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COVER STORY

Decoding the Factors Affecting Tomato Prices in India and Measures to Stabilize Fluctuating Prices

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From the Editors Desk

I am thrilled and proud to announce the release of the fourth issue of AgriTech Today Magazine. This month has been marked by significant fluctuations in the agricultural market. On one hand, agricultural products are fetching astonishing prices in the retail market, but on the other hand, farmers are grappling with losses caused by droughts in the southern region and extreme rains in the northern region of the country.

Notably, tomato prices have reached a record high for the year and ginger and chilli are also in fierce competition to attain peak prices. In this issue, we shed light on the various factors that have contributed to these market fluctuations, alongside exploring intriguing technologies and sharing inspiring success stories. It gives me great pleasure to inform you that we have curated and finalized 36 articles for publication in this issue.

My sincerest hope is that this issue will provide readers with valuable insights into agricultural technologies and innovations. I extend my heartfelt gratitude to the dedicated editorial team and the talented authors for their invaluable contributions in bringing this issue to fruition. Your efforts have played a pivotal role in making AgriTech Today Magazine a source of enlightenment and knowledge in the agricultural domain.

Editor-in-chief

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Cover Story

The recent surge in tomato prices has gripped India, causing concern among consumers and policymakers alike. Tomatoes, a staple in the Indian diet and a vital ingredient in numerous dishes, have witnessed a sharp increase in retail prices across major cities, impacting household budgets and food choices. While tomatoes serve as an early indicator, the rise in their prices has been accompanied by an upward trajectory in the cost of other vegetables, causing distress among the masses. Retail prices for tomatoes have witnessed a steep escalation, reaching up to ₹155 per kg in major cities across the country. In metropolitan areas, tomato prices ranged from ₹58 to ₹148 per kg, with Kolkata observing the highest price at ₹148 per kg and Mumbai recording the lowest at ₹58 per kg. Delhi and Chennai reported prices at ₹110 per kg and ₹117 per kg, respectively. The consumer affairs ministry's data indicates that the average retail price nationwide stood at ₹83.29 per kg, with a modal price of ₹100 per kg. The highest recorded price of ₹155 per kg was observed in Siliguri, West Bengal. In the national capital, local vendors are currently selling tomatoes within the price range of ₹120 to ₹140 per kg, depending on the quality and locality.

Major Contributing Factors for Price Surge

The monsoon effect and supply-demand imbalance

The initial red flag indicating a rise in vegetable prices, including tomatoes, emerged due to the erratic monsoon season. The disruption of transportation caused by the monsoon adversely affected the movement of vegetables across the country. Additionally, the failure of timely rainfall in certain regions further impacted production, resulting in a decline in vegetable arrivals in the market. The subsequent supply-demand imbalance has contributed to the surge in tomato prices. While the monsoon and logistical challenges are primary factors, there are other independent factors exacerbating the situation and driving prices higher.

Seasonality of production

The fluctuation in tomato prices primarily stems from the seasonality of production and irregular shocks. Seasonality exerts upward pressure on tomato prices from July to November, with July experiencing the highest impact. Around 70% of tomato production in India occurs during the Rabi

season, while Kharif production, spanning from July to November, contributes only about 30% of the total production. This seasonal variation in production creates price pressure during the July to November period.

Infrastructure and logistical support

India is the second-largest producer of vegetables and fruits globally, boasting diverse agro-climatic conditions conducive to crop cultivation. This diversity ensures a steady supply of produce, even if one region faces crop failure. However, the lack of sufficient infrastructure and logistical support for storage and transportation poses significant challenges to efficient distribution. Cold-storage facilities, especially crucial for perishable vegetables like tomatoes, play a vital role in preventing wastage and stabilizing prices. Unfortunately, inadequate storage infrastructure leads to substantial annual wastage of vegetables and fruits, with distressing images of farmers discarding tomatoes being commonplace. Strengthening infrastructure, particularly cold-storage facilities, is crucial to address price fluctuations and reduce wastage.

Climate extremes and agricultural vulnerability

Tomatoes, being highly sensitive to climate extremes, are particularly vulnerable to adverse weather conditions. Heatwaves, unseasonal rains, and heavy downpours have significantly impacted tomato production in various regions of India. The states of Karnataka and Andhra Pradesh, as the top producers of tomatoes, have experienced the adverse effects of these weather fluctuations. The combined impact of heatwaves, unseasonal rains, and heavy downpours has disrupted crop growth and harvesting, further exacerbating price surges. Ensuring the resilience of agricultural production, especially fruits and vegetables, in the face of weather vagaries, particularly monsoon rains, is crucial for achieving price stability.

Irregular shocks

In addition to seasonality, irregular shocks play a significant role in price fluctuations. Unseasonal rains, delayed harvesting, and crop damage due to various factors have been the main drivers of tomato price volatility. In November 2017, unseasonal rains in growing regions such as Karnataka and Madhya Pradesh, along with delayed harvesting in Maharashtra and fungus-damaged crops in Karnataka, triggered the initial uptick in prices. Supply disruptions caused by incessant rains and flood-like situations in key supplier states like Karnataka, Maharashtra, and Himachal Pradesh in May 2020 further aggravated the price surge.

Measures to stabilize tomato prices

Infrastructure Development

Governments should prioritize the development of storage and transportation infrastructure, particularly cold-storage facilities, to reduce wastage and ensure the availability of tomatoes throughout the year. Investing in modern storage, better road networks and transportation facilities, systems will improve the efficiency of distribution, reduce post-harvest losses, and stabilize prices.

Climate Resilience Measures

Agricultural practices need to be adapted to cope with climate extremes. Promoting the use of climate-resilient farming techniques, such as protected cultivation, drip irrigation, and mulching, can help mitigate the impact of heatwaves, unseasonal rains, and heavy downpours on tomato production. Providing farmers with access to

weather information and training on climate-smart practices will enhance their ability to adapt to changing weather patterns and minimize crop losses.

Crop Diversification

Encouraging farmers to diversify their crops can help reduce the impact of seasonality on tomato prices. By promoting the cultivation of alternative crops with different planting and harvesting seasons, the supply of tomatoes can be more evenly distributed throughout the year. This will alleviate the pressure on prices during the peak production months and ensure a more stable market.

Risk Management and Price Stabilization

Governments can implement risk management measures to stabilize tomato prices. This can include creating buffer stocks during periods of high production to regulate supply, implementing price controls to protect both farmers and consumers from extreme price fluctuations, and facilitating direct procurement from farmers to eliminate middlemen and ensure fair prices. By implementing these solutions, India can address the challenges posed by infrastructure limitations, climate extremes, seasonality, and irregular shocks in tomato production. A comprehensive approach involving government interventions, farmer support, and collaboration among stakeholders will be essential for achieving price stability and ensuring a sustainable tomato industry.

Optimizing Tomato Quality, Shelf-life and Preservation Techniques

During the harvest season, fresh produce is abundant, but its short postharvest life limits its edibility unless proper storage and preservation methods are employed. For centuries, storage and processing technologies have been utilized to transform perishable fruits and vegetables, such as tomatoes, into safe, delicious, and stable products. Storage is essential to ensure a continuous supply of raw materials for processors, extend the processing season, and maintain product availability throughout different seasons.

Storing tomatoes at ambient temperatures for an extended period is challenging due to their rapid ripening, rendering them unmarketable within a short timeframe. Therefore, storage practices are typically required to maintain an uninterrupted supply of raw materials. These practices also extend the processing season and ensure continuity of product supply.

Refrigeration storage has been commonly used by tomato handlers to prolong the shelf life of tomatoes. However, tomatoes are susceptible to chilling injury if stored below their critical temperature of 10°C. Chilling injury occurs when tomatoes experience temperatures of 10°C or below for more than 14 days, or temperatures of 5°C for more than 6 to 8 days.

Evaporative cooling is a technique used to extend the storage life of tomatoes by creating low temperatures and high humidity, which are necessary for preservation. The process involves reducing heat through a change in air pressure caused by volume expansion. By employing an evaporative cooling system, the desired optimum temperature of approximately 10–15°C and 85-95% relative humidity can be achieved, providing a cost-effective solution.

Ethylene, a natural plant hormone, plays a crucial role in the ripening process of climacteric fruits like tomatoes. It triggers various physiological changes associated with ripening. However, excessive ethylene accumulation can have negative

effects. To counteract this, ethylene inhibitors are used to prevent the detrimental impact of ethylene on fruits and vegetables. Potassium permanganate ethylene is one such inhibitor reported to effectively remove exogenous ethylene from the atmosphere. This ethylene removal process absorbs and oxidizes ethylene into carbon dioxide and water, subsequently increasing the concentration of carbon dioxide and blocking the synthesis of endogenous ethylene. Controlling ethylene synthesis is vital for regulating ripening and other plant developmental processes.

Modified Atmosphere Packaging (MAP) is a packaging technique that involves using specialized materials to package products in a predetermined composition of gases, primarily oxygen (O2) and carbon dioxide (CO2). MAP allows for the diffusion of gases until a stable equilibrium is reached between the external and internal gases within the package.

Preservation of Tomato

It refers to the process of drying, freezing, or treating foods with substances to prevent the growth of microorganisms and delay decomposition, thereby prolonging the shelf life of the produce.

Drying: It is an ancient method of preserving tomatoes. It involves removing moisture from the fruit until decay is unlikely. This can be achieved using an oven, dehydrator, or the sun's warmth. Once dried, the produce should be stored in dry, airtight containers.

Chemical preservatives: It can prevent the growth of microorganisms and aid in preserving tomatoes. Various types of chemical preservatives, such as sodium benzoate, sodium metabisulphite, sulphur dioxide, sodium chloride (common salt), and citric acid, are commonly used in food processing. For example, sulphur dioxide is effective against molds or bacteria and also slows down browning or darkening of certain products.

Boiling: It is an effective preservation method as heat can kill the majority of harmful pathogens. Heating food to temperatures near the boiling point of water is comparable to freezing in terms of food preservation, but it is more effective. Many other forms of food preservation, especially those involving packaging, often involve a preliminary step of heating the food to sufficiently high temperatures to destroy pathogens.

Pasteurization: It is also known as post-heat treatment, can be used to pasteurize tomato paste in bottles using hot water. It is crucial to maintain the same temperature for both the product and water to prevent the bottles from bursting. Filled bottles with closed lids are placed in a larger pan of boiling water and heated for at least 45 minutes before being cooled.

Freezing: It is another preservation method for tomatoes, where they can be frozen whole, sliced, chopped, or as puree. Tomatoes can be frozen raw or cooked. Firm, ripe tomatoes are selected for freezing and do not require blanching. Freezing at reduced temperatures inhibits the growth of pathogens responsible for food decay.

Curing: A practice recognized for centuries, involves adding salt or sugar to foods as a preservative. Salt acts as a dehydrating agent by binding with water molecules, while sugar has a similar preservative effect. Curing, along with the use of other natural materials, helps prevent spoilage of food. Salt or sugar solutions in appropriate concentrations effectively preserve various products, providing a pleasant flavor as a desirable side effect.

Value Addition of Tomatoes

Tomato juice production involves washing and trimming fully ripe tomatoes, which are then steamed, crushed, and heated until softened. The heated tomatoes are passed through a pulping machine to separate the juice from seeds and skin. Sugar and salt are added, and the juice is filled into bottles, sealed, pasteurized in boiling water for around 30 minutes, and cooled.

Tomato pastes production entails concentrating tomato pulp or juice to a desired soluble solids concentration of 14-15%. This concentration is achieved through open pans and vacuum pans. The paste is then packed in pre-sterilized bottles while still hot. Large-scale processing units may employ vacuum evaporators and utilize tin cans or bulk aseptic packages. Different types of tomato paste, such as Hot Break (HB) and Cold Break (CB), are used for various end products.

Tomato puree production involves vacuum concentration of pulp to approximately 9-12% total solids, resulting in a tomato puree. The scalded product is mashed to a puree by passing it through a sieve to remove skins, seeds, and fibrous substances. The liquid in the pulp is evaporated by heating until the desired consistency is achieved. The puree is then filled into bottles, crown-corked, processed in boiling water for 30 minutes, and cooled.

Tomato powder production involves dehydration, which removes moisture from tomatoes to inhibit the growth of mold and bacteria. Ripe tomatoes are sorted, cleaned, sliced, blanched, and dried using an oven, dehydrator, or sunlight. The dried tomatoes are then cooled, milled, and appropriately packaged to create tomato powder.

Conclusion

The recent surge in tomato prices in India is driven by irregular shocks, seasonal production, infrastructure challenges, climate extremes, and supply-demand imbalances. To stabilize prices and ensure a sustainable tomato industry, investments in storage and transportation infrastructure, promotion of climate resilience strategies, crop diversification, and risk management measures are essential. Government interventions, farmer support, and collaboration among stakeholders are necessary to overcome these challenges and achieve price stability. By addressing these factors, India can create a resilient tomato market that benefits both farmers and consumers. Furthermore, Proper postharvest handling practices and treatments are crucial for extending the limited shelf life of highly perishable tomatoes. Failure to adhere to these practices leads to significant losses, especially in developing countries. Employing appropriate storage, processing, and preservation methods like refrigeration, modified atmosphere packaging, drying, chemical preservation, boiling, pasteurization, and freezing helps maintain tomato quality and significantly extends their shelf life. This addresses the challenge of postharvest losses faced by tomato handlers, particularly in developing countries, and ensures the availability of high-quality tomatoes for a longer duration.

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Shredder for Agricultural Waste Management

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Shredder is a machine, a system that is used to reduce the size of the material. Volume reduction of bulky materials and items is all done using the shredder machine. The shredded waste can be spread on the field as organic manure to increase the moisture content, and fertility of the soil, simultaneously reducing the usage of chemical fertilizers. This machine is also suitable for preparing vermicompost. A shredder machine is a hydraulic system that propels the material to be processed onto a rotating rotor equipped with blades. The size of the fraction depends on the screen (sieve) installed under the cutting unit. The waste shredder machine aims to reduce the agro waste and convert it into useful nourishing fertilizer. Recent studies on coconut sheath/shells reveals that it can also be

Fig. 1: Coconut sheaths/shells before shredding by Shredder

used in the preparation of vermicompost. To make use of sheaths/shells in vermi composting by cutting into small pieces is a laborious, cost and time-consuming operation. Commercially available sheath shredders have promising results to cut coconut sheath/shells in to small pieces involving less labour, cost and time. Keeping all this in view, performance evaluation of shredder for shredding coconut nut shells and sheaths are carried out in the region to create awareness among the farmers.

Treatment details:

T1: Shredding by manual method

T2: Shredding by frond shredder

Fig. 2: Coconut sheaths/shells after shredding by Shredder

Results and Discussion

The performance of the shredder at research station, V.C. Farm, Mandya and farmers fields are as given below:

Table 1: Performance of coconut sheath shredder at research farm and farmers field

Sl No	Parameters	Details
1	Moisture content, % db	10-14%

2	Labour requirement, men hour/100 kg sheath	2
3	No. of knives	4
4	Size of the chaff, mm	10-15
5	Output of the machine, kg/h	250-260
6	Cost of the operation, Rs/h	231
7	Fuel consumption, l/h	0.95

Inference

Performance evaluation of shredder was carried out for 50 hrs at research station (5 ha) and 85 hrs at farmer's fields (10 ha) of Mandya district. Performance of coconut sheath shredder found satisfactory for dried sheaths/shells of 10-14% db moisture content. Preliminary field tests indicate average fuel consumption of 0.95 l/h with effective output capacity of 260-270 kg/h and 200-210 kg/h of coconut sheaths and coconut shells, respectively. Further, the chopped sheaths were added / mixed to vermicompost pits which enhance the yield, fertility and organic matter of the vermicompost. The cost of operation of shredding coconut sheaths/shells by shredder was found to be Rs.231 per hour.

Table 2: Comparative performance of coconut sheath shredder

Sl No	Parameters	Shredding by shredder	Shredding manually
1	Moisture content, % db	10-14%	10-14%
2	Labour equipment men hour/100 kg sheath	2	6
3	Size of the chaff, mm	10-15	250-350
4	Output of the machine, kg/h	260	50
5	Cost of the operation, Rs/h	231	188

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Perennial Indigenous Vegetable Crops- Rich but Neglected Sources of Nutrition and Health

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A variety of plants species have been gifted to the mankind by the Mother Nature for proper use and utilization that can fulfill all the dietary requirements. Ancient humans collected and ate variety of fruits and vegetables from wild. Many were domesticated for their parts being consumed as vegetables in various ways. In the last few decades, there has been an appreciable jump in the production and availability of commercially grown vegetables, however, most of them are annuals. According to recent report, a total of 1,097 vegetable species with different growth habits and uses are cultivated worldwide, but hardly 7% of these species are familiar to us (Meldrum *et al.,* 2018). Decreased biodiversity, intensive cultivation and off-season production of limited vegetable crops have led to increased biotic stresses and excessive application of chemicals for their management. The ill effects of plant protection chemical residues from commercial vegetable production are also alarming. In such a scenario, the establishment of nutritional gardens involving indigenous and perennial vegetable crops can play a vital role in ensuring nutritional security for the masses. There are a number of perennial vegetable crops indigenous to different parts of South Asian countries which remained underutilized despite their nutritional and medical richness. These crops can be raised naturally-organically, and have potential in ensuring the better human health. This article aims to provide brief overview of some potential but still under-utilized perennial vegetables and their importance.

Drumstick (Moringa *oleifera*)

Drumstick belongs to the family Moringaceae and is considered to be the native North West India and African tropics. Due to its nutritional sumptuousness, it is also called as Miracle tree. Drumstick pods and leaves very rich in essential nutrients. The leaves contain high amounts of proteins, calcium, iron, zinc, selenium and magnesium. Fresh pods and seeds are a great source of oleic acid, a healthy fatty acid which is known to promote healthy heart. It has very high levels of vitamin B, different anti-oxidants. It helps lowering cholesterol and has antifungal, antiviral, antidepressant, and anti-inflammatory properties.

Agase (*Sesbania grandiflora*)

Agase or Agethi is a perennial fast-growing tropical tree belonging to the family Leguminosae. Mainly two types exist in Agasi based on flower colour, one with white coloured flower and other with red colour flowers. The red group of leafy vegetables is considered more nutritious due to the presence of phenolic compounds but it has bitterness, therefore the white flower greens are mostly preferred as it is less bitter. The leaves, flowers and pods of *Sesbania grandiflora* are used for culinary purposes. Flowers are rich in magnesium, phosphorus, potassium, and selenium. Agathi leaves are the rich sources of vitamin A, vitamin C, folates, thiamin, niacin, calcium and phosphorus among all the green leafy vegetables. The leaves have anti-diabetic, anti- cancer, anti-bacterial properties, and help in lowering the cholesterol levels. It has a unique power of healing wounds, sprains, itches and

bruises. The root is used to cure malaria.

Rhododendron/ Burans

Rhododendron arboretum, locally known as Burans or Gurans, belongs to the family Ericaceae, and it is the state tree of Uttarakhand and state flower of Nagaland. The juices and squashes made from burans flowers are a delicacy in summer season due to its cooling effect. Sauces are prepared from the flowers along with other herbs like mint. A wine made from the flowers, known as 'Guranse', is commonly drunk in parts of the Himalayas. Burans leaves and flowers have been reported to have various medicinal properties *viz*., anti-diabetic, antioxidant, anti-inflammatory, anti-microbial, anti-allergic etc.

Lasura (*Cordia dichotoma/ Cordia myxa*)

Also known by the vernacular names like Gunda, dela, bhokar belongs to family Boraginaceae and is native of Indo-Malayan region. The unripe fruit of lasura has a sour taste. It is used in preparation of vegetable curry after splitting and removal of seeds. Fruits are also used in canning and pickling. The fruits are rich in carbohydrates, proteins and minerals like phosphorus, calcium, iron, zinc, manganese and copper. The fruits are considered useful in dry cough, chronic bronchitis, influenza and internal haemorrhage. They have diuretic, laxative, anthelmintic, anti-inflammatory, antibacterial properties, protect liver and lower the blood pressure. The leaf extract is reported to have anti-implantation activity and works as contraceptive drug. So, should be consumed wisely.

Kachnar (*Bauhinia variegata*)

It belongs to the family Leguminosae and is native to South-East Asia. The flower buds and flowers are popularly used traditionally for culinary purposes in form of vegetable curry and pickles. The open flowers are used to prepare cutlets. Different parts of Kachnar *viz*., flower buds, flowers, stem, bark, leaves and seeds have been used in various indigenous systems of medicine to cure various ailments in India. They are reported to have anti-inflammatory, anti-microbial, anti-tumour, anti-obesity and anti-diabetic activities. Bauhinia also has anti-oxidant compounds like quercetin and flavonoids.

Jack fruit and bread fruit

Jack fruit (*Artocarpus heterophyllus*) is a large tree belonging to the family Moraceae with Indo-Malayan origin. It bears large fruits with average weight of 12-18 kg. It is a composite fruit and popular mainly at ripe stage for its yellow to orange multiple bulbs inside, that are relished for characteristic aroma and taste. However, the immature unripe fruits also referred to as young jackfruit have mild flavour and used for preparation of curries. A core is present in the middle starting from stem end which is surrounded by bulbs / arils containing seeds and rags between the bulbs. The texture is meat like and is used as meat substitute in many countries like Indonesia. It is rich in carbohydrates, proteins, potassium, magnesium, Vitamin C and dietary fibre and sugars. The seeds of jackfruit are rich in soluble and insoluble fiber and prebiotics besides being rich in carbohydrates (38%) and proteins (6.6%). There is another related species of jack, called as breadfruit (*Artocarpus altitis*), native to Indonesia, where fruits are smaller than jackfruit (approx. 4 kg) and seedless, used at unripe stage for culinary purposes or may be processed in form of flour. These contain very low fats and rich in vitamin B, vitamin C and potassium.

Tamarillo / tree tomato

Tamarillo (*Solanum betaceum*) is a small tree or shrub belonging to the family Solanaceae. It is a

native of South America, however, distributed in various regions throughout the world including sub-tropical regions of India, Nepal, China, Myanmar and Philippines. It is less adapted to hot humid tropical lowlands. It is fast growing and grows up to 5 feet in height with a life span of around 12 years. The fruits are egg shaped, 4-10 cm long and 2-4 cm in diameter. The fruit colour may be yellow, orange, red or purple sometimes with dark longitudinal stripes on fruit. The fruits are used in curries, sauces and in toasts and burgers. They are rich in vitamin A, vitamin C, calcium, magnesium and iron.

Tamarillo contains chlorogenic acid that helps in reducing the level of blood sugar. Its antioxidant properties help in reducing oxidative stress in the liver and pancreas. Consumption of tamarillo fruit has also been reported good for cure of inflamed tonsils.

Perennial beans

Winged bean (*Psophocarpus tetragonolobus*) is herbaceous climber belonging to the family Leguminosae, with tuberous roots. It is also known as four angled bean due to the shape of its pods. It has perennial habit though cultivated as an annual crop. **It** grows abundantly in the hot, humid equatorial countries of South and Southeast Asia. All the parts of the plant *i.e.* tender leaves and shoots, flowers, immature pods, mature seeds, and tubers are used in the East-Asian cuisine. Due to its abundant uses and health benefits, it is also referred to as "supermarket on a stalk". Immature Winged bean pods are very rich sources of Vitamin A, B-complex, Vitamin C, iron, copper, manganese, calcium, phosphorus, and magnesium. The tender leaves are also nutritionally rich and used as fodder purpose also. The mature seeds have very high protein content comparable to soybean.

Runner bean (***Phaseolus coccineus***) or scarlet runner bean is another perennial climber of the same family with tuberous roots. Here the pods are knife shaped. All the plant parts are consumed in various forms.

Perennial cucurbits

Most of the members of the family Cucurbitaceae are annuals, few of them grown extensively globally. However, the cucurbits like Ivy gourd (*Coccinia grandis)*, pointed gourd (Trichosanthes dioica), spine gourd (Momordica dioica), and chow-chow (Sechium edule) are perennial and under-utilized crops. The first three crops are dioecious, while chow-chow is a monoecious climber. Once established, these vines continue yielding for few years with limited inter-cultural operations, though training of vines is required. The fruits of these cucurbits are used in curries and have cooling effects. These are considered good for the diabetics.

Chekurmanis

Chekurmanis (*Sauropus androgynus*) is a perennial shrub that grows wildly in South East Asia. It belongs to the family Euphorbiaceae. Leaves of chekurmanis are commonly used in Malaysia, but in India it is used only in some parts in Southern states. The leaves have very high protein as compared to any other leafy vegetables as high as 22.0g/ 100g (Platel and Srinivasan, 2017). The leaves also have high dietary fibre content and very rich in calcium, iron, zinc, ß-carotene, vitamin C and vitamin E, due to which it is also referred to as "multivitamin plant".

Basella

Also known as Indian spinach or Malabar spinach, it belongs to the family Basellaceae. It is distributed in tropical and sub-tropical regions of Asia and Africa. The slender stem may be a twining vine or semi-erect

which may grow 4-8 m long. The leaves are simple and fleshy, cordate in shape, 3-12 cm long and wide. The leaves along with stem are used in culinary purposes. There is variation with respect to colour. *Basella alba* possess green leaves and stems, while in *Basella rubra*, the veins in the leaves and stems have dark pink colouration. It is very high quantitiesof vitamin A, vitamin C, iron, manganese, calcium and copper. It has got several medicinal properties viz., hypoglycemic activity, anti-inflammatory, useful in treatment of gastrointestinal problems, ulcer and wounds.

Conclusion

There are many perennial species that are widely distributed and adapted to the climatic conditions of India and countries of South-east Asia, various parts of which are consumed as vegetables. These are highly rich in nutrients and possess medicinal properties too. Steps may be taken to establish "nutrition gardens" at village and community levels involving few plants of different perennial vegetable species. Most of these are propagated vegetatively and therefore true to type uniform plants can be obtained. Once established, these can survive with limited cultural operations and are not much susceptible to the biotic stresses. These crops have proved themselves to be climate resilient. This may prove helpful in solving hidden hunger problems even in the area where people cannot afford to buy sufficient quantities of costly vegetables. Owing to possibility of managing the perennial vegetables organically, they become more valuable in providing the health building substances for proper growth and development of populations. There is a need to revisit the traditionally grown vegetables and reintroduce them to the new generations to reap maximum benefits from nature's wealth.

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Molecular Surveillance of Recent Pandemics of Zoonoses: Advancements and Insights

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In recent years, the world has witnessed several devastating pandemics originating from zoonotic diseases, highlighting the urgent need for effective surveillance and control strategies. Zoonoses are infectious diseases that can be transmitted between animals and humans, posing significant threats to global public health and economies. The emergence and rapid spread of zoonotic pandemics, such as the COVID-19 pandemic caused by the novel coronavirus SARS-CoV-2, have underscored the importance of molecular surveillance in understanding and mitigating these crises.

Molecular surveillance refers to the systematic monitoring and analysis of the genetic material of pathogens to track their evolution, detect emerging strains, and identify potential transmission pathways. It has become an indispensable tool in understanding the dynamics of zoonotic diseases and their spread across different populations. Advancements in molecular surveillance technologies and techniques have revolutionized our ability to detect and respond to zoonotic pandemics. High-throughput sequencing technologies, such as next-generation sequencing (NGS), have enabled the rapid and cost-effective analysis of large numbers of pathogen genomes.


NGS Machine


PCR Machine

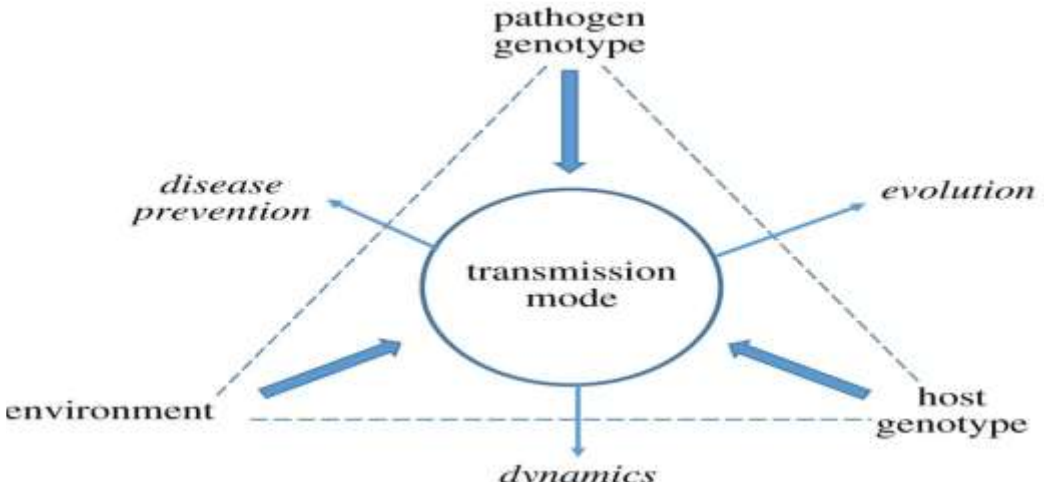

Serological Intrumentation

In this paper, we will delve into the advancements and insights gained from molecular surveillance in recent pandemics of zoonotic diseases. We will discuss the challenges and future directions in this field, including the integration of One Health approaches, data sharing mechanisms, and the development of global surveillance networks.

Molecular Surveillance Techniques

Various molecular surveillance techniques utilized in studying zoonotic pandemics. This includes next-generation sequencing (NGS) technologies, polymerase chain reaction (PCR), metagenomic sequencing, and serological assays. Every technique has their strengths and limitations

and their contributions to the field of zoonotic disease surveillance.



Transmission Dynamics

Characterization of Zoonotic Pathogens

Molecular surveillance enables the rapid and accurate characterization of zoonotic pathogens. Molecular surveillance plays a pivotal role in the characterization of zoonotic pathogens by providing insights into their genetic diversity, transmission dynamics, and potential for adaptation. By the molecular surveillance we can explores how genomic sequencing and phylogenetic analysis have helped identify the origin, evolution, and genetic diversity of zoonotic viruses, such as SARS-CoV-2, H5N1 avian influenza, and Ebola virus.

Understanding Transmission Dynamics

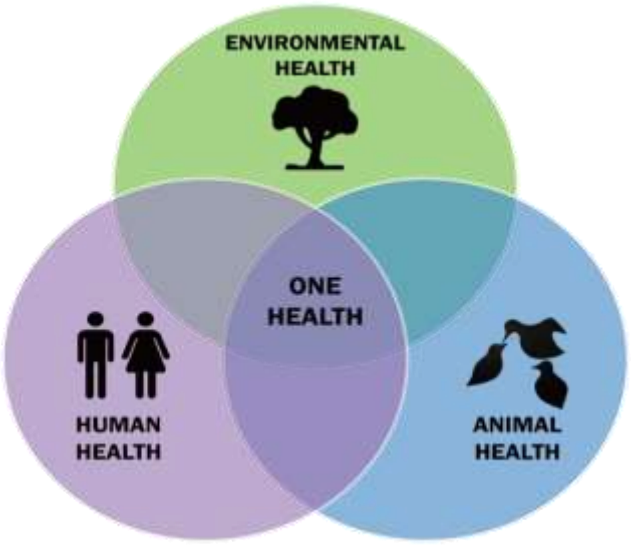
Molecular surveillance provides insights into the transmission dynamics of zoonotic diseases during pandemics. By the help of molecular surveillance, we can reveal patterns of human-to-human transmission, identify super-spreading events, and track the introduction of zoonotic pathogens into human populations.

Early Detection and Surveillance Networks

Molecular surveillance plays a great role in early detection and the establishment of global surveillance networks. It explores the importance of real-time data sharing, collaboration between researchers and public health agencies, and the utilization of genomic data for proactive surveillance and response.

One Health Approach

Molecular surveillance fosters the implementation of a One Health approach, integrating human, animal, and environmental data. It can identify zoonotic reservoirs, assess animal-to-human transmission risks, and inform preventive measures to mitigate future zoonotic pandemics. Molecular surveillance should increasingly embrace this holistic approach by integrating genomic data



from diverse sources, including humans, animals, and the environment.

Challenges and Future Directions:

While molecular surveillance has made significant contributions to our understanding of zoonotic pathogens, there are still challenges to be addressed and future directions to be explored. These include:

Data Sharing and Collaboration: One of the key challenges in molecular surveillance is the sharing of data and collaboration among researchers and public health agencies. Data sharing is essential for comprehensive analysis, timely detection of emerging pathogens, and understanding global trends. Future directions should focus on developing standardized data sharing mechanisms, fostering international collaborations, and establishing global surveillance networks to enhance data exchange and interoperability.

Bioinformatics and Data Analysis: The ever-increasing volume of genomic data generated through molecular surveillance requires sophisticated bioinformatics tools and data analysis pipelines. The development of user-friendly and scalable bioinformatics platforms is crucial to enable efficient data processing, quality control, and interpretation. Integration of machine learning and artificial intelligence techniques can also enhance the identification of genetic markers, prediction of pathogen behavior, and early warning systems for zoonotic outbreaks.

Capacity Building and Infrastructure: Molecular surveillance relies on robust laboratory infrastructure, skilled personnel, and access to advanced sequencing technologies. Building and strengthening laboratory capacity in low-resource settings, particularly in regions vulnerable to zoonotic outbreaks, is crucial. This includes providing training, resources, and funding to enable timely and accurate molecular surveillance, ensuring equitable access to the benefits of genomic research and surveillance.

Antimicrobial Resistance: The rise of antimicrobial resistance (AMR) poses a significant threat to global health. Molecular surveillance plays a critical role in monitoring the emergence and spread of AMR pathogens. Future directions should focus on integrating AMR surveillance into routine molecular surveillance programs, developing standardized methods for AMR characterization, and establishing surveillance networks to monitor AMR trends globally.

Emerging Technologies: Continued advancements in sequencing technologies, such as portable and point-of-care sequencing devices, hold great promise for enhancing molecular surveillance capabilities. These technologies can enable rapid on-site sequencing, real-time data analysis, and early detection of emerging pathogens. Exploring and integrating these emerging technologies into routine surveillance systems will enhance our ability to respond quickly and effectively to zoonotic outbreaks.

Conclusion

Molecular surveillance has revolutionized our understanding of recent zoonotic pandemics, providing critical insights into pathogen characterization, transmission dynamics, and the development of effective interventions. Strengthening data sharing, enhancing bioinformatics capabilities, embracing the One Health approach, building capacity, monitoring antimicrobial resistance, and integrating emerging technologies will collectively contribute to more

comprehensive and proactive surveillance systems, enabling timely responses and improved global health security. This article concludes by emphasizing the continued importance of molecular surveillance in combating zoonotic diseases and preventing future pandemics.

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Role of Agroforestry in Ecosystem Management and Carbon Sequestration

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Agroforestry is a land use system that combines the practices of agriculture and forestry in a mutually beneficial way. It involves the intentional integration of trees or woody plants with crops and/or livestock on the same piece of land, creating a sustainable and productive agroecosystem. In agroforestry systems, trees are strategically planted to provide multiple benefits. They can offer shade, windbreaks, and erosion control, while also providing timber, fruits, nuts, or other tree products. The presence of trees in agroforestry systems can improve soil fertility, enhance biodiversity, and conserve water resources. Moreover, they contribute to carbon sequestration, mitigating climate change impacts.

Agroforestry practices can take various forms depending on the specific goals and characteristics of the land. Some common types of agroforestry systems include:

1. Alley Cropping: This involves planting rows of trees or shrubs alongside crops, creating alleys where crops are grown. The trees provide shade, reduce soil erosion, and can be managed for timber or other products.

2. Silvopasture: It combines trees with livestock grazing. Trees provide shade and forage for animals, reducing heat stress and providing additional sources of food and income.

3. Forest Farming: This approach involves growing crops under the canopy of a managed forest. It combines the cultivation of understory crops such as medicinal plants, mushrooms, or berries with the sustainable management of timber-producing trees.

4. Windbreaks and Shelterbelts: Rows of trees are planted as barriers to reduce wind speed and protect crops or livestock. They help prevent soil erosion, provide microclimate control, and enhance biodiversity.

Agroforestry systems can be adapted to various climates and landscapes, making them suitable for both small-scale subsistence farming and large commercial operations. They promote ecological sustainability, economic diversification, and resilience in agricultural production systems. By combining the benefits of trees and crops, agroforestry practices offer a more integrated and holistic approach to land management, balancing productivity with environmental conservation and promoting long-term sustainability

Agroforestry contributes to carbon sequestration

Agroforestry is indeed recognized as a key approach for carbon sequestration and mitigating climate change. It is an integrated land management system that combines agricultural crops or livestock with trees or shrubs, creating a diverse and sustainable ecosystem.

i. Tree planting

Agroforestry systems involve the deliberate planting of trees alongside agricultural crops or livestock. Trees are highly efficient at sequestering carbon dioxide from the atmosphere through photosynthesis. They absorb carbon dioxide and store it as carbon in their biomass, including leaves, stems, and roots.

ii. Biomass production

Agroforestry systems generate significant biomass, both above and below the ground. The accumulation of biomass contributes to carbon sequestration. As trees grow, they continue to capture carbon dioxide and store it in their expanding biomass.

iii. Soil carbon storage

Agroforestry systems can enhance soil carbon storage. Tree roots and fallen leaves contribute organic matter to the soil, increasing its carbon content. This process, known as soil carbon sequestration, helps mitigate climate change by removing carbon dioxide from the atmosphere.

iv. Reduced soil erosion

Agroforestry practices, such as alley cropping or contour planting, help prevent soil erosion. By reducing soil erosion, agroforestry systems help retain organic matter and prevent the release of stored carbon into the atmosphere.

v. Improved land management

Agroforestry promotes sustainable land management practices. By diversifying agricultural systems, it reduces the reliance on monoculture farming, which often leads to soil degradation and carbon loss. Agroforestry systems enhance the resilience of ecosystems and improve overall soil health.

vi. Long-term carbon storage

Agroforestry systems have the potential for long-term carbon storage. Trees can live for several decades or even centuries, effectively sequestering carbon over an extended period. By adopting agroforestry practices, carbon sequestration can be sustained for many years.

