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World Pulses Day

Pulses: Nourishing Soils and People



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From the Editor-in-Chief's Desk

I am happy and proud to announce the release of the Volume 1, issue 11 of AgriTech Today Magazine.

World Pulses Day, observed on February 10th each year, celebrates the significance of pulses in global nutrition, sustainability, and food security. Pulses, including beans, lentils, and chickpeas, are nutrient-rich foods that play a vital role in combating malnutrition and achieving sustainable agricultural practices. This day raises awareness about the nutritional benefits of pulses and promotes their consumption worldwide. It also highlights the role of pulses in achieving the United Nations' Sustainable Development Goals, particularly in eradicating hunger and promoting environmental sustainability. Additionally, World Pulses Day serves as a platform to recognize the contributions of farmers, researchers, and policymakers in advancing pulse production and consumption.

It gives me great pleasure to inform you that we have curated and finalized 40 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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World Pulses Day and Its Significance

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Cover Story

Pulses, also known as legumes, refer to the edible seeds of leguminous plants/pod-bearing plants grown for food. They exist in various shapes, varieties, sizes, and colors and remain a large part of dishes from across the world, the most popular and widely-consumed types of pulses are red gram, black gram, lentils, green gram etc. A traditional Indian cuisine features various dal dishes made from peas or lentils. Pulses strictly comprise dried seeds of leguminous plants cultivated for food and exclude vegetable crops harvested while still green. Their seeds are loaded with essential nutrients such as fiber, protein, vitamins, and minerals, making them important and healthy super foods. It's important to note that pulses exclude crops harvested green (such as green peas and green beans), which are classified as vegetable crops. Additionally, crops primarily used for oil extraction (e.g., soybeans and groundnuts) and leguminous crops exclusively used for sowing purposes are not considered pulses.

Pulses are important crops for a variety of reasons. They provide essential nutrients, promote sustainable agriculture, contribute to food security, and have a positive impact on the environment. Pulses provide employment and entrepreneurial opportunities for rural women and youth. Pulses are important crops for multiple reasons, including:

Nutritional benefits

- **High protein content:** Pulses are an excellent source of plant-based protein, essential for building and repairing tissues. They are particularly important to them who do not consume non vegetarian food. They act as important sources of

Rich in fibre: Pulses are high in fibre, which helps with digestion, promotes gut health, and can help control blood sugar levels along with other health benefits.

- **Good source of vitamins and minerals:** Pulses are a good source of essential vitamins and minerals, including iron, zinc, folate, and magnesium. The nutritional quality increases further by sprouting.

Sustainable agriculture

- **Nitrogen-fixing:** Pulse crops are nitrogen-fixing crops and they can convert atmospheric nitrogen into a form that plants can use. This reduces the need for synthetic fertilizers, which can be harmful to the environment and also cost effective for the farmers.
- **Improves soil health:** Pulses improve soil health by adding organic matter by defoliating the vegetative matter and fix nitrogen to the soil through root nodules. This helps to improve soil fertility and crop yields.
- **Water-efficient:** Pulses require less water than many other crops, making them a more sustainable option in regions with limited water resources.

Economic benefits

- **Affordable source of protein:** Pulses are a relatively inexpensive source of protein compared to other sources like non vegetarian, making them accessible to people of all socio-economic backgrounds.
- **Contributes to food security:** By providing a reliable source of protein and other nutrients, pulses can help to improve food security and reduce hunger.
- **Supports small farmers:** Pulses are often grown by small farmers with less land holding, providing them with a source of income and contributing to rural development.

Environmental benefits

- **Reduces greenhouse gas emissions:** Pulses have a lower carbon footprint than many other protein sources, such as meat and dairy and

hence reduces greenhouse gas emission through animal husbandry sector.

- **Promotes biodiversity:** Pulses can be grown in rotation with other crops, which helps to promote biodiversity and soil health.
- **Adaptable to climate change:** Pulses are able to tolerate a wide range of climatic conditions and short duration crops. It makes them a more resilient crop in the face of climate change.

To honor the significance of these nutrient-packed food crops, the General Assembly of the United Nations, on December 20, 2013, adopted a special resolution (A/RES/68/231) and proclaimed 2016 as the International Year of Pulses (I.Y.P.). The Food and Agriculture Organization of the United Nations (F.A.O.) led the celebration in 2016 and the event successfully increased public awareness about the nutritional and environmental benefits of pulses.

Building on the success and momentum of the I.Y.P., and recognizing the potential of pulses to further achieve the 2030 Agenda for Sustainable Development, Burkina Faso, a landlocked West African nation, proposed the global observance of World Pulses Day. On December 20, 2018, the General Assembly of the United Nations proclaimed February 10 as World Pulses Day through resolution (A/RES/73/251), and the day has been celebrated as a global event since 2019 and supported by many member nations. According to the U.N., pulses remain influential in mitigating the global challenges of poverty, food security and nutrition, human health, and soil health.

World Pulses Day takes place on February 10 each year. It is a yearly global event designated by the United Nations in 2018 to recognize the significance and nutritional benefits of pulses. The U.N. believes that pulses are not only nutritional; they can also

contribute to the development of sustainable food systems towards eradicating world hunger and poverty. According to the U.N., this is an effective strategy for achieving its 2030 Agenda for Sustainable Development, which aims at strengthening global peace and enhancing food security.

Significance of World Pulses Day

Celebration of World Pulses Day, holds great significance for several reasons:

- Pulses offer a reliable and affordable source of protein, especially in regions facing food insecurity. World Pulses Day emphasizes their potential to address hunger and malnutrition.
- Pulses contribute significantly to the agricultural economy, supporting farmers and rural communities. The day highlights their economic importance and promotes their cultivation and consumption.
- The day promotes further research and development related to pulse production, processing, and utilization, leading to improved varieties, increased yields, and better nutritional profiles.
- Pulses are deeply embedded in cultural traditions and cuisines worldwide. World Pulses Day celebrates this diversity and encourages exploring new flavors and culinary experiences.
- The day encourages the preservation of agricultural biodiversity and traditional farming practices.

World Pulses Day serves as a crucial reminder of the valuable role pulses play in our lives. By raising awareness, promoting action, and celebrating diversity, the day inspires us to contribute to a more sustainable, food-secure, and healthier future.

* * * * *

Zero Budget Natural Farming: A Current Substantial for Indian Agriculture

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Zero budget farming, also known as "Subsistence Farming" or "Zero Budget Natural Farming (ZBNF)," is an agricultural practice that aims to minimize the use of external inputs such as chemical fertilizers and pesticides, thereby reducing the overall cost of farming. This method emphasizes the use of natural resources and traditional farming practices to achieve sustainable and eco-friendly agriculture. Zero budget farming emphasizes self-sufficiency and sustainability, reducing dependence on external inputs and promoting ecological balance. It's important to note that successful implementation may vary based on local conditions and ecosystems.

How Natural farming is different from other methods

- Modern agriculture is based on the principle that the soil has to be replenished by chemical nutrients such as nitrogen and phosphorous, depending on the intake by the crop. Using chemical inputs reduces the microbe population and hinders this natural process.
- In organic farming, similarly, the soil is replenished by applying organic manure like cow dung. But since cow dung contains very little nitrogen, massive amounts have to be applied, which may be difficult for a farmer to arrange.
- Natural farming works on the principle that there is no shortage of nutrients in soil, air and water, and healthy soil biology can unlock these nutrients.

Principles of Natural farming

According to National Mission on Natural Farming Management and Knowledge Portal, Government of India, Natural farming encompasses following principles:

- Implementation of diversified cropping system-based agriculture

- Recycling of naturally available nutrients in fields
- Reuse and recycle of on-farm generated biomass
- Use of locally developed and refined practices based on plant, animal and microbial source as raw materials
- Farmers employ innovative techniques that are always evolving in response to cropping patterns, regional climates, altitude, soil quality, insect and pest intensity and variability, etc.

Components of natural farming

1. Jivamrit: Made by fermenting well-rotted cow dung, cow urine, jaggery, and water for around 48 hours, it is a healthy organic biostimulant. By lowering the need for synthetic inputs, this nutrient-rich liquid fertilizer promotes soil fertility, microbial activity, and plant nutrient absorption, all of which support sustainable agriculture.

