, FFPOs can be federated.

Objectives of Fish Farmer Producer Organisations

I. Utilize resources in an effective, economical, and sustainable way to increase production.
II. Increase the ability of fishermen and fish farmers to become entrepreneurial so that the FFPOs may become self-supporting and commercially successful.
III. Access to quality seed and feed are available.
IV. To increase the bargaining power of fish farmers for their better market price with the elimination of intermediaries.
V. FFPO may offer and carry out significant services and operations throughout the fisheries value chain.

Aim of FFPO

I. Fishers and fish farmers' economic empowerment.
II. Better market integration and liquidity will enable you to realize higher returns.

III. To make FFPOs self-sufficient and economically sustainable, cultivate entrepreneurial abilities.
IV. Construct value chains for fisheries that are sustainable and geared toward generating cash.
V. Ensuring the safety of fishermen.

Services and activities of FFPO

- Pond, pen, cage, RAS, raceway, and Bio-floc operations associated with fish production should be performed for both inland and marine environments.
- In consultation with national organizations like the National Fisheries Development Board, Hyderabad (NFDB), the National Cooperative Development Corporation (NCDC), the National Bank for Agriculture and Rural Development (NABARD), the Small Farmers' Agri-Business Consortium (SFAC), and State/UT Fisheries Department and their entities, building capacity on advance and innovative aquaculture technologies.
- Post-Harvest Infrastructure and Management Through partnerships with organizations like the Fish Welfare Initiative, FFPOs, for example, may also recommend the establishment of high-value addition/processing units for increased price realisation and traceability-related activities.
- Make production and post-production tools and equipment accessible, including ice cubes, ice boxes, and logistics/transportation. Moreover, engage in higher income-generating industries such as cold chain development, seed and stock production, decorative fishing, seaweed farming, cold water fishing and fish stall manufacture.
- Direct market links in other states; connections with market intermediaries and processors to sell produce; establishment of wholesale or retail outlets.

How we can register a FFPO

The Cooperative Societies Act or the Companies Act may be used to register FFPOs.
The PMMSY released guidelines for the "Formation and Promotion of Fish Farmer Producer Organizations (FFPOs)" in 2021. By a single click on given link you can follow registration guidelines of FFPO:
https://dof.gov.in/sites/default/files/2023-05/Final_approved_FFPO_guideline.pdf

How a FFPO is helpful for fishers and fish farmers

- Obtaining financing for small and micro businesses, access to financing at a minimal interest rate to cover capital and operating expenditures.
- Support with cutting-edge fish packaging methods.
- Capacity building for contemporary tools and methods.

FFPO implementing agencies

1. Cooperative Societies Act, NCDC
2. Cooperative Societies Act and Companies Act NFDB
3. Cooperative Societies Act and Companies Act NABARD
4. State/UT Fisheries Department
5. SFAC-Companies Act

***Agencies can help the FFPOs to become economically viable by collaborating with Community-Based Business Organizations (CBBOs).**

Minimum Members required for FFPO body

In the Plains: eligibility requires a minimum of 100 members.
For places with hills and in the northeast: Eligibility requires a minimum member size of 35.

Strategy behind FFPO formation

Fisheries Business Cluster Area, which is widely described as the following, serves as the foundation for the creation and promotion of FFPO.

For the purposes of FFPO development, promotion, operations, and administration, "**Fisheries Business Cluster Area**" refers to a geographic region where a fisheries-related business may be established to utilize economies of scale throughout the full fisheries value chain in a sustainable way.

Funding Grant of FFPO by Government of India through Department of Fisheries (DoF)

1. FFPO Formation and Incubation Cost to CBBO Rs. 25 Lakh/FFPO
2. FFPO Management Cost (up to 3 years) to FFPO Rs. 18 Lakh/FFPO
3. Equity Grant Provision to FFPO Rs. 15 Lakh/FFPO

Important facts about the membership contribution and agencies contribution

A matching contribution of up to Rs 2000 per member of the FFPO, subject to a maximum of Rs 15 lakh per FFPO, is known as the equity grant provision.

The government agencies would contribute up to Rs. 25 lakh each FFPO toward the cost of FFPO creation and incubation.

One-time registration fee:

Under the plan, the fee for forming FFPOs under the Companies Act or registering under the Cooperative Societies Act would be reimbursed up to a cap of Rs. 40,000 or actual.

Working professional members for FFPO

Salaried CEO/Manager and of Accountant FFPO required after formation of FFPO for the better coordination and working of FFPO with Implementing agencies for their organization production, productivity and sustainable development.

- CEO and Manager should be graduate in Fisheries Sciences.
- Accounting professional with a 10+2 degree in mathematics.

Monitoring & Evaluation of FFPO

- Project Monitoring Unit (PMU) in NFDB
- State Level Approval and Monitoring Committee (SLAMC)
- District Level Committee (DLC) Third Party Evaluation of the Scheme

Eligibility Criteria for FFPOs

- It must be a legal organization that has been formed or registered in accordance with the relevant state's Cooperative Societies Act or Part IXA of the Companies Act.
- Small and marginal fishermen, fish farmers, and other fish workers must make up at least 50% of the company's stockholders; these individuals often operate in small-scale fisheries and sell their harvest on local markets or eat it themselves. It is preferable to have female shareholders participate.
- A member may not own more than 10% of the FFPO's total equity at any one time.

- A fisher or fish farmer may belong to many FFPOs with various produce clusters, but they may only be eligible for one FFPO at a time.
- It contains a business strategy and budget for the upcoming 18 months that are founded on a viable revenue model that the Implementing Agency may select.