Benefits of the agroforestry

Agroforestry is a land-use management system that combines the cultivation of trees or shrubs with agricultural crops or livestock. This approach offers numerous benefits, both for the environment and for farmers.

Advantages of agroforestry

Increased agricultural productivity: Agroforestry can enhance overall farm productivity by optimizing the use of land and resources. The combination of trees and crops can create favorable microclimates, improve soil fertility, and reduce the risk of pests and diseases. Agroforestry systems often have higher crop yields compared to monoculture farming.

Soil conservation and improvement

Trees and shrubs in agroforestry systems help prevent soil erosion by reducing the impact of wind and water. Their root systems bind the soil particles together, preventing loss of topsoil. Agroforestry also improves soil structure, organic matter content, and nutrient cycling, leading to healthier and more fertile soils.

Biodiversity conservation

Agroforestry promotes biodiversity by providing habitat and food sources for a variety of organisms. The combination of different plant species in these systems supports a diverse array of insects, birds, mammals, and microorganisms. This increased biodiversity can contribute to natural pest control, pollination, and overall ecosystem resilience.

Climate change mitigation

Trees in agroforestry systems play a crucial role in mitigating climate change. They absorb carbon dioxide from the atmosphere and store it in their biomass and soils, helping to offset greenhouse gas emissions. Agroforestry can thus contribute to

carbon sequestration and the reduction of atmospheric carbon levels.

Water management

Agroforestry helps regulate water cycles by reducing surface runoff and increasing water infiltration. Tree roots act as natural drainage channels, minimizing soil erosion and flooding. Trees also help maintain water quality by filtering pollutants and reducing the need for chemical inputs.

Economic benefits for farmers

Agroforestry diversifies farmers' income streams by incorporating tree products such as timber, fruits, nuts, and medicinal plants alongside traditional crops or livestock. This diversification can provide a more stable and resilient income, as well as additional products for personal consumption or local markets.

Resilience to climate variability

Agroforestry systems are often more resilient to climate variability, such as droughts or extreme temperatures. The presence of trees provides shade, windbreaks, and improved water availability, reducing the vulnerability of crops and livestock to adverse weather conditions.

Improved livelihoods and rural development

Agroforestry can contribute to poverty alleviation and rural development by generating employment opportunities and fostering local value chains. It can enhance food security, promote sustainable land management practices, and support the establishment of community-based enterprises.

Agroforestry not only contributes to carbon sequestration but also offers additional benefits such as enhanced biodiversity, improved water quality, and increased resilience to climate change impacts. Its potential as a nature-based solution makes it a valuable approach in the fight against climate change and sustainable land management. Overall, agroforestry offers a holistic and sustainable approach to land use that integrates ecological, economic, and social benefits, making it a valuable tool for addressing various environmental and agricultural challenges.

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Mushroom (White Button) Cultivation Under Shed System: Cost and Profit Analysis

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Mushroom cultivation has been practiced in the world for thousands of years, while the history of mushroom production in India is almost three decades old. At present, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka, and Telangana are the major mushroom growing states at the trade level.

In our country mushrooms are used as food and medicine. Mushrooms have special importance all over the world due to their high level of food values like protein, carbohydrates, mineral salts, and vitamins. In India, mushrooms are known as khumb, khumbhi, bhamodi and bunchi etc. In order to promote mushroom cultivation, agricultural universities and other training institutions conduct training programs throughout the year to farmers on subjects such as mushroom cultivation method, mushroom seed production technology, mushroom production, and processing, etc. The state government is also giving a 50 percent subsidy to the farmers of the state for the cost of mushroom cultivation.

Varieties of mushrooms grown in India

There are around 10,000 species of edible mushrooms in the world, out of which 70 species are considered suitable for cultivation. Five types of edible mushrooms are cultivated commercially in the Indian environment which are- White Button Mushroom, Dhingri (Oyster) Mushroom, Milky Mushroom, Paddy straw Mushroom, Shitake Mushroom.

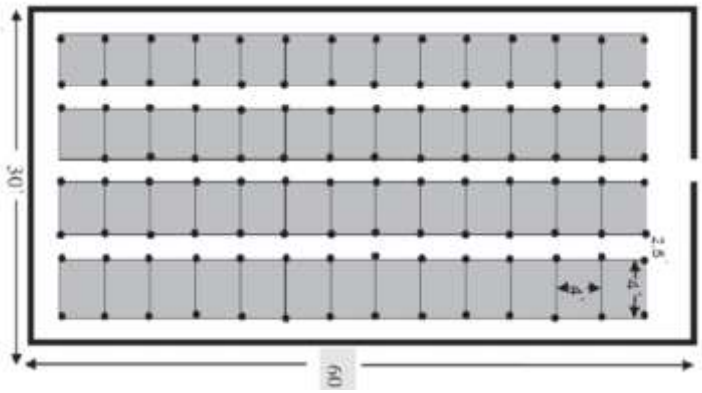
White Button Mushroom

The white button mushroom was first cultivated in low temperature places, but nowadays it is being cultivated elsewhere by adopting new techniques. 22–26 ° C temperature is required for the spread of the fungus trap of button mushrooms. The time from October to March is considered suitable for the seasonal cultivation of white button mushrooms in northern India. It can be grown easily in ventilated rooms, sheds, huts. Both permanent and temporary sheds can be used for white button mushroom cultivation. Farmers who are short of funds can use temporary sheds/huts made of bamboo and paddy straw in which 12 to 16 slabs of 4 x 25 feet size can be prepared for growing mushrooms. It accommodates about 10- 12 ton compost. For making the hut we clean the area and do the marking as per design given below. This is followed by digging holes at the marked points for inserting bamboos. Thereafter racks are made using plastic rope and the hut is covered with paddy straw that had polythene inside in the roof part to avoid damage due to rainfall and also sheets outside the sides of hut to control aeration and temperature. The polythene sheet is also spread on the racks and cultivation is done in beds instead of bags. Layout of a 60′x30′ feet shed is given in Fig 1.

Compost formation

Most farmers adopt the technique of preparing compost by the long method. It is easy and cheap to prepare compost by this method. The process of preparing compost by the long method is completed in 28-30 days which involves 6-7 turnings. Compost is made by using Wheat straw – 300 kg,

poultry manure – 60 kg, wheat bran – 7.5 kg, gypsum – 30 kg, farmer manure (calcium ammonium nitrate) 6 kg, urea – 2 kg, potash – 2.9 kg, single super phosphate – 2.9 Kilogram, molasses – 5 kg. Or Mustard husk – 300 kg, poultry manure – 60 kg, wheat bran – 8 kg, gypsum – 20 kg, urea – 4 kg, superphosphate – 2 kg, molasses – 5 kg. At the end when compost manure is ready, it appears dark brown. The moisture content in the compost should be 60-65 percent. The amount of nitrogen in the compost should be about 1.75-2.25 percent. Compost should be completely odorless of ammonia gas. Compost should be free of pests and germs. The pH value of the compost should be between 7.2-7.8



. Fig 1: Layout of mushroom bed preparation

Mushroom spawning

After placing polythene sheets on the slabs or beds in the shed prepared for mushroom production, a layer of compost 6-8 inches thick is spread followed by mushroom seeds / on top of the compost. Mix the spawn. 500 to 750 grams of seed is sufficient for sowing 100 kg of compost fertilizer. Polythene should be covered after sowing spawn.

Casing

Adding an inert material to the top layer of the compost is called casing which promotes the spore bearing structure to the mushroom. Casing is done after 2 weeks of spawn run and the casing layer should be 3.8-5 cm thick. Casing helps in retaining water in that area. Casing mixture can be- 2 parts of soil with one part of peat or 3 parts of cow dung with one part of light soil. To desicate the casing mixture, 2-3% formaline solution should be dampened and covered with a polythene sheet for 3-4 days. Casing helps in the vegetative growth of mushrooms. The appropriate amount of moisture remains in the compost after casing. In case of non-casing, mushrooms are released in very small amounts resulting in economic loss.

Fruiting and plucking

After 12-15 days of fruiting and plating the layer of casings, small buds of mushroom appear on the compost which develops in 4-5 days and turns into small white button mushroom. When the size of these white button mushrooms is 4-5 centimeters, it should be twisted and broken, considering them mature. The white button mushroom should be used soon after plucking because it begins to deteriorate soon. The most important thing is that about 5.00 kg of white button mushroom can be obtained from compost manure made from 10.00 kg of dried straw used.

Table 1: Cost economics of mushroom cultivation

Sl. No.	Particulars	Value
1.	Shed material (bamboo poles, polythene sheets, sutli, paddy straw) cost	20,000/-
2.	Compost & spawn cost	80,000/-
3.	Labour, water & electricity cost	34000/-
4.	Casing, insecticides & pesticides, packaging & transportation cost	10,000/-
Returns		
5.	Mushroom yield per shed (3000 kg sold at 100 Rs./kg)	300000/-

Cost and returns per shed

Seasonal cultivation of mushroom is done by making small sheds over specified area and the size of the shed is 60'x30'approximately. The cost incurred per shed is given in Table 1.

Total cost per shed here is Rs. 1,44,000. There is 11% interest rate and 10% depreciation rate for fixed assets and after adding these values the total cost becomes Rs. 1,44,485 so the profit earned is Rs. 155,515. Hereby, it can be concluded that mushroom cultivation is highly profitable enterprise for the farmers. In the last few years, the trend of farmers has increased rapidly towards mushroom cultivation, as mushroom cultivation has become a source of better income. Just a few things have to be kept in mind, good price of mushroom is available in the market. Farmers in different states are making good profits from mushroom cultivation, with less space and less time and also the cost of cultivation seems to be very low as compared to the profits. For mushroom cultivation, farmers can take training at any Krishi Vigyan Kendra or Agricultural University.

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Salicylic Acid Under Abiotic Stress: A Key Player in Plant Defence Mechanisms

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Abiotic stress factors have detrimental effects on plant physiology, including impaired photosynthesis, altered water relations, oxidative damage, and disrupted cellular metabolism. In response to these stressors, plants trigger a range of biochemical and molecular processes to enhance stress tolerance and minimize damage. Salicylic acid, a naturally occurring phenolic compound, has emerged as a critical signalling molecule involved in the regulation of plant defence responses against abiotic stress.

Role of Salicylic Acid

- Activation of Defence Genes: Salicylic acid plays a crucial role in activating defence-related genes, including those involved in antioxidant metabolism, osmoprotection, and stress signal transduction pathways. These genes collectively contribute to enhancing plant stress tolerance and minimizing stress-induced damage.
- Antioxidant Activity: Abiotic stress often leads to the production of reactive oxygen species (ROS), which can cause cellular damage. Salicylic acid acts as a potent antioxidant, scavenging ROS and minimizing oxidative stress. Additionally, SA stimulates the activity of antioxidant enzymes, such as superoxide dismutase (SOD) and catalase (CAT), to enhance the plant's antioxidant defence system.
- Osmotic Adjustment: Under abiotic stress conditions, plants experience osmotic imbalances due to altered water availability. Salicylic acid helps regulate osmotic balance by promoting the accumulation of compatible solutes, such as proline and sugars, which maintain cellular turgor and stabilize cellular structures.
- Hormonal Crosstalk: Salicylic acid interacts with other plant hormones, including jasmonic acid (JA) and abscisic acid (ABA), to modulate plant responses to abiotic stress. While SA is primarily associated with defense against biotic stresses, it also plays a role in mitigating the effects of abiotic stress by regulating hormone signaling pathways.

Role of salicylic acid under salt stress:

- Ion Homeostasis: Salt stress disrupts ion homeostasis, resulting in the accumulation of toxic ions, particularly sodium (Na+) and chloride (Cl-), in plant tissues. SA has been shown to alleviate salt-induced ion toxicity by regulating ion transporters, such as sodium/hydrogen exchangers (NHXs), potassium transporters (HKTs), and plasma membrane H+-ATPases, thus promoting ion balance and minimizing ion toxicity.
- Osmotic Regulation: Salt stress imposes osmotic stress on plants, leading to water deficit and cellular dehydration. SA assists in osmotic regulation by promoting the accumulation of compatible solutes, such as proline, glycine betaine, and sugars, which help maintain cellular water balance and prevent cellular dehydration.

- Antioxidant Defense: Salt stress induces the generation of reactive oxygen species (ROS), causing oxidative damage to plant cells. SA acts as a potent antioxidant, scavenging ROS and stimulating the activity of antioxidant enzymes, including superoxide dismutase (SOD), catalase (CAT), and peroxidases, to protect plants from oxidative stress-induced injury.
- Gene Expression Regulation: SA influences the expression of numerous genes involved in salt stress responses. It upregulates the expression of stress-responsive genes, such as those encoding late embryogenesis abundant (LEA) proteins, heat shock proteins (HSPs), and antioxidant enzymes. Additionally, SA enhances the expression of genes involved in signal transduction pathways, leading to improved salt stress tolerance.

Conclusion

Salicylic acid acts as a central player in plant defence mechanisms against abiotic stress. Through its multifaceted functions, SA regulates gene expression, acts as an antioxidant, contributes to osmotic adjustment, and modulates hormonal crosstalk to enhance plant stress tolerance. Understanding the molecular mechanisms underlying the involvement of salicylic acid in abiotic stress responses will help in developing strategies to improve crop productivity under challenging environmental conditions. Further research is warranted to explore the precise regulatory mechanisms of SA and its interactions with other signalling molecules to unlock the full potential of this remarkable plant defence compound. Salicylic acid emerges as a critical modulator of salt stress tolerance in plants. Through its involvement in ion homeostasis, osmotic regulation, antioxidant defence, and gene expression regulation, SA helps plants mitigate the harmful effects of salt stress. Understanding the precise mechanisms underlying SA-mediated salt stress tolerance will contribute to the development of strategies for improving salt stress resilience in crops, ultimately enhancing agricultural productivity in saline environments.

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Apni Kyari Apni Thali: An Innovative Model for Nutritional Security of Rural Woman and Children

BAU Communication No. 1463/230714

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Majority of children in Bihar have underprivileged childhoods starting from birth. The infant mortality rate of children is 34 and 25% of newborn children are underweight among other nutritional and immunization deficiencies of children in India. Integrated Child Development Services (ICDS) is a government programme, which provides food, primary healthcare, immunization, health check-up and referral services to children under 6 years of age and their mothers. ICDS has also been linked to Anganwadi centres established mainly in rural areas and staffed with frontline workers. Bihar Agricultural University, Sabour, Bhagalpur has taken an initiative to cope-up malnutrition through agricultural intervention "Apni Kyari Apni Thali (AKAT)" in collaboration with ICDS (Deptt. of Social Welfare, Govt. of Bihar) and UNICEF. Figure 1 indicates the different linkage towards adaptation of this innovative model. This initiative aims to bring together KVKs and Anganwadi centres and overcome nutritional deficiency of protein and micronutrients to the unprivileged infants and their mothers. The scheme of implementation of the project is represented in Figure 2. To achieve the ultimate goal of alleviating malnutrition, three objectives have been formulated: (I) Impact of nutrition education package on malnutrition among rural women and children through Community Radio Station (CRS); (II) Diversification of food intake among rural women and children through establishment of nutri-garden under AWCs; (III) Ensuring quality nutrition among malnourished children and mothers through mushroom enriched food in their diets.

Implementation of the model

The programme has been implemented under four districts viz., Patna, Nalanda, Purnea and Khagaria through the existing Krishi Vigyan Kendras. A systematic approach was followed to bring the perceptible improvement in the nutritional security through multipronged approach with special focus on one specific approach at each district. Creation of awareness through nutrition education through CRS, Barh under KVK, Patna, incorporation of Mushroom to daily diet at in Nalanda and enhancing diet diversity through establishment of nutri-gardens at AWCs at Purnea and Khagaria was the core strategy. Five villages were selected at each districts and a strong linkage was established between respective KVK and AWC with the help of ICDS, Govt. of Bihar. Nutritional garden were established at AWC to include green leafy vegetables/fruits in the diets of

pregnant/lactating women and children. Community Radio Services was employed to boost up the nutritional and health awareness programme. Awareness through Community Radio Services is one of the fascinating way the KVK has opted to reach rural mass. Our initiatives also encouraged the cultivation and inclusion of mushroom in diets to combat the malnutrition in children. Mushroom cultivation was promoted at each selected AWCs and same was served as a supplement in meal at selected AWCs. An extensive campaign was conducted to remove the stigmas and taboos related to food habits including mushroom consumption. The rural woman was empowered with technical knowledge of nutri-garden establishment, mushroom cultivation and diversification culinary. Nutrition education on selection of right food as per local availability, removal of taboos in food, causes of malnutrition and issues regarding micronutrient deficiencies were thoroughly discussed to bring about desirable changes in food consumption pattern.

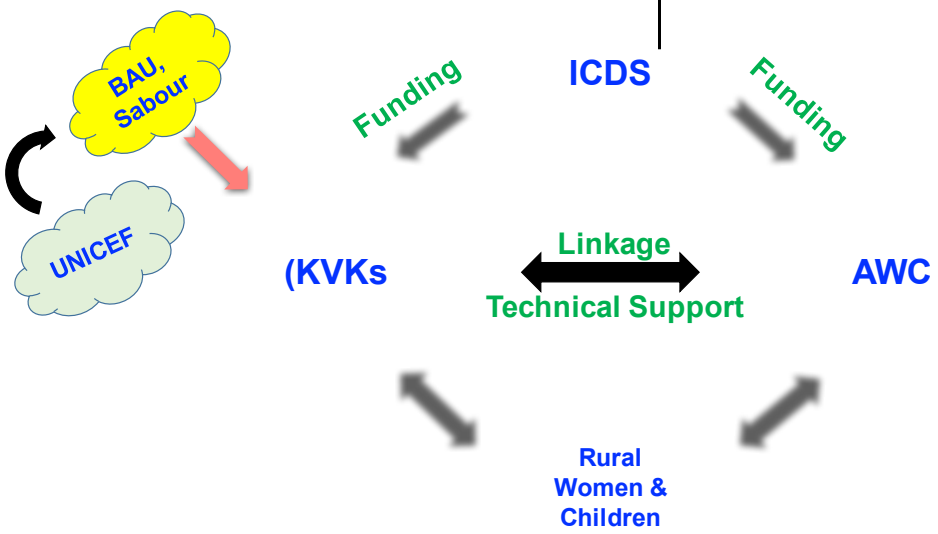

Figure 1: Linkage for adaptation of the model.

Approach and methodology adopted to bring innovation

This programme was started in 2018 at four KVKs centres (viz., Patna, Nalanda, Purnea and Khagaria) of BAU, Sabour. All these centres have their unique approaches to meet with the demands of micronutrients to the unprivileged one. The following section will enlighten the glimpse of major initiatives and achievements by these four KVKs so far.

1. KVK, Barh, has started nutritional awareness programme to combat malnutrition among children, pregnant, lactating women, adolescent girls and other rural people through Community Radio Services (CRS). Five blocks under KVK, Patna (viz., Barh, Athmalgola, Belchhi, Pandarak and Bakhtiyarpur) have been selected, where population was more than 3000. A quick survey to get the feedback from the people from this block was conducted and results were highly fascinating. People also shared the nutritional knowledge that they perceive through this platform. Balanced diet, food and nutrition, nutritional deficiency diseases, enhancing nutrition through low-cost diets, nutritional efficiency diet, benefits of moringa, mushroom, techniques for upgrading nutrition in regular food, cooking and processing method to retain nutrition availability like fortication, germination, fermentation and high protein diet etc. were the major attention covered for broadcasting every day for 3 hours. This programme

also comprised of question-answer interactive session, poshan songs, drama nukkad-natak, stories, poems and lectures and interviews, etc. with nutrition experts, AW workers, CDPOs, scientists, local leaders and progressive women and farmers. A special session on supplementary feeding and preparation was concealed in details. Table 1 represents Prevalence of symptoms related to malnutrition/hidden hunger among children in adopted villages before and after implementation of Apni thali Apni Kyari initiative at KVK, Nalanda under Poshan Abhiyan.

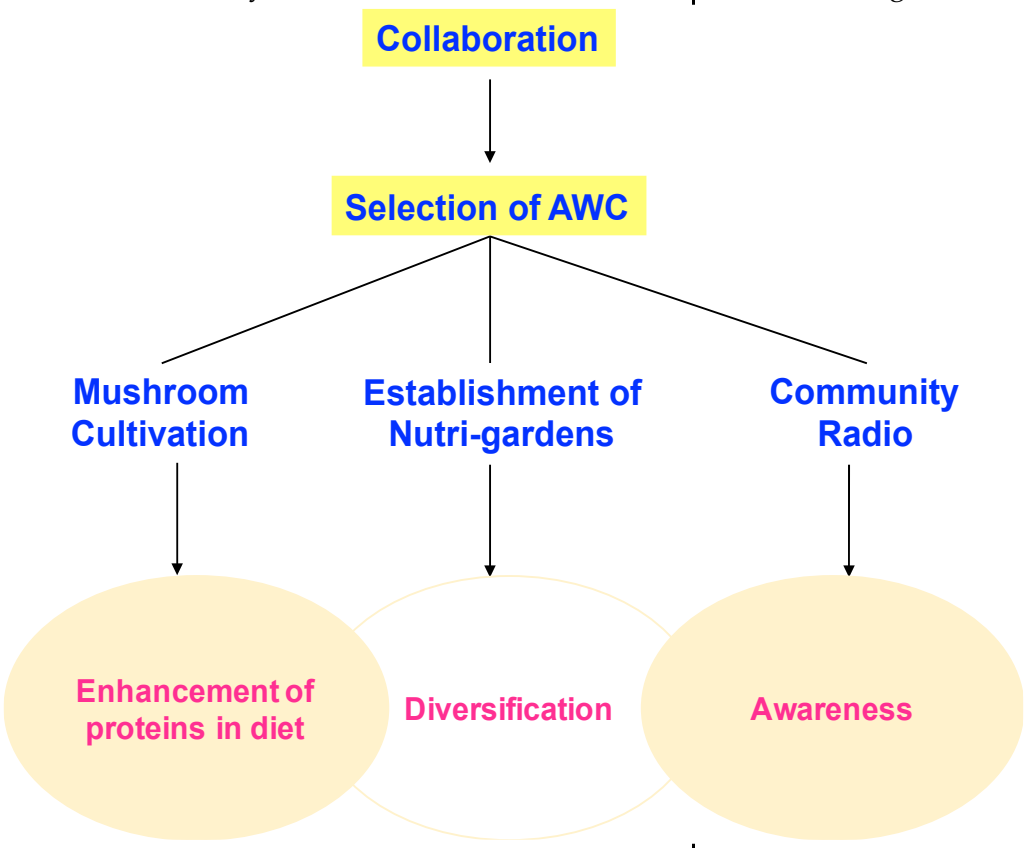

Figure 2: Working flow chart of the model.

2. KVK Khagaria ensured cheap, regular and handy supply of fresh vegetables via AWCs through establishment of nutritional garden. The major objective of nutritional garden was to provide green leafy vegetables and fruits into the diets of pregnant women and children of 6-24 month old. Supply of selected nutritious crops, garden tools, method of cultivation, uses and preservation techniques were facilitated by KVK to ensure their availability throughout the year. This programme was aimed to reduce atleast Rs 5000/- for fruits and vegetables from the total food budget of AW center. The nutri-garden at AWCs utilizes locally available compost for promotion of zero budget veg. cultivation. Local women of these area have been associated as committee members to the nutri-garden for production, management and efficient utilization. So far, 40 nutri-garden has been made and working day-night to fulfil the requirement of fresh fruits and green vegetables.

3. KVK Jalalgarh, Purnea also ensures to enhance or meet nutritional requirement through nutrigarden and local people are opting it with a great enthusiasm. Main objective of the project is to provide nutritional education and also to upgrade micronutrients consumption for pregnant and lactating women of selected villages through Anganwadi centers. Total of 50 nutrigarden has been established with technical support like availability of seeds and seedling cultivation of seasonal vegetables and fruits for whole year. The produce of nutrigarden were distributed among beneficiaries as well as in AW meal for children. We are also conducting the training programmes to the progressive women,

lactating mothers and others to facilitate this concept to them.

A

B

C

D

Figure 3: Glimpse of AKAT at different KVKs of BAU, Sabour, Bhagalpur. (A) Distribution of radio by Hon'ble Agricultural minister, Bihar to the rural woman. (B) & (C) Establishment of nutri-gardens and adaptation of mushroom cultivation by rural woman.

4. KVK, Nalanda employed mushroom cultivation, a nutrient-dense versatile food which shares some of the benefits of fruits and vegetable and complement almost every day meal. Total 25 mushroom production units were established in the selected villages. So far, 50 malnourished children ranging from 06-36 months and 20 pregnant women were selected from each center with the help of Anganwadi Sevika. We also conducting the detailed study or survey on approximately 250 children and 50 pregnant women to see the effect of mushroom supplementation. Each unit has produced approximately 50 kg mushroom so far, which was collected at ICDS center and distributed among 50 children and 20 pregnant mother. Mushrooms are being served as a supplement in meal at every AW center. We included mushroom in the recipe of pulao and halwa, which was well acceptable by children.

Impacts/Benefits resulting from the initiative

The initial baseline survey conducted across the selected AWCs in 04 districts of Bihar indicated presence of various symptoms of malnutrition among children, NPNL, pregnant and lactating woman. Community radio station led nutritional awareness campaign resulted in significant improvement in knowledge attitude and practice in various life styles related to diet. The use of green leafy vegetables, Mushroom, Moringa in daily diet

has been increased to the tune of 10-15 per cent. Awareness on hygienic food, safe drinking water, care during diarrhoea, anaemia management etc. has enhanced up the tune of 10-20 per cent through awareness campaign led by CRS (Table 2). Establishment of nutri-gardens has significantly enhanced the daily consumption of nutritious vegetables and fruits among the pregnant woman, lactating mothers and children. The midterm assessment of the nutri-garden suggests a positive change on several general indicators among the woman and children up the tune of 20-25 per cent. The innovative cropping system followed in current nutri garden across 50 AWCs has resulted in an average vegetable & fruit production worth of Rs. 34696 /- per AWC. An average of 1237 Kg of vegetable was produced per AWC per year fulfilling the recommended vegetables consumption needs 16-17 people as per FAO standards. Inclusion of mushroom in the regular diet of malnourished children and pregnant woman resulted in enhanced supplementation in amount of protein and micronutrients such as phosphorous, magnesium, calcium, iron and zinc etc. The supplementation of mushroom has resulted in fulfilment of approximately 12% protein, 22% niacin, 8% vitamin B, 43 % Mg and 36 % Zn towards RDA.

Table 1. Prevalence of symptoms related to malnutrition/hidden hunger among children in adopted villages before and after implementation of *Apni thali Apni Kyari* initiative at KVK, Nalanda under *Poshan Abhiyan*

Symptoms	Before (%)	After (%)
Frequency of falling sick	30	10
Pot belly (Vomiting and Diarrhoea)	12	04
Spoon shaped nails/Brittle nails	02	01
Lustreless and brown hair	05	03
Pale skin	55	53
Sore tongue	10	08
Loss of appetite	05	04
Depression/ Dizziness/ Poor concentration	57	52
Bleeding gums/ Blue spot-on skin	11	10
Lack of growth and low body weight	50	40
Tiredness, Fatigue and lack of energy	65	54

N= 250 families (50 in each village); No. of children - 25 (Under 05 years).
 # After six months of implementation of the Apni thali Apni Kyari initiative.

Summary

AKAT is an innovative initiative towards building a strong linkage between existing KVKs and AWCs through ICDS to roll out an integrated strategy to address malnutrition among the rural woman and children (Figure 2). The AKAT programme was conceptualised and implemented in 4 districts of Bihar on pilot basis. Five villages have been selected in each district viz., Nalanda, Patna, Purnea and Khagaria to implement and examine the agri-based innovative model to address the perennial problem of malnutrition (Figure 3). The principal behind the model has three pronged strategies including creation of awareness through CRS among the rural population, a self-reliant agricultural intervention to diversify the dietary habits through establishment of Nutri- gardens at AWCs and kitchen garden among the rural families and to include mushroom as important dietary component by creation village level production hubs. The initiative has been so for successful in its implementation and creating momentum among the selected villages to move towards sustainable, healthy and nutritious dietary habits. India has a vast network of Krishi Vigyan Kendra across the country

with sound experts on various aspects of farming including Home/community science experts. Whereas, AWCs are the village level centres mandated for woman and child development in rural areas. Malnutrition being a major challenge across the country, the institution like ICDS has taken several initiatives to address the same. However, there is lack of linkage between KVKs and AWCs to address this important challenge. The innovative idea of bringing AWCs and KVKs was principle component of the current initiative where, KVKs with their domain expertise are bringing the perceptible improvement in nutrition education through CRS, enhancing food diversity through Nutri garden and incorporating mushroom in daily diet to enhance availability of Recommended Dietary Allowances (RDA).

Table 2. Impact of Community Radio Station (CRS) led campaign on Knowledge (K), Attitude and Practice (P) of life style activities related to diet among rural woman and children

Activities promoted by awareness through CRS	Percentage population of practicing Prior to Project (%)	After Implementation	
		K	P
Use of Green Leafy Vegetables in daily diet	50	70	60
Use of mushroom in daily diet	25	75	47
Use Moringa products in daily diet	35	75	50
Hygienic & Scientific Processing and Cooking Methods	25	70	40
Frequency of supplementary Feeding among children	20	65	50
Knowledge on Symptoms of Malnutrition and their care	30	70	40
Knowledge and practice of Nutri-garden	50	80	60
Knowledge on different food groups	25	75	-
Immunization and safe Drinking Water	60	80	65
Level Diet Diversification	35	70	40
Scientific Care in Diarrhea	65	90	70
Care of pregnant and Lactating Women	40	85	60
Anemia management	60	90	55
Care of Children during Illness	50	80	60

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FPO: A Way to Ensure Better Income to Farmers

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It is one type of PO (producer organization) where the members are farmers. PO is a generic name for an organization of producers of any produce, e.g., agricultural, non-farm products, artisan products, etc. A Farmer Producer Organization (FPO) is a group of farmers who come together to form a company or an organization, with the aim of increasing their bargaining power and improving their economic status. These FPOs serve as powerful catalysts for change, addressing longstanding challenges faced by farmers such as limited access to markets, lack of bargaining power, and inadequate infrastructure. It can work as a platform to facilitate better access to government services, like PDS, MNREGA, scholarships and pensions, etc. It can liaison with the Government Departments for convergence of programmes, like drinking water, sanitation, health and hygiene. FPOs are typically formed to help small and marginal farmers, and they are regulated by the Indian Companies Act, 2013.

The government, meanwhile, has introduced various initiatives, such as the Formation & Promotion of 10,000 FPOs Scheme, PM-Kisan Scheme, and e-NAM to support farmers and increase their income. Small Farmers' Agribusiness Consortium (SFAC) is providing support for promotion of FPOs.

Functions of FPO

- To provide quality production inputs like seed, fertilizer, pesticides, and other inputs at wholesale rates.
- To make available the production and post-production machinery and equipment, such as cultivators, tillers, sprinkler sets, combine harvesters, and others, on a custom hiring basis to members to reduce per-unit costs of production.
- Offer value-added services such as cleaning, assaying, sorting, grading, packing, and farm-level processing facilities at affordable user charges. Additionally, storage and transportation facilities may be provided.

- Engage in higher income-generating activities like seed production, beekeeping, mushroom cultivation, and more
- Facilitates aggregation of smaller lots of farmer-members' produce and add value to make them more marketable
- Provide market information about the produce to facilitate judicious decision-making in production and marketing
- Offer logistics services like storage, transportation, loading/unloading, etc., on a shared cost basis
- Market the aggregated produce with better negotiation strength to buyers and in marketing channels that offer better and more remunerative prices.

Types of FPOs based on their functions:

Production Businesses

The main functions of these types of FPOs are production, procurement or manufacture of any primary produce for its members (for further sale) and to others.

Marketing Businesses

These businesses are involved in the marketing or promotion of primary produce or provision of educational services to members and others.

Technical Service Businesses

These types of FPOs are offering technical assistance to producers, providing training and educational services or conducting research and development in the related area.

Financing Businesses

These mainly deals with financing producer activities, be it in the production, marketing or development domain.

Infrastructure Businesses

Businesses involved in providing infrastructure to producers, whether in the form of electricity, water resources, irrigation techniques, land utilization, or consultation with regard to the same, may constitute themselves as a producer company.

Optimal size and parameters

- It is desirable to have a Farmer Producer Organization (FPO) for farmers having their lands in contiguous micro-watersheds to address the issues relating to sustainability.
- The productive land under an FPO may be around 4000 ha.
- The PO may cover generally one or two contiguous Gram Panchayats for ease of management.
- The number of farmer producers that need to be covered may be around 700 to 1000.
- The cost of managing a Producer Organization of the above nature may be around Rs. 2 lakh per month or Rs. 24 lakh per annum.
- The total value of the produce of the farmers/non-farmers handled by the Producer Organization may be around Rs. 2.5 crore, assuming that approximately 10% of the total turnover of the PO may be reasonably spent towards cost of management.
- Further, the markets selected for the Producer Organization for selling their produce may be within 200 KM to make their marketing activities viable.

FPO Registration Process

Farmer producer company registration process takes anywhere around 32-35 business days (subject to government authorization). A minimum of five directors must apply for a digital signature

registration online, which is necessary to file the producer company registration documents. For this, you will only need to provide a few scanned documents and details; our representatives will fill the form and submit it online. As soon as we apply for the DSC, we will prepare the SPICe i.e. INC-32 documents. These documents will take around a week to prepare, and will include the name for your company, the Memorandum of Association (MoA) and Articles of Association (AoA). Once these documents are prepared satisfactorily, they will be submitted to the RoC.

Depending on the workload of the RoC, the documents will be approved in 10 to 15 days. Once approved, the Certificate of Incorporation will be mailed to your registered office address. With this document, you can apply for a Permanent Account Number (PAN) and Tax Account Number (TAN), both of which are necessary for opening a bank account in the name of the business.

Central Sector Scheme for formation and promotion of 10,000 FPOs

Realizing the need to form and promote FPOs across the country, Government formulated a dedicated Central Sector Scheme "Formation & Promotion of 10,000 Farmer Producer Organizations (FPOs) and the same was launched by Hon'ble Prime Minister on 29.02.2020 at Chitrakoot (UP) for implementation.

The FPOs to be eligible under the scheme for financial benefit and technical handholding are required to be registered either under Companies Act, 2013 or States' Co-operative Societies Act with minimum number of 300 farmers in plain areas and 100 farmers in hilly and NER. Under the scheme, there is provision for financial support of maximum Rs.18.00 lakh per FPO for 3 years as management cost to make them sustainable and economically viable. To strengthen the financial base of FPOs and entail them to avail collateral free loan, there is also provision for matching equity grant of maximum Rs. 2000/- per member with ceiling of Rs, 15 lakh /FPO and Credit Guarantee facility up to bankable project loan of Rs. 2.00 crore respectively.

Under this scheme there are 3599 targeted FPOs, 2298 registered FPOs and 1871 are under process of registration. Uttar Pradesh state has the highest number of FPOs under this scheme (1762) followed by Madhya Pradesh (709) and Bihar (612). (SFAC 2023).

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Biochar in Plant Disease Management: Harnessing the Potential of a Sustainable Solution

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Plant diseases pose significant challenges to agricultural productivity and food security worldwide. Traditional disease management approaches often rely on synthetic pesticides and fungicides, which can have detrimental effects on the environment and human health. As the demand for sustainable and eco-friendly solutions increases, biochar has emerged as a promising tool in plant disease management.

Biochar, a carbon-rich material produced through the pyrolysis of organic matter, offers multiple benefits that contribute to enhanced plant health and disease suppression.

Biochar composition

Carbon (C): Biochar is primarily composed of carbon, which makes up a significant proportion of its structure. The carbon content in biochar can range from 50% to over 90%, depending on the production conditions.

Minerals: Biochar may contain various inorganic minerals derived from the feedstock and any impurities present. These minerals include calcium, potassium, magnesium, phosphorus, and trace elements, which can contribute to soil fertility.

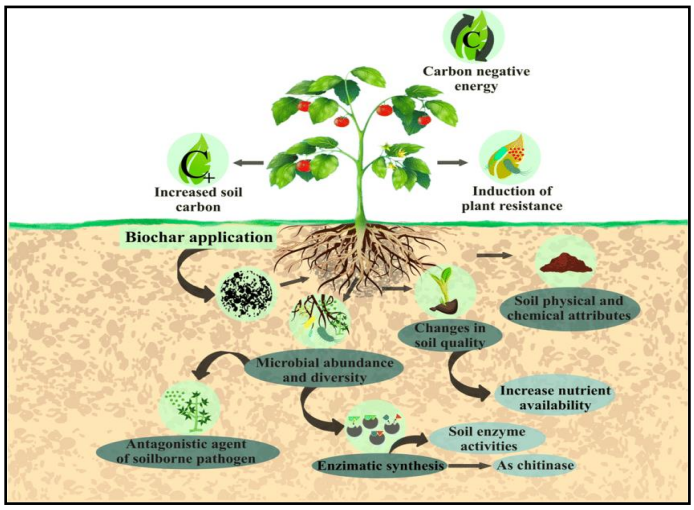
Volatile Organic Compounds (VOCs): Some volatile organic compounds may be present in biochar, depending on the pyrolysis conditions and the composition of the feedstock. These compounds can include organic acids, alcohols, and phenolic compounds.

Ash: Biochar typically contains a small percentage of ash, which is the inorganic residue left after the pyrolysis process. The ash content can vary depending on the feedstock and may contribute to the mineral content of biochar.

The specific composition of biochar can impact its properties, such as porosity, surface area, and nutrient-holding capacity. Different types of biochar may exhibit varying characteristics and have different applications in agriculture, horticulture, environmental remediation and other fields.

Benefits of Biochar in Plant Disease Management

Enhanced Soil Health: Biochar improves soil structure, water retention, and nutrient availability.