2. Bijamrit: Bijamrita is a naturally occurring seed treatment solution that is made by soaking seeds in a solution made of water, lime, cow dung, and cow urine. The seeds are soaked, dried, and then planted. This age-old method is said to improve seed germination, guard against illness, and encourage robust plant development in an organic and long-lasting way.

3. Acchadana – Mulching: Subhash Palekar suggests the following types of mulching:

a) Soil Mulch: avoids tilling topsoil and instead preserves it for farming purposes. Moreover, it aids in the aeration and water retention of the soil. Palekar has advised against plowing deeply.

b) Straw Mulch: The straw particles hint at the dried biomass waste from previous crops. Palekar suggests that this might include the rotting remnants of any living organism, including plants, animals, and so on.

4. Live Mulch (symbiotic intercrops and mixed crops): Palekar says that it is essential to design different cropping patterns of monocotyledons and dicotyledons planted in the same region in order to supply the necessary components to the soil and crops.

5. Whapasa - Moisture: Palekar refutes the popular belief that plant roots need a lot of moisture. In this approach, he criticizes the green revolution farmer's over-reliance on irrigation. He is adamant that water vapor is essential to roots. This is what he calls the condition of air and water molecules in the soil, or whapasa. He encourages reducing the amount of irrigation and emphasizes utilizing it just at noon.

6. Plant protection measures: The application of conventional, organic, and plant-based methods for controlling pests and diseases is emphasized in natural farming. Plant protection involves the use of several botanical concoctions, or "astras":

a) Neemastra: It is used to prevent or treat infections, as well as to get rid of insects or larvae that eat plant leaves and sip plant sap. Furthermore, this helps stop harmful insects from spreading. Neemastra is a very easy-to-manufacture bioinsecticide and pest deterrent for natural farming.

b) Agniastra: Neem leaf pulp, tobacco powder, green chilli powder, garlic paste, and turmeric powder are mixed to form a natural pesticide. All sucking pests and caterpillars, such as Leaf Roller, Stem Borer, Fruit Borer, and Pod Borer, are managed using it.

c) Brahmastra: The leaves of neem, karanj, custard apple, and daphnia, which contain specific alkaloids that repel pests, are used to make this all-natural pesticide. It controls all sucking pests and hidden caterpillars found in fruit pods.

d) Dashaparni ark: It acts as a substitute for Neemastra, Bramhastra, and Agniastra. It is prepared using tobacco powder, ginger paste, turmeric powder, Asafoetida, chilli pulp, garlic paste, and any 10 leaves, depending on what's available. Many plants, including neem, pogoamia pinnata, Annona squamosa, Castor, Datura, Rui, Hibiscus, mango, lantana camara, and guava, have leaves that we may use. It is used to manage a variety of pests, depending on how bad the infestation is.

e) Fungicide: It is created from curd and cow's milk, which is particularly effective at regulating and controlling fungal infections.

Features of zero budget natural farming

1. Nutrient uptake from air and sunlight: According to natural farming methods, plants get 98% of their nutrients from the air, water, and sunshine and just 2% from the soil. This highlights the significance of having good soil that is home to helpful bacteria.

2. Organic mulch for soil health: Organic mulch must be applied to the soil continuously in natural farming. This process produces humus and encourages the growth of beneficial microorganisms.

3. Bio-cultures instead of fertilizers: To improve the microflora in the soil, natural farming uses farm-made bio-cultures like Jeevamrit and Beejamrit, which are created from the urine and dung of native cow breeds, in place of commercial fertilizers.

4. Environmental and economic benefits: Natural farming has several benefits, such as lowering greenhouse gas emissions, improving soil fertility, and enhancing environmental health, and it also has the potential to raise farmers' revenue.

5. Dependence on Indian breed Cows: The method depends on cow dung and cow urine (Gomutra) from Indian varieties of cows, especially Desi cows, whose composition is favorable to microbes.

6. Exclusion of exogenous fertilizers: Organic or chemical external fertilizers are not used in natural farming, either on the crops or in the soil.

7. Encouragement of soil Microbes and earthworms: By promoting the decomposition of organic waste on the soil's surface by earthworms and bacteria, natural farming progressively enriches the soil with nutrients.

8. Natural weeding Practices: Natural farming minimizes the use of fertilizers, plowing, and soil disturbance while simulating the processes of weeding seen in natural ecosystems.

9. Natural pest control: Natural farming uses natural pesticides like Dashparni Ark and Neem astra to fight illnesses and pests.

10. Role of weeds as mulch: Weeds are seen as necessary for preserving the ecological balance and are purposefully used as layers of living or dead mulch.

11. Emphasis on multiple cropping: Multiple cropping is preferred over monoculture in natural farming because it increases biodiversity and improves soil health.

Constraints

Some major constraints of natural farming are as follows:

- Limitations in managing pests and diseases
- Reduced crop yields in comparison to traditional techniques
- Labor-intensive weed control
- Transition phase marked by lower yields and increased expenses
- Costs and conditions for certification
- Knowledge and training requirements
- Susceptibility to weather variations
- Competition from traditional agriculture

Future thrust

Natural farming has a bright future ahead of it as global agriculture struggles with environmental

issues and sustainability. The market for pesticide-free, organic vegetables is expanding as customers place a higher priority on making decisions that benefit their health and the environment. Natural farming is a sustainable approach since it may improve soil fertility, reduce greenhouse gas emissions, and support ecological health. It is also economically attractive because of its ability to raise farmers' revenue through lower input costs and higher pricing for organic products. The use of natural farming approaches is expected to increase with further study and information exchange, providing a route towards a future in agriculture that is more ecologically friendly and sustainable.

Conclusion

Sustainable agriculture may heavily rely on natural farming. It fits perfectly in the people, planet and profit philosophy. The goal of natural farming is to produce food that is safe and healthful for everyone to eat while lowering overhead costs and making a healthy profit for the farmers.

* * * * *

Integrated Weed Management

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A farming system that utilizes an array of inter dependent cultural, biological and herbicidal weed control practices is generally referred as Integrated Weed Management. It is important that IWM includes a variety of tools, including rotation of available herbicide groups, which ensures that weeds are exposed to different control mechanisms. The main goal of IWM is to reduce selection for resistance to any single insecticide and to delay or prevent the development of herbicide-resistant weeds. More over there is also problem of resurgence of weeds.

Principles of Integrated weed management:

- ✓ IWM place the crop in competitive advantage over the weeds by manipulating the crop habitat by utilizing some biological differences between crops and weeds.
- ✓ The goal of IWM interventions should be to reduce weeds' ability to survive in the soil.
- ✓ Each component of the weed control process should be beneficial to the environment and non-destructive.
- ✓ Weed management practices should be flexible to accommodate possible innovations and experiences of progressive farmers.

The different components of IWM are discussed below:

(A) Preventive methods

Preventive measures usually don not offer remedy over the already existing population of weeds in the crop fields but they focus on the prevention of further introduction and spread from different external sources. Preventive method of weed control include use of weed free crop seeds, weed free manure, clear equipments and elimination of weed infestation in and around irrigation channels and cultivated fields.

(1) Pure and clean crop seeds and seed certification

It is always advised to use pure and clean seeds of crops as possible. Clean crop seeds do not add seeds of the existing or new weeds species to soil seed bank.

It acts as a check against increasing weed problems in the long run. Seed should be certified and purchased from some authentic sources.

(2) Use of well decomposed organic manures

Fresh or undecomposed FYM/compost is a source of weed seeds. Therefore, it should be well decomposed and well rotten and free from weed seeds.

(3) Clean farm machineries and farm animals

The farm machineries like tillage and harvest implements should be cleaned properly and the soil sticking/adhered to the implements must be removed before carried to another field. Farm animals should also be cleansed in a similar manner.

(4) Clean irrigation channels and irrigation systems

Irrigation water carries soil and weed seeds to a field crop. Therefore, irrigation channels should be kept clean and weed free. Weedy irrigation channels also cause chocking/plugging problem.

(5) Clean farm bunds, road sides, fences and non-crop fields

Weeds on farm bunds, roads and fences should be controlled occasionally always before they go for flowering to avoid weed perpetuation in the field.

(6) Transport of sand and soil

Sand and soil from an infested area should not be transported and used to a clean or cultivated area.