ISSN : 2583-0910
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Article ID : 04/IV/24/0424

ROOTSTOCK'S ROLE IN FRUIT PRODUCTION: ENHANCING CROP YIELD AND RESILIENCE

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Introduction

Rootstock plays a pivotal role in fruit production, shaping the growth, vigor, and disease resistance of fruit-bearing plants. Acting as a foundation, it influences yield, fruit quality, and adaptability to various environments. Rootstock selection affects plant size, nutrient uptake, and water efficiency, profoundly impacting overall orchard management. By grafting desired fruit varieties onto compatible rootstocks, growers optimize resource utilization, enhance pest resilience, and extend fruiting longevity. Rootstock's crucial contribution to fruit production underscores its significance in sustainable and bountiful harvests, ensuring the vitality and success of orchards worldwide.

1. Understanding Rootstocks and Their Importance

Rootstocks are the lower portion of a grafted fruit tree, onto which the scion, or the upper portion, is grafted. They serve as the root system of the plant and are responsible for anchoring the tree to the soil, absorbing nutrients and water, and forming a symbiotic relationship with beneficial microorganisms. The choice of rootstock can greatly influence the growth, vigor, disease resistance, and adaptability of the fruit tree.

2. Enhancing Crop Yield with Rootstocks

2.1. Improved Nutrient Uptake Rootstocks can significantly impact nutrient uptake by influencing the root architecture of the fruit tree. Some rootstocks have extensive root systems that explore a larger volume of soil, leading to better access to nutrients like nitrogen, phosphorus, and potassium. This enhanced nutrient uptake can result in improved growth and higher crop yields.

2.2. Increased Water Absorption In regions with limited water availability or during periods of drought, rootstocks that exhibit superior drought tolerance can play a crucial role in maintaining fruit tree health and productivity. By efficiently absorbing and transporting water, these rootstocks can help fruit trees survive and continue producing fruit under challenging conditions.

2.3. Disease and Pest Resistance Certain rootstocks possess natural resistance to specific soil-borne pathogens and pests. By selecting appropriate rootstocks, fruit growers can reduce the risk of disease outbreaks and pest infestations, leading to a more stable and abundant harvest.

3. Rootstock-Scion Interactions

The interaction between the rootstock and scion is a critical factor in determining the overall performance of a grafted fruit tree. Compatibility between the rootstock and scion ensures the successful establishment of a vigorous and healthy fruit tree. Factors such as genetic compatibility, grafting technique, and the selection of appropriate rootstock-scion combinations must be considered to optimize fruit production.

4. Grafting Techniques for Fruit Production

4.1. T-budding- T-budding is a common grafting technique used in fruit tree propagation. It involves inserting a single bud from the desired scion into a T-shaped incision in the rootstock's bark. This method allows for a high success rate and enables mass propagation of fruit trees with desirable traits.

4.2. Whip and Tongue Grafting- Whip and tongue grafting is another popular technique used to join the scion and rootstock. It involves making diagonal cuts on both the scion and rootstock, fitting them together like a puzzle, and securing them with tape or grafting clips. This technique provides a strong union between the two components and is commonly used for grafting fruit trees with similar diameters.

4.3. Cleft Grafting- Cleft grafting is suitable for grafting larger scions onto established rootstocks. It involves making a vertical cut into the rootstock and inserting the scion, ensuring cambium layers align for proper nutrient flow. Cleft grafting allows for successful grafting of larger scions that may not be compatible with other techniques.

5. Rootstock Selection Criteria

5.1. **Soil Adaptability-**Choosing a rootstock that is well-adapted to the soil conditions of the planting site is essential for fruit production success. Different rootstocks have varying tolerances to soil pH, texture, and drainage. Matching the rootstock's preferences to the soil conditions helps ensure optimal nutrient uptake and overall tree health.

5.2. **Environmental Resilience-** Consideration of the local climate is crucial when selecting rootstocks. Some rootstocks may excel in cold climates, while others may be better suited for hot and arid regions. Understanding the environmental demands and challenges of the planting site is crucial in making the right rootstock choice.

5.3**. Disease Resistance-** Rootstocks should be chosen for their resistance to prevalent diseases in the area. For example, soil-borne diseases like Phytophthora and nematodes can significantly impact fruit tree health. Selecting rootstocks with resistance to these pathogens can reduce the need for chemical interventions and contribute to sustainable fruit production.

5.4. **Size Control-**Rootstocks can influence the ultimate size of the fruit tree. Dwarfing rootstocks are often used to control tree height, making fruit harvesting and maintenance more manageable. Semi-dwarf rootstocks offer a balance between tree size and yield, while standard rootstocks result in larger trees with higher yields.

6. Advancements in Rootstock Research

Over the years, advancements in horticultural research and biotechnology have led to the development of improved rootstocks. Scientists are continually working to identify and breed rootstocks with enhanced traits such as disease resistance, drought tolerance, and improved nutrient uptake. Genetic engineering techniques may further accelerate the development of rootstocks with desirable characteristics.

Conclusion

In conclusion, the role of rootstocks in fruit production is of paramount importance. The proper selection of rootstocks and appropriate grafting techniques can significantly enhance crop yield, improve disease resistance, and ensure the longevity and resilience of fruit trees. As the global

population continues to grow, the importance of optimizing fruit production through rootstock research and selection cannot be understated. By recognizing the significance of rootstocks and promoting sustainable practices, we can build a fruitful future for generations to come.