Healthy soils support robust plant growth and improve their ability to withstand and recover from disease attacks. Moreover, biochar increases beneficial soil microbial populations, including those

with antagonistic properties against pathogens, thereby promoting disease resistance.

Disease Suppression: Biochar has been found to possess inherent antimicrobial properties, capable of inhibiting the growth and development of certain plant pathogens. Its porous structure acts as a physical barrier, preventing pathogen colonisation and reducing disease incidence. Furthermore, biochar's high surface area facilitates the adsorption of disease-causing organisms and toxins, reducing their impact on plants.

Induced Systemic Resistance: Biochar application stimulates plants' natural defense mechanisms, triggering an enhanced immune response known as induced systemic resistance (ISR). ISR strengthens the plant's ability to ward off pathogens, even those that are not directly targeted by biochar. This systemic defense mechanism offers long-term protection against a broad range of diseases.

Nutrient Management: Biochar has the capacity to retain and slowly release essential plant nutrients, such as nitrogen, phosphorus, and potassium. By improving nutrient availability and reducing leaching, biochar enhances plant nutrition, optimising growth and development. Well-nourished plants are generally more resilient to disease outbreaks.

Environmental Sustainability: Biochar is a sustainable and carbon-negative material. Its production utilizes organic waste streams, such as agricultural residues or forestry byproducts, reducing their environmental impact. Additionally, biochar sequesters carbon in the soil, contributing to climate change mitigation.

Conclusion

Biochar offers an innovative and eco-friendly approach to plant disease management. Its ability to enhance soil health, suppress pathogens, induce systemic resistance, and optimize nutrient management provides multiple benefits for plant health and productivity. Furthermore, biochar's sustainable nature aligns with the growing need for environmentally friendly agricultural practices. As research in this field progresses, harnessing the potential of biochar can revolutionize plant disease management, contributing to sustainable agriculture and global food security.

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Alternaria blight (*Alternaria solani*) of tomato and its management

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Tomatoes are one of the most popular and widely cultivated vegetables worldwide. Tomato (*Solanum lycopersicum* L.) has secured the first position among processing crops in India, and it is the world's second most important consumed vegetable crop after potato (Kumar, 2015). In India, the tomato crop is mainly cultivated in Odisha, Andhra Pradesh, Madhya Pradesh, Karnataka, West Bengal, Chhattisgarh, Telangana, Bihar, Gujarat, Rajasthan and Uttar Pradesh. However, like any other crop, they are susceptible to various diseases, (Mark and Brooke, 2006 and Abada *et al.*, 2008).

Among fungal diseases, Alternaria blight (*Alternaria* sp.), late blight (*Phytophthora infestans*), Septoria leaf blight (*Septoria lycopersici*), powdery mildew (*Oidiopsis taurica*), Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*), collar rot (*Sclerotium rolfsii*) and damping-off (*Pythium* sp.) are a significant bottle eneck in the production of tomato and responsible for heavy economic losses. One of the most significant threats to tomato plants is Alternaria blight caused by *Alternaria solani*. It causes up to 46–90per cent blight disease intensity with huge fruit yield losses (Bessadat *et al.,* 2014).

Management of Alternaria blight is complex because the pathogen has a wide host range, pathogenic variability and prolonged active phase of the disease cycle.Available methods for managing Alternaria blight prevent long periods of wetness on the leaf surface, cultural practices, and host plant resistance with fungicides (Namanda *et al.*,2004 Kirk *et al.*, 2005 and Kumar and Srivastava, 2013). This article aims to shed light on the causes, symptoms, and management strategies applied against Alternaria blight to help farmers and gardeners to protect their tomato crops.

Causes

Most species of Alternaria causes necrotrophic diseases on crops. Depending on the species Alternaria produce unique club-shaped conidia, often beaked with horizontal and often vertical septa that may be produced either individually or in a chain. Hyphal cells are darkly pigmented with melanin, which guards hyphae and spores against environmental stress and allows spores to survive in soil for long periods of time (Rotem *et al.*, 1994). Alternaria blight is primarily caused by the fungus *Alternaria solani*. The pathogen can survive in plant debris, infected seeds, or on other host plants.

Disease Cycle

A. solani reproduces asexually. The fungus overwinters in soil, plant debris, seed and alternate hosts in the form of either conidia or mycelia, which may serve as primary sources of inoculum (Figure 1). Infection occurs during warm and humid conditions. Conidia germinates at temperature of 8–32°C in cool and humid conditions in the presence of moisture to form germ tubes (Jones *et al.*, 1991 and Kemmitt *et al.*, 2002). Germ tubes penetrate host tissue directly or enter through stomata or wounds, thereby causing infection. Lesions appear after 2–3 days of infection depending on environmental conditions, leaf age and cultivar susceptibility, and spores are produced

3–5 days after the appearance of lesions (Jones*et al*., 1991 and Sherf *et al.*,1986).

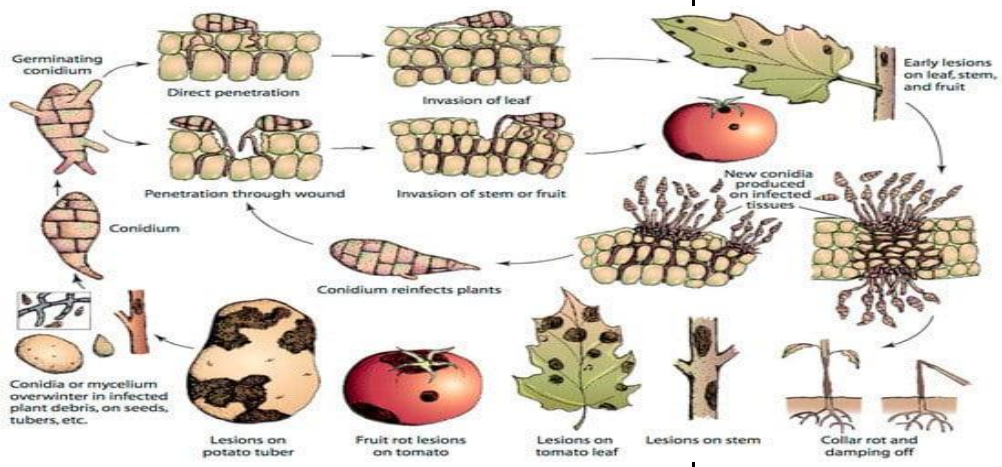

Fig 1: Disease cycle of Alternaria blight of tomato
Source: Agrios G.N. 2005

Symptoms

The symptoms of *A. solani* appear in leaf (leaf blight or early blight), stem (collar rot or stem lesions) and fruit (fruit rot) of tomato plant (Sherf *et al.*,1986 & Barksdale and stoner, 1977).

Leaf Lesions

It is characterized by dark, small, necrotic, coalescing and concentric lesions giving a target-board like appearance on the leaf surface. The lesions are surrounded by yellow rings (Sherf *et al.*, 1986). The disease first appears on lower older leaves and moves upward as the plant becomes mature (Rotem *et al*., 1994). Older leaves are more susceptible than younger leaves.

Stem and Fruit Lesions

Stem lesions appear as dark, sunken areas, leading to stem girdling and breakage. Fruit lesions initially appear as small, circular, sunken spots with dark margins. Over time, the lesions enlarge, become concentric, and may develop dark spore-bearing structures called conidia.

Defoliation

As the disease progresses, infected leaves may start to yellow, wither, and eventually drop prematurely, resulting in defoliation eventually drop prematurely, resulting in defoliation

Management Strategies

The disease can be management by three measures: cultural practices, the use of resistant varieties and fungicide treatment. Cultural practices and fungicidal treatment are more common practices (Foolad *et al.*, 2008).

Cultural Practices

Cultural practices include maintenance of a healthy field and crop vigor, sanitation, removing infected vines and fruits, plant debris and volunteer weeds from the vicinity of the field, crop rotation and reducing the leaf wetness by soil-directed irrigation systems (Foolad *et al.*, 2008 and Chaerani *et al.*, 2006).

Resistant Varieties

Planting tomato varieties with resistance against Alternaria blight can significantly reduce the impact of the disease. Consult local agricultural extension services or seed suppliers to identify suitable resistant varieties for your region. Pusa Ruby and Arka Rakshak are resistant varieties recommended

Fungicides

Several types of fungicides have been developed for the control of alternaria blight of tomato, but fungicide treatment is not economically feasible, nor environmentally sound. Fungicides are first applied 1–2 days after transplantation and then require routine application at the interval of 7–10

days for effective control, thereby increasing production cost and environment pollution (Foolad *et al.*, 2008 and Kemmitt *et al.*, 2002).

In addition, the role of fungi such as *Trichoderma viride* (Sarkar *et al.*, 2016) and *T. harzianum* (Chowdappa *et al.*, 2013) for the management of alternaria blight has also been reported. A new approach at the holobiont level is one in which microbial communities are also considered in the plant selection process (Wei and Jousset, 2017). This will ultimately help to improve the overall performance of plants under field conditions. One of the most effective methods for disease control is the use of fungicides and botanicals. However, the most important means of protecting plants against phytopathogenic fungi synthetic fungicides (Saha *et al.* ,2013 Abdel-Megeed *et al.*,2015). In India, Kumar *et al*. (2007) have tried many fungicides of triazoles and strobilurins groups and found them effective in managing Alternaria blight of tomato. Follow the recommended dosage and application instructions provided by the manufacturer.

Timely Pruning

Pruning the lower branches of tomato plants can improve air circulation, reduce humidity, and minimize the risk of infection.

Regular Monitoring

Prompt detection and action can prevent the disease from spreading to healthy plants. Remove and destroy infected plant material to limit further contamination.

Conclusion

Alternaria blight poses a significant threat to tomato crops, but with proper understanding and management strategies, its impact can be minimized. Implementing cultural practices, growing resistant varieties, and using appropriate fungicides can help control the disease. Timely monitoring and vigilance are crucial in preventing the spread of Alternaria blight and safeguarding tomato plants, ensuring a successful and bountiful harvest.

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Rewriting Plant Genetics: CRISPR-Cas9

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The world population is expected to reach 9.7 billion by 2050, and feeding this population is one of the biggest challenges facing humanity. Agricultural productivity needs to be increased while simultaneously minimizing the environmental impact of farming practices. One solution to this problem lies in plant breeding, which involves the selection and manipulation of plant traits to create new, improved varieties. The CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a third-generation gene editing technology. CRISPR/Cas9 technology has revolutionized the plant breeding field, providing scientists with a strong tool to edit plant genomes with unprecedented precision. In this article, we will explore the science behind CRISPR-Cas9 technology, its applications in plant breeding, and the ethical considerations surrounding its use.

The science behind CRISPR-Cas9 technology

CRISPR-Cas9 is a gene editing tool that uses a system of bacterial immune defence to make precise, targeted changes to DNA sequences. The system relies on a protein called Cas9, which acts like a pair of molecular scissors, and a small RNA molecule known as single guide RNA (sgRNA), which directs Cas9 to cleave the target DNA strand, leading to a double strand break (DSB). These breaks can be repaired by Non-Homologous End Joining (NHEJ) or Homology Directed Repair mechanisms (HDR). In NHEJ, the ends of DSBs are linked by the DNA ligase enzyme directly and it does not depend on the homologous DNA sequences. Thus, it is a fast repair process but is not accurate. Whereas, the homologous repair procedure is complex but accurate as It can only take place in the G2/S phase of the cell cycle and needs for a homologous DNA sequence template.

A novel target gene modifying technique has been developed based on the CRISPR/Cas system i.e., base editing technology. It utilizes a tethered deaminase domain for base conversion from A>G or C>T or C>G even in the absence if the donor DNA. Base editors are recently used to create single and multiple nucleotide alterations in the cells.

Mechanism of Cas9 protein

The Cas9 protein comprises six domains, namely

(1) Recognition lobe (REC I)

(2) REC II

(3) Arginine-rich bridge helix

(4) PAM Interacting

(5) HNH, and

(6) RuvC

The REC I domain plays a crucial role in binding with the gRNA, while the specific function of REC II has not been thoroughly investigated. The arginine-rich bridge helix triggers the cleavage activity once it binds to the targeted sequences. The interaction with PAM (Protospacer Adjacent Motif) determines the specificity towards PAM sequences, which is crucial for binding with the target sequence. The HNH and RuvC domains serve as nuclease domains, responsible for cutting/chopping the target sequence.

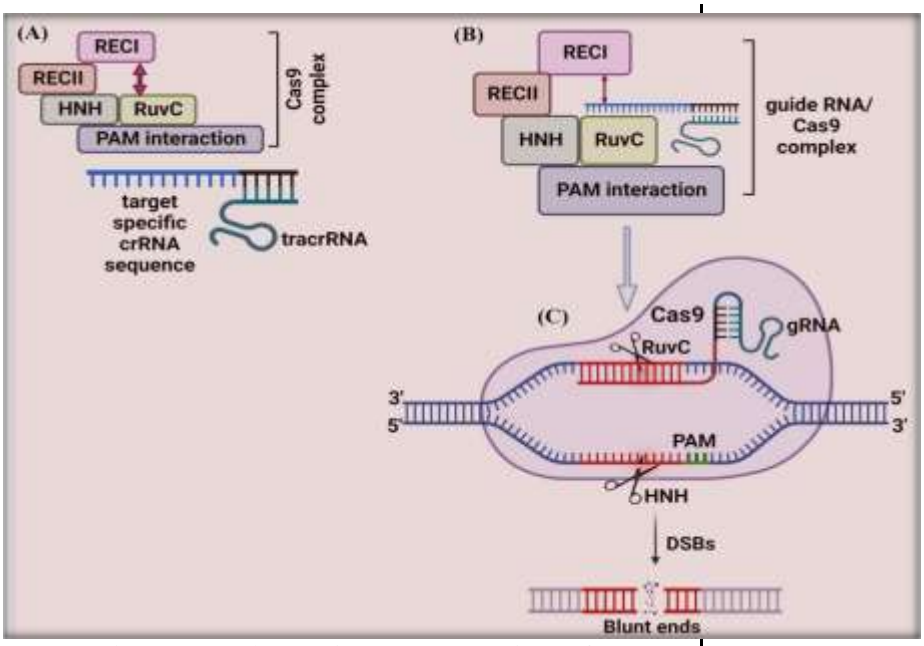

Figure 1: Schematic representation of CRISPR/Cas9 mechanism

(Source: Hillary *et al.*, 2023)

The inactivity of the Cas9 protein is attributed to the absence of guide RNA (gRNA). The engineered gRNA adopts a T-shaped structure, consisting of one tetra-loop and three stem-loops. The gRNA is designed to have a complementary 5′ end that matches the target sequence. Upon binding to Cas9, the programmed gRNA induces conformational changes in the protein, transforming the inactive Cas9 into its active form.

Upon activation, Cas9 surveys the DNA in search of a corresponding sequence that matches the PAM sequence (5′-NGG-3′). Following this identification, Cas9 employs its HNH and RuvC domains to cleave the double-stranded DNA, precisely three base pairs ahead of the PAM site. The HNH domain acts on the DNA strand that complements the 20-nucleotide sequence found in the gRNA's crRNA (known as the target strand). Simultaneously, the RuvC domain cleaves the non-target DNA strand, positioned opposite to the complementary strand.

In the spyCas9 system, the recognition of the target DNA involves identifying a short "seed" sequence containing the di-nucleotide 5'-NGG-3' with a PAM sequence. The tracrRNA:crRNA complex is fused together to form a single guide RNA (sgRNA), allowing the CRISPR/Cas9 system to cleave the targeted double-stranded or single-stranded DNA sequences.

Potential applications of CRISPR-Cas9 in plant breeding

The ability to edit the genome of plants using CRISPR-Cas9 technology has significant implications for plant breeding. It enables plant breeders to precisely edit specific genes associated with desired traits, leading to the development of crops with higher yields, enhanced resistance to pests and diseases, and improved tolerance to environmental stresses.

One area of focus for CRISPR-Cas9 in plant breeding is disease resistance. By targeting genes responsible for susceptibility to particular diseases, researchers can develop plants that are resistant to those diseases. This can lead to reduced use of pesticides and herbicides, as well as increased crop yield and quality.

Another area of focus is the improvement of nutritional content in crops. With the help of CRISPR-Cas9, plant breeders can target specific genes responsible for the production of essential vitamins and minerals, thus improving the nutritional value of crops. For example, scientists have used CRISPR-Cas9 to develop rice plants that

are enriched in beta-carotene, which the body converts to vitamin A.

Finally, CRISPR-Cas9 technology can also be used to develop crops with improved tolerance to environmental stresses such as drought, salinity, and extreme temperatures. By editing genes associated with stress response pathways, plant breeders can develop crops that can thrive in challenging environments, leading to improved yield and food security in regions that are prone to such stresses.

Base editing in plants allows for precise genome editing and has been used to edit the genomes of a number of plant species, such as rice, cotton, maize, oilseed rape, strawberry, tomato and watermelon. Base editors have contributed to a large extent in increasing the yields, improving herbicide resistance, and increasing stress tolerance.

Regulatory and ethical considerations

The use of CRISPR-Cas9 technology in plant breeding raises some regulatory and ethical considerations. While the technology is more precise and efficient than traditional breeding methods, it is still considered a form of genetic modification, which raises concerns about safety and potential environmental impacts.

In some countries, CRISPR-Cas9 edited plants are subject to regulation as genetically modified organisms (GMOs). This means that regulatory authorities require safety assessments before the plants can be released into the environment. The regulatory framework for CRISPR-Cas9 edited plants varies across countries, with some countries being more permissive than others.

In addition, there are ethical considerations related to the use of CRISPR-Cas9 in plant breeding. Some people argue that the technology should only be used to address pressing global challenges such as food security, while others raise concerns about the potential unintended consequences of editing the genome of organisms.

Regulation of CRISPR-Cas9 Technology: The use of CRISPR-Cas9 technology in plant breeding is currently subject to regulation in many countries. In the United States, for example, plants created using CRISPR-Cas9 technology are subject to the same regulations as conventionally bred plants. However, in the European Union, plants edited using CRISPR-Cas9 are subject to the same regulations as genetically modified organisms (GMOs), which are subject to more stringent regulations. This has created a regulatory grey area, as many argue that plants edited using CRISPR-Cas9 should not be subject to the same regulations as GMOs.

Future of CRISPR-Cas9 Technology in Plant Breeding: The future of CRISPR-Cas9 technology in plant breeding is bright. As the technology becomes more widely available and affordable, it has the potential to revolutionize the way we breed crops. It can be used to create crops that are better suited to changing climates, reducing the environmental impact of farming, and feeding a growing world population. However, it is important that the technology is used responsibly, with careful consideration of its potential impact on the environment and society.

Conclusion

CRISPR-Cas9 technology has the potential to revolutionize plant breeding by enabling precise and efficient editing of plant genomes. It offers the ability to develop crops with improved yield, disease resistance, nutritional content, and tolerance to environmental stresses.

However, the technology also raises regulatory and ethical considerations that need to be carefully addressed. As the technology continues to evolve, it is essential to strike a balance between the potential benefits and the potential risks associated with the use of CRISPR-Cas9 in plant breeding.

Overall, CRISPR-Cas9 is a promising technology that has the potential to contribute to global food security and sustainable agriculture. Its applications in plant breeding continue to expand, and scientists and policymakers must work together to ensure that its use is safe, ethical, and beneficial to society.

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Is Plastic Packaging a Real Threat the Environment? What is the Better Alternative to Safer Food Packaging?

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No, not if you dispose the plastics by considering the environmental hazards that can arise if they are not handled properly. Many of us have forgotten, whether intentionally or unknowingly, that plastic has become an integral part of day to day's activity. We have only been educated about its negative impacts on the environment, yet on the other hand it offers benefits too. If there were no plastic on the planet, we would have to rely on wood-based packaging material at their peak. And this would lead to a rise in and exploitation of other packaging material, resulting in global warming. Plastic as a packaging material is light weight, robust and compatible with wide range of commodities, making it suitable for multiple applications (Tyagi *et al*., 2021). One might be surprised to hear that; plastic materials have a beneficial impact on resource usage and emission reduction. When compared to alternative packaging materials, the commodity, which may be fruits, vegetables, electrical, pharmaceutical etc., when packed provides hygienic products and a purpose to buy the same (Barage *et al*., 2022).

Though plastic has various uses, we have been addicted to its one-time use and followed by its disposal which leads to serious environmental issues (Opeolu Olukunle, 2019). Every minute over one million drinking water bottles have been purchased and disposed, in general about half of the all-produced plastic materials are designed and used only once and thrown away. Importance of plastic and its utilization started from 1950's. During 1950's to 70's, only small amount of plastic has been manufactured and relatively less waste. By 1990's, plastic manufacturing was tripled and in the early 2000's the plastic waste has grown tremendously (Lebreton *et al*., 2019). Currently we are producing around 300 million tons of plastic waste, which is nearly equivalent to the weight of the human population on the earth (McGinty, 2020).

According to researchers, it is estimated that around 60 % of the plastic has been ended either in natural environment or in landfills. There is a need to minimize the use of plastic and manage the waste in a right way (Law & Narayan, 2022). We must know that rivers carry the plastic waste from the land and adds to oceans, if the present trend continues, there will be a greater number of plastics in the ocean rather than fish by 2050 (Ciner *et al*., 2023).

The concept of non-biodegradability plastic has become a source of research in current era; we cannot eliminate plastic from the planet since it has resulted in numerous inventions in its own field (Koh & Khor, 2022). To reduce waste and make it more efficient, one must adopt the reuse, reduce, and recycle concept, which we have been hearing since ages (Long *et al*., 2022). So, where are we going wrong?

Humans are becoming irresponsible, as we throw plastics and other thrash as land fill, which eventually ends up in the sea or river, causing pollution. There is a need to inculcate basic principles about the usage and handling of plastic. After using any plastic material, whether it is plates,

water bottle or a bag, wash it with clean water and crush the bottle or plates before disposing into separate garbage and handing it over to a plastic recycling agency (Weber Macena *et al*., 2021).

Along with the basic principles of reduce, reuse, and recycle, lets us also educate and create awareness among the public about handling and disposal. Let us recognize that plastic is not a burden but a manageable gift, and that it is in our hands to maintain the balance in the environment. If we can behave responsibly, we have the potential to make a significant impact on the economy.

Consumers and governments are becoming more aware nowadays that recycling plastic will not cut it when it comes to sustainability. Brands have been thinking about compostable packaging because the materials used mostly decompose in the environment, leaving a footprint that is significantly smaller than that of conventional plastic and even enriching the earth by creating an agricultural compost end-product that improves crop yields, helps soil retain water, and captures more carbon.

The better alternative to plastic food packaging material is eco-friendly packaging material. In recent years, edible coatings and films have drawn a lot of interest. Polysaccharide, lipid, and protein-based materials utilized in edible packaging, as well as their composites, clearly have advantages over synthetic films. It might assist in lowering environmental pollutants.

Consumer Demand

Consumer preferences are changing with regards to the purchase of food products, and people are becoming more conscious of the existence, function, and consequences of the food packaging that surrounds their retail food purchases (Chirilli *et al*., 2022). Additionally, consumers are choosing the biodegradable wooden spoons and paper straws that come with food packing. Paper or biodegradable materials are replacing single-use plastic straws, closures, lids, caps, and food trays in the food service industry. Due to rising consumer desire for prepared and packaged meals, there will be an increase in the market for green food packaging (Asawadechsakdi & Chavalkul, 2021).

Why choose Biodegradable packaging?

The fact that biodegradable packaging is environmentally friendly is its main advantage.

Free of Toxic Materials

Biodegradable packaging is a perfect substitute for plastics that would otherwise release dangerous chemicals into the atmosphere and remain in landfills for years because it is free of poisonous substances and compounds like phthalates or petroleum (Wojnowska-Baryła *et al*., 2022).

Convenient Disposal

Regardless of the type, companies should use recyclable or biodegradable packaging and delivery supplies. Given that biodegradable materials are used in eco-friendly packaging, it facilitates the disposal of shipping supplies. It takes fewer resources to disassemble the package once its purpose has been served. Customers who decide to compost their garbage can easily mix recyclable materials with biodegradable shipping and packaging materials. This procedure may also be advantageous to the environment (AZMI *et al.,* 2022).

Versatility

Flexible packaging is a fundamental benefit of biodegradable transportation goods. The majority of big industries often have the ability to reuse packaging and transportation materials. Whether the company needs packaging for electrical devices or

office supplies storage, there is unquestionably an eco-friendly material that can suit its needs (Escursell *et al.*, 2021).

Sustainability

Most of the used resources fall under one of the three sustainability criteria of reduce, reuse, and recycle (Yu *et al.*, 2021). Reduce focuses on using more durable yet lightweight materials that might be able to complete the same task as more powerful ones with less effort.

Reuse focuses efforts on creating items that can be used again after serving their primary purpose. Recycling each item is encouraged by creating more reliable and secure transportation materials for consumers and businesses. Naturally, recycling is focused on producing products that are mostly made of recycled materials. The bundled good can then be recycled by the business or the client.

Conclusion

Instead of concentrating on only one aspect of sustainability, packaging converters must adopt a comprehensive strategy. The survey's findings demonstrate that consumers want to see change in a variety of environmental fields. It will be vital to adopt environmentally friendly food packaging materials when packaging players respond to them so that customers can see and comprehend the sustainability story.

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Edible Coatings for Improving Quality and Shelf Life of Fresh Vegetables

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Vegetables, by virtue of their high (80-90%) water content, are highly perishable in nature and, therefore, post-harvest losses in vegetable crops are estimated to be around 20%. Majority of the losses in quality and quantity of fresh vegetables occurs between harvest and consumption. Most of the vegetables are botanically fruits, *e.g.*, tomato, eggplant, hot and bell pepper, okra, cucurbits, peas and beans etc., which continue some physiological processes like respiration and ethylene production even after harvest. These lead to gradual maturation and eventual senescence of the produce, and render them susceptible to contamination by enzymatic reactions such as browning, off-flavour development and texture breakdown and/or microbial attack. To alleviate the wastage of vegetables and extend their shelf life, it is essential to explore new methods of preservation. Several techniques like controlled atmospheric (CA) storage and modified atmosphere packaging (MAP) are already in use, however, edible coatings can provide an alternative to these methods. In fact, during the past two decades, there has been an increase in interest in the development and use of edible coatings to improve the shelf life and enhance the quality of fresh vegetables.

What are edible coatings?

Edible coatings are the thin layers (thickness <10 µm) of edible polymer materials that are directly applied over the fresh produce so as to prolong their shelf-life. They are generally prepared from biodegradable polymers as an alternative to the non-degradable packaging materials which generate large amounts of waste and cause environmental pollution. Edible coatings are affordable; non-polluting; possess good organoleptic properties, mechanical strength, biochemical and microbial stability; serve as moisture and gas barrier; and are safe for human consumption, *i.e.*, non-toxic.

How do edible coatings work?

Vegetables continue to respire even after harvest and use up all the oxygen within the produce, which is not replaced as quickly as by edible coating. The resultant carbon dioxide builds up inside the produce since it cannot escape as readily through the coating. Vegetables eventually transition to partial anaerobic respiration, which uses 1-3% less oxygen. Low oxygen concentration disrupts ethylene production (which accelerates ripening process) is disrupted and physiological loss of water is minimized. Thus, the vegetables remain firm, fresh and nutritious for longer period and their shelf life almost doubles. The natural barrier on fruit and vegetable, and the type and amount of coating influences the extent to which the internal atmosphere (oxygen and carbon dioxide) is modified.

Furthermore, studies have demonstrated that edible coatings containing antimicrobial agents, such as organic acids, essential oils from plants and polypeptides, prevent microbial growth on the produce (Nandane *et al.*, 2017). Edible coatings can reduce enzymatic activity, minimize browning reaction and softening of the texture. In addition, they have the potential to maintain the natural

volatile flavour compounds and colour components (Sapper and Chiralt, 2018).

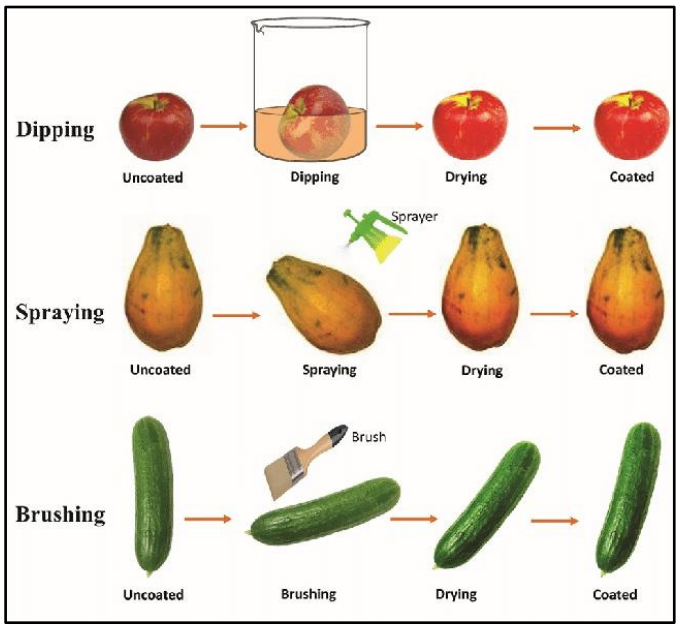

Fig 1: Methods of application of edible coatings on fresh produce

Salient features of edible coatings

Some of the specific requirements for edible coatings are as follows:

i. The coating should be water-resistant and cover the produce appropriately.
ii. It should reduce transpiration.
iii. It should neither deplete oxygen nor build up excess carbon dioxide.
iv. It should improve appearance of the produce.
v. It should be translucent to opaque and possess mechanical strength.
vi. It should be easily emulsifiable and non-sticky, and have good drying performance.
vii. It should not interfere with the quality of the fresh produce.
viii. It should melt above 40˚C without decomposition.

Vegetables that can be coated

Edible coatings can be applied on whole as well as fresh-cut vegetables. Vegetables that are coated as whole include tomato, bell pepper (capsicum), cucumber and melons.

Fresh-cut vegetables undergo physical stress while peeling, cutting, slicing, shredding etc. and the removal of their skin makes them highly perishable. Edible coatings are commercially applied on minimally processed carrot and onion; and fresh-cut lettuce, cabbage, tomato and muskmelon.

Method of application of edible coatings

The surface of fresh vegetables are coated with edible coatings by dipping, brushing, spraying or layer-by-layer (LBL) deposition technique followed by drying.

Composition of edible coatings

Edible coatings can be produced from materials which have the ability to form film. Film components must be disseminated and dissolved in a solvent during production, such as water, alcohol, a blend of the two, or a combination of various solvents. Antimicrobials, plasticizers, vitamins, minerals, colours or flavours may be added. The pH of the solution can be changed or the solution can be subjected to heat for effective dispersion depending on the polymer. To create free-standing films, the solution is then cast and dried at the correct temperature and relative humidity.

Polysaccharides, proteins, lipids and other substances may be found in edible coatings, none of which can provide the required protection by themselves. Therefore, they are used in combinations to get the best results.

Polysaccharides

These polymers are derived from marine and agricultural plants and animals. These coatings have been used to prevent moisture loss from produce

Table 1: Specific edible coating applications to different vegetables

Coating material	Composition	Vegetable	Effect of coating	References
Semperfresh™	Sucrose esters with high proportion of short-chain unsaturated fatty acid esters, sodium salts of CMC and mixed mono and di-glycerides	Zucchini	Reduced moisture loss and internal CO_2 of fruit	Avena-Bustillos *et al.*, 1994
		Tomato	Reduced colour changes, retained acid, increased shelf life and mainatained quality	Tasdelen and Bayindirli, 1998
Nature-seal™	Cellulose-based edible coating	Carrot	Retarded discoloration and carotene loss, and is a barrier for O_2 diffusion	Chen *et al.*, 1996
Chitosan	Chitosan and Tween 80	Cucumber and bell pepper	Antimicrobial coatings	El-Ghaouth *et al.*, 1991
		Carrot	Reduced decay and improved appearance	Cheah *et al.*, 1997; Li and Barth, 1998
Zein	Corn zein protein	Tomato	Delayed colour change, loss of firmness and weight, and extended shelf life	Park *et al.*, 1994
Brilloshine	Sucrose esters and wax (shine)	Melons	Increased shine and extended shelf life	Baldwin, 1994
Cellulose	MC and glycerol	Carrot	Extended storage life, resulting in more carotene than control	Li and Barth, 1998

during short-term storage. However, due to their hydrophilic nature, polysaccharides are not effective as physical moisture barriers. They serve as a sacrificial moisture barrier to the environment, so that the moisture content of the coated produce can be preserved. Various polysaccharide coatings not only reduce moisture loss but also decrease oxygen permeability. The commonly used polysaccharides included in edible coating formulations are cellulose and its derivatives; starch and its derivatives; chitin and chitosan; alginates and carrageenans; and pectin.

Proteins

Protein coatings are the least developed material for use as edible coating. Proteins are hydrophilic in nature and are susceptible to moisture absorption. Generally, proteins must be denatured by heat, acid, alkali or solvent to form extended structures that are required for film formation.

Protein films are expected to be good oxygen barriers at low relative humidity. The most commonly used protein-based edible coatings are gelatin, wheat gluten, corn zein, casein (milk protein), keratin, collagen and whey.

Lipids

Lipid coatings are mainly used for their hydrophobic properties, which makes them good moisture barriers. They can also reduce respiration and add shine on the vegetables, thereby extending shelf life and improving appearance. The most effective lipid substances used as edible coatings are beeswax and paraffin wax.

Advantages of edible coatings

i. Improve external appearance of vegetables by adding shine to their surface.
ii. Reduce physiological loss of weight (PLW) and maintain firmness of the produce.
iii. Delay senescence of vegetables by reducing rate of respiration and ethylene production.
iv. Prevent vegetables against chilling and freezing injuries, and storage disorders.
v. Coats the vegetables with antioxidants, vitamins and pigments that prevent enzymatic actions.
vi. Reduces the use of synthetic packaging materials.

Conclusion

At the moment, most of the studies related to application of edible coatings on vegetables have been conducted at a laboratory scale. However, future research focused on a commercial scale needs to be carried out. Lastly, more studies are necessary to understand the interactions among the components of edible coating materials. When active ingredients, such as antioxidants, antimicrobials and nutrients are added to edible coatings, they dramatically affect the mechanical, sensory and even functional properties of vegetables.

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Maintenance of Happy Seeder

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Source: KS Agrotech Pvt.Ltd.

Happy Seeder (HS) or Turbo Happy Seeder (THS) is a tractor-operated machine developed by the PAU in collaboration with Australian Centre for International Agricultural Research (ACIAR), for in-situ management of paddy stubble (straw). Happy Seeder technology (in situ paddy residue management technology) helps in timely sowing of wheat, saving of irrigation water, less infestation of weeds and reduces environment pollution due to non-burning of paddy residue. Normally Krishna Happy Seeder, Weight: 700kg at Rs 150000 in Cheeka | ID: 20602839933 is a good example of happy seeder. The main function of a seeding machine or seeder is a machine used in agriculture which sows seeds for crops by dropping seeds into a straight furrow within the soil at precise rates and specific depths. Happy Seeder is the ideal solution since it sows seed and removes the straw at the same time, scattering it evenly across the field, thus mulching the field and helping it retain its moisture, and encouraging seed germination. The straw naturally decomposes over time, enriching the soil. The field capacity i.e., 0.28 ha/h was recorded in case of happy seeder and corresponding field efficiency was found 52.80%. Draft requirement for seed drill was 4.98 KN whereas, for happy seeder it was 7.2 KN. Total time saving was found 71.84% and 79.17% in treatment T1 and T2 respectively over conventional method. With Happy Seeder, stubble of paddy remains in the field for a long time even after growing of the wheat crop. The Happy Seeder, an attachment that latches onto the back of a tractor, shreds agricultural waste and redistributes it as mulch while at the same time planting seeds for a new crop. It is one of several technologies that can be used to prevent the open burning of agricultural waste.

Maintenance of the Happy Seeder

The Happy Seeder is a tractor-mounted machine that cuts and lifts rice straw, sows' wheat into the soil, and deposits the straw over the sown area as mulch.

Happy Seeder is the best enhancement for sowing seeds and spreading fertilizer in the field. It can be attached and run with a tractor delivering power 50 HP or more. There are ten tines to sow seed or spread fertilizer and maintain a proper row distance of 228 mm. This implement can be easily

attached and can deliver a high rate of sowing in the field without any disturbance in the integrity of the soil. In fact, the machine enhancement makes a farmer capable of sowing wheat just after harvesting rice from the same field. The technical specification of a Happy Seeder is given as under.

Technical Specifications of Happy Seeder Machine

Power Source	50 Hp Or Above Tractor
Hitch Type	Three Point Linkage
No. Of Tynes	10 NOS
Row To Row Distance	228 MM
Type Of Furrow Openers	Inverted T- Type
Rotating Shaft Diameter	137.90 MM
Type Of Blades	Rectangular One Pair In Form Of Inverted

Metering Mechanism

For Seeds	Fluted Roller
For Fertilizer	Fluted Roller
Length	1750 MM
Width	2640 MM
Height	1555 MM
Mass (KG.)	650 KG (approx.)

Clean the seeder regularly; after use, clean the seeder thoroughly to remove any debris, dust, and dirt that may have accumulated during the seeding process. Lubricate moving parts: Lubricate all moving parts of the seeder, including the seed metering mechanism, chains, and bearings, to ensure smooth operation and prevent wear and tear. A happy seeder of nine furrow opener was tested were found with following performance of happy seeder.

- The operating speed of happy seeder could be varied from 2.5 to 3.5 kmph, working of happy seeder was found to be optimum at the speed of 3.5 kmph.
- The fuel consumption with happy seeder for sowing wheat varied from 4.12-4.36 l/hr and for seed drill 2.96-3.71 l/hr at different operating speed.
- The field capacity of happy seeder at 3.5 kmph was 0.29 ha/hr and for seed drill 0.435 ha/hr
- The field efficiency for happy seeder 43.4% and for seed drill was 65%
- The cost of operation per hectare by happy seeder was Rs. 2098.65 and cost of operation per hectare by seed drill + tillage operations was Rs. 3106.38.
- Therefore cost of operational with happy seeder is economical as compared to seed drill by Rs. 1008.38 per hectare.
- The crop residue was 0.830 kg/m2, 0.832 kg/m^2 and 0.839 kg/m^2 of different plots for happy seeder. The crop residue was found heavy.
- The farmer felt that the happy seeder reduce the labour requirement, they appreciated the fact that the use of happy seeder would make the sowing timely and essay, it is water saving and ecofriendly and farmer says it also controls weeds.