(7) Weed control in nurseries

In the nursery of vegetables and rice, appropriate weed control practices should be implemented. Before bringing the uprooted weeds to the main field, the seedlings should be eliminated during the uprooting process.

(8) Plant/weed quarantine law

All weed species in general and noxious plants in particular are prevented from spreading physically across areas, states, or nations by weed laws.

(B) Cultural methods: Cultural/ecological methods of weed control exploits the crop's competitive

behaviour. growing environment and crop management practices towards smothering of weeds.

(1) Crop species

Crop species differ in their germination pattern, tillering, branching, nature and orientation of inclination of leaf, root growth, plant height, total growing duration, etc. Therefore, variation in their competitive and weed smothering ability is quite apparent.

(2) Crop variety/cultivar

Crop variety/cultivar also very in their ability to compete with weeds on the same principles as crop plants.

(3) Sowing of crop (time, method, seed rate, spacing)

The environment in which crop germination and initial growth occur could be weed-free or less weedy if the initial flush of weed germination at one point in time is avoided by adjusting the time of crop sowing (a little sooner or later).

Line sowing usually encounters less weed infestation and provide more ease of controlling them than broadcasting method.

Greater initial seedling vigour of crop would result in healthy and competitive crop which itself would be able to smother weeds. Normally higher the density of a crop, lower is weed competition. For grain crops, the population must be maintained; however, for fodder and forage crops, the population may be raised. Generally closer row spacing reduces weed competition in crops. Therefore, suitable row spacing close enough which does not invite intra species competition among crop plants needs to be searched out.

(4) Crop rotation

Crop rotation modifies the environment and crops in each field on a regular basis. Crop rotation is seen as a "panacea" for managing weeds, diseases, and insect pests in crop field ecosystems in order to preserve soil health and long-term crop productivity. Crop rotation is effective in controlling of crop associated and crop bound weeds such as *Avena fatua* in wheat and *Cuscuta* in lucerne.

(5) Cropping practice

Crop variety according to situations and location offers an advantage over monoculture in terms of weed competition reduction. It is best to choose a compatible crop mixture (such as intercropping or mixed cropping) that lowers weed competition while also increasing overall production. Intercrops that suppress weeds include companion crops like smother crops, cover crops, and live mulches.

(a) Live mulch/cover crop

Live mulch is a living cover maintained by growing a cover crop. e.g. Live cover can be established between widely spaced rows of fruit and plantation crops. Intercrop having good weed smothering ability can be introduced in inter rows of an economic crop.

(b) Trap and catch-crops

Trap crops are false hosts which exude germination stimulants and induce weed seed germination, but after germination, weed may die for want of real host. This is called suicidal germination.

Catch crops are parasitic weed susceptible variety of crop, which is grown and ploughed into soil prior to the flowering of parasitic weeds and sowing of a crop of principal interest.

(6) Irrigation

Weed emergence and growth are influenced by irrigation time and technique; many weeds can be suppressed by submergence, drip irrigation minimizes weed development by wetting less soil area near the crops, and furrow irrigation suppresses weeds in arid environments.

(7) Fertilizer application

Fertilizers used in scientific alteration of the soil, crop, and weed environment will selectively stimulate crop development, which could act as a weed-smothering mechanism in and of itself.

Certain weed species may be selectively affected by the type of fertilizer used. While P and K are sprayed as a base coat, N must be treated in segments so that weeds cannot share much of it. Following manual weeding of the weed control measure, top dressing might be advised. To lessen weed competition, fertilizer should be applied to the

crop by hand, as a side dressing, or beneath the crop rows prior to planting. In general, weed development is inhibited by higher fertilizer rates, especially N.

(8) Stale seed bed

First irrigation is applied to the field and then ploughed on optimum moisture status and levelled. Crop sowing is withheld for about a fortnight to allow germination of weeds. Weeds are then controlled by shallow cultivation.

(9) Summer fallowing

One of the most efficient cultural techniques to slow the spread of perennial weeds in crop cultivation is the application of summer or off-season tillage. Farmers expose their fields to the sun in April, May, and June to combat weeds and other soil-born pests. Roots, rhizomes and tubers of shallow rooted perennials like Bermuda grass and nut sedge.

(C) Mechanical methods

This method includes such practices as hand weeding, hoeing, moving, flooding, mulching, burning and tilling the soil for the reduction of weeds

(1) Hand weeding & hoeing

The oldest technique for controlling weeds is hand weeding. It is labour-intensive, time-consuming, and frequently more expensive. Annual weeds are well controlled by it. Hand hoeing is an interculturing technique used after planting that loosens and stirs the soil. When used against annual weeds, it works well.

(2) Tillage

Tillage destroys weeds by removing them from the soil. Through damage from root and stem trimming, it may weaken plants, decreasing their ability to regenerate or compete: Tillage performed prior to planting helps in burying existing weeds.

(3) Moving and Slashing

The principle behind moving and cutting is suppression of weed seed formation and dispersion through concurrent control of weeds or wild vegetation mostly under non-crop scenario such as canal bunds, farm roads, parks and lawns.

(4) Flooding

Flooding creates anaerobic condition, which prevents weed seed germination and root respiration of already germinated seeds and kills plants by

reducing oxygen supply for growth. It is followed in both cropped and non-cropped areas.

(5) Burning and flaming

Burning is primarily used in non-crop situations to control weeds without being selective. In addition to illnesses and insect pests, it also eliminates weed seeds. Flaming could be used in a non-selective or selective manner. Since the flame is pointed downward, crop damage can be prevented.

(6) Digging

Digging in small scale may be carried out to remove the underground vegetative structures from deeper layer of soil if found perennial weeds.

(7) Chaining and dredging

Dredging is the mechanical removal of aquatic weeds and their roots and rhizomes from the mud. When chaining, tractors are used to drag a large, heavy chain over the ditch's bottom to create ditch embankments.

(8) Mulching

The mulch provides a physical barrier on the soil surface and must block nearly all light reaching the surface so that the weeds which emerge beneath the mulch do not have sufficient light to survive. For instance, polythene sheets and organic materials such as sawdust, powdered nut shells, and rice husk. If polythene is put in continuous sheets, its efficiency increases (more polythene). Both annual and perennial weeds can be successfully eradicated with it.

(a) Live mulch e.g. cover crop, inter-crop, green manure

(b) Dead mulch

a) Organic: Residue, trash, sawdust, organic matter, *etc.*

b) Synthetic: Polythene film

c) Soil dust mulch

(9) Soil solarization

The core concept behind soil solarization is that sunlight's short-wave radiation can readily enter soil through a transparent, colourless polythene layer. Long wave radiation is released and the soil gets heated as a result. This prevents heat from building up or being trapped in translucent polythene sheeting. Weeds, worms, and soil pathogens would all perish

from the ensuing temperature rise. The temperature of the surface soil may rise to 55–60°C during the hot summer months as a result of solarization.

(D) Biological methods

Table 1: Different bio-agents used for weed control

Weed	Bio-agent	Reporting Country	Kind of bio agent
<i>Chondrilla juncea</i>	<i>Puccinia chondrillina</i>	Australia	Plant pathogen
<i>Eupatorium riparium</i>	<i>Entyloma compositarum</i>	USA	Plant pathogen
<i>Hydrilla verticillata</i>	<i>Hydrellia pakistanae</i>	USA	Shoot fly
<i>Orobancha cornea</i>	<i>Sclerotinia sp.</i>	USA	Plant pathogen
<i>Parthenium hysterophorus</i>	<i>Zygogramma bicolorata</i>	India	Leaf eating beetle

Table 2: Some Commercial Mycoherbicides used in weed control

Product	Content	Weed controlled
De-Vine	A liquid suspension of fungal spores of <i>Phytophthora palmivora</i> . It causes root rot in the weed.	Strangler-vine. (<i>Morrentia odorata</i>) in citrus orchards.
Collego	Wettable powder containing fungal spores of <i>Colletotrichum gloesporioides</i> Sub sp. <i>aeschynomone</i>	Joint vetch (<i>Aeschynomone sp.</i>). In rice fields. The bioherbicide causes stem and leaf blight in the weed.
Bipolaris	A suspension of fungal spores of <i>Bipolaris sorghicola</i> .	Johnson grass (<i>Sorghum halepense</i>)
Biophos	A microbial toxin produced as fermentation product of <i>Streptomyces hygroscopicus</i> .	Non-specific, general vegetation.