ISSN : 2583-0910
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Article ID : 04/IV/25/0424

COMPUTATIONAL SOFTWARE FOR DATA ANALYSIS IN RESEARCH

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Abstract

Software automates many analytical tasks, reducing the risk of human error and saving time. The software provides powerful visualization tools that make identifying patterns and trends in data easier. The software can be customized to meet specific analytical needs and handle large and complex datasets. The software enables collaboration by allowing multiple users to access and analyze data simultaneously. Some software may not provide transparency into the underlying analytical algorithms, making it difficult to understand how results are calculated. Data visualization tools can simplify complex data but may also oversimplify and remove important details. Users may rely too heavily on software to generate insights without critically evaluating the results or understanding the statistical assumptions behind them. Software can isolate data from its real-world context, leading to overgeneralizations or incorrect interpretations.

Keywords : Statistical Software, Data Analysis, Visualization tools.

Introduction

The progress of research studies in the twenty-first century has surely benefited much from the introduction of statistical software. Humans, researchers, and organizations have placed a high value on ICT, making it a major national priority (Eshasrenan, 2006: Akindutire, 2013). For study analysis, data validation, and discoveries, statistical software (SS) is an essential instrument.

Various types of data analysis techniques have been used throughout history. Paper and pen were used at first, but punching machines were created with the development of computers. These were then updated to simple calculators and sophisticated scientific calculators. However, experts have disclosed that statistical software facilitates the computation and display of statistical data very simply (McDaniel, 2010). If researchers enter all of their data accurately, statistical software helps them avoid common mathematical errors and generate reliable figures for their research.

With statistical software, a large number of experts, scientists, researchers, and business managers are also able to provide future predictions clearly and reliably. Depending on the demands of the user, a variety of proprietary and freeware statistical software programs are available that are appropriate for various statistical analyses: Appropriate software includes programs like SPSS, SAS, MINITAB, STAT, R&MATLAB, MS-EXCELL, PSPP, EPI INFO and ADMB.

SPSS

The most popular usage of SPSS (Statistical Package for the Social Sciences, currently known as Statistical Products and Solution Services) is in social science courses and disciplines. The earliest software application is called SPSS; it was created and released in the 1960s and has since seen

numerous revisions. The most recent version is SPSS 29.0, which was released in May 2023. This program is used by many sociologists, psychologists, and social workers to enter study data and generate findings. Despite the fact that social science employs SPSS more frequently than other professions, many find it simple to use because of how user-friendly the program is, especially for novices. With the use of SPSS, a user can describe data, test hypotheses, and find a relationship or correlation between one or more variables. For the majority of regression analyses and various ANOVA types (regression, logistic regression, survival analysis, analysis of variance, factor analysis, and multivariate analysis), SPSS is a great tool. SPSS is taught to a large number of undergraduate and graduate students in research analysis classes in the social sciences, including psychology, sociology, and demography.

SAS

A lot of "power users" use SAS (Statistical Analysis System) because of its programmability and capability. Its most recent version, SAS9.4, was released in December 2021. A package that can be challenging to learn is SAS. Writing SAS programs to work with your data and do data analysis is a prerequisite for using SAS. Identifying the fault and determining how to fix it while running an SAS program can be challenging. Although many other programs, such as SPSS or STATA, have simpler command lines, learning and understanding data management in SAS might take a while. However, SAS can handle several data files at once. With up to 32,768 variables, SAS can manage massive data volumes.

The majority of general statistical studies, including factor analysis, survival analysis, regression, logistic regression, and analysis of variance, are carried out by SAS. ATS Ucla Edu (2014) states that SAS is likely weakest in ordinal and multinomial logistic regression (because these commands are particularly difficult) and robust methods (it is difficult to perform robust regression or other kinds of robust methods). SAS is probably strongest in ANOVA, mixed model, and multivariate analyses. Although some resources are available for survey data analysis, they pale compared to Stata.

MINITAB

MINITAB is statistical software researchers, scientists, educators, students, and business associates can utilise in many different contexts. Developed circa 1990, MINITAB is still among the most antiquated statistical software applications on the market. MINITAB is compatible with all major systems, including Linux, Macintosh, and PC**.**

MINITAB's user-friendly interface is still well-liked for novice statistical software users. MINITAB continues to be a well-liked option for instructing pupils in statistics and data analysis because it features drop-down options and dialogue boxes that outline how and what to perform next. The majority of MINITAB's users are educators who use the application to demonstrate to students how to conduct research and analyze data in graduate- and college-level courses. Although MINITAB has limitations with the general linear model (GLM) and multilevel regression, it can perform the majority of common statistical analyses, including factor analysis, survival analysis, logistic regression, and analysis of variance.

STATA

STATA is a robust statistical software that includes sophisticated data-management tools, a large selection of modern statistical methods, and a first-rate system for creating graphics suitable for publishing. Stata's latest version, a fast and easy-to-use data management package, was produced on March 15, 2023.

Computers running Mac OS X, Windows, or Unix can use Stata. Stata/IC, often known as Intercooled Stata, is the standard version that supports up to 2,047 variables. In addition to supporting longer string variables and larger matrices, Stata/SE is a special edition that can handle up to 32,766 variables. Stata/MP, on the other hand, Stata/MP is a version designed for multicore/multiprocessor systems with similar constraints but operates noticeably quicker. The majority of general statistical analyses, including factor analysis, survival analysis, analysis of variance, regression, logistic regression, multivariate analysis, and time series analysis, are carried out by STATA.

R & MATLAB

R & MATLAB: Stanford (2014) determined that R and MATLAB are by far the most feature-rich statistical systems. They have a remarkable collection of libraries that keeps becoming bigger every day. You can create a highly wanted specialized model yourself even if it is not included in the standard capability because R and Matlab are actually extremely easy programming languages. They let you express any notion because they are "languages". Whether you are a good writer or not is the question. R libraries are comparatively more extensive than Matlab libraries when it comes to contemporary applied statistics tools. R is a free program as well. However, Matlab boasts far superior graphics that you will be happy to include in a paper or presentation. The majority of general statistical analyses, including factor analysis, survival analysis, analysis of variance, regression, logistic regression, and multivariate analysis, are carried out by MATLAB and R. The most advantageous aspects of both are presumably their ANOVA, mixed model analysis, and analytical flexibility for users.