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Trichoderma: Biocontrol of Fungal Phytopathogens in Sustainable Agriculture

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Various actions and strategies of sustainable food production systems, such as Integrated Pest Management (IPM) and organic farming, are taken to protect the environment from the negative effects of chemical fungicides. Biological Control Agents (BCAs), which are based on living microorganisms or their metabolites, and natural products that control the population of plant pathogens, are one of these strategies. The majority of effort has been expended over the last several decades to investigate the efficacy and practicality of non-pathogenic bacteria and fungi in the hope of commercializing them as BCAs. As a result of the research, a large number of bacterial and fungi, one of the important fungi is *Trichoderma* which have been used as BCAs. The efficiency with which Trichoderma can be used in agriculture is determined by their metabolic activity and the type of interaction they have with plants and other microorganisms.

Bioremediation through Trichoderma

Trichoderma strains play an important role in the bioremediation of pesticide and herbicide-contaminated soil. They can degrade a wide range of insecticides, including organochlorines, organophosphates, and carbonates. It improves soil fertility, increase plant shoot and root growths, enhances flowering of the crops, increases phosphate uptake and increases resistance in plant against plant pathogens.

These fungi colonise the rhizoplane, rhizosphere, and plant roots effectively and produce a variety of metabolites with anti-microbial (cell wall degrading enzymes, antibiotics, volatile and non-volatile compounds) and bio stimulant (phytohormones, Phyto regulators) properties. Furthermore, Trichoderma is known for its intensive absorption of root schedules and interactions with not only pathogenic microorganisms, but also the entire soil microbiome.

Characteristics of Trichoderma

- The success of species belonging to the genus *Trichoderma* as biocontrol agents in the soil ecosystems results from their ability to rapid growth, the possibility of utilizing a variety of substrates, and resistance to many toxic chemicals, including fungicides (e.g., azoxystrobin, 3,4-dichloroaniline, and trifloxystrobin), herbicides, and other organic pollutants.
- *Trichoderma* was found to degrade some toxic contaminants through enzymes involved in cellulose/lignin degradation that have been shown to have xenobiotic-metabolizing enzyme potential.
- Trichoderma is a potent biocontrol agent and used extensively for soil borne diseases. It has been used successfully against pathogenic fungi belonging to various genera, viz. Fusarium, Phytopthara, Scelerotia etc.
- Trichoderma is not only abundant in the environment and easy to isolate, but it can also be easily multiplied under controlled conditions

on a variety of substrates and stored for months without losing viability or properties.

- Trichoderma reduces the occurrence of plant diseases through competition for nutrients and space, the synthesis of antifungal metabolites, mycoparasitism, the production of lytic enzymes that degrade fungal plant pathogen cell walls, and the induction of plant resistance.
- The most effective biocontrol properties are mainly attributed to the *T. virens*, *T. harzianum*, *T. koningii*, *T. longibrachiatum*, *T. asperellum*, *T. polysporum*, and *T. viride*, which have a significant impact on the development of plant diseases caused by *Rhizoctonia solani*, *Sclerotium rolfsii*, *Pythium aphanidermatium*, *Fusarium oxysporum*, and *Fusarium culmorum*, both under greenhouse and field conditions.
- The application of *Trichoderma* strains to the soil increased the productivity and quality of crops of monocotyledons and dicotyledons, such as cucumbers, tomatoes, carrots, beans, corn, cotton, tobacco, millet, and ornamental grasses.

How to apply

- Seed Treatment: Before sowing, mix 6 - 10 g of Trichoderma powder per Kg of seed.
- Nursery treatment: 10 - 25 g Trichoderma powder per 100 m2 nursery bed. The use of neem cake and FYM prior to treatment improves efficacy.
- Cutting and seedling root dip: In a litre of water, combine 10g of Trichoderma powder and 100g of well-rotten FYM, and dip the cuttings and seedlings for 10 minutes before planting.
- Soil treatment: After turning sun hemp or dhaincha into the soil for green manuring, apply 5 kg of Trichoderma powder per hectare. Alternatively, combine 1kg of Trichoderma formulation with 100 kg of farmyard manure and cover with polythene for 7 days. Sprinkle the heap with water intermittently. Turn the mixture in every 3-4 days interval and then broadcast in the field.
- Combination of soil application and leaf sprays with Trichoderma based bio preparate appears to be the most effective one, however, the increased quality and quantity of the yield in treated pepper plants may be due to the production of plant growth promoters or through indirect stimulation of nutrient uptake as well.

Conclusion

The Trichoderma and plant pathogen interaction is a complex and dynamic system. A thorough understanding of Trichoderma mechanisms toward plants and pathogens can significantly improve their effectiveness. Trichoderma employs a number of complex direct and indirect biocontrol mechanisms, both against biotic stresses (pathogenic microorganisms such as fungi, bacteria, insects, and nematodes) and abiotic stresses (unfavorable environmental conditions). Trichoderma has the ability to combine several benefits in one product, including the control of various plant diseases, the enhancement of plant growth, and the provision of a clean environment for the benefit of sustainable agriculture.

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Organic Moringa Cultivation – A Success Story of a Salem Farmer

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Organic agriculture started a century ago in the European Countries. Though it was neglected initially, the importance of organic cultivation of agricultural and horticultural crops has been accepted in the last two decades and given much importance. The hazardous effects of the chemical fertilizers on human as well as on environment has created awareness among the farming community in switching over to the organic cultivation practices. Also use of organic fertilizers would also reduce the depletion of natural resources.

Organic farming systems mainly rely upon crop rotations, crop residues, animal, manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, powders of mineral bearing rocks and biological pest and disease management methods. These components maintain soil productivity and tilth, supply plant nutrients and help to control insects, weeds and other pests.

Among the vegetable crops, moringa can fit very well as a candidate crop for organic cultivation. India is the largest producer of this nutritionally and medicinally important, fast growing, drought tolerant, hardy crop capable of getting adapted to varied ecosystems.

Area under vegetable crops is more than 15250 ha and area under Moringa cultivation in Salem district is around 50 ha. The farmers growing moringa in Salem district especially in Veerapandi block and Kadayampatti blocks, are only small and marginal farmers and are getting only lower net profit (in spite of better yield) because of the involvement of middleman in the supply chain of moringa as vegetable to the consumers. There is a huge scope in organic moringa due to its nutritional richness with medicinal properties too. Hence Krishi Vigyan Kendra, Salem, intervened with on campus and off campus trainings on moringa cultivation in organic manner. Apart from these regular trainings, KVK, Salem also organized many training programmes like Skilled trainings, Sponsored trainings and Entrepreneurship Development programmes for farmers, farm women and rural youth on production of organic inputs, organic farming and value addition etc. and different ways and means for marketing of the products. One of the impacts of the above initiatives of Salem Krishi Vigyan Kendra, a farmer named Sakthivel. M from Govinthapuram village near V. Muthampatti of

Kadayampatti block turned into an organic farmer to cultivate organic moringa pods and leaves for more than four years. Recently he has got an organic certification for his moringa products also.

He planted perennial moringa type at a distance of 6 x 6 m distance with two plants in pit at 2 feet distance. Planting of two plants at a pit resulted in providing tolerance against heavy wind. Regarding intercultural operations pinching was done at 30 days after planting at 20 days interval. It has been carried up to 4 months to get around 50 to 60 branches per plant. For flowering it takes only 75 days after pruning. He observed three seasons of flowering in a year (January - February, June and August) which resulted in three harvesting seasons such as March – May, July – August and October-November respectively. Among these three seasons, March to May harvesting is the main and extended season of fruiting.

He applied 10 kg of farm yard manure per plant with drip irrigation once in 10 days. It is recommended to apply additional 5 kg of vermi compost and each 100g of biofertilizers like Azospirillum and Phosphobacteria. Besides application of 3 % panchagavya as foliar spray resulted in better growth and development. For plant protection aspect, for managing moringa pod fly attack, he used to prepare his own pest repellent using urine of indigenous cattle breeds and plant leaves such as Adathoda, Vitex (nochi), Calotropis (Erukku), Wrightia tinctoria (veppalai) etc.,

Regarding the marketing of moringa, he relies only the markets of Salem and nearby districts like Dharmapuri, Krishnagiri etc., He also supplies the moringa pods and leaves to Sarabanga Farmer Producer Company in which he is also one of the members.

By witnessing the success of organic moringa production, many fellow farmers are also started cultivating moringa and trying to turn into organic methods of moringa cultivation. Thus, he is one of the pioneers in organic moringa cultivation in Salem District. The mentality of the farmers of other blocks of Salem district, like Veerapandy, Peddanayakkanpalayam also has slowly changed towards organic moringa cultivation.

Hence, demonstrations and trainings conducted by Salem Krishi Vigyan Kendra imparted knowledge of moringa growers on cultivation techniques of moringa in organic manner for both pods and leaves. It ultimately resulted in improving social status of the farmers apart from increasing their income and net profit.

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Festivals -A Celebration of Culinary Diversity

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One of the world's most flavourful and delicate cuisines is Indian. Culinary diversity is one of India's treasures. Indian food is so diverse that it is better to speak of "Indian Cuisines." Each region offers a variety of traditional foods as well as its own unique culinary traits. Due to the presence of functional ingredients like probiotics, dietary fibre, antioxidants, and body-healing compounds, traditional foods from India are also considered as functional foods.

Karnataka is blessed with a wide range of flora and fauna. In this region of the country, many of the people still rely on traditional foods and medicines to treat illnesses. Since ancient times, these communities have sourced their nutraceuticals from both wild and domesticated plant species. These customs are typically connected to local festivals and ceremonies, as well as the various seasons.

Festivals– An Expression of Culinary Diversity

"Let food be thy medicine and medicine be thy food." is a well-known quote by Hippocrates, the father of medicine. "Food as medicine" is emerging as an important concept in managing health and wellness. Particular foods produced especially for festivals have a long tradition of being made as deity gifts and have several health advantages.

Ganesh Chathurthi – The Festival of Hope and Prosperity

Ganesh Chaturthi, also called Vinayaka Chavithi, is an auspicious Hindu festival celebrated in the Bhadra month as per the Hindu calendar and marks the birthday of the beloved Lord Ganesha known as the God of wealth, sciences, knowledge, wisdom and prosperity.

As per the mythology of Ganesha, after consuming the demon Anasur, he faced a lot of irritation and acidity, attributable to a heavy meal. When everything else failed, durvas were offered to him, which gave him relief. Durva grass (Garike) assists in maintaining the alkalinity of the body; thereby it acts as a natural blood purifier. The festive cuisine includes puri, bhaji, dal rice, green sabzi, and favourite desserts like modak, laddoos, coconut barfi, and holige. Chakkali, Poha, Aloo Pakora, and Kothimbir (Coriander) Vada are a few snack items that are commonly offered to Ganesha., This balance diet offers the body the necessary macronutrients, micronutrients, and fluids in the right amounts and helps people maintain their ideal body weight and lowers their chance of developing chronic diseases.The nuts in modak contain unsaturated fat, omega-3 and vitamin E, which prevent the development of plaques in arteries. Coconut has no

sodium or cholesterol, which helps to protect the heart and decrease blood pressure.

Makara Sankranti

The winter chill is dissipating as the sun has emerged. Many have abandoned their blankets to enjoy the sunshine on the roof while colourful kites circle the clear skies. It is the season of the year when Makar Sankranti is celebrated. And as with any festivity in India, it comes with many traditional delicacies like seasonal vegetables, rice, pulses, nuts, sesame seeds, and sugarcane.

There are a variety of signature dishes and ingredients associated with Makar Sankranti. Sweet delights are made with coconut, sesame seeds, cardamom, besan, jaggery, or milk. And for a good reason – these ingredients are no less than super foods. Jaggery or gud activates the digestive enzymes in our body, aiding digestion and flushing out toxins from our system. By providing minerals like zinc and potassium. Til (sesame seeds) are a powerhouse of protein, vitamins, dietary fiber, vitamin B_1 and D_2 along with phosphorous, iron, magnesium, calcium, manganese, copper, and zinc. Sesame seeds and oil can help with arthritis, maintain sugar levels, and lower blood pressure. It is mentioned in a document that an Indian physician, Sushruta, used ladoos made of sesame seeds, jaggery, and peanuts as an antiseptic to treat his surgical patients. The ghee is also rich in conjugated linoleic acid (CLA) and vitamins A, K2, and E.

Sharad Navaratri

The nine days of fasting known as Shardiya Navratri signal the beginning of the festival in many parts of India. The most significant is by lowering pittprakopawastha (excess heat in the body). "The heat causes neurological, metabolic, and hormonal problems. Through the consumption of fruits, buttermilk, or coconut water during a fast, the body is detoxified while also becoming more cooled down.

The festive meal of chana, poori and halwa in ghee on Ashtami or the eighth day is for a purpose. The ghee calms the pitta (heat) and vatta (air) dosha. Kala chana (black chickpeas) gives strength to the body by providing iron, phosphate and calcium, and other minerals which are a boon for the bones and haemoglobin. If a full meal is consumed as part of a fast, it comprises things made of singhara (water chestnut), sabudana (sago), kuttu (buckwheat), samak (barnyard millet) and makhana (foxtail nuts). Seasonal changes make allergies, restlessness, and irritability worse. The satvik meal restores equilibrium to the body by upsetting pitta and vatta, particularly in women's pelvic muscles. Sabudana is a healthy energy food that is very simple to digest and has a cooling impact on the body and is a rich source of carbs. Rajgira atta, also known as amaranth flour, is another delectable and healthful option to ordinary wheat flour. This is gluten free, protein dense and tastes precisely the same as normal flour.

Ugadi- The new year for Hindus

The beginning of New Year, is celebrated as Ugadi, GudiPadwa, and this festival ushers in new hopes and aspirations. Traditional Ugadi sweets like obbattu or hollige is prepared from toordaal, wheat flour, jaggery and ghee. So, it has carbohydrates, proteins, fats and fibre, all of these

you need for a balanced diet. Bevu bella or pachadi as known in Andhra and Telengana, is a symbolic dish to signify six different tastes of life. Six distinctly different ingredients are used in the dish shows six different flavours of life. All the family members are encouraged to taste it. It is customary to begin the day with Ugadi Pachadi, a combination of six tastes- sweet, bitter, spice, salt, sour and tangy as it is believed that life is a combination of various feelings and emotions. The six ingredients used in the Bevubella or pachadi are, neem flowers; which symbolise bitterness of life, tamarind symbolises the challenges we face, pepper powder is for anger or upsetting moments in life, raw mango symbolises surprises in life, salt is for zest for life and jaggery symbolise the sweet taste of life like happiness.

Deepavali- The Festival of Lights

Festivals are the biggest cultural events that not only bring people together but spread happiness in our lives as well. It's a festival on which people love to make lots of food and treat their loved ones with both sweets and savoury dishes. There is one vegetable, which is a must-cook on this festival, as it is said to bring wealth and prosperity to your home. Elephant Foot Yam, also known as suvarnagadde, is what it is. In many houses, it has been customary to prepare suvarnagadde ki Sabzi and serve it with poori. Making this curry on Diwali is thought to be auspicious as it is wonderful at reducing inflammatory responses in the body. It was probably done to make sure people ate this nutritious vegetable during the changing of the seasons, when one is more susceptible to seasonal illnesses. Moreover, it is reported to possess qualities that lower blood pressure and aid in the treatment of infections.

In conclusion, Indian cuisine, regardless of geography, is well-balanced, incredibly healthy, and nutrient-rich. It contains antioxidants, vital minerals, and vitamins that aid in digestion, hasten metabolism, and elevates cholesterol and blood sugar levels. The substances strengthen immunity, promote brain health, improve memory, and lower inflammation. In addition to adding a delightful taste, flavour, and perfume, Indian spices and herbs provide therapeutic and medicinal benefits. Even the festival fare is created for a fun and wholesome season.

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Surrogate Technology and its Applications in Aquaculture

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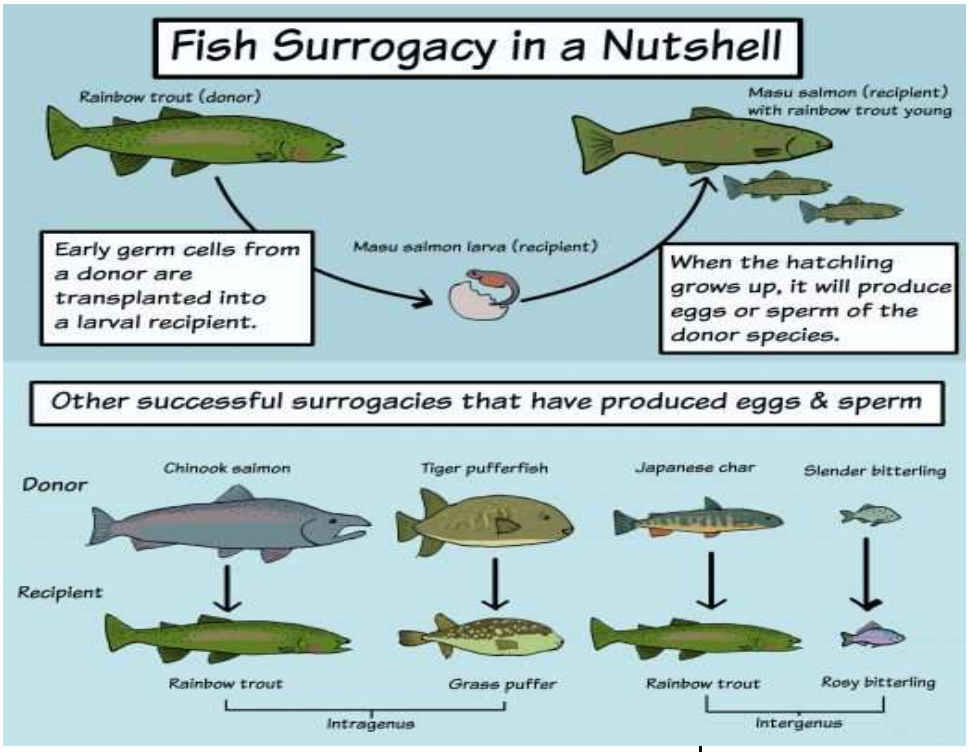

Source (Yoshikawa et al., 2018)

The process of creating donor-derived gametes in a surrogate fish through the transplantation of donor germ cells into a recipient of a different strain or species is known as "surrogate broodstock technology." Utilising germline chimaeras, surrogate propagation is a methodical process for creating donor-derived gametes. In the 1990s, zebrafish (*Danio rerio*) and medaka (*Oryzias latipes*), two model fish species, were employed to research germ cell development in fish. For effective gamete generation in model fish species and endangered species, surrogate propagation has been intensively researched. This method can be made possible by implanting a cell suspension from the testis or ovary into larvae as soon as they hatch. These cell suspensions include germline stem cells, which will eventually develop into sperm or eggs. It is crucial to extend the use of surrogate broodstock technology to more fisheries species and boost the effectiveness of donor-derived gamete production when doing so. Additionally, recipient larvae do not require the transplantation of donor-derived germline stem cells into their ovary or testis. A thin glass pipette is used to implant them into the intraperitoneal cavity, where they move on their own to the immature testis and ovary, where they are incorporated and start the spermatogenetic and oogenesis processes, respectively. The germline stem cells used for transplantation do not need to be purified (Yoshizaki *et al.*, 2019).

When testis or ovary tissues are dissociated by proteinase in preparing the cell suspension for transplantation, only germline stem cells migrate to the recipient's genital ridges for incorporation. In contrast, the remaining cells eventually die in the abdominal cavity. Therefore, germline cell transplantation comprises an extremely simple microscopic operation using a stereomicroscope and a coarse motion micromanipulator. In general, marine fish are kept as broodstock in sizable land-

based tanks, and fertilised eggs are collected using an egg collection net placed near the water exit of the tank. However, this approach is problematic for effective breeding techniques, such as selective breeding, which sometimes call for pairing certain parents with desired genetic features.

Some fish species' superior males and females can be artificially created using a maturity induction procedure that involves exogenous hormones. While collecting eggs or sperm, priceless parent fish can be lost because some marine species are extremely sensitive to handling stress. In vitro fertilised eggs typically have a lower survival rate than spontaneously produced eggs. Therefore, one must rely on spontaneous oviposition for fish species in which in vitro fertilization is difficult (Lacerda *et al*., 2013). It is difficult to get fertilised eggs from a few well-chosen individual fish in a tank of group-spawning marine fish (especially if only one male and one female are present). Extreme circumstances may prevent mating between males and females with superior qualities because they do not mature at the same time.

The lengthy generation times of many desirable aquaculture fish species are one of the main challenges to fish breeding. In order to minimise the generation time for breeding species for the aquaculture sector and fish research, mating experiments are essential in selective breeding programmes. It is feasible to significantly reduce the time required, as demonstrated by the example above, which describes the development of bluefin tuna from a little mackerel. We have successfully produced eggs and sperm of tiger puffer more quickly by transplanting germline stem cells of this species into grass puffer *Takifugu niphobles*. Generally, male tiger puffer requires 2 years to mature, whereas female tiger puffer fish require 3 years to mature. Reportedly, both sexes of the grass puffer can mature within a year when the water temperature is controlled and photoperiods. Similarly, it is now possible to produce eggs and sperm of Chinook salmon *Oncorhynchus tshawytscha* (which normally require 3–5 years to mature) in 1 and 2 years, respectively, when using rainbow trout as surrogate broodstock. Cryopreservation has not yet been fully adapted for fish because fish eggs are relatively large and rich in lipids and egg yolk (Yoshikawa et al., 2018).

Germline stem cells are tiny (about 10 m) and do not contain much lipid or egg yolk, making it simple to cryopreserve them in liquid nitrogen. It is well documented to freeze in liquid nitrogen the testis of immature individuals, which contains a significant number of immature spermatogonia, and it is potentially conceivable to keep germline stem cells within the testis in a frozen condition forever. In fact, our research team demonstrated that there was no decrease in the survival rate even after we thawed the rainbow trout testicles five years after they had been frozen in liquid nitrogen (Lee *et al*., 2013)

Additionally, it has been established that cryopreserved cells can create sperm and eggs even after they are thawed and transplanted into recipient fish. Gametes can also develop normally in the gonads of surrogate fish. As a result, cryopreservation is a potent technique for safeguarding priceless genetic resources because it doesn't call for any specialised or expensive equipment and is practical as long as liquid nitrogen and cryo containers are accessible. A combination of cryopreservation and transplanting of germline stem cells may be crucial for protecting the genetic resources of endangered species because there is currently no method for cryopreserving fish eggs.

Cryopreservation is a powerful method for preserving precious genetic resources as this technology requires no special and expensive

equipment and is feasible as long as liquid nitrogen and cryo containers are available. Because a cryopreservation technique for fish eggs is not yet available, a combination of cryopreservation and transplantation of germline stem cells could be extremely important for preserving the genetic resources of endangered species. Cryopreservation is a powerful method for preserving precious genetic resources as this technology requires no special and expensive equipment and is feasible as long as liquid nitrogen and cryo-containers are available. Because a cryopreservation technique for fish eggs is not yet available, a combination of cryopreservation and transplantation of germline stem cells could be extremely important for preserving the genetic resources of endangered species (Hayashi et al., 2014).

Application of surrogate broodstock technology in aquaculture

The following applications of this technology are expected in the field of aquaculture:

- This technology efficiently and reliably produces offspring carrying superior genetic traits by transplanting donor germ cells from a single selected fish with superior traits into many recipient fish.
- Time required to breed fish by using a recipient species with a short generation time to produce gametes of a species with a long generation time.
- The long-term storage of valuable species or strains as genetic resources by cryopreserving germ cells for transplantation.
- The mass production of genetically sterile fish by transplanting germ cells of a donor fish that is sterile due to a mutation in the somatic cells into normal recipients without this mutation.

Combining these techniques is expected to accelerate the breeding of aquaculture species greatly. It is important to adapt surrogate broodstock technology to a wider range of fishery species and further improve the efficiency of donor-derived gamete production when using surrogate broodstock (Yoshizaki et al., 2019).

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Agricultural Insurance Service System in India: Roles and Responsibilities of stakeholders

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Insurance refers to in exchange for payment of a predetermined premium, a corporation or the government agrees to guarantee reimbursement for a specific loss, damage, illness, or death. It is a method of risk management that is mostly employed to protect against the danger of a potential or assured loss.

People prefer insurance for safety and protection in advance. Life is incredibly unpredictable and has a tendency of shocking us when we least expect it. For ex: Life insurance plans safeguard our family & their financial needs. Along with the life cover, they also provide maturity benefit. A prized possession like car or bike also needs protection to safeguard us from out of pocket expenses towards it repairs or uneventful loss. People want their future goals to be secured. Securing future of family, that will help the nominee or dependent receive a lump sum to help them deal with their financial necessities at the time of need. It encourages savings by reducing expenses in long run. Pocket payments can be avoided for unfortunate events like medical ailments and accidents. Insurance play a great role to manage risks. The risks of falling sick, risk of losing car, the risk of facing an accident and more can be dealt with an effective insurance policy.

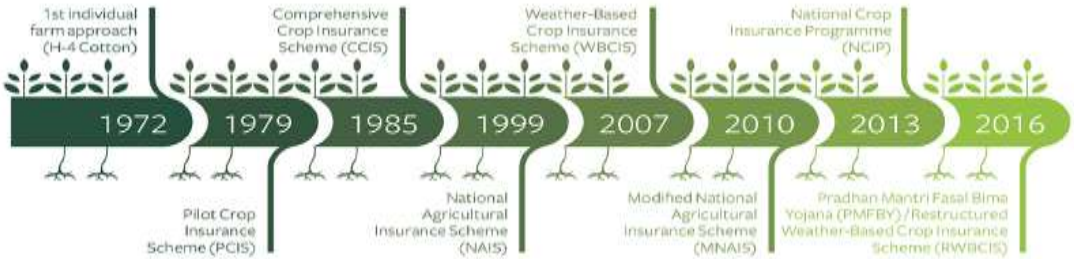

Fig 1: India's Crop Insurance Schemes

(Source: The Actuary)

Agricultural insurance is purchased by agricultural producers & subsidised by federal government, to protect against either the loss of their crops due to natural disasters, such as hail, drought and floods or the loss of revenue due to decline in the prices of agricultural commodities.

Agricultural insurance is required in country like India as in agriculture in India is highly susceptible to risks like droughts & floods. It is necessary to protect the farmers from natural calamities & ensure their credit eligibility for the next season. Indian farmers are relying on weather conditions to grow their crops and hence there is a need to protect farmers from agriculture variability. Price fluctuations of agricultural crops are high and that necessitates insurance against income failure.

History of Crop Insurance In India

Comprehensive Crop Insurance Scheme (CCIS)

Comprehensive Crop Insurance Scheme (CCIS) was introduced in the country with effect from Kharif, 1985. The participation in the scheme was voluntary and the States were free to opt for the scheme. All farmers who availed crop loans from Commercial Banks, Regional Rural Banks and Cooperative Banks for growing wheat, paddy, millets (including maize), oilseeds and pulses were eligible for coverage under the scheme. CCIS remained under implementation till Kharif 1999.

National Agricultural Insurance Scheme (NAIS)

To enlarge the coverage in terms of farmers (loanee and non-loanee both), more crops and more risks, 'National Agricultural Insurance Scheme (NAIS) – (Rashtriya Krishi Bima Yojana)' was introduced in Rabi 1999-2000 season in the country. The scheme was available to all the farmers – loanee and non-loanee both - irrespective of their size of holding.

Pilot Modified National Agricultural Insurance Scheme (MNAIS)

Modified NAIS was approved for implementation on pilot basis in 50 districts during the remaining period of 11th Plan from Rabi 2010-11. The major improvements made in MNAIS were – actuarial premium with subsidy in premium ranging up to 75% to farmers; indemnity for prevented sowing/planting risk & for post-harvest losses due to cyclone in coastal areas; on account payment up to 25% of likely claims as immediate relief; more proficient basis for calculation of threshold yield; minimum indemnity level of 80% and 90% etc. From Rabi 2013-14, it was launched as a full-fledged component scheme under the aegis of NCIP. Scheme was being implemented on actuarial basis but subsidy on premium up to 75% of Sum Insured was provided to farmers.

Pilot Weather Based Crop Insurance Scheme (WBCIS)

With the objective to bring more farmers under the fold of Crop Insurance, a Pilot Weather Based Crop Insurance Scheme (WBCIS) was launched in 20 States since Kharif/Rabi 2007. WBCIS aims to provide insurance protection to the farmers against adverse weather incidence, such as deficit and excess rainfall, high or low temperature, humidity etc. which are deemed to impact adversely the crop production. It has the advantage to settle the claims within shortest possible time. During pilot period, premium actually charged from farmers was restricted to at par with NAIS. The Scheme was being implemented on full-fledged basis as component scheme of NCIP w.e.f. Rabi 2013-14 on actuarial premium however upto 50% subsidy in premium (maximum premium for the farmers is restricted to 6%) are being provided to farmers.

Pilot Coconut Palm Insurance Scheme (CPIS)

Coconut Palm Insurance Scheme (CPIS) was implemented on pilot basis from the year 2009-10 in the coconut growing areas of Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu and West Bengal. 50% of premium is contributed by Coconut Development Board (a Central Govt. agency); 25% by the concerned State Govt. and the remaining 25% by the farmer. The Insurance Company i.e. Agriculture Insurance Company of India (AIC) is implementing the scheme and responsible for making payment of all claims. The CPIS is administered by the Coconut Development Board (CDB).

National Crop Insurance Programme (NCIP)

Planning Commission while conveying its approval for continuation of on-going crop

insurance schemes during the year 2012-13, advised DAC to re-structure the same based on the evaluation of erstwhile schemes. Accordingly, this Department had engaged an Independent Agency i.e. Agriculture Finance Corporation (AFC) to undertake the evaluation and impact assessment of crop insurance schemes. Based on the recommendations of evaluation study, experience of implementation and views of stakeholders, farming community, States etc., a restructured scheme in the name of "National Crop Insurance Programme (NCIP)" was been formulated by merging the erstwhile pilot MNAIS, WBCIS & CPIS with some improvements and approved for its implementation with effect from Rabi 2013-14 season. Hence, all the three schemes that were being implemented on pilot basis till then were launched as a full-fledged component under the umbrella scheme -NCIP with some improvements. NAIS was decided to be discontinued simultaneously. However, based on the representations from some States, NAIS was allowed to such States for implementation during Rabi 2013-14. Again, all State Governments/UT Administrations had been given the option to implement either NAIS or MNAIS for the year 2014-15 and 2015-16.

New Crop Insurance schemes

Pradhan Mantri Fasal Bima Yojana (PMFBY)

Pradhan Mantri Fasal Bima Yojana (PMFBY) has been approved in place of MNAIS/NAIS for implementation from Kharif 2016 season. Premium structure under Restructured WBCIS has also been rationalized and made at par with PMFBY. CPIS component will also be continued. In addition, a Unified Package Insurance Scheme (UPIS) covering other risks of farmers including life, accident like house, tractor, pump set, student safety etc. besides crop insurance has also been approved for implementation on pilot basis in selected 45 districts. It will provide a comprehensive insurance cover against failure of the crop thus helping in stabilising the income of the farmers and encourage them for adoption of innovative practices. The scheme is compulsory for loanee farmers obtaining Crop Loan /KCC account for notified crops. However, it is voluntary for Other/non loanee farmers who have insurable interest in the insured crops. The scheme provisions have been simplified for easy understanding and the Maximum Premium payable by the farmers will be 2% for all Kharif Food & Oilseeds crops, 1.5% for Rabi Food & Oilseeds crops and 5% for Annual Commercial / Horticultural Crops.

Stakeholders of Agricultural Insurance Service System

Agricultural insurance is a policy in which a farmer pays a small fee to an insurance company in exchange for a guarantee against loss. The stakeholders of agricultural insurance service system are such as state agriculture departments, banking institutions, insurance agencies, and farmers.

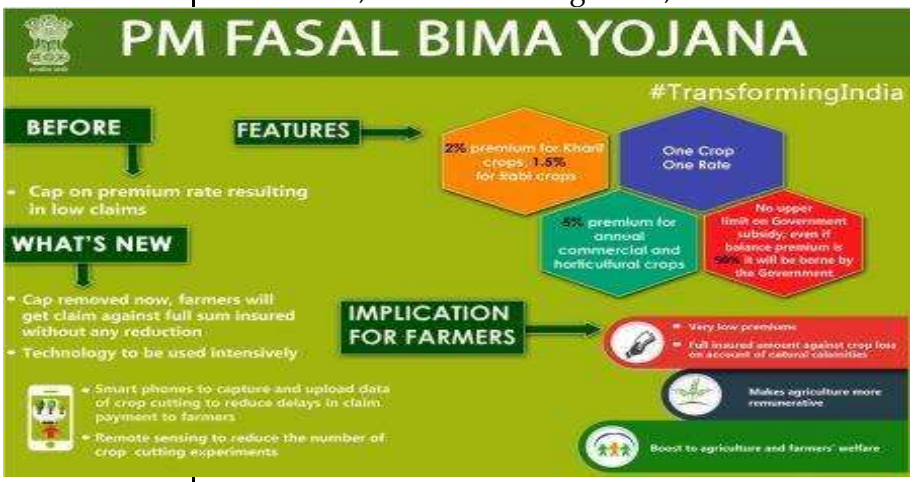

Fig 2: Pradhan Mantri Fasal Bima Yojna

(Source: Vikaspedia)

Fig.3 Distribution of stakeholders

- State Dept. of Agriculture: Directorate of Agriculture and Directorate of Horticulture provide Agricultural Insurance System. Under the Directorate of Agriculture and Horticulture at block level Assistant Agriculture Officer and Assistant Horticulture Officer facilitates the farmers in providing insurance.
- Banking Institution: Institutional credit was designed to play a significant part in India's agricultural development. The disbursement of loans to agriculture involves a significant number of institutional bodies. The fact that an agriculturist cannot operate his business without outside funding is proven by history and illustrated by the poverty and debts of those who work in agriculture. Agriculture finance is a critical component for increasing agricultural productivity and assisting India's poorest farmers in satisfying their investment needs.
- Insurance agencies: Insurance companies are aided by the government in a variety of ways, including covering all or part of the administrative costs, sharing a portion of the indemnity; and paying a portion of the premium to ensure that farmers can afford insurance. Covering a broad pool of risk exposure, which allows insurance companies to spread their risk among consumers with different sources of income, over geographic area and time, is a crucial step in decreasing risk for financial institutions when creating insurance products. The primary goal of insurance is to protect the insurer from the risks covered by the policy.
- Farmers: Farmers are the most influential stakeholder group when making final decisions about land use. Agricultural insurance is an effective mechanism to reduce the losses that farmers have to bear due to natural disasters such as floods, droughts and epidemics of pests and diseases. It allows farmers to obtain credit and finance to invest in new technologies, tools and equipment in order to improve and maintain their production capacity.

India's agro-meals area is at a crucial juncture, going through a couple of demanding situations and a couple of opportunities. The coverage guidelines launched into now and with inside the following few years will play a big position in figuring out how a hit India is in developing meals protection for its significant population, enhancing the nice of existence of its tens of thousands and thousands of smallholders, overcoming excessive aid and weather pressures, whilst producing sustainable productiveness boom and developing a modern, green and resilient agro-meals machine that can make a contribution to jobs and economy-wide.

Table 1 Roles & responsibilities of stakeholders

Stakeholders	Roles and Responsibilities
State Dept. of Agriculture	➢ To educate the farmers on the scheme features. ➢ To guide the farmers in filling the proposal forms & collecting the required documents. ➢ To prepare the consolidated statements for loanee & non loanee members, forwarding the same to the branch along with premium amount. ➢ To follow the guidelines while disbursing crop loans. ➢ To maintain the records of proposal forms, other relevant documents, statements for the purpose of verification of district committee or representative of the insurer. ➢ To identify the crops and beneficiaries under crop insurance programme. ➢ To conduct meetings and get involved while deciding the scale of finance ➢ To obtain feedback while assessing the claim from the farmers.
Banking Institution	➢ To provide financial support to farmers. ➢ To facilitate access to short term credit to farmers. ➢ To simplify credit mechanism, so that farmers can receive credit on time. ➢ To make payment on the account of the claims to the eligible insured farmers.
Insurance Agencies	➢ To decide scale of finance. ➢ To decide the premium rates/ premium subsidies for the crop ➢ To make inspection visit to the field for claim settlement. ➢ To prepare the consolidated statements for loanee & non loanee members, forwarding the same to the branch along with premium amount.
Farmers	➢ To have an account in the branch of the designated bank. ➢ To approach the designated branch / PACS and submit the proposal form in the prescribed format. ➢ To provide documentary evidence in regard to the possession of cultivable land.

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Millets: Power House of Nutrition and Energy

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Millets are small-seeded grasses that are hardy and grow well in dry zones as rain-fed crops under marginal conditions of soil fertility and moisture. They are possibly the first cereal grain to be used for domestic purposes, the commonly grown millets are Sorghum, Pearl Millet, Finger Millet, Barnyard Millet, Foxtail Millet, Kodo Millet, Proso Millet and Little Millet. Unlike rice and wheat that require many inputs in terms of fertiliser and water, millets grow well in dry regions as rain-fed crops. Highly nutritious, non-glutinous and rich in fibre, they are easy to digest.

With advantages loaded in its favour such as low-maintenance, disease and pest resistance, nutritional benefits, market demand, fodder value and ecological benefits, millet is being considered as a smart crop. Known as C4 crops, millets are highly efficient in absorbing and using carbon dioxide. Most varieties of millets are well known for their hardiness and have the capacity to withstand prolonged periods of drought, high temperatures and still produce grains and fodder.