This method involves utilization of natural enemies for the control of certain weeds. This can be achieved by direct or indirect action of biological control agents. In direct action, firstly the bio control agent bores into plant, weakens its structure which

leading to its collapse and consumes as food and destroys the vital plant parts. In indirect action the bio control agent reserves the competitive ability of weed over other plants and enhances the condition favourable for plant pathogens.

(E) Chemical methods

Common salt, ash etc. have been used for centuries to control weeds on roadsides, fence rows & pathways. A great breakthrough in selective weed control was accomplished in 1945, with the development of 2,4-D & MCPA in USA & England independently by P.W. Zimmerman and A. E. Hitchcock. It was discovered that MCPA and 2,4-D are both extremely selective for cereals and phytotoxic to weeds with broad leaves. Over 45% of all pesticides used in agriculturally developed nations are herbicides. Herbicide usage makes to only 8% of all pesticide use in India.

(F) Allelopathy as a Weed Management

Inter-weed-competition determined by allelopathy can be manipulated in the natural control of weeds. Natural compounds released by some plants inhibit or prevent the growth of nearby plants. Merigold flowering plant is found to suppress the growth of parthenium. Thistle exudation inhibits the growth of oats. Wheat, oats & peas suppress the growth of *Chenopodium album*.

Conclusion

The aim of weed management is to find best effective methods or techniques that can be used to make cropping systems prohibitive to the emergence and establishment of weeds. Integrated weed management is a science-based decision-making approach that includes multiple weed control methods rather than relying on a single method to reduce weed populations below an economic threshold. Therefore, the best approach is to integrate the cropping system and weed control blueprint into a sustainable comprehensive system that is economically and environmentally viable.

References

Yadav, A. and Chahal, G. (2022). Integrated Weed Management, Just Agriculture e-Newsletter. 2(7):2582-8223.

Advancements in Semen Separation Methods for Buffaloes

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The livestock industry is crucial to the nation's economy, making substantial contributions to agriculture, rural sustenance, and ensuring food security. The native water buffalo (*Bubalus bubalis*) plays a crucial role in India's agricultural economy, with the country leading globally in both buffalo production and population. Nevertheless, reproductive techniques utilized in this sector encounter numerous challenges including issues like silent heat, inadequate oestrus detection, anoestrus, seasonal infertility, extended calving intervals etc. Addressing these limiting traits specific to the female component can be achieved through the use of high-quality semen, which also needs to be optimized for fixed-time insemination. Under in vivo conditions, potentially fertile spermatozoa undergo separation from immotile spermatozoa, debris, and seminal plasma in the female genital tract via active migration through the cervical mucus. This process not only selects progressively motile spermatozoa but also induces physiological changes known as capacitation, which are essential for the sperm's functional competence, including acrosome reaction. The advent of assisted reproduction, particularly in vitro fertilization (IVF), in the 1980s spurred the development of various sperm separation methods.

Table 1: Mean volume of the ejaculate in Indian buffalo breeds

Breed	Volume (mL)
Banni	4.09 ($\pm$ 1.59)
Bhadawari	4.11 ($\pm$ 1.57)
Jaffarabadi	5.10 ($\pm$ 1.80)
Murrah	4.48 ($\pm$ 1.87)
Pandharpuri	4.79 ($\pm$ 1.80)
Surti	4.68 ($\pm$ 1.73)

Buffaloes and cattle bulls, both considered large ruminants, exhibit anatomical and sperm characteristic differences. Notably, these include variations in ejaculate volume, concentration, pH, sperm density, and abnormal sperm percentages. Additionally, there are significant differences in their capacity for in vitro fertilization and subsequent

embryo development. The average ejaculate volume in genetically characterized Romanian buffaloes was determined to be 4.07 ($\pm$ 0.02) mL, which is lower compared to other indigenous buffalo breeds (Table1).

Sperm separation methods

In addition to various enrichment protocols, sperm separation techniques (Fig 1) have become valuable tools in the realm of reproductive biology and assisted reproduction. The optimal method for separating sperm should be swift, easy and cost-effective while maximizing the isolation of viable spermatozoa. It should avoid inducing damage or non-physiological changes to the sperm cells, while effectively removing dead spermatozoa, leukocytes, bacteria, and harmful substances such as decapacitation factors or reactive oxygen species (ROS). Additionally, it should have the capacity to process larger volumes of ejaculates.

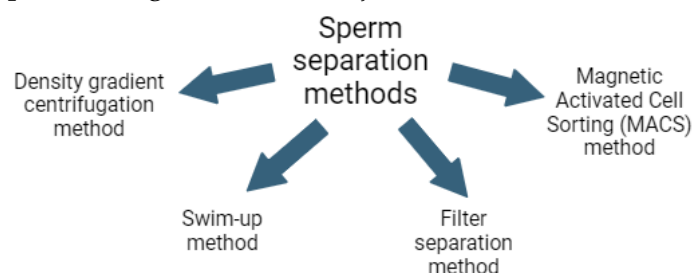


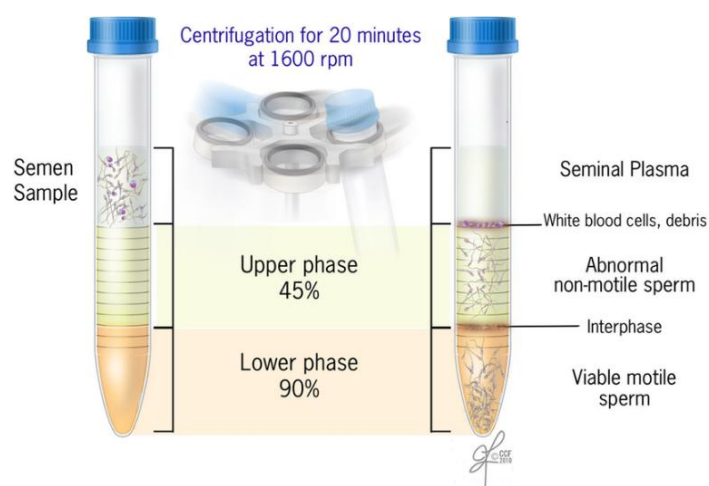
Fig. 1: Different sperm separation methods

Density gradient centrifugation method

Various density gradients have been assessed for selecting bovine sperm, aiming to obtain samples with increased motility while maintaining intact gene expression, acrosomal membrane, and DNA integrity. Percoll gradient centrifugation uses the higher density of sperm cell nuclei to make them settle in the denser part. Additionally, research in bovines demonstrated that highly motile sperm cells align more faster with centrifugal forces, resulting in rapid deposition. Percoll density gradient technique also increases the proportion of viable X-bearing sperm by as much as 70%, while maintaining the integrity of the sperm membrane and acrosome, supports its application for sexed semen in livestock reproductive studies. In buffalo, enriched semen following Percoll treatment

was also investigated for the separation of X and Y sperm, with later evaluation of its impact on sperm quality compared to filtration methods or traditional swim-up techniques. The usage of taller and denser column could make it harder for the sperm cells to move, making them stay in contact with Percoll for longer. This could lead to some changes, like more capacitation and earlier acrosome reactions. So, it's possible that using smaller volumes of Percoll gradients might cause less damage to the acrosome. Therefore, when using large volumes of density gradients in assisted reproduction, we should consider the chance of this kind of acrosomal damage.

Fig. 2: Density gradient centrifugation method
(Image taken from Malvezzi et al; 2014)



The swim-up method

First described in 1984, swim-up (SU) works based on the ability of moving sperm to swim towards a medium without cells typically positioned above the sample. Researchers evaluated SU's usefulness and its impact on sperm quality in buffaloes, finding that it outperformed other separation techniques for certain important traits needed in assisted reproductive technology (ART). Previous studies found that sperm separated using the swim-up (SU) method showed better motility and significantly higher motility index compared to density gradient centrifugation (DGC), although the recovery rates were generally lower. Additionally, analysis of cleavage rates suggested that SU might be more suitable for in vitro fertilization (IVF) (with significant differences in cleavage rate and cleavage index $p < 0.05$). A modified swim-up (SU) method has been confirmed for sperm sexing, with a

notably higher recovery rate for sperm carrying the X chromosome compared to those carrying the Y chromosome. Although both X and Y groups showed higher motility index and acrosome integrity rates compared to the control group, the progressive motility of the unseparated samples was higher. However, these findings were observed before freezing, and post-thawed samples subjected to the modified SU method actually showed superior progressive motility.