MS-EXCEL

One of the most widely used software programs globally is Microsoft Excel 2010, which is a component of the Microsoft Office 2010 productivity package. Excel may be used to evaluate data from a variety of sources, including billing, budgeting, accounts, and many more. You can experiment with Excel's menu bar and its various functionalities. You can practice basic math operations, row and column addition and deletion, and worksheet preparation for printing by working on sample spreadsheets. In a chart, table, or other template, you can visually analyze your data to display trends, patterns, and comparisons between the data. Excel is good at performing most general statistical analyses, but it is not very good at factor analysis, survival analysis, logistic regression, regression, or analysis of variance.

PSPP

PSPP - This software offers basic functions, such as factor analysis, cluster analysis, principal components analysis, chi-square analysis, and more. It also offers cross-tabs comparison of means (t-test and one-way ANOVA), logistic regression, linear regression, and reliability (Cronbach's Alpha, not failure or Weibull).

Numerous statistical graphs can be generated, including histograms, pie charts, Scree plots, and np-charts. PostgreSQL databases, ASCII files, Gnumeric and Open Document spreadsheets, and comma-separated values can all be imported into PSPP. It can export files to ASCII files and into the SPSS "portable" and "system" file formats. At the close of the 1990s, the PSPP project—originally named "Fiasco"—was launched as a free software alternative to SPSS, a data management and analysis program made at the time by SPSS Inc. The author was inspired to build an alternative because of the exclusive licensing of SPSS and the existence of digital rights

management. This alternative subsequently became functionally equivalent but was distributed with permission for anyone to copy, change, and share. The most recent edition was made available on December 13, 2022.

EPI-INFO

Epi Info is public-domain statistical software for epidemiology developed by the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia (USA). With over 20 years of experience, Epi Info is presently accessible on Microsoft Windows. Data entry, analysis, and survey generation may all be done electronically with this application. T-tests, ANOVA, nonparametric statistics, cross-tabulations and stratification with estimates of odds ratios, risk ratios, and risk differences, logistic regression (conditional and unconditional), survival analysis (Kaplan Meier and Cox proportional hazard), and analysis of complex survey data are among the analytical procedures found in the analysis module. The program is free and in the public domain.

ADMB (Automatic Differentiation Model Builder)

ADMB is an open-source software platform designed for building and fitting statistical models using nonlinear parameter estimation techniques. It employs automatic differentiation (AD) to efficiently calculate derivatives and optimize complex models.

ADMB has been used in various scientific domains, including Ecology Population modelling, ecosystem dynamics, and conservation planning. Fisheries Science Fish stock assessment, harvest management, and population dynamics. Epidemiology Disease transmission modelling, outbreak analysis, and vaccine evaluation. Biostatistics Clinical trials, longitudinal and survival analysis, and complex data analysis.

Advantages of ADMB Efficiency and Accuracy- AD eliminates errors and inconsistencies in manual differentiation, leading to more accurate and efficient model estimation. Flexibility - Supports a wide range of model structures and estimation methods, allowing users to customize models to specific research questions. User-Friendly Interface- The intuitive syntax makes model specification and fitting accessible to researchers with various backgrounds. Open-Source- Freely available, allowing for customization, collaboration, and transparent model development.

Conclusion

Computer software development for data analysis has revolutionized how we understand and utilize data. These tools provide powerful data exploration, visualization, statistical analysis, and predictive modelling capabilities. This software empowers users of all skill levels to extract meaningful insights from data by automating complex tasks and providing intuitive interfaces. Whether in academia, business, or scientific research, the availability of these tools has enabled unprecedented advancements in various fields. Furthermore, the integration of artificial intelligence and machine learning techniques in data analysis software enhances their capabilities by automating feature engineering, model selection, and hyperparameter optimization. This reduces the time and effort required for data analysis and improves models' accuracy and predictive power. As technology continues to evolve, we can expect computer software for data analysis to become even more sophisticated and accessible. The future of data analysis lies in the development of tools that seamlessly integrate with various data sources, provide real-time analysis, and offer personalized insights based on individual user needs.

ISSN : 2583-0910
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Article ID : 04/IV/26/0424

REARING TECHNIQUE OF HOVER FLY, *Ischiodon scutellaris*, AN EFFICIENT BIOLOGICAL CONTROL AGENT OF APHID PESTS

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Abstract
Syrphid flies or hoverflies are the prominent dual role players in most of the cropping ecosystems. They control one of the important plant virus-carrying vectors, *i.e.,* aphids as well as act as effective pollinators of crop plants. Thus, it crowns a tag "one stone-two birds" for its dual ecological role in agroecosystems. The laboratory rearing of the yellow-shouldered syrphid fly, *Ischiodon scutellaris* is quite different and completely relies on the availability of its natural host because of the non-availability of an artificial diet for its oviposition, growth and development.

Introduction
Yellow-shouldered hover fly, *Ischiodon scutellaris* belongs to the family Syrphidae, and the adult flies are versatile pollinators in several crops like Coriander, Fennel, Onion, Mustard, and Carrot. The larvae of *I. scutellaris* is an efficient predator of several species of aphids *i.e.,* Cowpea aphid (*Aphis craccivora)*, Wild lettuce aphid (*Hyperomyzus carduellinus), Cabbage aphid, (Brevicoryne brassicae)*, Cotton aphid*, (Aphis gossypii)*, Green peach aphid, (*Myzus persicae), Fennel aphid, (Hyadaphis coriandri)and Maize aphid, (Rophalosipum maidis) and it is* an effective biological control agent for aphids.