United Nations declared the Year 2023 as the International Year of Millets on 5th March 2021, on the proposal moved by India and supported by 72 countries. It is essential to give such honour to the traditional wisdom of humanity. These are the first plants to be domesticated for food. On 6th December 2022, the Food and Agriculture Organization (FAO) of the United Nations organised an opening ceremony for the **International Year of Millets** (IYM) 2023 in Rome, Italy. The revival of millet cultivation in the southern provinces of Karnataka, Andhra Pradesh and Telengana, agronomics say, is a step towards sustainable cropping practices that respects biodiversity in nature.

Table 1: Miilets with Scientific name

Millet	**Scientific name**
Pearl Millet	*Pennisetum glaucum*.L.
Sorghum	*Sorghum bicolor*
Finger Millet	*Eleusine coracana*
Small Millets:	
Foxtail Millet	*Setaria italica*
Barnyard Millet	*Echinochloa frumentacea*
Kodo Millet	*Paspalum scrobiculatum*
Proso Millet	*Panicum miliaceum* L.
Little Millet	*Panicum sumatrense*
Two Pseudo Millets:	
Buck wheat(Kuttu)	*Fagopyrum esculentum*
Amaranthus (Chaulai)	*Amaranthus viridis*

Pearl Millet (Bajra)

Pearl millet (*Pennisetum glaucum*, *P. typhoides, P. tyhpideum, and P. americanum*) is the most extensively cultivated millet and characterized by

English : Pearl Millet
Hindi : Bajra
Bengali : Bajra
Gujarati : Bajri
Kannada : Sajje
Marathi : Bajri
Oriya : Bajra
Punjabi : Bajra
Tamil : Kambu
Telugu : Sajja

large stem, leaves, and condensed panicles (spike) of

10 to 150 cm in length.It has the highest yield potential of all millets

Table 2: Pearl Millet Nutrient per 100g

Energy (Kcal)	361
Protein	11.6 g
Carbohydrate	65.5 g
Crude Fiber	1.2 g
Calcium	42mg
Iron	8.0 mg

- ✓ Reduce the risk of diabetes & cardio vascular diseases
- ✓ Beneficial in treating and prevention of gallstones and stomach ulcers
- ✓ Nutritionally dense and reduce anaemia, liver disorder and asthma
- ✓ It's hypo allergic properties help prevent allergic reactions
- ✓ Relieves constipation
- ✓ Lowers blood glucose response and reduce the risk of Type II diabetes
- ✓ Rich in anti-oxidants and hence reduce oxidative stress
- ✓ Reduce the risk of cancer
- ✓ Reduce the occurrence of Hypertension

Pearl millet is found to be beneficial in the process of weight loss due to its high fibre content and ability to prolong satiety. It has been found that due to its high fibre content it reduces the risk of occurrence of gall stone It is also a rich source of calcium and phosphorus which helps to attain peak bone density.

Sorghum (Jowar)

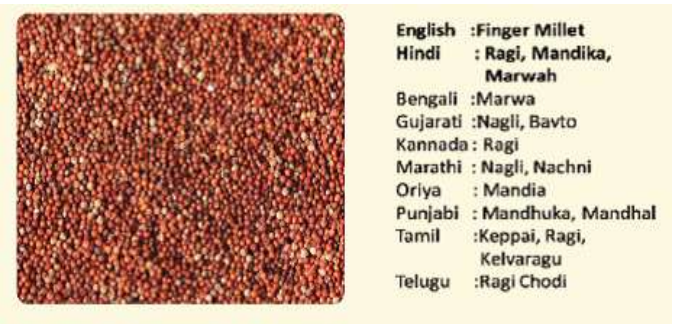
Sorghum (*Sorghum bicolor L.*) commonly known as the "King of millets', is a highly productive crop plant, which can be used for grains, livestock feed or industrial purposes.

Table 3: Sorghum Nutrient per 100g

Energy (Kcal)	349
Protein	10.4 g
Carbohydrate	72.6 g
Crude Fiber	1.6 g
Calcium	25mg
Iron	4.1 mg

Sorghum and their products have high nutritional value and showed antioxidant, anti-obesity, anti-diabetic, anti-cardiovascular, anti-inflammatory, antimicrobial and anticancer activities. However, sorghum have some limitations due to the presence of some anti-nutritional factors such as tannins, phytates, trypsin inhibitors, and protein crosslinker. Technological processing such as soaking, germination, fermentation, thermal processes, irradiation, and others are suitable ways for removing or reducinganti-nutritional factors, improving sorghum quality, and producing foods with high nutritional value.

Finger Millet (Ragi)



Finger millet (*Eleusine coracana*), often known as ragi in India, stands unique among the cereals such as barley, rye and oats with higher nutritional contents and has outstanding properties as a

subsistence food crop. It is rich in calcium, dietary fiber, phytates (0.48%), protein, minerals and phenolics. It is also a rich source of thiamine, riboflavin, iron, methionine, isoleucine, leucine, phenylalanine and other essential amino acids. The abundance of these phytochemicals enhances the nutraceutical potential of finger millet, making it a powerhouse of health benefiting nutrients. It has distinguished health beneficial properties, such as anti-diabetic, anti-diarrheal, antiulcer, anti-inflammatory, antitumerogenic, atherosclerogenic effects, antimicrobial and antioxidant properties.

Table 4: Finger Millet Nutrient per 100g

Energy (Kcal)	328
Protein	7.3 g
Carbohydrate	72 g
Crude Fiber	2.6 g
Calcium	344mg
Iron	8.9 mg

Foxtail Millet

Foxtail millet (*Setaria italica* L.) an annual grass plant, produces seeds that possess health-promoting properties owing to its unique protein composition containing a high content of essential amino acids. It is one of the earliest cultivated crops, extensively grown in the arid and semiarid regions of Asia and Africa, as well as in some other economically developed countries of the world where it is more commonly used as bird feed. Antinutrients like phytic acid and tannin present in this millet can be reduced to undetectable amounts by using the proper processing methods. Additionally, the millet is said to have antioxidant, low-glycemic index, and hypolipidemic properties.

Table 5: Foxtail millet nutrient per 100g

Energy (Kcal)	331
Protein	12.30 g
Carbohydrate	60.9 g
Crude Fiber	14.0 g
Calcium	31.00 mg
Iron	3.6 mg

Barnyard Millet

Barnyard millet (*Echinochloa crusgalli, E. colona*), is a short duration crop that can grow in adverse environmental conditions with almost no input and can withstand various biotic and abiotic stresses. In addition to these agronomic advantages, the grains are valued for their high nutritional value and lower expense as compared to major cereals like rice, wheat, and maize. It contains a rich source of protein, carbohydrates, fiber, and, most notably, micronutrients like iron (Fe) and zinc (Zn) that are related to numerous health benefits. All these features make barnyard millet an ideal supplementary crop for subsistence farmers and also as an alternate crop during the failure of monsoons in rice/major crop cultivating areas.

Table 6: Barnyard millet nutrient per 100g

Energy (Kcal)	341
Protein	7.7 g
Carbohydrate	67.0 g

Crude Fiber	7.6 g
Calcium	17.00 mg
Iron	9.3 mg

Kodo Millet

In India, Kodo millet (*Paspalum scrobiculatum*) grown mostly in the Deccan region and the cultivation extends to the foothills of Himalayas. Kodo millet is rich in dietary fiber and minerals like iron,antioxidant. The phosphorus content in kodo millet is lower than any other millet and its antioxidant potential is much higher than any other millet and major cereals, higher amount of antioxidants helps against oxidative stress and maintain glucose concentrations in type-2 diabetes. Kodo millet is useful in curing asthma, migraine, blood pressure, heart attack and atherosclerosis, diabetic heart disease and for postmenopausal in women.

Table 7: Kodo millet nutrient per 100g

Energy (Kcal)	302
Protein	08.03 g
Carbohydrate	69.9 g
Crude Fiber	8.5 g
Calcium	22.00 mg
Iron	9.9 mg

Proso Millet

Proso-millet (*Panicum miliaceum L.*) is an underutilized crop which is highly nutritious cereal grain used for human consumption, bird seed, and/or ethanol production. Grains of proso millet are a rich source of vitamins (niacin, B-complex vitamins, folic acid), minerals (P, Ca, Zn, Fe) and essential amino acids (methionine and cysteine), starch, and phenolic compounds like antioxidants and betaglucans. Seeds also contain components with healing benefits, which decrease the level of low-density lipoprotein cholesterol in blood and injury to the liver and high lecithin content which supports the neural health system.

- It contains the highest amount of proteins (12.5%).
- Health benefits of proso millet come from its unique properties. It has significant amounts of carbohydrate and fatty acids.
- It is cheaper source of manganese as compared to other conventional sources like spices and nuts.
- It contains high amounts of calcium which is essential for bone growth and maintenance.
- It reduces cholesterol levels and also reduce the risk of heart diseases

Table 8: Proso millet nutrient per 100g

Energy (Kcal)	309
Protein	08.03 g
Carbohydrate	65.90 g
Crude Fiber	9.0 g
Calcium	27.00 mg
Iron	0.50 mg

Little Millet

English : Little Millet
Hindi : Kutki, Shavan
Bengali : Sama
Gujarati : Gajro, Kuri
Kannada : Same, Save
Marathi : Sava, Halvi, Vari
Oriya : Suan
Punjabi : Swank
Tamil : Samai
Telugu : Samalu

Little Millet (*Panicum miliare*) is one among the minor millets grown to a limited extent all over India up to altitudes of 2100 m. It is a relative of proso millet but the seeds of little millet are much smaller than proso millet. With their low carbohydrate content, slow digestibility and low water-soluble gum content. The complex carbohydrates, phenolic compounds, antioxidant content present in them helps to prevent metabolic disorders like diabetes, cancer, obesity etc.

- It is smaller than other millets.
- It is high in iron content.
- It has high antioxidant activities.
- It contains about 38% of dietary fiber.

Table 9: Little millet nutrient per 100g

Energy (Kcal)	314
Protein	10.13 g
Carbohydrate	65.55 g
Crude Fiber	7.72 g
Calcium	32.00 mg
Iron	1.30 mg

Amaranth (Ramdana/ Rajgira)

- High protein content (13-14%) and a carrier of lysine, an amono acid that's missing or negligible in many other grains.
- Consists of 6 to 9% of oil which is higher than most other cereals. Amaranth oil contains approximately 77% unsaturated fatty acids and is high in linoleic acid.
- It is high in dietary fibre.
- High in iron,magnesium, phosphorus, potassium and appreciable amounts of calcium.
- A rich dietary source of phytosteriols, with cholesterol - lowering properties.

English : Amaranth Seed, black
Hindi : Ramdana, Rajgira
Bengali : Amaratba bīja
Gujarati : Rajgaro
Kannada : Danthu beeja
Marathi : Cavali biya
Oriya : Kosala sag manji Dhala
Punjabi : Chaulai beej
Tamil : Keerai vidai
Telugu : Thotakoora ginjalu

- Contains a lunasin - like peptide and other bioactive peptides which are thought to have cancer - preventive and antihypertensive properties.

Table 10: Amaranth nutrient per 100g

Energy (Kcal)	125.5
Protein	4.7 g
Carbohydrate	23 g
Crude Fiber	2.6 g
Iron	2.6 mg
Magnesium	80 mg

Buckwheat (Kuttu)

English : Buckwheat
Hindi : Kuttu
Bengali : Bā'ikavāṭa
Gujarati : Biyāṁ sāṭhēnō dāṇō
Kannada : Huruḷi
Marathi : Baṭaravhīṭa
Oriya : .....
Punjabi : Bā'ikavāṭa
Tamil : .....
Telugu : Bukvīṭ

- It contains protein 13-15% protein and rich in the amino acid lysine.

- Rich in carbohydrates (mainly starch).
- Contains vitamins B1, C and E.
- Rich in polyunsaturated essential fatty acids, such as linoleic acid.
- Contains higher levels of zinc, copper, and manganese than other cereal grains, and the bioavailability of these minerals is also quite high.
- High in soluble fibre.
- A rich source of polyphenol compounds.
- Contains rutin, a bioflavonoid thought to help control blood pressure and possess anti - inflammatory and anti - carcinogenic properties.

Table 11: Buckwheat nutrient per 100g

Energy (Kcal)	118
Protein	04.3 g
Carbohydrate	21.3 g
Crude Fiber	2.1 g
Magnesium	65 mg

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Smart Phone Addiction and Young Children

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Technology has reached the peak of advancement in our world today. Technology, like a coin, has both its blessings and its disadvantages. Smartphones, in particular, have made our lives too easy that we have somehow become dependent upon them. Despite the advantages, various negative smartphone consequences affect physical and mental health, reduce social interaction, cognitive disorders, sedentary lifestyle, sleep quality, vision, obesity, nervous system problems, tumours because of cell phone radiation and psychological dependence which includes smartphone addiction in children.

Smartphone addiction, which can also be thought of as a fear of being without a connection to the internet has been related to many mental health concerns. The doctors say there are proven facts that smartphone addiction in children develops anxiety and low self-esteem, and also in a some cases there are very young children develop communication problems.

Some recent research found that smartphone addiction has become extremely common among kids. This has been exacerbated by the COVID-19 pandemic, during which due to virtual classes' parents should give smartphones to children and also in some schools assignment is being sent on whatsapp, so children became more dependent on their screens than ever before.

In today's digital world our children use phones limitlessly and they are gradually becoming addictive. This smartphone is affecting the growth

and development of children when they use it without limits. Hence, reducing smartphone addiction among children is extremely important.

Signs and Symptoms of cell phone addiction in kids

Some possible warning signs of cell phone addiction in kids could include:

- Low appetite
- Sleep disturbances
- Fear of missing out
- Weak or unreal social life.
- Problems of the nervous system
- More and more time using a phone.
- Accidents or injury due to phone use.
- Changes in behavior (temper tantrums).
- Difficulty with emotional regulation
- Continuous worry about where the cell phone is
- Extreme reactions when separated from device
- Trouble in completing duties at work, school, or home.
- Aggression over wanting to use the phone constantly

- A need to use the phone even when watching television, eating, or doing any other activity

Reasons why kids are addicted to smartphone

There are many reasons for cell phone addiction, some of them are as given below:

Parents first introduce: It has been a common situation that parents first introduce mobile phones to their children, so they do not irritate them when parents are otherwise engaged. Parents do so to distract them while they eat as well, to avoid any fussy behaviour. Hence, children become addicted to mobile phones.

Parental ignorance: Essentially, parents do not want to devote much time with their children, which results in addiction to mobile phones. Most parents do not worry at all to halt the growing habit of their children of using smartphones. In many cases, they are happy to see their children's different talents when using a smartphone. Most parents do not find anything wrong with this obsession with technology and social media and go on to ignore the dangerous effects of too much screen time on their kids.

Cellular video games: Users are compelled to use their phones more repeatedly as a result of the video games available on them. In today's market for cell phones and smartphones, gaming is noticed as an essential feature that has the ability to appeal users.

Pleasure: Smartphone addiction works similarly to game addiction. Every once in a while, the user gets some sort of a reward. Reward makes people feel happy and desire more. It also causes a rapid message check turn into endless Facebook feed scrolling.

The need to produce and socialize: It's a part of human nature to imitate, and make models in the process of personal progression. Mobile devices help children with that. They take selfie, select the best picture and socialize.

Adverse effects of Mobile Addiction in Kids

Smartphones can harm children if they are used and exposed continuously. Here's a list of side Effects of excessive use of smartphones in children:

Problems with sleep – this might it reveal itself as insomnia, worse sleep quality or taking a long time to fall asleep. This might be triggered by staying up late to play games and watch videos, waking up during the night to check notifications.

Depression and anxiety – Lack of social contact can result in mental health problems. Cell phone addiction affects relationships with friends and family in a bad way. There's also a tight association between mental health problems and an increase in modern media screen activities.

Relationship problems – Mobile phone engagement might reach such a degree that a child becomes unfocussed from being present in the real world. It unfavourably affects all spheres of their lives – school, family and other responsibilities. A child might detach from friends and family, spending time absorbed in the digital world.

Obsessive-compulsive disorder – Cell phone addicted children persistently feel the pressing need to use their mobile devices all the time. Turning the phone off can cause increased anxiety. The obsessive idea of staying connected round the clock is a real problem that might require professional care.

Mental health: kids who are active on social media are usually the targets of cyber bullies. The problem is that many of them don't disclose it until after they have already suffered mental damage. Depression and anxiety can also be prompted by social media.

Disturbed Brain Activities: Children are simply

affected by the waves from their mobiles because the waves penetrate their brains. When a child speaks for just two minutes on the phone, the electrical motion in his or her brain can be affected.

Tumours: According to the World Health Organization, mobile phone radiation has been shown to cause cancer. Children who tend to keep smartphone close to their ears for extended periods of time may be more prone to develop non-malignant tumours, especially in the brain and ear.

Here are some creative ways for parents to break child's smartphone addiction:

If you want to support your child to overcome digital addiction, here are some ideas:

1. **Break time**: Children have a lot of energy and it should be invested efficiently. Make sure your kids do something active frequently. Indulge them in mini stretching exercises every 30 mins. It's essential to break up screen time and move around.
2. **Set Priority for other things:** Ensure your child finishes homework, before they get on the mobile device. This helps in setting the priorities straight right from an early age.
3. **Make a strict smartphone schedule:** Setting sufficient time allows parents to keep track and restrict the amount of time spending on gadgets and avoid excessive usage of the smartphone. By presenting a schedule, parents can improve the habit of routine which prevents the child from spending more time on screen.
4. **Bonding with child**: These days parents lead very busy lives and the time they get to spend with their children becomes inadequate. Therefore, it is vital to take the time out for bonding activities with children. Playing board games or engaging your child in household tasks like cleaning, cooking or gardening will keep her away from smartphones.
5. **Encourage play time:** Physical play fuels the brain. Activities that involve physical movements permit children to use their energy and give children the chance to develop gross and fine motor skills, learn new things and socialize. Indulge them in activity-based learning.
6. **Encourage face-to-face communication:** Studies showed that the two-way communication with children advances language development much more effectively than inactive listening or one-way interaction with a screen. Spend time together with your kids.
7. **Set passwords**: Set a password on your phone to avoid the usage of the phone by your child in your absence.
8. **Be a great role model**: Children learn more from your movements than your words. They are great observers, and they imitate the habits of parents. Be a good role model for your child by controlling your smartphone usage. Spend more

time with your children by interacting, hugging, playing with them.

9. **Say no to smartphone:** Media can be helpful in keeping kids calm, but it should not be the only way to calm them down. It is the responsibility of parents to help their child detect and handle strong emotions, come up with activities to manage boredom, open communication to solve the problem.
10. **Replace the phone with healthy options.** Involve your kid in active family time or fun activities. Teach them to enjoy the real world and to get along without a cell phone.
11. **Use kids mode**: Mobile phones have the option to set children mode or to set passwords for certain apps, permit these options when you give smartphones to your kids. It is not possible to monitor your children every time.
12. **Stop giving phones as a reward**: Sometimes parents promise their children that they get costly gadgets when they top in academics or win some competition. Offering these can distract them easily so you can try to gift them with some other thoughtful gifts.
13. **Strict Supervision**: It is essential to restrict mobile phones, having a one-to-one discussion with your child helps to avoid smartphones**.** Explain to them clearly why you should not use them often and talk to them about the drawbacks while using them beyond their boundary. Educate children on the side effects of too much screen time.
14. **Encourage physical activities:** Make sure your child is spending sufficient time away from technology at home to play outside or do other physical activities. Outdoor games help brain

development in children, they increase attention and concentration. Leaving your kid to play outside helps to quit their smartphone addiction completely.

Researches showed that face-to-face time with family, children, and friends has a major influence on children's healthy development. Smartphone apps, social media and gaming are built around encouraging endless use. And child brains often aren't furnished to regulate their own use in a healthy way without parental boundaries. So, it's vital for caregivers to step in to help them learn this important skill. As adults do not let your child get lost in a stream of technology and media. According to a World Health Organization recommendation, a digital mobile phone or laptop should never be within the reach of a kid younger than one-year-old. Children between ages two and five could use their phones for one hour every day. So, before claiming that the condition is out of control and that children are bound to be addicted to mobile devices, parents must consider what effective interventions they are taking to end this addictio

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Digital Image Processing and Its Application in Fisheries

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A digital image, also known as a pixel or picture element, represents a two-dimensional image as a limited set of digital values. The smallest unit of information in a digital image is called a pixel (or picture element). A 2-dimensional grid made up of squares is used to organize pixels. Pixel values commonly represent colours, heights, opacities, and other properties. Each pixel serves as a sample of the original image, whereas additional models typically yield more accurate duplicates of the original. The application of digital image processing in fisheries or marine fields is technically still under study by researchers. Image processing techniques play a big role in ocean conservation.

Types of digital images

Generally, we consider four types of images; Binary, Grey-scale, Colour, and Multispectral.

Binary images

Binary images frequently occur in black and white or the 0 and 1 values. Binary images are also called 1-bit images since they only require 1 binary number to represent each pixel. Optical character recognition (OCR), for instance. Binary pictures are produced using threshold operation from grayscale images. Every pixel over the threshold value is converted white during a threshold operation, while every pixel below the threshold is turned black (zero).

Grey-scale image

These images are additionally referred to as monochromatic or one-colour photos. Images with a grey level only include information at the grey level; no colour information is present. The number of bits used for each pixel determines the range of available grey levels. For instance, an image with 256 different grey levels should include 8 data bits per pixel. For astronomy and medical imaging, 12 or 16 bits per pixel are utilised.

Colour images

Three-band monochrome image data, where each band of data represents a different colour, is used to create colour images. Because red, green, and blue are the primary colours used to represent colour images, colour images are also referred to as RGB images. Using the 8-bit monochrome standard as a model and 8 bits for each of the three colour bands (red, green, and blue), colour images would have 24 bits/pixel.

Multispectral images

Information that is outside the usual human perceptual range is contained in these kinds of images. These are not images in the traditional sense because the human eye cannot directly see the information provided. However, the information is visualized by mapping the various spectral bands to RGB components. Radar data, X-rays, ultraviolet, infrared, and acoustic waves are all included in multispectral photographs.

What is a Digital Image Processing

Using a digital computer to run an algorithm on digital photographs is known as "digital image processing." Digital image processing has significant

benefits over analogue image processing as a subfield or area of digital signal processing. Multidimensional systems can be used to model digital image processing. The key factors influencing the creation and advancement of digital image processing include

1. First, the development of computers
2. The second concern is the advancement of mathematics
3. particularly the growth and refinement of discrete mathematics theory
4. Third, there is a growing need for various environmental, agricultural, industrial, military, and medical science applications

Key stages in digital image processing:

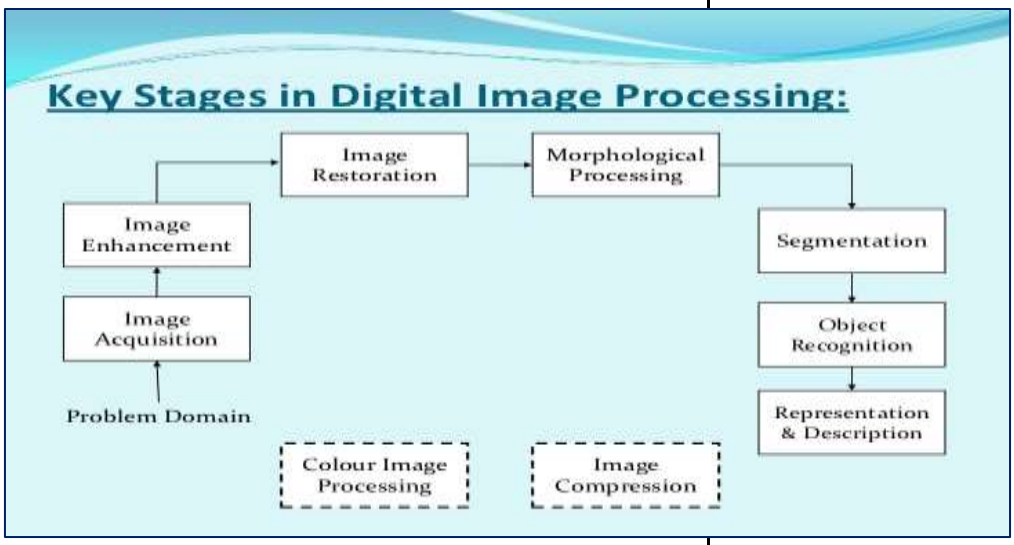

Fig. 1: Key stages in Digital Image Processing

Gonzalez *et al.*, 2002

Image acquisition: The image is captured by a sensor (e.g. Camera), and digitised if the output of the camera or sensor is not already in digital form, using an analogue-to-digital convertor.

Image enhancement: The process of manipulating an image to make the result more suitable than the original for specific applications. The idea behind enhancement techniques is to bring out hidden or simple details to highlight certain features of interest in an image.

Image Restoration: Improving the appearance of an image tend to be mathematical or probabilistic models. On the other hand, enhancement is based on subjective human preferences regarding what constitutes a "good" enhancement result.

Colour image processing: Use the colour of the image to extract features of interest in an image.

Wavelets: These are the foundation of representing images in various degrees of resolution. It is used for image data compression.

Compression: Techniques for reducing the storage required to save an image or the bandwidth required to transmit it.

Morphological processing: Tools for extracting image components that represent and describe shape. In this step, there would be a transition from processes that output images to processes that output image attributes.

Image segmentation: Segmentation procedures partition an image into its constituent parts or objects

The use of image processing techniques in fisheries

Image processing is used in many fields of knowledge because it allows automated processes to get more information about the examined object. Studying fish diseases by applying the methodology of colour image segmentation. The surfaces of the fish body are considered the main information source to detect infections. They successfully

detected infected areas on the fish body and identified a total area of lesions.

The proposed method makes it possible to automate the process and reduce the time of diagnosis of Infectious dangerous fish diseases. Fish affected with Epizootic Ulcerative Syndrome (EUS) were collected from the different parts of the Barak Valley, Assam and identified by human experts. The SLR camera took pictures of diseased fish. Images were 200 by 200 pixels, so an engineering compromise can be obtained between the processing time of algorithms and clarity retention of input images [Fig 2].

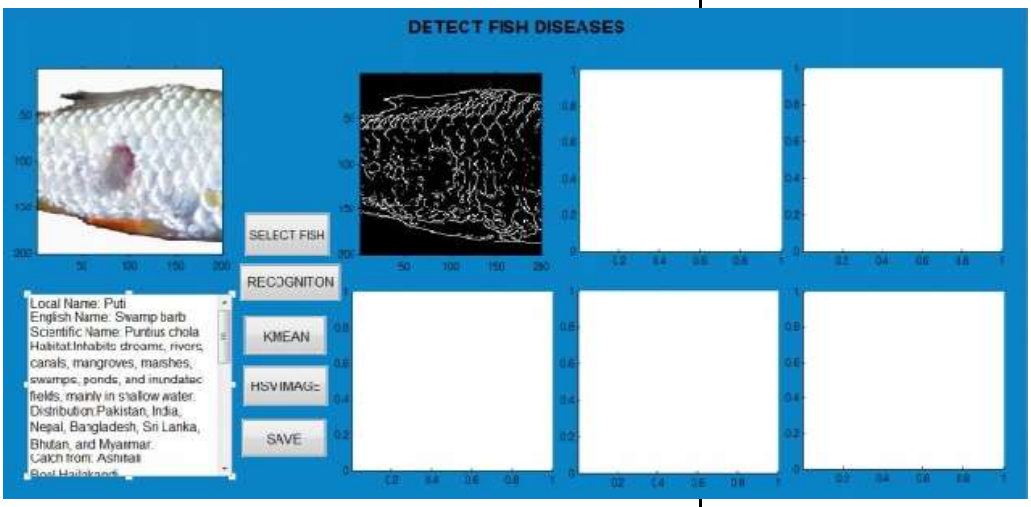

Fig 2: Image processing to detect fish diseases

Fish Classification

Hu *et al*. (2012) used colour model space of (RGB and HSV), Color feature extraction, and applying the classifier of multi-class support vector machine (MGSVM).

Fish weight and length measurement:

Islamadina *et al*. (2018) used an automatic visual capture to estimate the fish's length, width, weight and height. Image processing techniques involved in the study consist of segmentation, feature extraction and statistical analysis. Image modelling in the form of fish length estimation is calculated through the scaling process to equalize and reduce the size to make it easier to calculate in the system so that the results are obtained from estimating the length of the fish automatically. Estimated length of fish through a web service application using anaconda navigator. Bounding boxes from fish show that fish is estimated by estimating their body length from the tip of the jaw to the tail.

Fish Detection /Tracking/ Identification

Allken *et al*. (2018) utilised a deep learning neural network (NN) to identify fish species that are present in the images from the Deep Vision trawl camera system.

Fish tissue

Sengar *et al*. (2018) proposed using image processing techniques to extract the skin tissue of fish in order to identify fish freshness. The HSV colour model is used to identify degradation patterns for fish freshness.

Coral reef study and fish abundance

Kaeli *et al*. (2006) proposed using morphological operator and texture features extraction to segment out areas of coral reef cover in the image. Awalludin *et al*. Proposed using colour feature extraction from Hue Saturation Value (HSV) colour model and texture feature from Local Binary Pattern (LBP). All the features of colour and texture were used in the Multilayer Perceptron Neural Network (MPLNN) classifier to estimate coral reef distribution.

Conclusion

Digital image processing uses a computer algorithm to perform image processing on the digital

image. It deals with sharpening, converting, blurring, detecting edge detection, and recognition. The application of digital image processing in fisheries or marine fields is technically still under study by researchers. Image processing techniques play a big role in ocean conservation. Therefore, monitoring activity by applying image processing will be able to maintain a healthy ecosystem by lowering the possibility of extinction of species.

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One Health Aquaculture: Integrating Sustainable Practices for Human and Environmental Well-being

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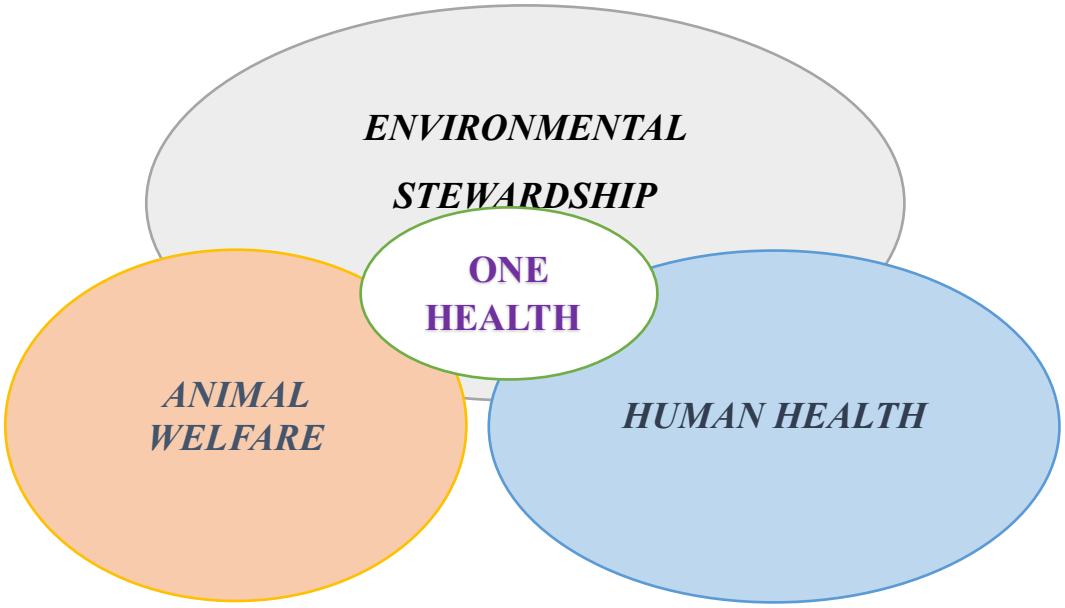
The term 'One health' was first used in 2003-2004, and was associated with the emergence of severe acute respiratory disease (SARS) in early 2003 and subsequently by the spread of highly pathogenic avain influenza H5N1, and by the series of strategic goals known as the "Manhattan principles" derived at a meeting of wildlife conservation society in 2004, which clearly recognized the link between human and animal health and the threats that diseases pose to food supplies and economies.



The Principles of One Health Aquaculture

This concept is a worldwide strategy that recognizes that public health is connected with animal health and the environment. It concerns multidisciplinary collaboration between physicians, veterinarians, environmental scientists, public health professionals, wildlife experts, and many others. With a multisectoral and transdisciplinary approach, public health threats can be better monitored and controlled. The resulting synergism enhances the knowledge of how diseases, known as zoonotic diseases, can be shared between animals and people with the goal of achieving optimal health outcomes. One Health is not a new concept, but it has become more important since 2006 as a result of emerging and re-emerging diseases.

Many One Health initiatives focus mainly on the relationship between humans and livestock or wildlife health, because several zoonotic disease pandemics and (re)emerging infectious diseases originated from these animal species. Examples of such infections are West-Nile virus, corona virus (SARS, Covid-19), zika virus, avian H5N1 influenza virus, Nipah virus, and Hendra virus [8]. The recently founded One Health European Joint Programme (OHEJP) also focuses on foodborne zoonoses, antimicrobial resistance and emerging threats, while companion animals are absent.

As the world grapples with the challenges of food security, population growth, and environmental sustainability, the concept of One

Health Aquaculture has emerged as a promising solution. One Health Aquaculture recognizes the interconnectedness of human health, animal health, and the environment, emphasizing the need for a holistic approach to aquaculture production. By integrating sustainable practices, this approach aims to maximize productivity while minimizing negative impacts on ecosystems and human populations. In this article, we will delve into the principles and benefits of One Health Aquaculture and its potential to shape the future of responsible aquaculture.

Environmental Stewardship

The most important element determining the aquacultural microflora is its environment. Improper disposal and recycling facilities in food-producing and processing plants would lead to an increased risk of the pest as well as insect population, resulting in food spoilage and contamination. The water temperature, harvesting techniques, season, and processing methods may also influence the spoilage. The predominant bacterial spoilage agents are located on the slime layer of the skin, gills, and intestine. As the tissues of fish contain higher levels of non-protein nitrogenous (NPN) compounds (trimethylamine oxide, free amino acids, and creatinine), proteins, and peptides, the growth of microbes results in the decomposition of proteins and production of metabolites which would result in spoilage.

Inappropriate aquacultural practices could result in environmental degradation; eutrophication and organic pollution constitute common adverse impacts. Together with chemical pollution, these could deplete oxygen, reduce water quality, coral death, and habitat disruption of water bodies. Such a hostile environment would sustain the growth of harmful microbes to aquatic life.

One Health Aquaculture promotes sustainable and responsible management of aquatic resources. It focuses on minimizing habitat destruction, conserving biodiversity, and reducing pollution associated with aquaculture operations. This includes employing ecosystem-based approaches, such as integrated multi-trophic aquaculture, where the waste products from one species are used as inputs for another, thus creating a balanced and more sustainable system.

Animal Welfare

Food production involves complex socio-ecological systems within an environment with a wide variety of species habitat. Farmed macrobiotic communities interact often with a wide range of eukaryotic as well as prokaryotic microbes inside the aquatic environment. Within the aquatic ecosystem involves a variety of known and unknown pathogens that may produce infection and disease. Hence, the crop-growing water bodies are regarded as artificial ecosystems that can act as a conducive environment for rapid propagation of pathogens and emergence of public health outbreaks. It is therefore, important to consider the stock management in terms of public health aspects, particularly biosecurity, zoonosis, therapeutic and/or interventional impact on the limited aquatic environment.

The intensive aquacultural practices have necessitated the use of chemicals (pond fertilizers, biocides, chemotherapeutics, and formulaic feeds) for improving stock performance. On the research front, microbial identification and hazard profiling employing sophisticated technologies such as metagenomic analysis or next-generation sequencing of water bodies, feed, and host tissues are attracting wide momentum. Such technological advancements could not only identify the

biosecurity risks associated with aquaculture but also prevent the pathogen spillover to the adjoining environment and wildlife.

Ensuring the health and welfare of farmed aquatic animals is a key principle of One Health Aquaculture. By providing optimal rearing conditions, including appropriate water quality, nutrition, and disease prevention measures, farmers can enhance animal well-being and reduce stress levels. This approach not only promotes animal welfare but also improves the overall quality and safety of aquaculture products.

Human Health

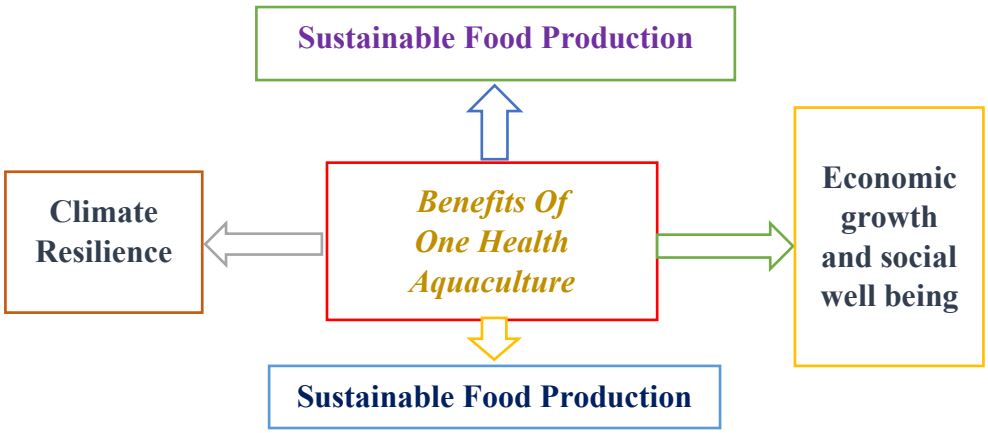
Food production systems can provide a wide range of public health as well as socio-economic benefits. The One Health principles can achieve investment and optimization towards productivity, welfare concerns, and ecosystem health. Practically, the market preferences or societal goals to tolerate health will play a crucial role. The ever-increasing population, as well as urbanising trends in the human population, may compromise the accessibility and nutritive quality of natural foods; therefore, the processed foods are of utmost importance. Aquaculture enterprises can solve this issue to a greater extent by providing locally available nutritious foods mainly in low- and middle-income countries, thereby opening up employment avenues to many. In short, scope for trade, opportunities for better employability, quality diet and better infrastructural facilities determine the success metrics of aquaculture. Moreover, a safe supply chain (farm- to- fork) is imperative to alleviate the burden of public health impacts and to enhance the economic stability of the society and nation. Hence, access to an optimum quantity of safe and nutritive food is pivotal for the sustenance of life, promoting better health and thereby stabilizing the economy.