Fig. 3: Swim-up method (Image taken from Agarwal and Sharma; 2016)



Filter separation method

The glass wool filtration involves a meticulous protocol wherein a tuberculin syringe is cut and filled with 15 mg of glass wool, followed by flushing with medium to remove debris. The ejaculate is washed, and the pellet is resuspended and laid onto the glass wool for gravity filtration. This technique exploits the altered plasma membranes of dead or damaged spermatozoa, leading to their binding with glass fibers and enhancing filtration efficacy. Notably, the type of glass wool used significantly impacts the method's success, as evidenced by its superior results compared to colloid centrifugation in stallions and buffaloes. Moreover, glass wool filtration enables the recovery of higher proportions of motile spermatozoa compared to other methods like swim-up or density gradient centrifugation.

Sephadex gel filtration utilizing specific pore sizes of dextran gel columns, is effective in trapping spermatozoa with damaged membranes. Comparative studies highlight the superiority of

Sephadex filtration over other methods in enhancing sperm quality and fertilizing ability across various species. Notably, Sephadex filtration outperforms swim-up and glass wool filtration in terms of total and motile sperm recovery rates and post-filter quality in buffalo, bovine, and boar semen samples. Additionally, the choice of Sephadex grade and buffer type significantly influences the filtration outcomes, further emphasizing its versatility and efficacy in sperm separation and enrichment.

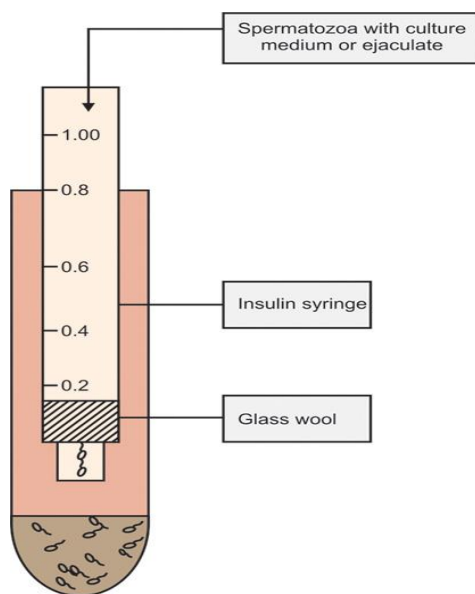


Fig. 4: Glass wool filtration method (Image taken from Malik and Ved; 2007)

The magnetic-activated cell sorting (MACS) method

This method addresses the lack of correlation between sperm density and apoptosis observed in density gradient centrifugation (DGC), potentially leading to unsuccessful fertilization. By exploiting phosphatidylserine (PS) externalization, MACS separates apoptotic and non-apoptotic spermatozoa using annexin V-conjugated microbeads. Combining MACS with DGC enhances sperm quality and function, as indicated by improved motility, viability, and reduced apoptotic markers. The annexin-negative fraction obtained through MACS + DGC exhibits minimal cell loss and expresses fewer apoptotic markers compared to DGC alone. Furthermore, MACS + DGC significantly reduces sperm DNA fragmentation, mitochondrial membrane potential disruption, and PS externalization. The increased sperm recovery rates observed with MACS + DGC

underscore its superiority over DGC alone, particularly in producing motile, viable, and non-apoptotic spermatozoa. This combined technique shows promise even in cases of teratospermic, asthenozoospermic, and oligoasthenozoospermic conditions, offering improved DNA integrity and functionality and potentially enhancing the production of good quality embryos in assisted reproduction.

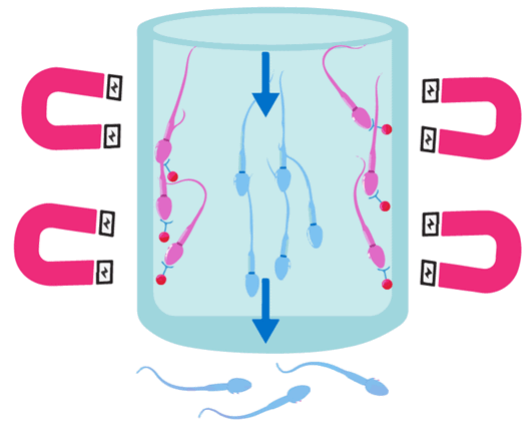


Fig. 5: The magnetic-activated cell sorting (MACS) method (Source: <https://www.invitra.com/en/annexin-v-column-macs/>)

Conclusion

Advancements in buffalo reproduction have led to new avenues for diagnosing and treating subfertility, particularly in sperm analysis. Traditional sperm sorting methods, often involving centrifugation, raise concerns about oxidative stress and cell damage. Quantitative assessment of sperm motility, morphology, and genetics aids in diagnosing male infertility and selecting optimal sperm for assisted reproductive technologies (ART). Various buffalo sperm selection methods have pros and cons, with conflicting results raising questions about their clinical relevance. Sperm-up (SU) shows higher motility index than density gradient centrifugation (DGC), but with lower recovery rates. Magnetic-activated cell sorting (MACS) combined with DGC yields higher recovery rates than DGC alone. Sperm separation techniques improve the freezability of low-quality buffalo ejaculates, but research in veterinary medicine, especially in buffaloes, is still limited.

Further investigation is needed to fully understand the efficacy and clinical applicability of these techniques in buffalo reproduction and male fertility enhancement. In summary, while semen separation techniques show promise, their widespread use requires thorough validation and research.

References

Agarwal A, Gupta S, Sharma R. Sperm preparation for intrauterine insemination (IUI) by swim-up method. Andrological evaluation of male infertility: A laboratory guide. 2016:109-12.

Andrei CR, Posastiuc FP, Constantin NT, Mitrea IL. New insights into semen separation techniques in buffaloes. *Frontiers in Veterinary Science*. 2023;10.

Henkel RR, Schill WB. Sperm preparation for ART. *Reproductive biology and endocrinology*. 2003;1(1):1-22.

Malik S, Ved S, "Techniques of Sperm Preparation for ART". Telang Mangala (ed). *Atlas of Human Assisted Reproductive Technologies*. Jaypee Brothers Medical Publishers (P) Ltd.,2007:19.

Malvezzi H, Sharma R, Agarwal A, Abuzenadah AM, Abu-Elmagd M. Sperm quality after density gradient centrifugation with three commercially available media: a controlled trial. *Reproductive Biology and Endocrinology*. 2014; 12:1-7.

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Advancements and Innovations in Protected Cultivation

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Protected Cultivation practices is a cropping technique wherein the micro environment surrounding the plant body is controlled partially /fully as per plant need during their period of growth to maximise the yield and resource saving. Among these protecting cultivation practices, green houses /polyhouses, plastic low tunnels, pit nursery, mist chambers, shade nets and screen houses etc. is useful.

This technology has the potential to improve the availability of high-quality vegetables, flowers, and fruits in urban areas by lowering transportation time and providing fresh food. Greenhouses are structures made of transparent materials such as polythene or glass. The covering functions as a selective radiation filter, allowing shortwave solar light to pass but trapping long wave radiation. Because of its low transparency, long wave radiations released by plants and items in the greenhouse cannot flow through it. The trapped solar energy inside the greenhouse causes the temperature to rise. The increased temperature inside the greenhouse impacts leaf temperature, which influences leaf transpiration, stomatal aperture, and the plant's photosynthetic rate. The climatic control in the greenhouse can be used to change the physiological conditions of plants. Closing the greenhouse at night increases the CO₂ level due to plant respiration, which is then used for photosynthesis by the plants in the early morning hours of the following day. The rise in temperature, relative humidity, CO₂ levels, and improved nutrition under greenhouse conditions is responsible for rapid growth and greater yield.