Steps involved in Laboratory rearing of Yellow-shouldered hover fly
Materials needed:

- **Eggs or Larvae**: The fly eggs or larvae can be collected from the plants infested with aphid colonies in the field.
- **Containers**: Use small, well-ventilated meshed containers for rearing. Plastic or glass containers with mesh lids work well. The containers should have enough space for larvae to move around and pupate.
- **Food**: The fly larvae feed on aphids. If we are rearing them for pest control, we need a steady supply of aphids for their feeding. Culturing aphids on host plants like cowpea, maize, fennel and field beans can help to provide a continuous food source.
- **Oviposition source for *I. scutellaris***: Host plants infested with aphids serve as an oviposition substrate for the syrphid flies. Pollen pellets, honey and yeast increase the fecundity of the flies. Cowpea seedlings infested with aphid, *Aphis craccivora* are well suitable for successful oviposition and culture maintenance of adult flies of *Ischiodon scutellaris.*

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Rearing steps:

- **Collect or obtain eggs/larvae**: Collect syrphid fly eggs or larvae from the wild or suppliers. We can also collect eggs from the field-collected mated female flies.
- **Introduce larvae**: Gently introduce the syrphid fly larvae into the container. Make sure they have access to food and a suitable substrate for pupation.
- **Provide food**: Continuously provide fresh aphids for the larvae to feed and remove unconsumed aphids regularly to prevent mold and bacterial growth.
- **Pupation and emergence of adults**: As the larvae mature, they turn into pupae. After some time (7-8 days), adult flies will emerge from the puparium.
- **Release or utilization of adult flies**: Depending on your purpose, you can release the adult flies into the wild to contribute to pest control and pollination or use them for research purposes. The steps involved in laboratory rearing of syrphid fly, *I. scutellaris* are presented in Fig 1.

Conclusion

Hoverflies or syrphid flies an economically important insects, with their better ecological potential by pollinating the crops as well as feeding the phytophagous aphids in the field. Laboratory rearing of *I. scutellaris* is successfully exploited and implemented. Preparation of artificial diets, year-round storage, supply and successful field utilization of hoverflies are being carried out in our institute.

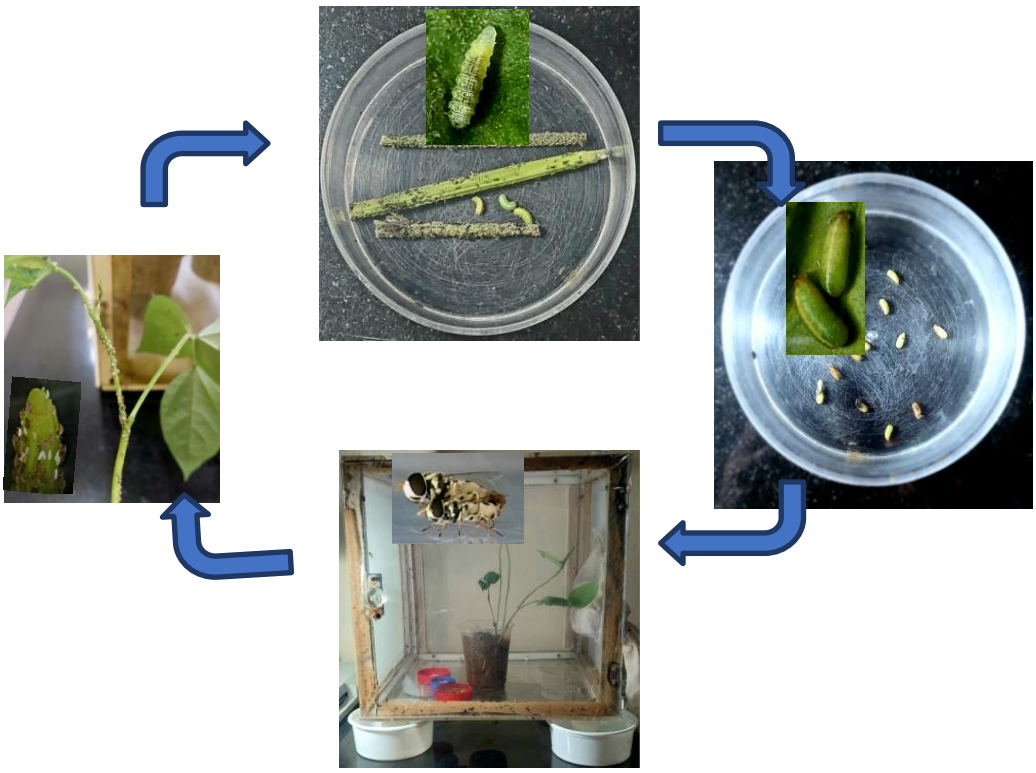

Fig 1: Steps involved in laboratory rearing of Yellow-shouldered syrphid fly

ISSN : 2583-0910
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Peer reviewed
monthly newsletter

Article ID : 04/IV/27/0424

THE IMPACT OF SMARTPHONE APPLICATIONS ON THE FISHERIES SECTOR: A CLOSER LOOK

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Abstract

The primary and most important reason why mobile phones applications are targeted is because of their portability and user-friendly interface, which can be downloaded from the Play store. With billions of users worldwide, mobile applications have completely changed the way people use technology and are now a necessary part of daily life that deals with education, transportation, retailing and finance. Currently several apps have been developed for fisheries sector that benefits fishermen to be prepared to create a more enjoyable fishing experience; conversely, early detection of fish health, improving significant financial gain by trading and most importantly connecting consumer and producer via mobile apps. These applications provide a plethora of advantages that improve people's convenience, effectiveness, connectedness, and general quality of life in a variety of ways. Some of the smartphone apps that had been developed in India for fisheries in the Play Store aremKRISHI® Fisheries, Thoondil, Fish box by MPEDA, FISHCOPFED, FFMA, Fish Disease Advisory, Fish tube, Aquaconnect, mJhinga for aquaculture, Fish Farms India, Fish for Life, Fishzilla.