While public health threats are emerging, early evaluation of such risks is essential to uphold the One Health principles. One Health Aquaculture recognizes the interconnectedness between animal and human health. By implementing robust biosecurity measures and strict quality control protocols, the risk of transmitting diseases from aquaculture products to humans can be minimized. Additionally, promoting a nutritious and balanced diet that includes sustainably farmed seafood contributes to improved human health and well-being.

Benefits of One Health Aquaculture

Sustainable Food Production

With global population growth and increasing demand for protein, One Health Aquaculture offers a sustainable solution to meet the growing food needs. By maximizing production efficiency and minimizing resource use, it provides a reliable and environmentally-friendly source of nutritious seafood.



Biodiversity Conservation

One Health Aquaculture prioritizes the protection of natural habitats and ecosystems. By avoiding overfishing and destructive fishing practices, it contributes to the conservation of wild fish stocks and the preservation of marine biodiversity.

Climate Resilience

One Health Aquaculture practices can be designed to mitigate the impacts of climate change. Sustainable aquaculture systems, such as land-based recirculating systems or carefully planned sea-based operations, can reduce the sector's vulnerability to extreme weather events and minimize its carbon footprint.

Economic Growth and Social Well-being

One Health Aquaculture has the potential to generate employment opportunities, particularly in coastal and rural communities. By supporting local economies, it can contribute to poverty reduction and enhance the social well-being of communities dependent on aquaculture.

The Future of One Health Aquaculture

By 2050, it is anticipated that aquaculture will supply the majority of aquatic dietary protein. Aquaculture's effects on the environment's integrity, the health and welfare of farmed organisms, and human health must be appropriately considered if it is to deliver greatly increased amounts of food in a sustainable way. As we look to the future, One Health Aquaculture holds significant promise in ensuring a sustainable and resilient seafood production system. However, its successful implementation requires collaboration among various stakeholders, including governments, aquaculture producers, researchers, and consumers. Governments need to enact supportive policies and regulations, while the aquaculture industry must adopt best practices and invest in research and innovation. Consumers, on their part, can make informed choices by favoring responsibly farmed seafood and supporting sustainable aquaculture initiatives.

Aquaculture can mitigate the negative consequences associated with land-based food production systems particularly where land and water-based systems are integrated to protect terrestrial habitats from the impact associated with some current farming systems 54,55. The One Health principles will facilitate increasing production of aquaculture species with efficient food production and sustainable environmental footprints, while supporting local socio-economic needs. If put into practice, the success metrics will serve as an example for the design and assessment of not just aquaculture, but whole food systems.

Conclusion

The food safety has now become a pressing and burning global issue. Hence, stakeholders from diverse domains (government agencies, industry experts, researchers, academicians, and the community) should involve themselves to simplify the food systems to uncouple the public health benefits of consuming good quality aquatic protein sources from adverse impacts on the environment, organism, and the society. Integration of good aquacultural practices with the existing regulations may deliver encouraging impacts. The convergence of various sectors in a holistic pattern under 'One Health umbrella' would facilitate increased production of aquaculture species for effective food production and sustainable environmental footprints meeting the regional socio-economic demands.

Taking leads from this approach and the past successes involved in various other domains like zoonotic infections, it is the need of the hour to inculcate a OH approach in food safety, especially the fisheries sector with an ultimate aim of achieving health and well-being for humans, co-existing non-humans and their communal environment for achieving planetary health.

One Health Aquaculture offers a comprehensive and sustainable approach to the production of seafood, addressing the intertwined challenges of environmental conservation, animal welfare, and human health. By embracing this holistic approach, we can create a future where aquaculture plays a vital role in meeting the global demand for food while safeguarding ecosystems and supporting the well-being of both animals and humans. By recognizing the interdependencies between these factors, we can pave the way for a more sustainable and resilient aquaculture industry that benefits present and future generations alike.

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Contingent Crop Planning for Dryland Agriculture in Vidarbha Region of Maharashtra State of India

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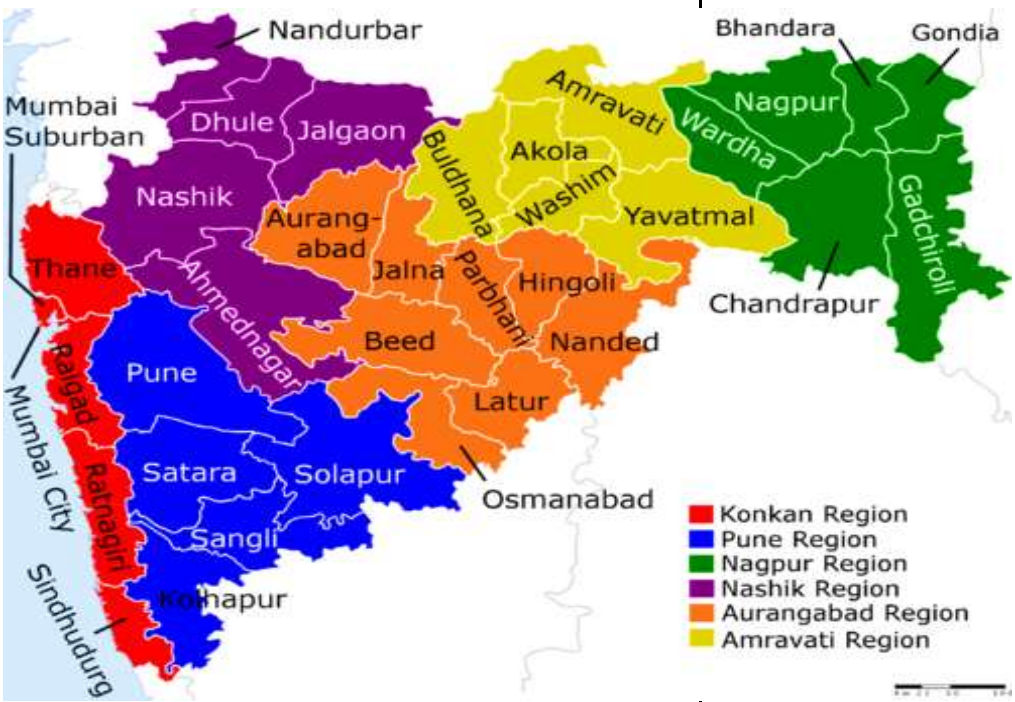
The Vidarbha region comes under the Deccan Plateau, hot moist semi-arid ESR with medium land deep clayey Black soils (shallow loamy to clayey Black soils as inclusion), medium to high AWC and LGP 120-150 days. (K5Dm4). Vidarbha region has been divided into three agro-climatic zones based on rainfall, soil types and vegetation viz., Western Vidarbha Zone (Rainfall 700 to 950mm), Central Vidarbha Zone (Rainfall 950 to 1250mm) and Eastern Vidarbha Zone (Rainfall <1250mm). It lies in between 17^0 57′ - 21^0 46′ N Latitude and 75^0 57′ - 80^0 59′ E Longitude and covers an area of 97762.9 km^2, which is 31.92 per cent area of Maharashtra. The region comprises of eleven districts *viz.* Buldana, Akola, Washim, Amravati, Yavatmal, Wardha, Nagpur, Bhandara, Gondia, Chandrapur and Gadchiroli.



The mean annual rainfall ranges from 700 mm at the West to 1700 mm at the East. The day length and temperature varies giving a rise from North to South and rainfall from West to East. Thus, it gives rise to various agro climatic situations. Monsoon sets in from 8th June regularly and rains commence in between 18th to 25th June with highest rainfall during July and August and withdraw on 8th October. However, rains are meager after first fortnight of September, Total rainy days ranges in between 47 to 65. The coefficient of variation of monthly rainfall is 40 to 50 per cent even for the wet month *i.e.* July indicating the uncertainty of rains during the season. The dry spells had been experienced during July, August and September coinciding with the vegetative or reproductive stages of the major rainfed crops. Cold wave with moderate intensity at least once or twice is the characteristics of winter. The mean minimum temperature ranges from 12.3 to 27.2^0 C and the mean maximum temperature ranges from 26.2 to 40.8^0 C. The normal mean monthly maximum temperature is 42.5^0 C during the hottest month (May), while the normal mean monthly minimum temperature is 10.6^0 C in the coldest month (December).

Problems / constraints identified in dryland agriculture in the Western and Central Vidarbha region:

- Prolonged dry spells occurring during flowering and pod formation/seed development phases.
- Continuous mono cropping and weather shift causing outbreak of insect pest and disease.
- Lack of irrigation resources and inappropriate rain water management.
- Limited input use and adoption of technology by farmers; mainly inadequate and imbalanced crop nutrition.
- Premature or delayed harvest.
- Lack of mechanization and harvester for small farm conditions.
- Inappropriate post harvest management.
- Price security and market accessibility.
- Lack of awareness and education level of farmers.
- Small land holdings.
- Financial constraints due to poor economic conditions of farmers.

Cropping Pattern

The major rainfed crops cultivated in the Vidarbha region in the semi arid zone during kharif are cotton, soybean, pigeonpea, greengram, blackgram, sorghum and during rabi are chickpea, safflower, wheat and rabi sorghum whereas in summer greengram, maize and groundnut are the major crops of concern for the farmers in the region. Soybean -Chickpea (Sequence cropping) as prominent and major cropping system in Vidarbha region. Soybean + Pigeonpea in row proportion of (4:2)/(5:1)/(6:1) is soybean based major inter-cropping system followed by the farmers in the region. In cotton based intercropping systems Cotton + Pigeonpea in row proportion of (7:1)/(9:1) is evolving as a prominent intercropping system. Paddy is the major crop grown in eastern Vidarbha region which includes districts viz: Gondia, Gadchiroli, Chandrapur, Bhandara and some parts of Nagpur region.

Contingency crop planning for the major crops cultivated in Western and Central Vidarbha:

In rainfed areas, as a general rule, early sowing of crops with the onset of monsoon is the best practice that gives higher realizable yield. In Western and Central Vidarbha, rainfall is concentrated in just a few months of the year (about 84% of annual rainfall during June-September) and is highly variable in frequency, intensity and geographic coverage. Mainly the swings in the onset, continuity and withdrawal pattern of monsoon make crop production in rainfed areas a risky proposition and hence selection of crops needs to be precisely done in critical situations of dryland agriculture especially during the emergency situations such as late onset of monsoon and delayed sowing. Effective crop selection in these situations can avoid re-sowing and crop failure in the contingency situations. Selection of crops as per the prevailing weather situations in critical rainfall situations of the Western and Central Vidarbha region is given in the table 7.

Crop/cropping system for normal onset of monsoon (second week of June)

- Cotton (AKH-09-5, AKH-9916), Soybean (AMS-1001, AMS-MB-5-18, JS-335 & JS-93-05), Pigeonpea (AKT-8811, Vipula, PKV- Tara & BSMR-736), Sorghum (CSH-9, PDKV Kalyani) Greengram (PDKV Greengold, PKV AKM-4), Blackgram (PDKV Black gold, PKV Udid-15)

- Intercropping systems: Cotton+pigeonpea (8:1/9:1), Cotton+greengram/blackgram (1:1), Soybean+pigeonpea (4:2/6:1), Cotton+cowpea (1:1), Cotton+clusterbean (1:1), Cotton+soybean (4:10)> Safflower, Cotton+soybean (6:6)> mustard.

Suggested contingency crops/ cropping systems and cultivars under delayed onset of monsoon

Delay by 2 weeks (4th week of June)

- Cotton (AKH-081 (B*t*), AKH-09-5, AKH-9916), soybean (JS-9560 & JS-93-05), Pigeonpea (PKV-Tara & BSMR-736), Sorghum (CSH-14, CSH-17, CSH-30), Greengram (Pusa vaishakhi, Kopergaon) and Blackgram (TAU-2).
- Intercropping systems: Cotton+pigeonpea (8:1/9:1), Cotton+greengram/blackgram (1:1), Soybean+pigeonpea (4:2/6:1), Cotton+cowpea (1:1), Cotton+clusterbean (1:1), Cotton+soybean (4:10)> safflower, Cotton+soybean (6:6)> mustard.
- Area under cotton be reduced and replaced by sorghum and area under groundnut be reduced and replaced by sunflower.
- Prefer Greengram, Blackgram, Soybean, Pigeonpea as intercrops.
- Delay by 4 weeks (2ndweek of July)
- Cotton (AKH-081, AKH-09-5, AKH-9916), Soybean (JS-9560 & JS-93-05), Pigeonpea (PKV- Tara & BSMR-736), Sorghum (CSH-14, CSH-17, CSH-30), Greengram (Pusa vaishakhi, Kopergaon) and Blackgram (TAU-2)
- Intercropping systems: Cotton+pigeonpea (8:1/9:1), Cotton+greengram/blackgram (1:1), and Soybean+pigeonpea (4:2/6:1).
- Prefer early varieties of American/ *Arboreum* cotton
- Replace Sorghum, Greengram and Blackgram by Soybean (JS-9560 & JS-93 -05) or Pigeonpea (AKT8811,Vipula,PKV-Tara & BSMR-736)
- Adopt 20-25% more seed rate than recommended seed rate and reduce fertilizer dose by 25% for cotton
- Prefer three tier intercropping of Cotton:soybean:pigeonpea:soybean (3:2:2:2) or Cotton:sorghum:pigeonpea:sorghum (3:1:1:1).
- Replace the hybrids with improved varieties in cotton (American cotton: AKH-8828, PKV Rajat (B*t*) & AKH-081(B*t*); *Desi* cotton: AKA-5, AKA-7 & AKA-8).
- Delay by 6 weeks (4th week of July)
- Sole pigeonpea (AKT-8811, Vipula, PKV Tara, BSMR-736); Sunflower (hybrids) or Sesame (AKT64) or Castor (AKC-1, GCH-4,5,6 & DCH-117, 32) or Pearl millet (PKV Raj, Shraddha, Saburi)
- Intercropping systems: Pearlmillet + pigeonpea (2:1, 4:2).
- Avoid sowing of cotton otherwise use only short duration deshi varieties with 25 to
- 30% more seed rate and reduced intra-row spacing; replace the hybrids with improved varieties in cotton (American cotton: AKH-8828, PKV Rajat (B*t*), AKH-081(B*t*); Desi: AKA-5, AKA-7, AKA-8).
- Avoid sowing of Sorghum, Greengram and Blackgram.
- Alternative crops include Sunflower, Pearlmillet, Sesame, Castor and Pearlmillet + Pigeonpea

Delay by 8 weeks (2nd week of August)

- Pigeonpea (AKT-8811, Vipula); Sunflower(hybrids)/Sesame (AKT64)/Castor (AKC-1, GCH-4,5,6 & DCH-117,32/Pearlmillet (PKV Raj, Shradha, Saburi); Pigeonpea (PKV Tara, BSMR-736); Pigeonpea (AKT-8811,

Vipula); sunflower (hybrids)/sesame AKT64/ Castor (AKC-1, GCH-4,5,6 & DCH-117, 32)/Pearlmillet (PKV Raj, Shradha, Saburi); Greengram, Blackgram.

3. Crop, soil, water and nutrient management strategies during seasonal drought

Early season drought:

- Adoption of risk resilient cotton and soybean based intercropping systems such as Cotton+greengram (1:1), Cotton+cowpea (1:1), Cotton+clusterbean (1:1), Soybean+pigeonpea (4:2), Soybean+pigeonpea (6:1) as preparedness to cope up with drought situations instead of sole cropping of cotton and soybean for assured and sustainable crop production.
- Sowing of cotton and soybean on broad bed furrow through BBF planter for in-situ moisture conservation and to cope up with moisture stress during early season drought.
- Raising of cotton seedlings in polythene bags for transplanting when sufficient moisture
- is available after receipt of rains can be practiced to compensate loss in plant stand with seedlings of similar age.
- If moisture stress occurs at very early stage i.e. within a week to10 days after sowing, it is recommended to resow with subsequent rains for better plant stand.
- In case of failure of kharif crops, prefer sowing of photo insensitive crops such as Pearl millet, Sunflower, Sesame and Pigeonpea once adequate rains are received.
- Gap filling to be done by pot watering 7 to10 days after sowing when crop stand is less than 75%.
- Interculture for removal of weeds and creating soil mulch.
- Open conservation furrows in each row in cotton and soybean by tying a rope to hoe and furrow across the slope for in-situ moisture conservation.
- In Pigeonpea, gap filling either with sesame or maize.
- In Sorghum, adopt thinning to maintain optimum plant population.
- Avoid applying fertilizer till sufficient moisture is available in soil.

Mid-season drought

- Take up repeated interculture to remove weeds and create soil mulch to conserve soil moisture.
- If severe moisture stress, ratooning or thinning may be done in kharif sorghum and pearl millet.
- Open conservation furrows in each row in soybean and cotton for in-situ moisture conservation by tying a rope to hoe during hoeing.
- Open alternate furrows in row crops such as soybean or furrows for every 6-8 rows of Pigeonpea with Balaram plough in medium to deep soils.
- Foliar spray of 2% urea solution at flowering stage in cotton to supplement nutrition during mid-season drought.
- Foliar spray of 19:19:19 mix water soluble fertilizer at pod initiation stage in soybean to supplement nutrition during mid-season drought.
- Avoid top dressing of fertilizers until receipt of rains.
- Adopt surface mulching with crop residue or tree loppings of Glyricidia wherever possible.

c. Terminal drought

- Provide lifesaving or supplemental irrigation, if available preferably through sprinkler or drip irrigation at pod development stage in soybean and at boll development stage of cotton during prolonged dry spells of terminal drought.
- Harvest at physiological maturity with some reliable yield or harvest for fodder and prepare for rabi sowing in double cropped areas.
- Foliar spray of 1% KCl at boll development stage in cotton to supplement nutrition during prolonged dry spell.
- Advantage of this situation is exploited for double cropping with safflower and chickpea.
- Safflower may be sown after sorghum till15th October. Beyond 15th October, chickpea may be sown.

Area, production and productivity of major crops cultivated in Western and Central Vidarbha region

Table No. 01. District wise Area (A), Production (P) and Productivity (Py) of major Kharif Crops cultivated in Western and Central Vidarbha

Particulars		Soybean			Cotton lint			Pigeonpea			Greengram		
Sr.	District	A ("00ha)	P ("00 ton)	Py (Kg/ha)	A ("00ha)	P ("00 ton)	Py (Kg/ha)	A ("00ha)	P ("00 ton)	Py (Kg/ha)	A ("00ha)	P ("00 ton)	Py (Kg/ha)
1	Akola	2166	2656	1226	1591	3355	359	541.16	504	931	202.98	12	61
2	Amravati	2387	2203	923	2761	7404	456	1000.12	1011	919	126.78	7	56
3	Buldana	4157	6951	1672	2035	4751	397	949.54	1426	1502	180.73	89	494
4	Washim	3000	5253	1751	218	818	639	626.56	535	854	75.3	56	750
5	Yavatmal	2851	2851	1000	4734	7620	274	1375.62	799	581	56.10	19	331
6	Wardha	1257	680	541	2435	5949	415	716.33	1328	1855	0.16	0.1	340
State Total		**16150**	**20990**	**1186.4**	**19180**	**43919**	**425.8**	**5420.18**	**5774**	**1064.8**	**897.92**	**249.1**	**327.14**

(Source: Maha-agri, Department of Agriculture, Govt. of Maharashtra, 2020-21)

Table No. 02. District wise Area (A), Production (P) and Productivity (Py) of major Rabi and Summer Crops cultivated in Western and Central Vidarbha:

Particulars		Rabi Crops						Summer Crops					
		Wheat			Chickpea			Maize			Groundnut		
Sr.	District	A ("00ha)	P ("00 ton)	Py (Kg/ha)	A ("00ha)	P ("00 ton)	Py (Kg/ha)	A ("00ha)	P ("00 ton)	Py (Kg/ha)	A ("00ha)	P ("00 ton)	Py (Kg/ha)
1	Akola	278.83	399.40	1433	842.71	970.08	1151	0	0	0	35.05	43.07	1228.96
2	Amravati	430.46	721.73	1677	947.83	1178.26	1243	11.31	20.31	1795.50	12.91	11.85	917.98
3	Buldana	555.60	1120.18	2016	1916.64	2391.04	1248	64.75	117.38	1812.80	53.35	104.05	1950.60
4	Washim	359.72	570.05	2419	662.84	1045.19	1577	0	0	0	79.94	254.45	3182.89
5	Yavatmal	488.90	698.42	1429	1238.19	1425.17	1151	0	0	0	105.70	114.21	1080.56
6	Wardha	158.88	342.46	2155	477.37	806.64	1690	0.33	0.43	1302.46	12.85	20.69	1610.59
State Total		**19091.9**	**16328.8**	**855.2**	**23217**	**25973.5**	**1118.7**	**141.09**	**271.4**	**995.8**	**312.89**	**571.82**	**1680.99**

(Source: Maha-agri, Department of Agriculture, Govt. of Maharashtra, 2020-21)

Table No. 03. Normal sowing window of rainfed crops cultivated in Western and Central Vidarbha

Sowing Window					
Kharif Crops				Rabi Crops	Summer Crops
Cotton	**Soybean, pigeonpea**	**Greengram**	**Sorghum**	**Chickpea, Sorghum, Maize**	**Greengram,Groundnut and Maize**
Entire June	Third week of June to second week of July	Third to fourth week of June	Third week of June to first week of July.	Third week to fourth week of October	2nd week of January to 1st week of February

Table No. 04. Crops and varieties/hybrids suggested for cultivation in Western and Central Vidarbha

Crop	Varieties/	Yield Potential (kg/ha)	Duration	Tolerance to abiotic and biotic stresses
Cotton	AKH-09-5	1200-1500	170-80	Tolerant to drought, resistant to arm, tolerant to grey mildew and Jassids and resistant to wilt
	AKH-9916	1200-1500	170-180	-do-
	PKY HY-2 (BG-II)	1200-1500	170-180	-do-
	PDKV JKAL (BG-II)	1500-1800	180-200	-do-
	AKA-5	700-800	170-180	-do-
	AKA-7	1000-1200	140-150	-do-
	AKA-8	1000-1200	170-180	-do-
Soybean	JS-335	2200-2400	98-105	-
	AMS-1001 (PDKV Yellow Gold)	2200-2600	95-100	-
	AMS-MB-5-18 (Suwarn Soya)	2400-2800	98-102	-
	JS-9560	1800-2000	82-88	-
	JS-9305	2000-2400	90-95	-
Pigeonpea	TAT-10	800-900	110-115	-
	ICPL-87	900-1000	125-135	Tolerant to drought, resistant to wilt and sterility mosaic
	AKT-8811	1000-1100	130-140	Tolerant to drought
	BDN-2	900-1000	170-175	Resistant to wilt
	PKV Tara	1900-2000	178-180	Tolerant to drought, resistant to wilt and sterility mosaic
	BSMR-853	1300-1400	178-180	- do-
	BSMR-736	1300-1400	180-200	- do-
	Asha (ICPL-87119)	1200-1400	180-210	- do-

Greengram	PDKV Greengold	1000-1200	65-70	Medium Tolerant to powdery mildew
	PKV AKM -4	800-100	65-70	Kharif and summer cultivation and multi disease tolerant
Sorghum	CSH -14	4200-4500	100-105	-
	CSH -17	4200-4500	100-105	-
	CSH -30	4000-4500	100-105	-
	CSH -9	4500-4800	100-105	-
	CSH -16	4500-5000	110-115	-
	CSH -25	4500-5000	110-115	-
	SPH-1635	4800-5000	110-115	-
	CSH -35	4800-5000	110-115	-
	SPV-669	3800-4000	115-120	-
	SPV-15	3600-3700	115-120	-
	PVK-400	3500-3600	115-120	-
	SPV-1616	3600-3800	115-120	-
	CSV-23	2500-3000	110-115	-
	CSV-27	2500-3000	110-115	-
	CSV-28	2500-2800	115-120	-
	PDKV Kalyani	3500-4000	115-120	-
	CSV-34	3800-4000	110-112	-

Table No. 05. Crops and varieties suggested for Rabi season in Western and Central Vidarbha

Crop	Varieties/ hybrids	Yield Potential (kg/ha)	Duration	Tolerance to abiotic and biotic stresses
Chickpea	JAKI-9218	1800-2000	105-110	Tolerant to wilt
	PDKV Kanchan	2100-2300	105-110	-do-
	PKV Kabuli-4	1600-1800	100-125	-do-
Sorghum	CSH-15 R	2800-3000	120-125	-
	CSH-19 R	3800-4000	115-120	-
	PKV Kranti	2500-3000	120-125	-
	SPV-504	2200-2400	120-125	-
	CSV 14 R	2500-2600	120-125	-
	Phule Yashoda	2500-2600	120-125	-
	CSV 18 R	3300-3400	120-125	-
Safflower	AKS-207	1400-2000	125-130	-
	Bhima	1200-2000	130-135	-
	Nari-6 (thornless)	1000-1500	135-137	-
	PKV Pink	1500-1800	135-140	-

Table No. 06. Crops and varieties suggested for Summer season in Western and Central Vidarbha

Crop	Varieties/ hybrids	Yield Potential (kg/ha)	Duration	Tolerance to abiotic and biotic stresses
Groundnut	TAG-24	2400-2600	110-115	-
	TAG-76	2500-2800	110-115	-
Greengram	PDKV Greengold	1000-1200	65-70	Medium Tolerant to powdery mildew
	PKV AKM -4	800-100	65-70	Kharif and summer cultivation and multi disease tolerant
Maize	PKVM Shatak	5500-6000	90-100	-
	African Tall	4000-5000	100-110	-
	Pusa Hy-1	4000-5000	80-90	-
	Vivek Hy-21	4500-5000	80-90	-

Table No. 07. Cultivation of crops in real time as per prevailing contingent situation

SN	Time of arrival of sufficient rains for sowing	What crops should be grown?	What crops should not be grown?
1	15-30 June	All kharif crops	-
2	1-7 July	All Kharif crops	-
3	8-15 July	Cotton, Hybrid Sorghum, Hybrid Millet, Soybean, Tur, Sesame and Sunflower	Groundnut, Greengram and Blackgram.
4	16-31July	Hybrid Millet, Sunflower, Tur, Soybean, Millet castor and Coriander	Cotton, Hybrid Sorghum and Groundnut
5	1-15 August	Castor, Sesame, Millet, Ragi, Sunflower, Tur, and Coriander.	Cotton, Hybrid Sorghum and Groundnut
6	16-31 August	Millet, Sunflower, Tur, Castor and Coriander	Cotton, Sorghum, Groundnut, Ragi and Sesame
7	20-30 September	Rabi Sorghum, Safflower and Sunflower	Gram, Linseed and Wheat
8	1-15 October	Rabi Sorghum, Safflower and Linseed	Sunflower and Wheat
9	16th October to 1st November	Gram, Safflower, Wheat and Linseed	Rabi Sorghum and Sunflower

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Farmer Success story: Integrated Farming Approaches

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Name of the farmer : Mavuram Mallikarjun Reddy

Age : 32

Education : B.Tech (Computer Science)

Land holding : 12.5 acres

Address : H.No: 1-180, Pedda Kurumapally, Post: Revelli, Mdl: Choppadandi, Dist: Karimnagar, Telangana, India.

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Situation Analysis/Problem Statement

In general, many of the farmers are using conventional farming methods which involve inorganic fertilizers and following monocropping, which puts a strain on farmers' soil and water resources. This often leads to less productive crop yields, which in turn means less food and lower incomes. As they already strained situation gets worst due to climate change, farmers are now in need of more efficient modes of production. To make the farming economically viable, environmentally sound and sustainable a holistic all around approach is required.

Plan, Implement and Support

Integrated Farming approach represents an appropriate combination of farm enterprises (cropping systems, horticulture, livestock, fishery, forestry, poultry) and the means available to the farmer to raise them for profitability. To integrate all above activities, with the technical support of KVK he has planned and implemented the different approaches

- Direct seeding (Drum seeder & Broadcasting) method of paddy cultivation.
- Traditional cultivation of Azolla as a bio fertilizer and application in Paddy field, used as livestock feed.
- Growing of Horticultural crops like Vasu & Ginger.
- Maintaining 4 cows (Ongole, Ghir, Sahilwal and local breeds) and 2 cattles in dairy unit.
- Rearing 21 sheep (20 Female + 1 Male) and 30 lambs in farm.
- Rearing 600 fish in open well present in the field.
- Rain water harvesting through farm ponds and open wells for entire Agriculture land to increase ground water level.
- Generation of 2 KW Solar power through solar system and utilizing for Agriculture, domestic purpose.
- Production of Bio gas through utilization of animal and various types of organic wastes and utilization of animal slurry in Agriculture land
- Cultivation of improved fodder varieties like Super Napier and Hedge lucern

- Growing of green fodder through Hydroponics to feed livestock
- Practicing Organic farming to preserve natural resources
- Development of low cost feed for Animals from Pulse crops
- Maintenance of Poultry farm and Rearing of Vanaraja chicks

Output

In this integrated farming practices, with the technical support of KVK Scientists, Cultivated paddy through Direct seeding method**.** By following the better innovative practices like weeding with Manual operated weeder (Self innovated instrument), AWD method of irrigation management and application of Azolla along with bio fertilizers leads to reduction in cost of cultivation. With the above practices the yield levels were enhanced due to this income levels were higher than farmer practice.

S. No	Name of the Parameter	Broad Casting method (Innovative practice)	Normal Transplanting (Farmer practice)
1	Cost of Cultivation (Rs/ha)	38,137	47,000
2	Yield (Q/ha)	82.5	80.5
3	Gross Income (Rs/ha)	1,55,100	1,51,984
4	Net Income (Rs/ha)	1,16,963	1,04,984
5	C:B Ratio	1:3.06	1:2.23

- The Net income received by this practice is 1,16,963/- per ha and with normal transplanting method net income received is 1,04,984/-. The Average additional income gained per hectare is 11,979/-**.**

Horticulture crops

S. No	Name of the Parameter	Vasu (Acorus Calamus)	Ginger
1	Cost of Cultivation (Rs)	88,700	15,650
2	Yield (Q)	30	5
3	Gross Income (Rs)	1,80,000	32,500
4	Net Income (Rs)	91,300	16,850
5	B.C Ratio	1:1.02	1:1.07

Developed model horticultural farm by cultivating Vasu (Acorus Calamus) & Ginger in one hectare area and received net income 1,08,150/-.

Livestock, Fisheries

Sl. No.	Name of the Parameter	Dairy	Sheep rearing	Fish farming
1	Cost of Investment per year (Rs)	53,000	64,020	18,600
2	Milk per year (Litres)	1925	-	-
3	Gross Income (Rs)	92,125	1,80,000	48,000
4	Net Income (Rs)	39,125	1,15,880	30,600
5	C:B Ratio	1:0.73	1:1.81	1:1.64

- By maintaining dairy farm (4 cows (Ongole, Ghir, Sahilwal and local breeds) and 2calves) receiving net income 39,125/-.
- By rearing of sheeps (21 sheep (Deccen breed) (20 Female + 1 Male) and 30 lambs) receiving net income 1,15,880/-.
- By fish farming (Rearing 600 fish in open well present in the field) receiving net income 30,600/-.

Sl. No	Name of the technology	Area (Acres)	Farmers (No)
1	Direct seeding in Rice	500	300
2	Weeding with Manual Operated paddy weeder	200	100
3	AWD method of water management in paddy	800	350
4	Cultivation of Azolla - using as animal feed & applying in paddy fields	300	100
5	Organic farming practices like growing of green manure crops, crop rotation, usage of FYM, IPM methods etc.	200	100

Outcome

Disseminating the innovative practices of Integrated farming approaches of the farmer in a horizontal way by KVK through conducting awareness programmes like field trainings, farmers group discussions, field days in collaboration with ATMA and other line departments.

Farmers were in a position to understand the field problems while managing the integrated farming approaches for sustainable income in different conditions.

Details of Technology Spreading

Integrated farming approaches like integration of Agriculture with livestock and fish farming or integration of horticulture with livestock results in higher profitability and sustainability-enhancement.

In broadcasting method of paddy cultivation, the organic farming practices followed by farmer results in enhancement of soil fertility status, saves water by 20-30%, reduction in cost of cultivation 6500/- per hectare and increases yields by 10%.

Integration of livestock with cropping systems have sustainable income and synergic effect of on all enterprises.

Impact

- By adopting AWD method of water saving technique in paddy, saves up to15-30% of the

nearly 5,000 litres of water commonly used to produce 1kg of un milled rice.

- Rice cultivation contributes 11% of the global CH_4 anthropogenic emissions. The alternate wetting and drying (AWD) irrigation practice can conserve water while reducing CH_4 emissions through the deliberate, periodic introduction of aerobic soil conditions.
- Manual operated paddy weeder is portable and easy to transport, Cost of weeding is reduced by Rs 2400/acre.
- With the direct seeding methods of paddy cultivation, we will overcome labour scarcity problem and saves Rs. 11250/- per hectare (Labour wages for transplanting)
- With the INM practices, soil fertility levels were increase by restoring soil organic content.
- Reduced usage of nitrogen fertilizers due to continuous application of Azolla (both *kharif* and *rabi* seasons) in paddy field.
- Harvesting rain water management through farm ponds and open well (16 lakh lit capacity)
- Preparation of Compost through Paddy straw and other crop wastes by using waste decomposer.
- Received appreciations from District Collector, Karimnagar for innovativeness in developing Integrated Farming System (IFS).
- Received "IARI innovative farmer award" nominated by KVK, Jammikunta during the "Pusa Krishi Vigyan Mela 2021" held at IARI, New Delhi during 25-27 February, 2021.

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Dry Fish: Reliable Nutrition in Challenging Times

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The drying method is considered the least expensive method of fish preservation (Balachandran, 2001). Drying of different species is the most primitive and oldest method for preserving fish and is traditionally practiced in the world (Payra *et al.,* 2016 & Balachandan *et al.*, 2013). The dry fish sector (Production and marketing) is crucial in creating jobs and improving public health. Notably, women have been extensively involved in the curing, processing, and marketing dry fish, contributing to their empowerment and economic independence (CMFRI, 2010).

In the face of ongoing food security challenges, dry fish has emerged as a reliable source of nutrition. Its long shelf life and preservation of essential nutrients make it an invaluable food source, particularly during challenging times when fresh fish may be scarce or inaccessible. Dry fish offers a practical solution for communities in regions with limited resources, allowing them to meet their nutritional needs sustainably.

Nutritional value and preservation

Dry fish is nutritionally rich, offering high-quality proteins, healthy fatty acids like omega-3s (EPA and DHA), and essential nutrients like iodine, zinc, copper, selenium, and calcium. It provides a gastronomically nourishing experience with high protein content and fewer calories than animal meat, making it a delicious and healthy choice. (Siddhnath *et al*., 2022)

Dried fish products are favored for their taste, flavor, and high content of (n-3) polyunsaturated fatty acids, which offer various health benefits. Dried fish provides health benefits by reducing stroke risk, lowering triacylglycerol levels, regulating blood pressure, and influencing glucose metabolism. It is a valuable protein source that contributes to balanced health and serves as an essential protein intake in countries with low cholesterol levels and rich nutrient profiles. (Rasul *et al*., 2021)

It provides a concentrated dose of nutrients to support overall health, especially when fresh seafood is scarce or inaccessible. In the country, poor people take advantage of dry fish as a cost-effective protein source in their nutritious food (Reza *et al.* 2005). It was reported that dry fish contain more amino acids than eggs (Paul *et al.*, 2018).

Preservation techniques

Drying is a simple and oldest method of fish preservation that relies on the sun and wind (Balachandran, 2001). Additionally, artificial dehydration techniques have been developed. These methods remove water from the fish, leading to shrinkage and irreversible changes that alter the properties of the dried fish compared to its original state. (Murali2 S, 2017).

Different preservation methods, including drying, salting, chilling, freezing, and smoking, prevent microbial spoilage and maintain nutrient quality for year-round storage. Among these techniques, drying is the most commonly utilized method for fish processing and preservation in developing nations. This traditional approach

ensures long-term storage while preserving the nutritional value of the fish (Banna *et al*., 2022). These techniques not only extend the shelf life of fish but also enhance its flavor and texture. Preservation also permits the smoothing of seasonal fluctuations in the abundance and scarcity of fish throughout the year (Belton *et al*., 2022). These preservation techniques ensure that dry fish remains a reliable and nutritious food source even during challenging times.

Long shelf life and accessibility

Fresh fish's poor handling and storage practices often lead to rapid postharvest deterioration, resulting in limited availability. These challenges meeting the market demand for fish and its nutritional benefits. However, dried fish offers a solution to this problem.

One of the critical advantages of dry fish is its extended shelf life. Unlike fresh fish, which can spoil quickly, dry fish can remain edible for an extended period. This characteristic is precious in regions with limited access to fresh fish, such as remote coastal areas or landlocked communities. By preserving fish through drying, communities can overcome the limitations imposed by geography and ensure a stable supply of nutritious food (Banna *et al*., 2022).

Furthermore, dry fish does not require expensive storage facilities. Unlike fresh fish, which necessitates refrigeration or freezing to prevent spoilage, dried fish can be stored at room temperature.

Dry fish offers a high nutritional value, extended shelf life, and doesn't require expensive storage facilities. It is a practical solution for communities in challenging circumstances, ensuring accessibility to reliable nutrition (Immaculate *et al*., 2013).