Protected cultivation requires distinct management approaches compared to open field production. To accommodate the demand for fresh vegetables, strawberries, flowers, and fruit trees, multi-storey greenhouses in urban areas are necessary. Protected cultivation technologies include natural ventilation, polyhouses, drip irrigation, fertigation, and mulching. Walk-in polytunnels are beneficial for cultivating tomatoes, capsicum, and cucurbits and

propagating nursery plants during the off season. Site selection is a key factor for profitable and sustainable greenhouse production. The main factors determining location and site selection of a greenhouse production area are: cost of production, quality of produced yield, and transportation cost to markets (Castilla, 2007). Other factors affecting greenhouse location are microclimate, Harsh weather conditions, Irrigation, Drainage, Pollution, Availability of space, Availability of labour, Infrastructures and Orientation (Salah and Azmi 2015).

Types of Green Houses

Low-cost greenhouse/polyhouse:

The low-cost polyhouse is made of 200 micron (800 gauge) transparent polythene sheet supported by bamboos, jute ropes, and nails. It is used to protect crops from heavy rainfall. The temperature inside a polyhouse rises by 6-10°C higher than outside. The UV stabilized plastic film-covered pipe-framed polyhouse has a greater daytime temperature than the exterior. The polyhouse receives 30-40% less solar radiation than the surrounding soil surface. During summer, open the sides of the greenhouse to regulate the temperature during the day.

Medium-cost greenhouse/polyhouse

The medium-cost greenhouse is slightly higher cost when compared to low-cost polyhouses. It is quonset-shaped and can be constructed with GI pipe (class B) of 15mm diameter. The structure is protected by a single layer of UV-stabilized polythene measuring 200 microns thick. Natural ventilation can be achieved by opening windows on the sides and roof, or exhaust fans can be employed. The fanpad system can humidify the polyhouse, lowering the temperature.

High-cost greenhouse/polyhouse:

It is constructed with iron/aluminium and has a dome or cone shape. Crop-specific temperature, humidity, and light levels are automatically regulated for optimal results. The floor and half of the side walls

are built of concrete. Although incredibly durable, it is around 5-6 times more expensive. This requires a qualified operator, adequate maintenance, and safeguards during operation.

Classification of Polyhouses Based on Shape

Lean-to Greenhouses: Lean-to greenhouses are attached to an existing building, such as a house, barn, or garage. They share one wall with the existing structure, which helps to provide thermal mass and may reduce construction costs.



Lean-to Greenhouses

A-Frame Greenhouses: A-frame greenhouses feature a distinctive roof design that slopes downward on both sides, resembling the letter "A". This design allows for efficient shedding of rain and snow, and it maximizes natural light penetration.



A-Frame Greenhouses

Gothic Arch Polyhouses: Gothic arch polyhouses feature a peaked roof with curved sidewalls, resembling the shape of a Gothic arch. This design provides additional headroom and allows for efficient shedding of snow and rainwater. Gothic arch polyhouses are suitable for taller crops and can withstand heavy snow loads.

Gothic Arch Polyhouses

Quonset Greenhouses: Quonset greenhouses have a rounded or semicircular shape, resembling a tunnel.

They are often made of metal or PVC pipes covered with plastic sheeting. Quonset greenhouses are popular for their simplicity, cost-effectiveness, and



ability to withstand strong winds.

Quonset Greenhouses

Ridge-and-Furrow Greenhouses: Ridge-and-furrow



greenhouses consist of multiple connected bays or sections arranged in a straight line with a ridge along the top. This design maximizes space utilization and allows for efficient heating and ventilation systems.



Ridge and furrow

Uneven span types green house: This type of greenhouses is constructed on hilly terrains. The roofs are of unequal width, make the structure adaptable to the side slope of the hill.

Even type greenhouses: Even type greenhouses are also known as even-span greenhouses, are a type of greenhouse structure characterized by a uniform roof pitch and consistent height across the entire width of the structure. These greenhouses are designed to maximize interior space and optimize growing

conditions for crops. Here are some key features and advantages of even type greenhouses



Even type greenhouses



Uneven span types green house

Functions of Green Houses

Temperature Regulation: Greenhouses effectively trap solar radiation, creating a warmer environment than the external surroundings. This enables growers to extend the growing season, start crops earlier in the spring, and continue production later into the fall or even through the winter in some regions. Temperature regulation is vital for optimizing plant growth, as different crops have specific temperature requirements for germination, flowering, and fruiting.

Humidity Control: Greenhouses help to maintain optimal humidity levels for plant growth. The enclosed environment prevents rapid moisture loss, particularly in arid climates, while adequate ventilation prevents excess humidity that can lead to fungal diseases and rot.

Protection from Extreme Weather: Greenhouses shield plants from adverse weather conditions such as heavy rains, hailstorms, and strong winds, which can damage crops and reduce yields. They also provide protection against frost, allowing growers to cultivate sensitive crops that would otherwise be vulnerable to cold temperatures.

Pest and Disease Management: The enclosed nature of greenhouses acts as a physical barrier against pests such as insects, rodents, and birds, reducing the need

for chemical pesticides. Additionally, the controlled environment enables growers to implement integrated pest management (IPM) strategies more effectively, utilizing biological controls and cultural practices to minimize pest damage.

Optimized Growing Conditions: Greenhouses allow growers to manipulate various environmental factors to create ideal growing conditions for specific crops. These factors include light intensity, photoperiod (day length), carbon dioxide levels, and air circulation. By fine-tuning these parameters, growers can optimize photosynthesis, improve crop quality, and increase yields.

Resource Efficiency: Greenhouses promote resource efficiency by minimizing water usage and fertilizer runoff. Drip irrigation systems and soilless growing mediums (e.g., hydroponics, aquaponics) deliver water and nutrients directly to plant roots, reducing wastage and maximizing efficiency. Moreover, the controlled environment allows for precise nutrient management, minimizing excess fertilizer application and environmental pollution.

Research and Experimentation: Greenhouses serve as invaluable research tools for plant scientists, breeders, and agronomists. They provide a controlled setting for conducting experiments on plant genetics, physiology, and cultivation techniques. Researchers can study the effects of environmental stressors, test new crop varieties, and develop innovative growing methods to enhance agricultural productivity and sustainability.

Other protective structures

Plastic low tunnels

Plastic low tunnels are simple structures at a height of 0.75-1.0m that protect plants from adverse climatic conditions and pest. For low tunnels, a 100-micron film is sufficient which costs approximately Rs.10-20 per square meter. These are used to cover seedling and individual growing beds in the field. Cladding materials can be removed during favourable weather conditions. Crops grown in polytunnels are Tomato, Cucumber, capsicum (coloured), red cabbage, radish, spinach, Gerbera, Gladiolus, rose, Chrysanthemum, Carnation, Sapota and Strawberry (Rahul & Arunabha 2020).



Plastic low tunnels

Net houses

Net houses are constructed at a height of 3 meter to cultivate vegetable and flower crops. The crop was covered with a shading net with a sufficient shade capacity (35-90% shade) and colour based on its needs. Low and medium-cost greenhouses are ideal for producing high-value crops and flowers during the rainy season (July-October). Vegetables including tomatoes, cherry tomatoes, coloured capsicum, cucumbers, and pole type French beans are challenging to grow in open conditions during this period. Due to their scarcity, these commodities command high market prices, enhancing profitability. Shade nets are of different types such as flat roofs, slopped roof, net tunnels.



Shade net

Innovations in Protected Cultivations

Heating and cooling technologies

In polyhouses, heating and cooling technologies often involve systems like radiant heaters and evaporative cooling pads to regulate temperatures. Ventilation and air circulation systems incorporate fans and vents to ensure proper air exchange, preventing heat buildup and humidity fluctuations. Humidity control mechanisms such as misting systems and automated vents help maintain

ideal moisture levels for plant growth while preventing fungal diseases.

Irrigation Techniques and Resource Efficiency

Efficient water management is a cornerstone of sustainable agriculture, particularly in water-scarce regions. Protected cultivation enables precise control over irrigation practices, with techniques such as drip irrigation, fertigation, and hydroponics minimizing water wastage and nutrient runoff while promoting uniform plant growth and enhanced nutrient uptake. Furthermore, the integration of sensor-based irrigation systems and data analytics enables real-time monitoring of soil moisture levels, facilitating precise water delivery and resource optimization.