Keywords : Mobile apps, Fish trading, Virtual market, Digital records, Real-Time updates

Introduction

In this modern age, everyone needs a mobile phone to get by in their daily lives. In a number of industries, using mobile applications has become indispensable. The original purpose of smartphone apps was to help with productivity in areas like email, calendaring, and phone databases. However, the demand for apps from the general public led to a rapid expansion into other areas, including mobile games, work automation, GPS and location-based services, order tracking, and ticket pricing. The public's desire drives the development of a large number of apps in many industries. Apps are typically downloaded through application delivery networks operated by the mobile OS owner, such as the Google Play Store or the App Store for iOS.

This essay discusses the significance and applicability of smartphone apps for aquaculture and fisheries. One of the industries that generates the most revenue is aquaculture. India's current fishing output is 13.42 million metric tonnes (2018–19). The government has now started the Pradhan Mantri Matsya Sampada Yojana (PMMSY) programme to enhance the aquaculture and fisheries industry going forward. The government has set out Rs. 20,050 crores for this programme. Farmers and fishermen must have greater awareness in order to do this. This digital platform will assist in attaining lucrative and sustainable fisheries and aquaculture output.

mKRISHI® Fisheries:

mKRISHI® Fisheries is a mobile application created by Tata Consultancy Services (TCS) with the intention of providing fish farmers and fishermen with access to fisheries information and advisory

services. The information it offers includes market prices, weather reports, disease management guidance, best practices for aquaculture, and specifics about government initiatives and subsidies that are relevant to the fishing sector. This innovative smartphone software was created especially to meet the requirements of fish farmers, fishermen, and other industry participants. The app is a part of the wider mKRISHI® app suite, which aims to give rural communities in India access to extensive information and advisory services pertaining to the agricultural and allied sectors.

mKRISHI® Fisheries offers a wide range of information and advisory services related to fisheries management, aquaculture practices, and fish farming. Users can access valuable insights, best practices, and recommendations on various topics, including pond preparation, stocking, feeding, water quality management, disease prevention, and harvesting techniques. mKRISHI® Fisheries enables users to access current market prices for different fish species in various regions. This information helps fishermen and fish farmers make informed decisions about selling their produce, identifying profitable markets, and negotiating fair prices with buyers.

Fishbox by MPEDA:

The smartphone application Fishbox created the Marine Products Export Development Authority (MPEDA), an independent organisation within the Ministry of Commerce and Industry of the Government of India. By giving stakeholders access to trustworthy data regarding the origin, calibre, and certification status of seafood items, the app seeks to improve traceability and transparency in the seafood supply chain. Users of Fishbox can follow the path of seafood items from the location of harvest or catch to their ultimate destination. Consumers, retailers, and exporters can obtain comprehensive details regarding the product's origin, species, fishing vessel or farm, processing facilities, and shipping routes by scanning QR codes or entering batch numbers found on product labels or packaging.

Thoondil

The National Centre for Coastal Research and the Tamil Nadu Department of Fisheries collaborated to develop the THOONDIL app, which offers real-time information such as possible fishing zones and weather forecasts. It is an effective assistance tool that can help save many fishermen's lives. An Android app was released to support the fishing community. This application covers fishing communities on the West Coast, from Neerody to Pulicat on the Coromandel Coast. It has many essential features, such as a compass, weather, PFZ, daily travels, my team, my boats, live view, previous excursions, rescue setup, incident reporting, and SOS. The owner of the boat can use this app's live read feature to see the boat's current location from the land. This software will be more helpful in locating the boat and rescuing the fishermen in the event of a storm or hurricane.

FISHCOPFED

The National Federation of Fishers Cooperatives Ltd. (FISHCOPFED), an apex cooperative federation that represents fisher cooperative organisations throughout India, is the developer of the FISHCOPFED mobile app. The goal of the software is to help fishermen's cooperatives run more efficiently while offering their members a range of services and resources. Members of fisher cooperatives can receive pertinent news, announcements, and updates from FISHCOPFED and other regulatory authorities in the fisheries industry through the app, which acts as an information hub for them. Through the app, members may remain up to date on market prices, government regulations, industry trends, and forthcoming events.

Fishery cooperative societies can keep digital records of their transactions, membership information, and activities with the help of this app. It helps cooperatives maintain accountability, transparency, and regulatory compliance in their operations by providing capabilities for tracking inventories, sales, purchases, financial transactions, and compliance documents. Officials and members of the fisher cooperative may communicate and work together more easily thanks to the FISHCOPFED mobile app. Members of the cooperative network can share experiences, ask peers and professionals for assistance, and exchange ideas via the discussion forums, chat groups, and messaging aspects of the app.

FFMA (Fisher Friend Mobile Application)

The app was piloted in 2013 by the Qualcomm and TCS-affiliated MS Swaminathan Research Foundation (MSSRF). INCOIS tracks everything, including wave forecasts and tsunamis. Next, MSSRF successfully uploads INCOIS-captured satellite images to this app. There are nine languages in which the material is offered. Every 24 hours, it updates information about the movement of fishing shoals and flags dangerous areas, such as sunken ship wreckages. Every six hours, it updates information about wave height and wind speed. The Fisher Friend mobile application gives fishermen access to features including GPS facilities, conventional fishing zones, potential fishing zones, and species-specific forecasts for tuna. It offers alerts for natural disasters like tsunamis and cyclones.