Dry fish as a solution in challenging times

Fish is vital in the daily diet, and it contains a good source of protein. It is a crucial dish in the diet, with many food items as a flavoring agent (Soumyadip *et al*., 2018). Dried fish has a significant source of micronutrients in an Indian meal, and it plays crucial in the fight against malnutrition and other health problems in developing South Asian countries like India (Siddhanth *et al*., 2022).

During the monsoon season, when fishing is prohibited, dry fish becomes highly sought after in the market due to the absence of fresh fish supplies, highlighting its historical significance in offering sustenance during scarcity or restricted access to fresh seafood. (Das *et al*., 2013).

The COVID-19 pandemic exposed the linkages between globalization, economic vulnerabilities, and essential food provision. As a portable and affordable source, dried fish is crucial in ensuring food security, sustaining livelihoods and addressing nutritional needs, highlighting the significance of supporting small-scale dried fish market chains. Additionally, due to the prevailing COVID-19 pandemic situation in recent years, the demand for shelf-stable dried fish products has spiked in households as it is a non-perishable food item (Mandal *et al*., 2021; Jayasekara *et al*., 2022). During monsoon season, crises, such as natural disasters, conflicts, or disruptions in the food supply chain, dry fish has proven to be a reliable source of nutrition.

While dried fish presents a valuable source of nutrition and plays a crucial role in addressing health and food security challenges, its economy encounters sustainability issues. Addressing labor exploitation, improving sanitary conditions, ensuring ecological integrity, managing resource allocation, and enhancing governance are essential for a sustainable and resilient dried fish industry (Belton *et al*., 2022). Dry fish is crucial during

emergencies as it offers a stable food source that can be stored for a long time without refrigeration. It helps combat food shortages and ensures the availability of nutritious meals during challenging times.

Conclusion

Dry fish has emerged as a reliable and accessible source of nutrition, offering a long shelf life and high nutritional value. Its preservation techniques, including drying, salting, chilling, freezing, and smoking, ensure the maintenance of essential nutrients year-round. The cost-effective drying method, widely practiced in the dry fish sector, contributes to job creation and improved public health. Dry fish is a practical solution during food scarcity or limited access to fresh seafood. It can overcome geographical limitations, providing sustenance in remote coastal areas and landlocked regions. The COVID-19 pandemic has further highlighted its importance in ensuring food security and sustaining livelihoods. However, ensuring the sustainability of the dried fish industry requires addressing issues such as labor exploitation, sanitary conditions, ecological integrity, resource management, and governance. By addressing these challenges, the dry fish sector can continue to provide a stable source of nutrition, combating food shortages and supporting the availability of nutritious meals during challenging times.

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Protection of Plant Varieties and Farmer's Rights Act

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PPVFR Act was enacted by the Govt. of India following a Sui generis system for protection of plant varieties in compliance with the TRIPS (Trade Related Intellectual Property Rights) agreement of 1995 in order to provide for the establishment of an effective system for Protection of plant varieties and rights of farmers and plant breeders. To encourage the development of new varieties of plants and to accelerate agricultural development, it is necessary to protect plants breeders' rights to stimulate investment for research and development for the development of new plant varieties. Moreover, it has been considered necessary to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of the new plant varieties.

Such protection is likely to facilitate the growth of the seed industry which will ensure the availability of high-quality seeds and planting material to the farmers. India having ratified the Agreement on Trade Related Aspects of the Intellectual Property Rights has to make provision for giving effect to Agreement. To give effect to the aforesaid objectives the Protection of Plant Varieties and Farmers' Rights Act, 2001 has been enacted in India.

Objectives

- To establish an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants.
- To recognize and protect the rights of farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties.
- To accelerate agricultural development in the country, protect plant breeders' rights; stimulate investment for research and development both in public & private sector for the development new of plant varieties.
- Facilitate the growth of seed industry in the country which will ensure the availability of high-quality seeds and planting material to the farmers.

For the purposes of this Act, Protection of Plant Varieties and Farmers' Rights Authority has been established by the Department of Agriculture and Cooperation, Ministry of Agriculture on 11th November, 2005 at New Delhi.

General functions of the PPVFR Authority

- Registration of new plant varieties, essentially derived varieties (EDV), extant varieties;
- Developing DUS (Distinctiveness, Uniformity and Stability) test guidelines for new plant species;
- Developing characterization and documentation of varieties registered
- Compulsory cataloguing facilities for all variety of plants

- Documentation, indexing and cataloguing of farmers' varieties
- Recognizing and rewarding farmers, community of farmers, particularly tribal and rural community engaged in conservation, improvement, preservation of plant genetic resources of economic plants and their wild relatives
- Maintenance of the National Register of plant Varieties and
- Maintenance of National Gene Bank

Rights under the Act

1. **Breeder's Rights:** Breeders will have exclusive rights to produce, sell, market, distribute, import or export the protected variety. Breeder can appoint agent/ licensee and may exercise for civil remedy in case of infringement of rights.
2. **Researcher's Rights:** Researcher can use any of the registered variety under the Act for conducting experiment or research. This includes the use of a variety as an initial source of variety for the purpose of developing another variety but repeated use needs prior permission of the registered breeder.
3. **Farmer's Rights**

- A farmer who has evolved or developed a new variety is entitled for registration and protection in like manner as a breeder of a variety;
- Farmers variety can also be registered as an extant variety;
- A farmer can save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under the PPV&FR Act, 2001 in the same manner as he was entitled before the coming into force of this Act provided farmer shall not be entitled to sell branded seed of a variety protected under the PPV&FR Act, 2001;
- Farmers are eligible for recognition and rewards for the conservation of Plant Genetic Resources of land races and wild relatives of economic plants and their improvement through selection and preservation from the Gene Fund, provided that the material so selected and preserved has been used as donors of genes in varieties registrable under this Act;
- There is also a provision for compensation to the farmers for non-performance of variety under Section 39 (2) of the Act, 2001 and
- Farmer shall not be liable to pay any fee in any proceeding before the Authority or Registrar or the Tribunal or the High Court under the Act.

Who can apply for the protection of a variety

- Any person claiming to be the breeder of a variety
- Any successor of the breeder of a variety
- Any person being the assignee of a variety
- Any farmer, group of farmers or community of farmers claiming to be the breeder of that variety
- Any persons authorized in the prescribed manner by the persons mentioned above
- Any university or a public funded institution claiming to be the breeder of the variety

What are all the Varieties that can be registered

- Novel variety
- Extant variety
- Farmers variety
- Essentially Derived Variety

Registration fees

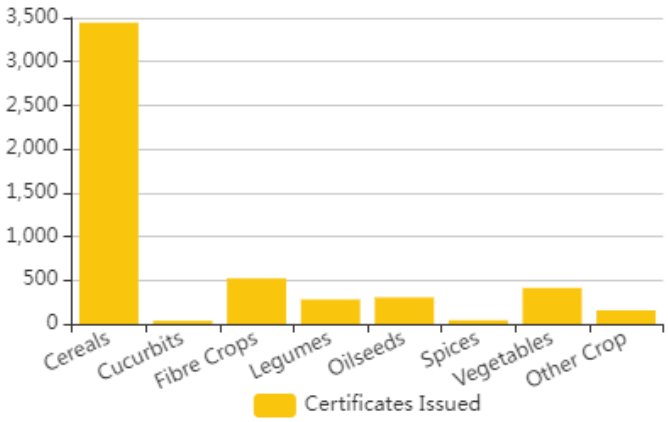
Type of variety	Fees for Registration
Essentially Derived Varieties	Individual Rs. 7000/- Educational Rs. 10000/- Commercial Rs. 50000/-
Extant variety notified under section 5 of Seeds Act, 1966	Rs. 2000/-

New Variety	Individual Rs. 7000/- Educational Rs. 10000/- Commercial Rs. 50000/-
Extant variety about which there is common knowledge	Individual Rs. 7000/- Educational Rs. 10000/- Commercial Rs. 50000/-
Farmers' Variety	No fee

No. of Certificates issued by PPVFR Authority as on June, 2023 – 5198 No.

Sl. No.	Crop Group	No. of certificates
1.	Cereals	3445
2.	Fibre crops	521
3.	Vegetables	448
4.	Oilseeds	304
5.	Legumes	280
6.	Fruits	80
7.	Sugar crops	53
8.	Spices	42
9.	Flowers	11
10.	Trees	8
11.	Plantation crops	6

Crop group wise

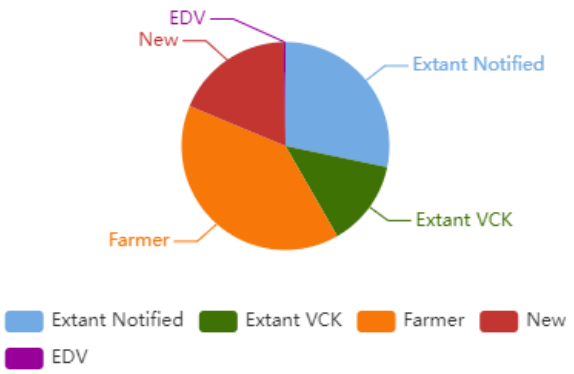


DUS Testing

The variety to be registered should satisfy the following criteria

- Distinctness (Clearly different)
- Uniformity (homogenous)
- Stable (Unchanged)

Category wise



Year wise

Salient features of the PPVFR Act

The owner of the protected variety has the following rights

- Produce the protected variety
- Sell the variety
- Market the variety
- Distribute the variety
- Import the variety
- Export the variety

In case the variety being an Essentially Derived Variety (EDV), where the EDV derived from a protected variety, an authorization is required from the breeder of the initial variety

Researcher's Rights (Sec 30)

- Use of the variety for research and experimental purpose
- Use of the variety as an initial variety for creation of new varieties

Whereas, Repeated use of the variety for commercial production of a new variety is not allowed without the authorization of the breeder of the regiatered variety

Farmer's Right – Essential component of IPR

The PPVFR Act allows the registration of traditional varieties or farmers' varieties. Registration of the variety grants PBR on the variety, which allows exclusive legal right to the PBR holding farmers to produce and market the seeds. However, in the case of a traditional variety, it is important to involve all communities associated in its conservation, if there is no clear evidence to establish an exclusive role for the origin of the said variety. The farmers need not have to pay any fee either to register their varieties or to renew these registrations. This is a major incentive to the innovative breeders among farmers. On the contrary, professional breeders and public research institutions are required to pay registration and renewal fees.

In recognition of the important role farmers have been playing for the conservation of varietal wealth of crop plants, the PPVFR Act has a provision to reward and recognize individual farmers or farming and tribal communities for such contribution. According to the Act, a National Gene Fund is to be created to facilitate reward and recognition to eligible farmers and communities.

Benefit Sharing

The Act provides for equitable sharing of the benefit earned from the new variety with farming or tribal communities that had contributed varieties used as parents.

The benefit share is disbursed from the National Gene fund to the eligible individual, community or institution. Therefor for claiming eligible benefit share, the farming communities should have

- Timely information on the varieties being registered under the Act
- Timely understanding on the notification on such varieties inviting claims for benefit share
- Capability to understand the disclosed characteristics of the new variety those of parental varieties

Compensation for undisclosed use of traditional varieties

If the breeder uses Farmers' variety as source material to develop new variety, he has to share his royalty with the community.

Or, in case where it is established that the breeder has not disclosed the source of varieties belonging to a particular community, compensation can be granted through the National Gene Fund.

Compensation for the loss suffered from a Registered variety

- The act has the provision to check unfair marketing practices by the breeders and the seed sellers
- The act requires that the seeds be sold with a declaration on its agronomic performance and the cultivation conditions ensuring their performance.

The Act tries to promote the availability of high-quality seed and planting materials to the farmers by ensuring the adequate supply of the seeds of the registered variety at reasonable cost. According to the Act, when the PBR holder does not satisfy this requirement three years after the

registration of the variety, farmers have the right to take the matter of non-availability of the seed, its poor supply or its high price to the PPVFR Authority.

A Compulsory Licensing System

Under the Section 47 of this Act, if the seeds of the protected variety are not available after 3 years of registration in adequate quantity, and at reasonable price, the Authority may grant license to a third party to

- Undertake production
- Distribution and sale of the seed at reasonable royalty

By this PPVFR Act, farmers' varieties can also be registered under the Act if the application contains a declaration stating that genetic or parental material acquired for breeding has been lawfully acquired.

There is no concept of Farmers' rights in the UPOV system particularly under the 1991 Act. In UPOV, rights are granted only to the breeder, which in today's context means the seed companies. The PPVFR Act provides a balance between the breeder's rights and farmers' right, the provisions for compulsory licensing, researcher's rights and exclusion of certain varieties from registration. About 75% of the Indian population involves in agriculture. The literacy percentage of rural population is very low. Considering the status of education of the farmers, the Section 42 of the Act also provides safeguard against innocent infringement. The farmer who unknowingly violates the breeders' rights shall not be punished if he can prove that he is innocent about the Act.

The PPVFR Authority in consultation with Government of India, has established the following awards annually to the farmers engaged in the conservation of the Genetic Resources of the landraces and wild relatives of economics plants and their improvement through selection and preservation provided the material so selected has been used as a donor of genes in respect of varieties registerable under the Act.

a. Plant Genome Savior Community Awards

Five Plant Genome Saviour Community Awards of Rs 10 Lakh with citation and memento

b. Plant Genome Savior Farmer Reward

Ten Plant Genome Saviour Farmer Rewards of Rs 1.5 Lakh each with citation & memento

c. Plant Genome Savior Farmer Recognition.

Twenty Plant Genome Saviour farmer Recognitions of Rs 1 lakh each with citation and memento

The PPVFR Authority now registers 190 crop species covering cereals, millets, pulses, oilseeds, sugar crops, fibre crops, spices, fruits, vegetables, medicinal and aromatic crops. The time limit for the registration of farmer's varieties in 17 crop species viz., Rice, Bread wheat, maize, sorghum, pearl millet, chick pea, pigeon pea, green gram, black gram, lentil, field pea, kidney bean, cotton, jute, closes by 1st July 2024 and sugarcane, jute, turmeric closes by 29th July 2024. Hence maximum number of farmers varieties need to be registered for protecting the valuable genetic resources.

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Retting of Bast Fibres: A Pretreatment Process for Development of Biocomposites

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Today, the increasing environmental concerns, growing global waste problems, continuously rising high crude oil prices and depletion of petroleum resources urged governments all over the world to increase the legislative pressure towards a bio-economy based on the exploitation of natural resources. This in turn motivates researchers, industries and farmers towards developing the concepts of environmental sustainability while reconsidering renewable resources from agriculture or forestry to obtain biobased materials or alternative energy. Fibre crops are the commodities with the longest tradition among technical and nonfood agricultural products. Actually, bio-fibres have gained popularity especially for the development of sustainable materials, thanks to their great potential for use in biocomposite materials for applications in packaging, automotive, and other industries especially as reinforcing fibres.

Natural fibres are renewable resources because they are produced as a part of the plant from photosynthesis, where O_2 is released by absorbing CO_2 gas and they decompose naturally, consequently imposing lesser burden to the environment. Natural fibres have begun to pace towards becoming the main alternative source in the modern world industry. Recently in 'environmental-friendly-era' natural fibres has definitely gained its place in the heart of most industries as it is biodegradable and most crucially, renewable. Natural fibres can be extracted from three sources i.e. plants, minerals, and animals. The main component in mineral and animal fibres is asbestos or basalt and protein, respectively. Plant fibres themselves can be recognised as a biocomposite material since they are composed mainly by cellulose, hemicelluloses, lignin, and other components. Performance of natural fibres is often influenced by their chemical composition and physical properties. Climatic, plant and geographical variations influence chemical composition of the natural fibres. Fortunately, their properties can be enhanced by giving different surface treatments.

Figure 1: Different Types of Bast Fibres

Approximately 2,000 species of natural fibres have been used as composite's reinforcement, but only a few types of fibres are dominating by holding 90% of the natural plant fibre's market. Bast fibres are the most widely used among other groups which include fruit fibres, grass fibres, root fibres, seed fibres, and leaf fibres. The use of bast fibres to prepare polymeric materials represents an interesting example of the enhancement of a natural, old resource. Retting is usually required for the successful extraction of high quality bast fibres. Bast fibres are linked among them by different compounds like pectins and waxy substances that generate unstable interfaces. After retting process, fibres are more homogeneous and fine which are suitable for the development of good quality biocomposites.

Bast Fibres

Bast fibres are cellulosic fibres that are extracted from the phloem or outer part of the plant. Since bast fibre plants are annual crops, continuous supply of fibres is one of the attractive strong points for gaining interest from nonwood biocomposite manufacturing. Bast fibre, also called phloem fibre, is a type of plant fibre that can be collected from the phloem or bast surrounding the stem of certain dicotyledonous plants. Bast fibres can be obtained either from cultivated herbs, such as flax, hemp, ramie, jute, *dhaincha* etc. or wild plants, such as linden, wisteria, mulberry etc. Epidermis, shives, woody core, and a combination of xylem must be removed in order to obtain the bast fibres. A fibre bundle consists of numerous single fibres, and each fibre is connected by the middle lamella to act as glue, composed by pectin and lignin components. The major task of retting process is to remove these gluing components and release the fibres from bundle attachment.

Retting Process

Fibre extraction from straw is the very first step in fibre processing. At this moment, the outer layer of fibre bundles must be separated from the plant by breaking off the bonds between stem cores and fibre bundles. Fibre retting is a complex process and its properties are highly dependent on the type of retting methods and parameters. During the retting process, phloem-derived fibre bundles are loosened from hemicellulose, lignin and pectin. Left-over fibres are rich in cellulose contents and exert high strength properties. Since retting is a biological process, it requires both moisture and a warm temperature for microbial action to occur. To date, several retting methods are applied; the most traditional, still widely used approaches, i.e., water retting and dew retting are based on the microbiological retting. Other approaches involve mechanical, physical, chemical, and enzymatic retting. The latter is very promising but not yet practiced on an industrial scale. All retting processes except chemical retting use enzymatic activities to extract fibres from bundles.

Techniques of Retting

Water Retting

Water retting is the oldest historical retting method. This process is famous for producing quality retted bast fibres. Retting is a biochemical process in which various decomposition is carried out in stagnant water, accumulation of these products causes hindrance to the growth and activity of the causative micro-organisms. Vary fat moving water, removes these toxic substances quickly, but it carries away the microbial population along with it resulting in uniform retting. Retting is best carried out in slow moving clear water (canal, river, etc.) with low content of materials as salts, iron and calcium content is preferable for good retting. It is

desirable to change water to keep the pH about 7 and 35°C temperature. When retting water is soft, the quality of fibre is better than when hard water is used. The presence of iron, particularly ferrous iron, is not desirable as it imparts a dark colour to the fibre.

Dew Retting

In dew retting, also called field retting, harvested plants are thinly spread out for 2-10 weeks in fields. During this period, microorganisms, mainly filamentous fungi or aerobic bacteria present in soil and on plants, attack noncellulosic cell types, removing pectins, and hemicelluloses from parenchyma cells and the middle lamellae, without attacking cellulose fibres. In this process, the colonizing fungi possess a high level of pectinase activity and the capacity to penetrate the cuticular surface of the stem: thus, fibre bundles come out separated into smaller bundles and individual fibres. Currently, dew retting is the most used process for the industrial production of bast fibres, mainly flax and jute, because of its low cost. Unfortunately, the method is limited to geographic regions, where the weather is suitable for fungi proliferation. Moreover, often low and inconsistent fibre quality is produced as compared to other methods, such as water retting. Risks of under retting and over retting are also reported: they may cause difficulties in separation or weaken the fibre. Therefore, it is necessary to monitor the retting process to ensure the quality of the fibres.

Chemical retting

With respect to water retting or dew retting, chemical processes are sometimes preferable since they produce fibres characterized by high-constant quality, regardless of weather conditions, usually in shorter times. Numerous chemical treatments can be performed on the fibres depending on their type. In chemical retting, the cementing material can be removed by dissolution with certain chemicals. The fibre obtained by chemical method of retting seems to be a little coarser, rough in the feel and stiff. The fibre strands after drying needs to be softened by rubbing with hand to open up the fibre and to remove the stiffness of the strand. The most used chemical process is alkalization, a treatment aimed at removing hemicelluloses: it is usually carried out with sodium hydroxide, added as an aqueous solution at a variable concentration in the range 1-25% by weight.

Enzyme Retting

Enzyme retting process has been introduced for some years back as a potential substitution to other retting methods. Dew retting process is often constrained by the poor and inconsistent fibre quality as well as geographical region, which require optimum temperature and moisture to promote microbial growth. Therefore, it is less efficient in countries with dry climate. A modification of water retting is the enzymatic treatment, also called bioscouring, where degrading enzymes are directly added to tank water or in a bioreactor. This technique has been demonstrated to be a promising replacement for traditional retting methods in terms of time-saving, ecology friendliness, and convenient characteristics. The duration of enzymatic retting ranges from 8 to 24 h. The high energy input and non reusability of enzymes are the main concerns, which affect the cost-effectiveness of the process. Pectinases are the main enzymes employed for retting, in order to free the fibres from other tissues.

Mechanical Retting

The mechanical extraction of fibres consists of various steps, as developed since ancient times, mainly to recover hemp and flax fibres. Today, this treatment is a completely automated process but

steps have not changed which includes breaking, scutching and hackling to obtain clean and uniform fibres. Another process currently used to mechanically separate the fibres is called decortication and can be performed by hammermilling or rollermilling. The choice of the preferable mechanical retting depends on the type of the fibre, its final application and type of ensuing treatments. Therefore, with these multiple variables in mind, it is continuously under investigation.

Physical Retting

Among the physical treatments of fibres, the processes using electromagnetic radiation, high temperature, and/or pressure can be considered. Steam explosion is an autohydrolysis process involving the use of saturated steam at high pressure followed by a sudden decompression, which causes the substantial breakdown of the lignocellulosic structure, the hydrolysis of the hemicellulose fraction, the depolymerization of the lignin components, and the defibrillation. High decompression rates lead to improved fibre freeness but shorter fibre length. During the process, high temperature softens the material and mechanical action during the high-pressure discharge results in fibre separation. Another interesting physical treatment to extract the fibres is based on the hydrothermal method: the lignins and hemicellulose are degraded by using water at elevated pressure and temperature. To specifically modify the surface of fibres in order to improve their compatibility with polymeric matrix, the plasma treatment is an effective physical method, which can be performed at both atmospheric and high pressure under the flow of different types of gas usually oxygen or argon.

Application of Retted Bast Fibres in Biocomposites

The use of natural fibres for biocomposites is an attractive field from an environmental and sustainable perspective. In particular bast fibres, given their high cellulose and low lignin content, are particularly suited to composite applications and are the most promising replacement for glass fibres in composites. Bast fibres have long been valued for their high strength and remarkable length, and were extensively used in the fabrication of ropes and sails, as well as for paper and textiles. Nowadays they are also used as a (partial) substitute for synthetic fibres, such as glass, carbon or metallic fibres for the reinforcement of polymer based matrix. They are especially employed in the automotive industry for the manufacture of some parts of the interior, in the building and furniture industries due to their good thermal, mechanical, acoustic and aseptic properties. They are also a low-cost raw material and can act as a vector of development for local agricultural resources in emerging countries well as an industrial output for crops in developed countries.

The development of lignocellulosic fibres-based biocomposites requires the selection of an appropriate biopolymer matrix, suitable surface treatments of the fibres, along with low-cost but high-speed fabrication techniques. The retting process is a successful pretreatment for the improvement of matrix/fibre adhesion and the development of high-grade biocomposites. A wide range of biodegradable products has been produced using biopolymers containing lignocellulosic fibres for different applications, ranging from automotive vehicles including trucks, construction, and insulation panels, to special textiles (geotextiles and nonwoven textiles). Other identified uses for these materials include bathtubs, archery bows, golf clubs, boat hulls, maintenance-free roofing panels, and longer lasting and better-looking lightweight

components, such as cosmetic packaging, tableware, and furniture. Furthermore, thanks to their loadbearing potential, the use of natural fibre-based biocomposites has spread to various sectors, including aircraft, grain and fruit storage, and footwear. Due to the identification of all such new applications, a remarkable growth of the market for these new biocomposites is expected in a next future.

Conclusions

In recent years, the various retting techniques have experienced a sizable evolution and improvements that tend to minimize the lack of consistency in fibre qualities and the high levels of variability in fibre properties. As more and more innovative research is being conducted on natural bast fibre-reinforced biocomposites in advanced sectors, bast fibres with high performance must be achieved. Bast fibre retting process is the first and the most important process for obtaining promising strength. Water retting process used to be the most recommended retting process for quality bast fibre production. Nevertheless, generation of large amounts of wastewater has it prohibited by most countries. Chemical and dew retting was then applied to substitute water retting process. However, high chemical cost and low retted fibre quality, of chemical and dew retting process, respectively, have driven people to look for another suitable process. Enzyme retting is claimed to have a more environmentally friendly process by reducing wastewater products, shorter retting period, and controllable fibre biochemical components under mild incubation conditions. Retting process, especially enzyme retting, could offer a tremendous benefit to bast fibres as green composite reinforcements and, at the same time, increases the value of nonfood crops by optimizing its potential as advanced materials.

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Therapeutic and Health Benefits of Jamun

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Jamun or *Syzygium cuminii* is an important indigenous fruit of the family Myrtaceae. Large, evergreen tree with approx height of 30-40 m and it's widely distributed in different agro-climatic conditions in South Asia but remains underutilized. The ripe fruits are purplish black in colour due to the presence of anthocyanins. Fruits are rich in minerals and have high antioxidant property which contributes to many health benefits. Jamun is highly perishable; therefore, very difficult to store and market at distant places Jamun seeds are used in traditional medicine. The ripe fruits are used for health drinks, making preserves, squashes, jellies and wine. (Warrier *et al.* 1996).

It's a fruit that has been used in Ayurvedic treatments and medications since ancient times. Jamun is known to treat many health conditions such as heart problems, diabetes, skin issues, infections, asthma, stomach pain, flatulence, and a lot of other medical problems. It can be consumed in fruit form, made as a juice, or even used in powder form. It can be used in many healthy recipes like salads, and smoothies as it aids in weight loss.

Jamun is a very nutritious summer fruit that has a wide range of health benefits. The fruit is commonly called the Indian blackberry, Java plum, or black plum. There are two types of jamuns - one variety is the white flesh Jamun, while the other is the purple flesh variety. The white flesh jamun comes with a higher amount of pectin and the purple flesh variety has a lower amount. Pectin is a substance that acts as a thickening agent when preparing jellies and jams.

Jamun has many medicinal properties as well and is strongly recommended in Ayurveda for treating many health conditions. It helps in cases like stomach pain, arthritis, heart issues, flatulence, asthma, dysentery, and stomach spasm.

The black plum can be consumed raw or even enjoyed as a juice. The fruit is used in a variety of recipes such as smoothies and salads, while the seed can be consumed in powder form. Today, the leaves, bark, and fruit are used to make health supplements that are available in capsule and tablet form.

Harvesting

The ripe fruits are available during summer and disappear with onset of the monsoon. A Common method of harvesting is by shaking the tree and collecting the fruits by holding a big piece of cloth or canvas under the tree. The fruits cannot remain on the tree in the ripe stage and start dropping to the ground immediately after ripening. As a result, a considerable amount of fruit is damaged and become unfit for fresh consumption. It is unfortunate that no proper technique for harvesting jamuns has yet been developed.

Therapeutic value of Jamun seed

- Seeds contain an alkaloid Jambosine and glycoside jambolin or antimellin which halts the

diastatic conversion of starch into sugar (Morton, 1987).

- Seed extract has been reported to lower blood pressure by 34.60 per cent due to the presence of ellagic acid (Morton, 1987).
- Seeds are also rich in flavonoids and are well know antioxidants (Ravi *et al.*, 2004).
- Seeds are fairly rich in protein, calcium and other minerals also (Ayyanar and Babu, 2012).

Table 1: Average Nutritional composition (per 100g) of Jamun fruit

Carbohydrate	14.00 %
Protein	0.15-0.30 g
Fibre	0.30-0.90 %
Calcium	8.30-15.00 mg
Potassium	55.00mg
Magnesium	35.00mg
Phosphorus	15-16.20mg
Iron	1.20-1.60mg
Folic acid	3.00mcg

Table 2 : Physico-chemical composition of different types of Jamun

Parameter	Large seeded	Small seeded
Weight (g)	9.50	3.30
Seed (G)	18.58	36.36
Edible portion (%)	81.42	63.64
Juice (%)	57.75	49.42
TSS (°B)	15.00	11.42
Acidity (%)	1.44	01.60
Total Sugar (%)	013.16	08.40
Total anthocyanins (mg/100g)	179.00	242.5
Total tannins (mg/100g)	297.5	428.75

Table 3: Composition of Jamun seeds

Parameters	Quantity dry weight basis
Moisture (%)	40.86
Crude protein (%)	04.16
Extractable fat (%)	01.55
Ash (%)	02.16
Crude fiber (%)	01.28
Total carbohydrate (%)	90.85
Energy (Kcal/100g)	393.96
Starch (%)	29.20
Total dietary fiber (%)	40.38
Polyphone (mg/100g)	40.38

Health benefits of Jamun fruit

Jamun tree has a special mention in ancient Indian medicare system 'Ayurveda'. Different local folks are using its fruits, leaves and other parts of the tree to cure digestive, urinal

and other numerous ailments from ancient ages.

Power pack of nutrients

Jamun fruits are rich source of Iron, Vitamin C, Vitamins Bs, Magnesium, Calcium,

Potassium and fructose. It is also rich in antioxidants and other beneficial alkaloids.

Boon for Diabetics

Jamun fruits are prescribed as a curative medicine for Diabetes Melitus and its complications. The Seed powder contains Jambolin which effectively lowers the blood sugar level and stimulate insulin formation. Therefore, in addition to ripe fruits, diabetic patients are suggested to take a spoonful powder of seed, leaf and bark mixture.

Diarrhoea and Gastric disorders

Local people use Jamun juice and Jamun Vinegar in folk medicines since time immemorial to cure gastric disorders particularly diarrohea. It also solves problem of gastric ulcers and Spleen enlargement. Increases blood heamoglobin content as Jamun fruits are rich in anthocyanin, they supply Iron to our body which helps in haemoglobin formation.

Improves our immunity

Jamun is packed with different vitamins and micronutrients such as iron zinc, calcium and thus helps in overall strengthening of our immune system.

Improves skin health and prevents ageing

Jamun fruits are rich in Vitamin C which helps to boost skin health and thus reduces wrinkles and ageing

Helps in weight loss

Jamun is power packed nutritional fruit low in calories but rich in fibre. Thus, it strengthens our digestive system and ultimately helps in weight loss.

Rich in antioxidants

Jaumn Fruits are rich in antioxidants, the compounds which help in protecting our cells. Antioxidants remove free radicals from our body which disturbs the normal activities of our cell.

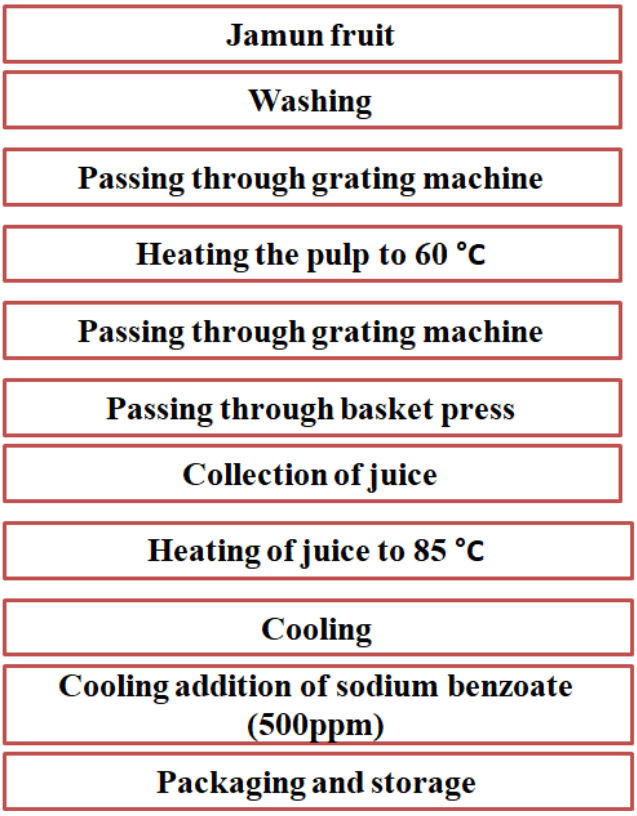
Jamun fruit and products

Jamum fruits are sweet in taste with slight astringent flavour. It is highly relished and fetches good price in market but lacks organized orchard production.

Extraction of Jamun juice

A method of extraction of Jamun juice with high level of anthocyanins and other soluble constituents has been standardized.

Fig 1: Process flow chart Jamun juice



Utilization of Jamun Juice

- Jamun juice can be processed into different types of beverages like RTS, nectar, syrup etc.
- A method of concentration of Jamun juice on lab scale has been standardized by Ramanjaneya (1985)
- Concentrate can be used by the beverage industries.

Conclusion

Jamun is traditionally used for the treatment of various diseases especially diabetes and related complications. With regard to the antineoplastic activities studies suggest that Jamun is selective in its action in breast cancer cells. The effect of Jamun and its phyto-chemicals should also be investigated for its chemo preventive effects in other models of carcinogens, that includes chemical, radiation and viral carcinogenesis models.

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Success Story on Inland Fish Farming by Effective Utilization of Farm Pond

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Background: Shri Mohamad Khilledar, has got 2.5 ha. land at Gudageri village of Kundagol taluka. Basically, he was growing sorghum, chilly, wheat and green gram in his field. His land was sloppy and low land, hence he was losing crop due to over flow. In this regard to overcome this problem, he has constructed farm pond to collect over flow water and utilizing for agriculture purpose. Overall, his farm income was very low and he was putting lot of effort to increase farm returns. He approached KVK, Dharwad line departments and progressive farmers to gain knowledge and practical experience. In this regard, KVK team guided him with adoptive technologies suited to his farm conditions and advised to take up fish farming in farm pond as additional income with regular monitoring and field visits

Interventions

Process: He has under gone inland fish farming in farm pond, training in inland fish farming sponsored by KVK and line departments which has resulted in breakthrough of yield and profit.

Technology: Shri Mohamad Khilledar, highly enthusiastic and innovative farmer is involved in cultivating field crops *viz.*, sorghum, wheat, chilly, green gram. He was utilizing the farm pond only for crop cultivation and other agricultural activities. Through intervention of Krishi Vigyan Kendra, Dharwad, Shri Mohamad Khilledar had started fish farming in underutilized farm pond of size 25 m X 20 m X 3.5 m by rearing high yielding varieties of fishes Catla, Rohu and Common carp. Around 6000 fingerlings were reared in farm pond, daily fish feed containing rice husk, groundnut husk and sorghum flour were fed daily for three times a day for eight months, later fishes harvested and they were gained around 0.6 to 0.8 kg body weight at the time of harvest. Total 2000 kg fish production was obtained from 500 m^2 farm pond size and he sold fish at the rate of Rs. 75 per kilogram. A manifold increase in fish production and economic status have been evidenced with adoption of fish farming in

underutilized farm pond, also reduction in soil erosion, farm pond acted as water reservoir and

rainwater harvesting structure to recharge ground water.

Impact

Horizontal Spread: Helped in the dissemination of technology in and around the villages of Gudageri.

Economic gains: Motivational interventions and mentoring by scientists of Krishi Vigyan Kendra, Dharwad enabled the farmer to carry out composite inland fish farming in farm pond which has not only resulted in socio-economic security but also helping in attaining food and nutrition security of the community. Before adoption of this technology, there is severe erosion of soil and water, after construction of farm pond this water was being utilized only for crop cultivation and his farm income was Rs. 72,000/-. The adoption of innovative technology through intervention of Krishi Vigyan Kendra, Saidapur Farm, Dharwad enhanced his additional income of Rs. 1,50,000/- by inland fish farming in farm pond.

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Rice Root-Associated Microbiome

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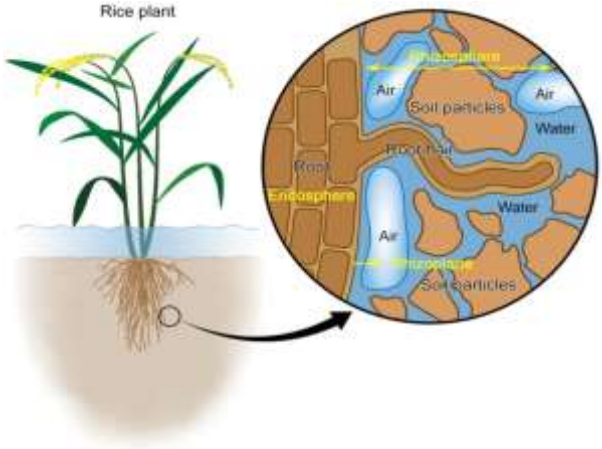
The microbiome is defined as both the composition of a microbial community in a specific environmental niche (microbiota) and its collective genome. The whole system consisting of plants, their environments and all organisms in that environment is called as phytobiome (Ding *et al*., 2019). Metagenomic and proteomic approaches have been used to identify different microbial genes present in the rice microbiome. HTS-based studies have revealed that plant-associated microbial communities are more extensively involved in promoting the health and fitness of their hosts than those of human and animal microbial communities. As an example, the root bacterial community is essential for maintaining multi kingdom interactions and for maximal plant growth and health of *Arabidopsis thaliana*. Plants depend upon beneficial interactions between roots and microbes for nutrient availability, growth promotion, and disease suppression. The three root-associated compartments, the endosphere (root interior), rhizoplane (root surface), and rhizosphere (soil close to the root surface), each of which was found to harbour a distinct microbiome. Under controlled greenhouse conditions, microbiome composition varied with soil source and genotype.