Robotics in enclosed agriculture

Protected cultivation is a high-risk, high-cost innovative strategy that only allows for the production of valuable crops. In recent years, agricultural technologies have attracted much attention in scientific research studies, and many attempts have been made for their development, particularly focused on the application of robots and automation on intensive crops. In particular, the application of robotics in protected agriculture would improve overall performance and production efficiency and also enhancing labour quality and safety. Robots can effortlessly do repetitive operations, replacing human labour, at the same time, can operate in a hazardous environment, significantly lowering human operators' exposure to risks, such as spraying chemicals and pesticides in protected farming (Giorgia *et. al.*, 2022).

Crops grown under protected cultivation

High value vegetables like tomato, cherry tomato, coloured capsicum, parthenocarp cucumbers, french beans (pole type), winter watermelon, muskmelon and strawberries can be



grown successfully out of season under polyhouses/ walk-in tunnels in Northern India (Rahul and Arunabha 2020). The technology has also been proved valuable to produce grafted fruit plants year-round.

Conclusion

Protected cultivation represents a paradigm shift in modern agriculture, offering a sustainable approach to meet the growing demand for food while minimizing environmental impact. Continued research and innovation are essential to address existing challenges and unlock the full potential of protected cultivation systems. By embracing advancements in technology, adopting sustainable practices, and fostering interdisciplinary collaborations, stakeholders can propel protected cultivation towards a more resilient and resource-efficient future. With the high adoption of protected cultivation, there's continuous new development in agriculture crops analysis and production and development within the connected industries (Kang et al., 2013).

Reference

Rahul Adhikary and Arunabha (2020) Crops grown under poly tunnel (Poly Tunnels: Advantages, Present

Status and Future Prospects- Review Study. Biosc. Biotech. Res. Comm. Special Issue Vol 13 (12): 48-52

Castilla, N. 2007. Invernaderos de plástico: Tecnología y manejo (2nd ed.). MundiPrensaLibros, Madrid.

Salah and Azmi 2015. Greenhouses Specifications Appropriate to the Climate of the Sudan. Journal of Agricultural Science and Engineering. Vol 1(1): 34-38.

Bagagiolo, G.; Matranga, G.; Cavallo, E.; Pampuro, N. (2022). Greenhouse Robots: Ultimate Solutions to Improve Automation in Protected Cropping Systems – A Review. *Sustainability*, Vol 14 (11).6436

Kang, Yunyan; Chang, Yao-Chien Alex; Choi, Hyun-Sug; Gu, Mengmeng, (2013). Current and future

status of protected cultivation techniques in Asia, *Acta horticulturae*, ISSN : 0567-7572.

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Scope and Cultivation of Fodder Crop in Red-Lateritic Zone of West Bengal

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Agriculture development is targeted with livestock rearing and both are inseparable it plays pivotal role in sustainability of this enterprise. Livestock contributes enormously in food and nutritional security apart from livelihood security to rural population all over the world. India has the largest number of livestock, representing over 17% of world population. Availability of forage legumes is essential for better animal health, production and increasing the nutritive value of forage-based rations, besides providing a source of biological nitrogen fixation for enriching soil, reducing land degradation and mitigating climate change. India with only 2.29% of land area of the world, is maintaining nearly 17.4% of world human population and 10.7% of livestock (more than 510 million heads) creating a huge pressure on land, water and other resources. Furthermore, some part of our country is also largely inhabitable due to harsh climate as reflected by very low population density (Roy *et al.*, 2019). In India, West Bengal is a fodder deficient state due to huge population pressure, low land holding capacity and poor extension activity. There exists a huge gap between requirement of fodder and its availability. While the state has surplus of availability over requirement in respect of dry fodder to the tune of 53.4%, it has a nightmare-like situation as far green fodder is concerned. Deficiency of green fodder is 99.60% implying that the state is able to provide only 0.40% of the requirement. Risks in rainfed agriculture has generated narrow range of fodder cultivation in red lateritic belt of West Bengal due to farm distress problem. Less fodder availability become lead to overgrazing problem in Jhargram and its adjoining block as per our personal experience from last two years (2021-2023). Overgrazing reduces the usefulness, productivity and biodiversity of the land and is one cause of desertification and erosion. Overgrazing is also seen as a cause of the spread of invasive species of non-native plants and of weeds (Saha *et al.*, 2023).



Fig 1: Grazing problem in cultivated land

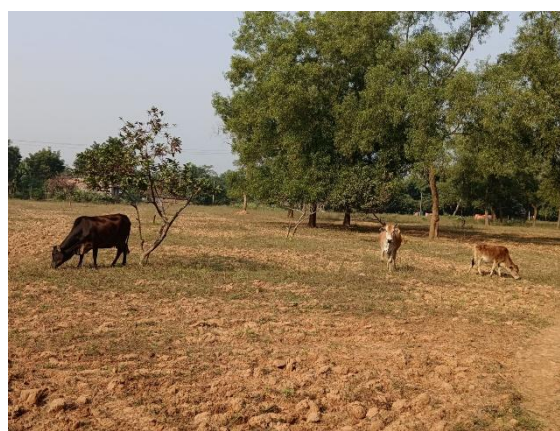


Fig 2: Grazing problem in orchard plantation

India does not have natural pasture land due to climatic conditions. Grazing lands in the country have come up only due to removal of vegetation. This also greatly distort soil fertility and it's economic value (Mukherjee, 2014). To add to the problem, the scope of increasing area under cultivated forage is rather limited because of the preference given to production of "human food". Free grazing of land also causes untold damages to the natural regeneration of the land.

Forage crop and importance

Agricultural, livestock and fodder & forage cum food related interventions were very important for socio-economic uplift of tribal farmers/families particularly in red-lateritic belt. The agricultural economy in this zone is predominantly characterized and supported by the small and fragmented holdings. The average size of holding is less than one ha and per capita availability of land is just 0.16 ha. The

challenges of ushering for fodder for animal feed is now just below 2%, is showing sharp indication of dwindling productivity and becoming more complex with the vagaries of weather reflected through the changing rainfall pattern, distribution of mean temperature and increased frequency of extreme weather phenomenon like cyclone, heat/cold wave, flood and drought etc. Red and Laterite zone mainly covering the districts of Birbhum, Bankura, Purulia, Jhargram and west Medinipur, are list bother about forage crop cultivation. Forages form the main stay of our animal farming to reduce the competition between human beings and animals due to increasing demand for land and other inputs. Sole feeding of green forages to dairy animals is much cheaper than feeding concentrates with crop residues and has the potential of higher level of milk production. Main forage crops gama, rice bean, oat, hybrid napier, para-grass, and lathyrus become very profitable in Binpur I and II block of Jhargram district. However, supply of quality green fodder is extremely precarious, and the gap is huge against demand. The major fodder legume crops which become cultivate in other part of latertici belt are *Medicago sativa*, *Trifolium alexandrinum*, *Vigna unguiculata*, *Vigna umbellate* and range legumes are *Stylosanthes* spp. and *Desmanthus virgatus*.

Fodder crop in crop sequence

More values for below-ground N as a percentage of the total plant N are 22–68% for the pulse and oilseed legumes, *Glycine max*, *Vicia faba*, *Cicer arietinum*, *Vigna radiata*, *Lupinus albus*, *Pisum sativum* and *Cajanus cajan* and 34–68% for the pasture/fodder legumes, subterranean clover, white clover and alfalfa become also very popular in different blocks. Fodder crops are cultivated and harvested for feeding the animals in the form of green forage, silage, hay or other forms. This is not only using as good source of fodder for grazing animals, but also for improvement of soil quality aspect also. Further, more biomass yielding of napier hybrid grass in one of the important perennial forage grasses which can able to increase carbon sequestration through extensive root system and the consequential improvement of soil productivity. Identification of cropping systems introducing forage as a component

crop either as intercrop or a sole crop e.g. rice - fodder oat - sesame; rice -fodder lathyrus- fodder moong; rice bean- fodder oat – fodder moong become good for higher economic output.