Additional applications include identifying danger zones in the ocean, such as submerged boats, rock substrate, dead coral reefs, and market prices for different fish species; registering the International Border Line (IBL) alert with the state; offering the SOS (Save our Soul) possibility of rescue once in the critical oceanic scenario; monitoring fishing routes; and providing career facilities and essential contact information. In addition, it offers forecast data on the ocean's status, including wind direction and speed, sea surface temperature, wave height, and more. It also offers daily news and updates on government initiatives. Approximately 10,000 families and fishermen are benefiting from this software.

Fish Disease Advisory

The Central Inland Fisheries Research Institute, also known as ICAR-CIFRI, created the educational app Fish Disease Advisory. The publication date was October 22, 2018. It was started to disseminate information about diseases that affect fish in inland open waterways, including those caused by fungi, bacteria, viruses, parasites, nutritional deficiencies, genetic abnormalities, and prawn diseases. For the disorders listed above, it also offers a disease gallery. Given that diseases have a significant impact on fish output in both capture and culture systems, it is best to use this application to learn as much as possible about diseases in real time, including their type, the pathogen that causes them, illness outbreaks, etc. The FDA is helpful in administering chemotherapy in the fight against the illness.

Fishtube:

A company in Kerala, created the creative mobile app Fishtube with the intention of modernising and enhancing the fish trade process through interaction and engagement. Fish trading is given a gamified twist by the software, which turns the customary buying and selling process into an online marketplace with entertainment and business components. With Fishtube's user-friendly and engaging platform, users can purchase and sell fish in a virtual marketplace. Users may browse through listings, check product descriptions, and make purchasing selections based on their

requirements and preferences with this app, which mimics the experience of a genuine fish market.

The software includes features for bidding and negotiating to spice up the trading process and make it more exciting and competitive. Users can compete with other buyers, bid on fish stocks, and haggle over prices with sellers to get the best offers. To keep consumers informed and involved, Fishtube offers real-time updates on fish availability, market prices, and trade activity. To increase their chances of completing lucrative transactions, users should keep an eye on pricing changes, competitive bids, and strategy adjustments. Fishtube's user-friendly interface is made to accommodate a wide range of user preferences and needs. Users may easily explore the platform and have a seamless and immersive trading experience because to the app's straightforward navigation, clear images, and seamless functionality.

Aquaconnect

A Chennai-based firm called Aquaconnect created the cutting-edge Aquaconnect mobile app with the goal of transforming aquaculture management via the application of technology and data-driven insights. The app uses machine learning (ML) and artificial intelligence (AI) algorithms to give fish farmers practical advice and insights for streamlining their aquaculture operations in real time. Aquaconnect analyses data from a variety of sources, such as historical farming data, water quality monitors, and environmental sensors, using AI and ML algorithms. Based on this data, the app provides customised recommendations and insights suited to the unique requirements and circumstances of every fish farm, assisting farmers in making well-informed choices about crop planning, disease prevention, feed management, and water quality optimisation.

Real-time monitoring of indicators related to water quality, including temperature, dissolved oxygen, pH, ammonia, and turbidity, is made possible via Aquaconnect. In order to reduce the spread of disease and minimise losses, Aquaconnect assists farmers in identifying possible health hazards and putting preventive measures like water treatment, immunisation, and biosecurity policies into place. In order to reduce the spread of disease and minimise losses, Aquaconnect assists farmers in identifying possible health hazards and putting preventive measures like water treatment, immunisation, and biosecurity policies into place.

mJhinga for aquaculture

With financing support from the National Agricultural Higher Education Project, ICAR-CIFE, the Central Institute of Fisheries Education, Mumbai, created the mJhinga mobile application to give farmers comprehensive advice on setting up new ponds. It was primarily created for the aquaculture of prawns. The pricing trends of the market are displayed. Farmers can use this bilingual, dynamic programme to identify issues on their own. It also offers the opportunity to consult the specialists. To manage and record daily inputs, costs, and water quality, there is a digital notebook. Farmers can greatly profit from this software by using it to boost inland saline aquaculture. Additionally, a helpline number for government and technical support is included in this.

Fish for Life

The Central Marine Fisheries Research Institute (CMFRI), an independent research institution within the Indian Council of Agricultural Research (ICAR), created the Fish for Life mobile application. The app is made to help communities of fishermen and fisherfolk improve their

standard of living, encourage ethical fishing methods, and guarantee the preservation of marine resources by offering useful information and services. Theapp's capability to warn fisherman about Potential Fishing Zones (PFZs) is one of its main advantages. The ocean's protected fisheries zones (PFZs) are regions where high fish population is anticipated as a result of advantageous environmental factors such water temperature, currents, and nutrient availability. The app gives users access to oceanographic data, which is essential for comprehending the marine environment and forecasting fish behaviour. Examples of this data include sea surface temperature, chlorophyll content, and ocean currents. The app offers safety advice and information to assist fishermen in reducing the dangers and hazards related to sea fishing. In order to assist anglers in making more informed and safe fishing trip plans, Fish for Life provides real-time weather forecasts and updates.