In field conditions, geo-graphical location and cultivation practice, such as organic vs. conventional, and their factors contributing to microbiome variation. Rice cultivation is a major source of global methane emissions, and methanogenic archaea could be detected in all spatial compartments of field-grown rice. Dynamic changes observed during microbiome acquisition, as they all as steady-state compositions of spatial compartments, support a multistep model for root microbiome assembly from soil wherein the rhizoplane plays a selective gating role. Plants and microbes have both adapted to use their close association for their mutual benefit. Critical nutrients are converted to more usable forms by microbes before assimilation by plants. In turn, bacteria in the rhizosphere receive carbon metabolites from the plant through root exudates. Beneficial soil microbes also contribute to pathogen resistance, water retention, and synthesis of growth promoting hormones (Edwards *et al*., 2015).

The below ground microbiome can be studied in different compartments of rice root as follows,



1. Rhizosphere (soil surrounding the root surface)
2. Rhizoplane (root surface)
3. Endosphere (inside root)

Fig.1 Rice root is composed of three different compartments based on spatial resolution

Rhizosphere

The rhizosphere is defined as the soil adjacent to plant roots. Plant roots alter the chemical and nutrient composition of soil by secreting organic and inorganic substances, which also affects its physical and biochemical properties. Such secreted substances, also referred to as root exudates, are important for maintenance of root–soil contact and contribute to root growth and plant survival (Walker et al. 2003). Root exudates facilitate the physicochemical adaptation of plants to the soil environment and provide nutrients for early colonization of soil microbial communities. Consequently, root exudates contribute to the biological adaptation of plants in a soil environment by recruiting microbes that functionally enhance the rhizosphere. Rhizospheric microbe's benefit plants by providing nutrients or plant hormones, suppressing pathogens, and increasing resilience to abiotic stresses such as drought. The compositions of communities of rhizosphere bacteria and fungi of rice at various developmental stages are investigated using DGGE and found that both communities varied according to growth stage. Improvements in meta-omics technologies have enabled investigations of the com- position and diversity of rhizosphere microbiotas. For example, communities of bacteria and archaea have been found to be more abundant in the rhizosphere than in bulk soil, but the two types of soil have similar diversities of these microorganisms. The compositions of bacterial communities in bulk soil and the rhizosphere are similar to those of the rhizoplane and rhizosphere; only 169 of 27,147 OTUs (152 enriched and 17 de- pleted OTUs) differed between the soil types (Edwards *et al.* 2015).

Considering that oxic and anoxic zones coexist within the rhizosphere of rice cultivated in flooded condition, strict and facultative anaerobes as aerobes have to be taken into account in terms of biological and ecological functions. Although some studies identified strictly or facultative anaerobic bacteria and fungi from bulk and rhizosphere soils of rice ecosystems, given that metabolic versatility of anaerobic microbial communities in rice fields and the possibility that aerobic and anaerobic microbes can coexist in the aerobic state, anaerobic microbes might be key modulators or players that maintain the structure of overall rhizosphere microbial communities.

Endosphere

The internal regions of the plant's leaves, stems, roots, fruits, and seeds are termed the endosphere, and the resident microorganisms are endophytes. Commensal endophytes generally show neutral effects on plant performance, whereas beneficial endophytes confer beneficial effects on plant development or protection from pathogens and herbivores. Another group is opportunistic or latent pathogen showing detrimental effects in certain conditions (Hardoim *et al.* 2015; Garcia-Vidal *et al.* 2009). Among these endophytes, beneficial endophytes are considered a new source of biocontrol agents and biofertilizers for increasing crop productivity.

Research on endosphere microbiome is technically constrained when compared to other compartments because of the enormous quantity of genomic DNA present in a host plant, which might mask the endophyte's very little contribution. Specifically, during the creation of the bacterial amplicon, the mitochondrial and plastid DNAs are co-amplified. In the endophyte's raw sequence data, the high ratio of host to endophyte DNA leads to low sequencing depth and quality.

Rhizoplane

The rhizoplane is the root surface where the host plants are in direct contact with the rhizosphere soils (Fig.1) (Ding et al. 2019). The separation distance between the rhizoplane and rhizosphere is

extremely close and thus both zones are commonly regarded as a continuum. At the rhizoplane level, roots actively interact with the rhizosphere soils through releasing substrates and competing for nutrients, and hence, the rhizoplane is anticipated to be a compartment that drives nutrient exchange and transformation in the soil-plant systems. Moreover, the rhizoplane might act as a selective barrier in the establishment of plant root microbiome, as only a proportion of microbes in the rhizosphere could attach the rhizoplane, and then a subset of them could invade and thrive in the endosphere (Edwards *et al*. 2015).

Generally, bacteria are the major population colonizing the rice rhizoplane, and can exert positive, negative or neutral influences on plant growth. *Bacillus* (e.g., *Bacillus velezensis*) and *Pseudomonas* genera (e.g., *Pseudomonas fluorescens*) have been reported to be typical rhizoplane inhabitants for rice plants on the basis of culture-dependent studies. *B. velezensis* is capable of phosphate solubilization as it possesses genes encoding phosphorus-solubilizing proteins. *P. fluorescens* has high antifungal activity due to the production of cyanide or siderophore, and is a putative antagonistic bacterium for the biocontrol of fungal pathogens of roots.

Therefore, colonization of these bacterial populations on the rice rhizoplane could favor the growth of rice plants through improving P availability and antagonism of soil-borne phytopathogens. Additionally, microbes involved in the N2 fixation (e.g., *Azospirillum* spp.) and nitrification (e.g., *Nitrobacter* and *Nitrosospira* spp.) has also been isolated from the rice rhizoplane. Proteins of α-, β- and δ-proteobacteria phyla have been found to be predominant groups on the rice rhizoplane using metaproteomic analyses (Knief *et al.* 2012). These proteins are assigned to multiple genera responsible for the biogeochemical cycles, like *Azospirillum* and *Bradyrhizobium* for N2 fixation, Methylosinus for CH4 oxidation, and Anaeromyxobacter and Geobacter for Fe (III) reduction (Knief *et al*. 2012). The rhizoplane and endosphere they are the most similar rhizocompartments, sharing 271 enriched OTUs. Most of the OTUs enriched between the rhizoplane and endosphere compartments belonged to Alpha-, Beta-, and Deltaproteobacterial classes, Chloroflexi, and Bacteroidetes. Not surprisingly, a subset of the OTUs enriched in the endosphere and rhizoplane belong to Fibrobacteres and Spirochaetes, phyla that are associated with cellulose degradation (24, 25) In comparison, the rhizoplane enriches for many OTUs while simultaneously depleting a larger proportion of OTUs (422 vs. 730). The endosphere is the most exclusive compartment, enriching for 394 OTUs while depleting 1,961 OTUs.

The separation distance between the rhizoplane and rhizosphere is extremely close and thus both zones are commonly regarded as a continuum as only a proportion of microbes in the rhizosphere could attach the rhizoplane, and then a subset of them could invade and thrive in the endosphere AT this compartment roots actually interact with rhizoshere soil through releasing substrates and competing. Proteins of Alpha-, Beta- and Delta proteobacteria phyla have been found to be predominant groups on the rice rhizoplane using metaproteomic analyses. Ex: Bacterial community *Bacillus* and *Pseudomonas*

Composition and structure of rice microbiome

Before the emergence of HTS platforms, other molecular techniques such as 16S rRNA gene cloning, polymerase chain reaction-denaturing gel gradient electrophoresis (PCR-DGGE), and terminal restriction fragment length polymorphism analyses is used to evaluate the composition of microbial communities in soil and plant tissues. The emergence of HTS has accelerated research on the composition and structure of rice-associated

microbial communities. Microbiome is distributed ubiquitously in or adjacent to rice plants. Rice microbiome can be dissected into the compartments where microbial communities reside. Among the compartments, bulk soil and root system (rhizosphere and root endosphere) are more widely investigated than other compartments. Community analyses with respect to aboveground parts (phyllosphere and seed) are also employed with both culture-dependent and -independent approaches. Before the introduction of omics technologies, PCR-denaturing gel gradient electrophoresis (DGGE), terminal restriction fragment length polymorphism (T-RFLP), and clone libraries of 16S rRNA genes are used for investigating the compositions of microbiome. However, these techniques are not enough to unveil the nature of microbiome because of their low resolutions. With the application of omics technologies, the composition and functions of microbiome are widely investigated. Another is a culture-dependent approach. Despite the low recovery of natural communities, this approach is inevitable in order to prove predicted functions of microbiome. For this, isolation of microbes from samples and characterization of isolates, using both *in vitro* and *in-vivo* assays are conducted.

This parallel application of both culture-independent and -dependent approaches can give us the chance to construct synthetic communities or combinations of metabolites as probiotics and prebiotics for improving sustainability and productivity of rice. ACC, aminocyclopropane-1-carboxylate; IAA, indole-3-acetic acid; M-, not inoculated with beneficial microbes; and M+, inoculated with beneficial microbes.

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Promising Characteristics of Bacteriophage Endolysins in Food Preservation

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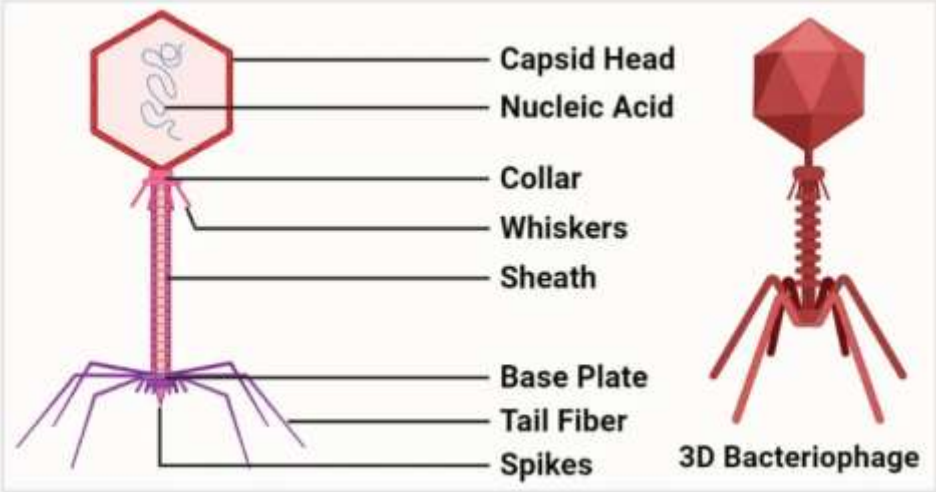
According to the World Health Organization (WHO) in 2015, there were 33 million foodborne outbreaks annually, leading to approximately 420,000 deaths worldwide. This highlights the significant impact of foodborne illnesses on public health. Furthermore, the emergence of antibiotic-resistant bacteria, such as Methicillin-resistant *Staphylococcus aureus* (MRSA), poses a global threat. In the United States alone, the Centers for Disease Control and Prevention (CDC) reported over 2.8 million antibiotic-resistant infections and more than 35,000 deaths each year in 2019 (Kadri, 2020). It is worth noting that antibiotic resistance also presents a food safety concern. The use of antibiotics in food animals, whether for treatment, disease prevention, or growth promotion, facilitates the spread of resistant bacteria and resistance genes from animals to humans through the food chain.

Thus ensuring food safety remains an ongoing and significant challenge for the food industry and healthcare systems worldwide. In recent years, bacteriophage-based biocontrol methods have garnered attention as natural and environmentally friendly technologies that effectively target bacterial pathogens in different food products. In this context, this discussion focuses on the potential of endolysins, cell wall lysis proteins derived from bacteriophages, as a promising class of antibacterial agents for controlling foodborne pathogens.

Bacteriophages

Bacteriophages, commonly known as "bacteria eaters," are a diverse group of viruses that exclusively infect bacterial cells. In nature, they are abundant and exhibit remarkable diversity, surpassing the number of bacterial species. Bacteriophages are considered obligate intracellular organisms, relying on host bacteria for their replication and survival. Structurally, bacteriophages are complex entities, consisting of distinct components such as a head, tails, collar, tail fibers, and base plate (Fig 1).

Fig 1. Structure of bacteriophage



The head of a bacteriophage houses its nucleic acid genome, which can be either RNA or DNA, but not both. This genetic material is encased within a protective protein coat called a capsid or can be surrounded by a lipid membrane known as an envelope. The capsid, composed of repeating protein subunits called protomers, plays a crucial role in packaging the phage genome and facilitating its transfer into a host bacterial cell. These structural intricacies enable bacteriophages to effectively target

and infect specific bacterial species, perpetuating their life cycle as viral predators in the microbial world (Nobrega *et al*., 2018).

Life cycle of Bacteriophage

Bacteriophages exhibit two primary life cycles: the lytic (virulent) cycle and the lysogenic (temperate) cycle. During the lytic cycle, lytic phages attach to bacterial cells and release their genetic material into the host cell. Inside the host cell, the phage genetic material utilizes the host cell's machinery to replicate and assemble new phage particles. Once mature, these phages cause the host cell to lyse, releasing the newly formed phages to infect other host cells. In contrast, the lysogenic cycle does not result in immediate host cell lysis. Instead, after the phage genome enters the host cell, it integrates with the host's genomic DNA and replicates alongside it without causing harm. In some cases, the phage genome may become established as a plasmid within the host cell.

During the lytic cycle, the bacteriophage first attaches to specific receptor sites on the surface of the host cell, followed by irreversible attachment. Enzymatically degraded tail penetration enables the insertion of the phage DNA into the host cell's cytoplasm. Since bacteriophages lack an independent replication system, they hijack the host cell's DNA replication and protein synthesis machinery. Within the host cell, specific enzymes encoded by the phage genome redirect the host cell's DNA and protein synthesis processes to generate new phage particles. These enzymes include structural phage proteins and enzymes necessary for cell lysis and the release of progeny phages. The newly synthesized phage structural components assemble to form complete phage particles, while the newly replicated phage genomes are packaged into the phage heads. At a precise time in the phage cycle, phage-encoded holins create pores in the cell membrane, allowing phage-encoded endolysin to access the peptidoglycan layer of the host cell. This action leads to cell lysis and the release of progeny phages (Mahmoudabadi *et al*., 2017).

Bacteriophage Endolysins

Endolysins are enzymes produced by bacteriophages (viruses that infect bacteria) to degrade the bacterial cell wall and release progeny phages. These enzymes have the ability to specifically target and destroy bacterial cells, making them promising antimicrobial agents. Endolysins are proteins that can effectively target and destroy bacteria. They remain stable and active under environmental conditions similar to those of the bacteria they target. These proteins have an optimal temperature range of 20 to 37°C and require a pH level between 6.0 and 7.0 for maximum activity. Endolysins are soluble and are expressed as cytoplasmic proteins. Endolysins encoded by bacteriophages that infect Gram-positive bacteria typically have a molecular weight ranging from 25 to 40 kDa. On the other hand, those effective against Gram-negative bacteria are generally smaller, weighing between 25 to 20 kDa. Gram-positive endolysins usually have a modular structure consisting of distinct functional domains. They possess an N-terminal end with enzymatic activity domains (EADs) and a C-terminal end with a cell wall binding domain (CBD), which are connected by a short linker. The EADs are responsible for breaking various bonds in the peptidoglycan of the bacterial cell wall, while the CBD exhibits high specificity in recognizing and binding to the bacterial cell wall. An example of such an endolysin is LysH5 from Staphylococcus aureus phage ΦH5. In contrast, Gram-negative endolysins often have a globular structure and typically only possess enzymatic activity domains (EADs). They rarely exhibit a modular structure. (E.g. EL188 from Pseudomonas aeruginosa phage EL) (Barrera-Rivas *et al.*, 2015; Liu *et al.*, 2023)

Modular Structure of Endolysin

A feature of all Gram-positive phage endolysins is their two-domain structure (Fig 2). The N-terminal domain contains the catalytic activity of the enzyme (EAD). This activity may be an N-acetylglucosaminidase, N-acetylmuramidase, transglycosylase, an endopeptidase or an N-acetylmuramoyl-L-alanine amidase (or amidase). On the other hand, the C-terminal cell binding domain, also known as the CBD domain, binds to a particular substrate (often a carbohydrate) present in the host bacterium's cell wall. The binding domain of the enzyme must bind to its cell wall substrate in order for cleavage to occur efficiently. This imparts some specificity to the enzyme because these substrates are only present in bacteria that are enzyme-sensitive.

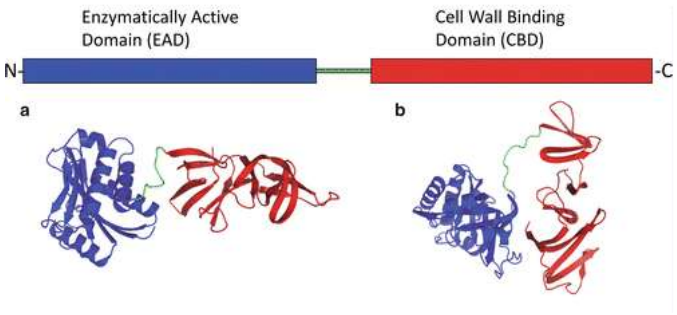


Fig 2. Modular structure of endolysin

Application of bacteriophage endolysins in food preservation

Bacteriophage endolysins have shown potential for various applications, including food preservation. Enzymatically active domain (EAD) has been mainly used in food preservation. Bacteriophage endolysins can be used to target and eliminate specific bacteria that may cause spoilage or foodborne illnesses. Endolysins possess several features that make them highly suitable for food preservation applications. They are:

Potent antimicrobial efficiency: Endolysins exhibit remarkable antimicrobial power, capable of eliminating bacteria in nanogram levels within seconds. This rapid and effective killing of microorganisms sets endolysins apart from other biological compounds.

Lack of bacterial resistance: Unlike traditional antibiotics, repetitive exposure to low concentrations of endolysins does not lead to the development of resistant bacterial strains. The unique mechanism of action of endolysins targets vital components of bacteria that cannot be easily modified, making bacterial resistance rare.

Host specificity: Endolysins selectively target bacterial cell walls by cleaving specific peptidoglycan linkages found exclusively in bacteria. This feature allows for the development of endolysins with a broad host range or a narrower, more specific range depending on the desired application.

pH tolerance: While the optimal pH for most endolysins is between 6 and 7, some endolysins retain significant antibacterial activity over a wide pH range. This flexibility in pH tolerance allows for effective action in various food environments.

Temperature tolerance: Endolysins have shown effectiveness across a wide range of temperatures. They can remain stable and active at elevated temperatures, with some endolysins exhibiting resistance up to 100°C. This thermal stability makes them suitable for food processing and storage conditions.

Long-term stability: Many endolysins demonstrate exceptional long-term stability, retaining their activity over extended periods. This characteristic is advantageous for food preservation, as it allows for prolonged storage without significant loss of efficacy.

Synergism with other antimicrobials: Endolysins can work in synergy with other bactericidal agents, such as antibiotics, organic acids, or high hydrostatic pressure (HHP). This synergistic effect enhances their antimicrobial activity, making them valuable in hurdle technology approaches for food preservation.

These features collectively make endolysins excellent candidates for food preservation applications, offering efficient and targeted antimicrobial action with minimal risk of bacterial resistance. Bacteriophage endolysins can be applied directly to food surfaces, incorporated into food packaging materials, or used as food washes or sprays. The specific application method depends on the food product and the desired outcome. Studies have demonstrated that endolysins show an excellent and efficient bacterial elimination activity from food matrix such as milk with a high content of lipids and proteins and a pH ranging from 6.4 to 6.8, green leafy vegetables, meat products etc.(Chang, 2020).

Advantages of using endolysins as antimicrobials

- No resistant bacteria to phage endolysins have been described to date
- No risks of transferring virulence genes
- Efficient on antibiotic resistant pathogens
- Rapid bactericidal effect
- Both specific and broad activity spectrum
- Target prokaryotic peptidoglycan and are harmless to humans, animals and plants
- Minimal interference with commensal flora
- Apparent safe status (non-toxic)
- Not self-replicating antimicrobial agent (better acceptance)

Future challenges

There are some challenges associated with using bacteriophage endolysins for food preservation. They are unable to inactivate bacterial spores, yeasts, and molds, which may restrict their efficacy in certain food preservation scenarios. Additionally, each endolysin needs to be thoroughly characterized before its application in a food system. This characterization involves evaluating its effectiveness under specific food matrices and conditions, such as varying ionic concentration, composition, pH, and temperature. Such characterization studies are crucial for gaining a better understanding of the potential of endolysins as effective antimicrobials in specific food environments.

Conclusion

It's worth noting that while bacteriophage endolysins hold promise for food preservation, more research and development are still needed to optimize their effectiveness, stability, and commercial viability. Regulatory bodies in different countries may have specific requirements and approvals for the use of these enzymes in food applications.

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Reproductive Altruism in Honey Bees: A Theory to Understand Social Evolution

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Source: Galbraith D. A. (2015)

Altruism refers to the selfless concern for the well-being and welfare of others, often at the expense of one's own interests or benefits. It involves acts of kindness, compassion, and generosity towards others without expecting anything in return. Altruistic behaviour can be observed across various species, including humans and animals. It can manifest in different forms, such as helping others in need, sharing resources, and sacrificing personal interests for the greater good. Similarly, reproductive altruism is a phenomenon observed in honey bees where certain individuals forgo their own reproductive opportunities to assist in the reproduction of their relatives. In a honey bee colony, there are three main types of bees: the queen, drones, and workers. The queen is the reproductive female in the colony and her primary role is to lay eggs. Drones are the male bees whose sole purpose is to mate with queens from other colonies. Workers are the sterile females who perform various tasks within the colony, including foraging, nursing the brood, and defending the hive. Honey bees demonstrate this idea as their entire social structure is based on preserving the community rather than the individual. Honey bees are classically considered one of the most selfless organisms, but it is not fair to say that all honey bees in a colony benefit equally from their social structure. Only female worker honey bees are truly selfless in a colony, as they do not reproduce and instead, invest their energy into the wellbeing of the colony. Workers in a honey bee colony exhibit reproductive altruism by suppressing their own reproduction and helping the queen to rear her offspring. They do not mate and do not lay eggs. This behaviour is known as worker sterility. It's important to note that the altruistic behaviour of worker bees in relation to egg-laying is just one aspect of their complex social structure and behaviour. Honey bees exhibit a wide range of cooperative behaviours within the colony, including food sharing, brood care, and defense, all of which contribute to the survival and success of the hive as a whole.

Altruism in egg-lying worker bees

Altruism is a concept that refers to selfless concern for the well-being and welfare of others. In the context of egg-lying worker bees, there are certain aspects of their behaviour that can be considered altruistic. In a honey bee colony, workers

engage in policing behaviour, selectively destroying eggs laid by other workers to maintain the queen's reproductive monopoly. However, in some rare cases, worker bees may lay eggs. This behaviour is known as "worker policing." When a worker bee lays an egg, it is usually an unfertilized egg that develops into a male bee or drone. Drones are the male bees whose primary purpose is to mate with the queen. The presence of worker-laid eggs can be detrimental to the colony because the resources needed to raise drones are wasted. The worker-laid eggs divert resources away from the production of worker bees, which are essential for the survival and functioning of the colony. Therefore, worker bees have developed mechanisms to suppress and remove worker-laid eggs in order to maintain the efficiency of the colony. In this context, the behaviour of worker bees can be seen as altruistic. By removing worker-laid eggs, they are sacrificing their potential reproductive opportunities to benefit the overall well-being and productivity of the colony. This behaviour can be considered selfless, as it helps maintain the harmony and functionality of the honey bee colony. This reproductive division of labour is a key characteristic of social insect colonies, including honey bees. Honey bee worker sterility is a result of complex social interactions and physiological factors. The queen produces a pheromone called queen mandibular pheromone (QMP), which inhibits the development of workers' ovaries and suppresses their reproductive capabilities. This behaviour is essential for the colony's survival and growth.

Source: Getty images

"Kin Selection Theory" and "Selfish Gene Theory"

Honey bees, despite their social hierarchy based on selflessness, still follow the "Selfish Gene theory". They exhibit altruism, which means they preform selfless actions that benefit others while decreasing their own fitness. This can lead to a worker honey bee foraging for food and providing it to the rest of the colony, benefiting other members of the population while reducing their own fitness. Kin selection, on the other hand, suggests that honey bees increase the inclusive fitness of the population by increasing the inclusive fitness of the population. This means that the genes of close family members are just as important as an organism's own genes for passing on, as they are not trying to benefit themselves but rather ensure the survival of their genes.

One prominent explanation is kin selection or inclusive fitness theory, proposed by biologist Hamilton (1963). According to this theory, individuals may exhibit altruistic behaviours towards their close relatives because they share genetic material. By helping relatives survive and reproduce, individuals indirectly promote the transmission of their own genes, even if they themselves do not directly reproduce. Queller (2003) model predicted that under queen less conditions in a honey bee colony, patrigenes promote selfish behaviour, while matrigenes promote altruistic behaviour, according to Galbraith (2015). Galbraith et al. (2016) investigated kin selection by examining the social behaviour of worker honey bees, which are all female. They found that the genes the workers

inherit from their queen (matrigenes) direct worker bees' altruistic behaviour, forgoing production of their own offspring to help rear their siblings. When the queen dies, the workers can begin to selfishly compete with one another to lay eggs. The genes they inherit from their different fathers (patrigenes) direct this behaviour.

Factors affecting altruism

Altruism in honey bees, specifically in the context of their social organization and division of labour, is primarily influenced by various factors. Some key factors that affect altruistic behaviour in honey bees are:

Genetic Relatedness: Honey bees exhibit a eusocial structure, characterized by a reproductive division of labour, where only a few individuals (queens) reproduce, while the majority (workers) help raise the brood and maintain the colony. The workers are often more closely related to their sisters than they would be to their own offspring. This high genetic relatedness enhances the evolutionary benefits of altruistic behaviour, as workers can increase the representation of their shared genes in future generations by supporting the reproduction of the queen.

Kin Selection: Altruism in honey bees can be explained by kin selection theory. Since workers are more closely related to their sisters, they can enhance their inclusive fitness by helping the queen produce more offspring. By doing so, they indirectly pass on a portion of their genetic material to the next generation, promoting the survival and reproductive success of their kin.

Chemical Signaling: Honey bees rely on chemical signals, specifically pheromones, to coordinate their activities and communicate within the colony. The queen bee produces pheromones that help regulate worker behaviour, suppress worker reproduction, and maintain colony cohesion. These chemical signals play a crucial role in shaping altruistic behaviour by influencing the workers' response to the queen's needs and the overall division of labour within the colony.

Environmental Conditions: The environment can also impact altruistic behaviour in honey bees. Factors such as resource availability, seasonality, and colony size can influence the division of labour and the extent of altruistic acts. For example, during times of abundant food resources, worker bees may allocate more resources toward the growth and reproduction of the colony, exhibiting heightened altruistic behaviour.

Age and Task Specialization: Honey bee workers transition through different tasks as they age, starting with tasks inside the hive, such as nursing brood, and progressing to tasks outside the hive, such as foraging for nectar and pollen. The allocation of workers to specific tasks is influenced by age-related physiological changes, pheromonal cues, and colony needs. Task specialization ensures efficient resource utilization within the colony and enhances the overall survival and productivity of the colony.

These factors interact and shape the altruistic behaviour observed in honey bees, contributing to the success and sustainability of their highly organized social structure.

Altruism as social evolution in honey bees

Altruism in honey bees is a prime example of social evolution, as it involves the evolution of traits that benefit the colony as a whole, even at the expense of individual reproduction. Social evolution refers to the process by which traits or behaviours that enhance the fitness of a social group or community are favoured by natural selection. In honey bee colonies, the reproductive division of labour is a key aspect of social evolution. The

majority of individuals in the colony, known as workers, forego their own reproduction and instead support the reproduction of a few individuals, particularly the queen. This altruistic behaviour benefits the colony as a whole, ensuring the survival and reproductive success of the queen and the overall productivity of the colony.

Genetic relatedness, therefore, plays a crucial role in the evolution of altruism in honey bees. The workers' sacrifice of their own reproductive potential is offset by the inclusive fitness benefits gained through the reproductive success of their genetically related sisters. Additionally, the social structure and organization of honey bee colonies, facilitated by pheromonal communication, division of labour, and cooperation, further promote the evolution of altruism. Through the coordinated efforts of individuals within the colony, resources are efficiently gathered, brood is cared for, and the survival of the colony is maximized. Overall, the social evolution of altruism in honey bees is driven by the inclusive fitness benefits gained through kin selection and the complex social structure that promotes cooperation and division of labour within the colony. These evolutionary mechanisms have led to the development of highly organized and successful honey bee societies.

Conclusion

In conclusion, reproductive altruism in honey bees is a remarkable phenomenon that demonstrates the intricacies of social evolution. The division of labour within a honey bee colony, where the majority of individuals (workers) forego their own reproduction to support the reproduction of a few individuals (queens), highlights the benefits of altruistic behaviour for the survival and productivity of the entire colony. This altruism is driven by the workers' high genetic relatedness to their sisters, promoting the propagation of their shared genes through indirect fitness benefits. The chemical signaling, environmental conditions, and task specialization further contribute to the development and maintenance of reproductive altruism in honey bees. The study of reproductive altruism in honey bees provides valuable insights into the evolution of social systems and cooperative behaviours, highlighting the intricate balance between individual and group fitness. By understanding the factors influencing reproductive altruism in honey bees, we gain a deeper understanding of the fascinating dynamics of social organization and cooperation in the natural world.

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An Insight into The Behavioural Aspects of Dogs: Understanding Their Language

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Do dogs talk? Well, the answer should be on the affirmative, as dogs have plenty of ways to express their feelings, emotions, desires & intensions. Just as humans interact through verbal & nonverbal means of communication, dogs do have their own vocal & behavioural means to interact among themselves as well as with their human masters. Understanding the language of your pets is utmost important for upbringing them properly and to see that they are not deprived of their rights, companionship & welfare. At the same time, some dogs may develop several behavioural disorders during their lifetime, which could often turn out to be a menace. In this chapter, an attempt has been made to explore the language of dogs with special emphasis on the understanding of their tail wags & ear positions. Dogs don't speak, yet can communicate effectively, here are some important aspects of their unspoken language.

The tails are not just tails; they are very expressive:

Tail wagging & positioning of the tail in dogs has a lot do with their feelings, emotions & intentions. It's true that the dogs wag their tails when they are happy, joyful & exuberant. The intensity, speed & height of the wag are directly proportional to the level of happiness & excitement of the dog. However, dogs can use their tails as versatile means of communication and to convey a wide range of emotions to their fellows & human beings.

- Holding the tail high & erect signifies that the dog is confident, assertive & dominant. Approach such dogs with respect & caution.
- If the dogs keep their dogs low & tucked, it's a sign of fear, anxiety & submissiveness. Such dogs are quite vulnerable & desire not to indulge in conflicts.
- If the dogs carry their dogs in neutral positions, not too high-not too low, indicates that they are calm & relaxed
- Tail wagging during social interactions: A relaxed & loose wags indicates that the dog is friendly & playful while a stiff & rapid wag might indicate that the dog is tensed & could be aggressive. Treat the dogs accordingly.
- Slow, side to side tail wagging could be indicative of the dog's curiosity while a rapid, wide wag accompanied by relaxed body posture indicate excitement & anticipation.
- However, it's essential that the pet owner should be aware of the normal tail carriage & positioning in individual breed of dogs to interpret the signals provided by the tail.

Thus, the tail wags & positioning are one of the effective means by which dogs communicate. By thorough understanding of the language of the tail, we can establish a better, harmonious & empathetic bondage with our dogs.

Ears don't just listen; they tell quite a few tales:

- If the dog's ears are fully erect & face forwards, it signifies the alertness & attentiveness of the dog. Such dogs are engaged with their surroundings, ready to respond to stimuli & potential threats.

- When a dog is perked up & positions its ears forward, it means that it's confident, attentive & positive. It suggests that the dog is ready for interaction, either with other dogs, or humans.
- Keeping one ear up & the other down indicates that the dog is curious & perceptive, they are trying to gather as much information from the environment – they are inquisitive & ready to explore their surroundings.
- If the dog's ears are pulled back tightly against their heads, it's a clear indication of fear, anxiety & submissiveness. Such dogs desire to minimize their presence & avoid conflicts, try to create a safe & reassuring environment for such dogs.
- In extreme cases, the dogs may even pin-up their ears very tightly against their skull – associated with intense fear or aggression, a clear warning sign – approach such dogs with caution, try to provide them space & reassurance.
- Ears positioned forwards is a sign of their confidence, attentiveness & positive attitude while the ears pulled back indicate defensiveness or defensive aggression. Such dogs are wary & uncomfortable – create a supportive environment so that they feel secure.

Thus, a thorough understanding of the ear position & movement of dogs helps us to understand the dog's state of mind by which we can deepen our bonds besides understanding their needs & desires accurately.

Peep into the eyes of dog and try to read the facial expressions; you can explore his emotions

Eyes are the reflection of the mind and it holds good for dogs too. Dogs can communicate their feelings & emotions through their eyes & facial expression. Here are some of the hidden messages in the eyes of dogs & their facial expressions.

- Eye contact is an important tool for effective communication in humans. Similarly, by maintaining proper eye contact with the dogs, we can build trust & establish emotional connection with them. We just need to meet their gaze & maintain the eye contact.
- A soft & relaxed gaze by the dog is indicative of affection & contentment while a direct, unwavering gaze signals aggression & a challenge. Observe carefully & act accordingly
- If the dog's eyes appear, soft & relaxed, it's a sign of comfort, trust & contentment. The dog feels safe, its well-being is assured and we can maintain a positive, nurturing environment for them.
- Some dogs squint & blink to express their calming signals. Such gestures indicate a non-threatening intent of dogs and that they are trying to resolve a stressful situation. Be considerate and try to create a sense of security & reassurance to the pet in such situations.
- Dogs exhibit "soft eyes" or "eye kisses" – by deliberately blinking to signal their trust, relaxation & a lack of threat. Reciprocate the gesture to develop strong bond with your pet and create a harmonious, comfortable atmosphere.
- If the pupils of your dog's eyes are dilated, it can be a sign of fear, stress & excitement. Try to interpret the situation with the help of other body language signals and provide the appropriate support to such dogs.
- Dogs exhibit the whale-eye or the half-moon eye, when they have anxiety, fear & discomfort. You can clearly see the white of the eye in such condition. You can assume that the dog is stressed & take necessary measures to alleviate the stress & make him comfortable.

- If a dog locks his gaze directly into somebody or something, he's signalling his assertiveness & dominance and that he's ready to challenge the ensued threats. It could also indicate his intention to play. Interpret with other body language signs & act accordingly.

Thus, the simple understanding of canine eye contact & facial expressions can uncover the intentions & emotions of the dogs. A thorough interpretation of the same can promote the emotional well-being of your pets.

Postures & Body positions also contribute to canine communication:

Dogs have an uncanny ability to communicate through their body posture, positions & gestures.

- The dog displays its trust & submission by willingly rolling on to its back & exposing the belly. Recognize & respect this submissive gesture to create a safe & secure environment for them.
- Dogs often exhibit the "Play Bow" posture – They bend forward with both their forelimbs stretched out and the hind limbs raised. It's a sign of their friendly interaction & willingness to play. You can engage in joyful & playful sessions with your canine companions in such situations.
- A Dog with stiff, upright posture by holding its head high, body tall & tail erect is assertive & confident, with a sense of self-assuredness.
- Raised hackles in a dog, i.e., raised hairs along the dog's back, is an indication of fear, excitement & aggression. Interpret the posture with other signals.
- Freeze posture of dogs – the dog becomes completely still, holding its body tight, rigid & tense – is a clear sign of fear in the dog. It's a defensive posture that can precede either fight or flight responses.
- Dogs with loose, relaxed body with wiggly movements indicate that they are relaxed, happy & content. They wag their tails, wiggle the body & display relaxed facial expressions.
- A dog that sleeps & snores in your presence signifies high level of trust in you. It indicates the dog's confidence with the surroundings & trust in its care takers. Just respect its need for rest & provide a safe, secure sleeping environment.

The intricacies of canine body postures, position & gestures provide valuable insights into the dog's feelings & emotions. Interpret & respond to such cue from your pet and create a more accommodative, comfortable environment.

Significance of paws in canine communication:

Most kids get fascinated when their pet dogs shake hands with them. The movements of the dog's paws convey quite a few messages, express their emotions & communicate their needs.

- The dog generally lifts its paw to express its attentiveness & curiosity. The gesture is usually accompanied by a tilted head & forward posture. Pawing is a common behaviour that dogs use to seek attention & initiate interaction. Recognizing the pawing behaviour is important to understand his potential needs.
- If your dog places its paw on you or gently nudges you with its paw, it's expressing its desire for physical affection – the dog trusts you & expects reassurance from your side
- Sometimes the dog paws at doors, objects or at your body when he is anxious and it's an indication that he is seeking your help. Provide the necessary support & console him.
- Dogs use their paws to interact with their food/water bowls - either paw at them or push them around. It may be indicative of their

need of fresh water or the preferences for foods. Adjust their feeding by understanding such paw movements.

- Dogs can be trained easily to give a high five or shake hands and its adds a lot of fun to your interaction with them. They actively engage with you & respond to your cues when you encourage them after such acts.

Barking is as good as Speaking; Follow the language of barking!

Dogs bark in various ways to express their feelings, convey their messages and to alert other dogs or the owners in certain situations. Let us embark on the different types of barks & vocalizations that dogs use to communicate.

- If your dog's barks are in the form of sharp & short bursts, he's trying to draw your attention to potential threats & unfamiliar situations. It's a sign of its vigilance & a warning signal for you to take appropriate action.
- Your dog's barks could be playful & full of energy when he is excited. Such barks are often accompanied by a wagging tail & it's an indication that he's inviting others to join the play & fun.
- Deep & assertive barks are usually defensive in nature and dogs use them to protect their territories as well as their loved ones. Invasive barks are distinct from the defensive barks and are triggered by the presence of intruders or strangers. Recognize such barks and take stock of the situation.
- Howling is a special type of vocalization in dogs which could be used to express their loneliness, anxiety or it could be a response to specific stimuli.
- Soft, high-pitched sounds – whining & whimpering by dogs is an attempt to seek attention and express discomfort. Such vocalizations are often associated with pawing & nudging. Console them & comfort them adequately.

Thus, from simple tail wagging to variety of vocalizations dogs have been very effective communicators. It's upto their masters to learn the language of dogs & interact with them effectively.

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