Fish Farms India

A smartphone app called Fish Farms India was created to link suppliers, hatcheries, fish farmers, and other aquaculture sector participants throughout India. Fish Farms India functions as a marketplace where customers may purchase and sell a variety of goods and services connected to aquaculture. This covers the feed, chemicals, equipment, fish seeds (fingerlings), and other inputs required for fish farming operations. Users can access a wide variety of fish species, breeds, and variants by using the app, which compiles product listings from different hatcheries and vendors. Users are empowered to make well-informed selections based on their own needs and preferences by having access to comprehensive product descriptions, specifications, and pricing data.

A thorough list of hatcheries, suppliers, and service providers for aquaculture in India may be found on Fish Farms India. Finding trustworthy and respectable providers for their needs in fish farming is made simple for users by offering the option to search for suppliers by area, product category, or company name. The app provides tutorials, articles, and educational materials on a range of topics related to aquaculture technology, trends in the business, and fish farming. Users may stay up to date on the most recent advancements in the aquaculture industry and improve their knowledge and proficiency in fish farming by utilising the insightful advice, tools, and resources available.

Fishzilla

Fishzilla is a fascinating smartphone app that was created with the novel idea of gamifying the fish trade. Fishzilla wants to make the usually boring process of buying and selling fish more interesting, participatory, and pleasurable for customers by introducing game aspects into the mix. With its vibrant visuals, energetic animations, and dynamic interactions that capture the frantic pace of a bustling marketplace, the app imitates the ambiance of a real fish market. Fishzilla's bidding dynamics, which let users compete in bidding wars to purchase fish stocks, are one of its main attractions. Fishzilla has gameplay components for bargaining, which requires users to haggle and negotiate pricing with virtual fish dealers in addition to bidding. Users must balance their demand for cheaper pricing with the seller's requirement to turn a profit by using their negotiating skills to reach mutually beneficial agreements with vendors. Users can access additional levels, milestones, and incentives within the programme by trading and earning virtual cash, often known as points. Users are encouraged to play and explore more areas of the virtual fish market as they advance in the game, which raises the app's total entertainment value.

ISSN : 2583-0910
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Article ID : 04/IV/28/0424

THE VITAL ROLE OF COLD STORAGE IN PRESERVATION TECHNIQUES

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The world's population is projected to increase to over 10 billion by the year 2050, which will require a 70% increase in food production (Tilman et al., 2001). Food, including fish, is in high demand due to the growing global population; in Asian countries, fish is a significant part of human nutrition, providing 30-40% of the required daily intake of animal protein (FAO, 2022). Preservation techniques have been vital throughout human history, enabling societies to store perishable goods for extended periods. Among these techniques, cold storage stands out as one of the most effective and widely used methods. From ancient ice houses to modern refrigeration units, the concept remains the same: maintaining low temperatures to inhibit microbial growth and slow down chemical reactions that lead to spoilage. In this article, we delve into the significance of cold storage in preserving various perishable items.

Preservation in the Modern Era:

In today's world, where food travels vast distances and demand for fresh produce remains high year-round, cold storage has become indispensable. It plays a crucial role in preserving not only food but also pharmaceuticals, vaccines, and other temperature-sensitive products. Cold storage facilities, ranging from small refrigerators to massive warehouse-sized units, are equipped with precise temperature control systems to maintain optimal conditions for different goods. Temperatures either above or below the optimal range can accelerate deterioration as a result of freezing or chilling injury (Kader et al., 2022).

Preventing Microbial Growth:

One of the primary mechanisms by which cold storage preserves perishable items is by inhibiting microbial growth. Cold storages are crucial to minimizing postharvest losses of fresh fruits and vegetables (Kader, 2003). Bacteria, molds, and yeast, which cause food spoilage and pose health risks, require specific temperature ranges to thrive. Cold temperatures slow down their metabolic processes, reducing their growth rate and extending the shelf life of stored items. For example, fish, dairy products, and fresh produce can be stored for weeks or even months in cold storage, significantly reducing the risk of contamination and spoilage.

Maintaining Product Quality:

A cold chain for perishable foods can be defined as the uninterrupted handling of the product within a low-temperature surrounding during the postharvest steps of the value chain (Kitinoja, 2013). Cold storage not only prevents spoilage but also helps maintain the quality and freshness of perishable items. The need for adopting and strengthening measures for the precooling and cold storage of fruits and vegetables to improve their value chains (Makule et al. 2022). Many fruits and vegetables, for instance, continue to respire even after harvesting, leading to loss of moisture and nutrients. By storing them in cold environments, the rate of respiration decreases, preserving their texture, flavor, and nutritional content for longer periods. Similarly, fish and seafood can be stored in cold temperatures to maintain their firmness and prevent deterioration.

Extending Seasonal Availability:

Cold storage enables consumers to enjoy seasonal foods year-round by preserving surplus produce during peak harvest times. Fruits and vegetables can be harvested at their peak freshness and stored in cold storage facilities for later distribution. This not only reduces food waste but also ensures a steady supply of fresh produce even during off-seasons or in regions where certain items cannot be grown year-round.

Ensuring Medication Efficacy:

Cold storage is not limited to preserving food; it also plays a crucial role in preserving the efficacy of medications and vaccines. Many pharmaceuticals and vaccines are sensitive to temperature fluctuations and can degrade rapidly if not stored properly. Cold storage facilities, such as refrigerators and freezers, maintain consistent temperatures to ensure the potency and effectiveness of these products, safeguarding public health.

Conclusion

In conclusion, cold storage is an indispensable tool in preservation techniques, playing a vital role in preserving perishable items, maintaining product quality, extending seasonal availability, and ensuring the efficacy of medications and vaccines. As technology advances, cold storage solutions continue to evolve, offering more efficient and sustainable ways to store temperature-sensitive goods. In an era where global supply chains are increasingly complex, the importance of cold storage in preserving the safety, quality, and availability of essential goods cannot be overstated.

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