Heat stress and crop cultivation

The impacts of climate change are increasingly threatening fodder crop sustainability and food security (Mukherjee, 2022). Particularly, the crops that rely on rainfed cultivation are highly vulnerable to heat and drought stress, affecting plant growth and development. This ultimately affect the livestock farming aspect. Heat stress or exposure of plants to high temperatures during crop growth period is a major impediment to forage crop production in red-lateritic belt of west bengal. Heat stress leads to an array of morphoanatomical, physiological and biochemical changes in plants, which affect plant growth and development eventually reducing economic yield. Heat stress is often the rise in temperature beyond a threshold level for a period of time sufficient to cause irreversible damage to forage plant growth and development. In general, a transient elevation in temperature, usually 10–15°C above ambient, is considered heat shock. High temperature, in general adversely affects photosynthesis, respiration, water relations, membrane stability and production of ROS (Reactive Oxygen Species) and anti-oxidants, accumulation and adjustment of compatible solutes etc. Due to erratic rainfall pattern and early withdrawn of winter, cultivation of green fodder or legume-based fodder production affected significantly and animal bound to graze crop field such as maize, blackgram or mustard field etc.

Strategies to improve fodder availability

- ❖ Optimum utilization of land resources.
- ❖ Improving production by using high yielding fodder varieties.
- ❖ Enhanced fodder seed production and supply of good quality seeds of forage crops to the resource poor farming community.
- ❖ Adopting suitable crop combinations.
- ❖ Forage production for proper utilization of marginal land and conservation of natural

resources, particularly in red and lateritic zone in rice-based cropping sequence.

- ❖ Improvement of grasslands/wastelands and other community lands.

References

- Mukherjee, D. 2022. New paradigm for higher crop productivity through climate smart strategies. *In: Innovative Approaches for Sustainable Development-Theories and Practices in Agriculture*. (eds. Mahdi, S.S. and Singh Rajbir). Springer Publication, page 65-91.
- Mukherjee, D. 2014. Nutrient and its management: Prospect and challenges under the changing environment scenario. *In: Advances in Plant Physiology* - Vol. 15 (eds. Hemantaranjan, A.). Scientific Publishers, Jodhpur, India. Pp 413-442.
- Roy, A. K., Agrawal, R. K., Bhardwaj, N. R., Mishra, A. K. and Mahanta, S. K. (2019). Revisiting National Forage Demand and Availability Scenario. In: *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 1-21.
- Shah, M.H., Mandal, B., Mukherjee, D and Kundu, S. 2023. Effect of weed management in transplanted rice under new alluvial zone of West Bengal. *The Pharma Innovation Journal*, 12(8): 1834-1838.

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Key Initiatives taken by Indian Government for Agriculture 4.0

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The foundation of the Indian economy is the agriculture sector, which generates roughly 20.2 percent of GDP (gross domestic product), compared to 19.9 percent in 2020–21. More importantly nearly half of India's population depends heavily on agriculture and related industries for a living. Over time, the agriculture sector's contribution to GDP has decreased while other sectors especially the services sector have seen an increase. The nation is expected to produce a record 308.65 million tons of food grain, 11.15 million tons more than in 2019–20. On the other hand, small and marginal holdings make up 85% of all operational holdings, or 44% of all operated land, with 157.35 million ha of small holdings farming.

Despite more than 70 years of planning after independence, the majority of farmers continue to struggle with low yields and low profits. The Indian Council for Agricultural Research (ICAR) projects that by 2030, there will be a 345-million-ton demand for food grains. India's average income, growing population, and the effects of globalization will drive up demand for nutritious, high-quality food. As a result, demand to produce more food in greater quantities and of higher quality will keep rising on a decreasing amount of cultivable land. Digital precision agriculture technology makes this possible.

The agriculture sector is undergoing amazing transformation because of drones, sensor-equipped satellite imagery, and digital learning technologies. With the use of digital technology and agricultural modernization, new ideas have emerged, such as digital agriculture with the help of digital education. In order to make farming profitable and sustainable while providing everyone with healthy, nutritious, and reasonably priced food, digital agriculture uses information and communication technologies (ICT) and data ecosystems to assist the development and delivery of timely, targeted information and services.

Agriculture 4.0

The arrival of digital technology in the early 2010s, including low-cost microprocessors, high-bandwidth cellular connection, cloud-based ICT systems, cheap and better sensors and actuators, and big data analytics, set off a new evolution in the agricultural area. With platforms combining data from multiple sources, including sensors and equipment in the field or farm or external sources, these technologies led to the emergence of agricultural eco-systems (FAO, 2017). This allows farmers to monitor their operations from a dashboard with real-time (or nearly real-time) information and make decisions based on quantified hypotheses to increase the outcome. As a result, the agricultural development entered a new phase known as Agriculture 4.0.

The term "Agriculture 4.0" refers to the fourth industrial revolution in farming, which is a significant component of the primary industry. This revolution occurs simultaneously with the similar change in the entire industrial sector, which is known as "Industry 4.0." A growing population—which is predicted to reach 9 billion people by 2050—can be fed by increasing global food production, which is possible with the help of agriculture 4.0. In fact, the use of digital technologies in agriculture raises farming operations' productivity. Simultaneously, the progression towards Agriculture 4.0 benefits both farmers and the sustainable growth of the primary sector. India's National Strategy on AI also aims to realize the potential economic and social benefits the technology offers. Further, the National Strategy on AI recognizes agriculture as one of the priority sector areas for implementation of AI driven solutions. (Niti Aayog, 2019)

The World Government Summit launched a report called Agriculture 4.0–The Future of Farming Technology, in collaboration with Oliver Wyman for the 2018 edition of the international event. The report addresses the four main developments placing the

pressure on agriculture to meeting the demands of the future:

- ♣ Demographics
- ♣ Scarcity of natural resources
- ♣ Climate change and
- ♣ Food waste.

Novel Digital Technologies of Agriculture 4.0

- **Digital Agriculture Mission (2021)**

The Digital Agriculture Mission 2021–2025 was established by the Union Minister of Agriculture and Farmers Welfare. Its goal is to support initiatives based on emerging technologies like artificial intelligence (AI), blockchain, remote sensing, and geographic information systems (GIS) and to advance digital agriculture through experimental projects. Drones and robots are employed in these projects.

- **National e governance Plan for Agriculture (NeGPA)**

To accommodate new and developing digital agriculture technology and release funds to the States/UTs only for projects involving the use of modern information technologies such as Artificial Intelligence & Machine Learning, Block Chain Technology, Internet of Things, Robotics, and so on.

The Department developed the Farmers Portal (www.farmer.gov.in) as part of the NeGPA initiative to share knowledge on a wide range of agricultural topics, including seed variety, storage facilities, pests and plant diseases, best agricultural practices, watersheds, mandi data, and so on.

- **Mobile Applications for Farmers**

To assist farmers in obtaining information on critical topics such as weather, market pricing, plant protection, agro-advisory, extreme weather warnings, and input dealers (of seed, pesticide, fertilizer, and farm machinery), soil health card, cold storage and godowns, soil testing laboratories, veterinary centers and diagnostic labs, crop insurance premium calculator, and the government scheme, there are various apps available such as Kisan Suvidha, Farm Mech' App, Farm Safety App, and Water Balance Simulation Model for Roof Water Harvesting (Mobile App).

- **India Digital Eco-system for Agriculture (IDEA)**

IDEA, or the India Digital Eco-system for Agriculture, is a project being developed by the Digital Agriculture Division of the Ministry of Agriculture & Farmers Welfare. A framework connecting digital land records to publicly available data from various initiatives is being built to provide the architecture for the federated farmers' database. The IDEA would assist in building the nation's Agri-stack architecture, which would act as a basis for the creation of creative Agri-focused solutions utilizing cutting-edge technologies in order to effectively contribute to the improvement of India's agricultural environment. The government will be able to create more efficient plans with the help of this ecosystem, which will raise the income of farmers in particular and the sector's general efficiency.

- **Sub Mission on Agricultural Mechanization (SMAM), 2014.**

By bringing small and marginal farmers into the center of farm mechanization and providing them with the benefits of it, the scheme seeks to "reach the unreached." It does this by promoting "custom hiring centers," establishing hubs for high-tech and valuable agricultural equipment, distributing a variety of agricultural equipment, raising stakeholder awareness through demonstration and capacity building activities, and guaranteeing performance testing and certification at specially designated testing centers spread throughout the nation.

- **National Agriculture Market (e-NAM)** is an electronic trading portal that covers all of India, connecting the current Agricultural Produce Market Committee (APMC) mandis to establish a single, nationwide agricultural commodities market on the web at <https://www.enam.gov.in>. Provide users access to the current commodity price via a mobile app. Include a GPS-based function that records e-NAM mandis and mandi prices within a radius of around 100 km, along with a route map. Through digitalization, e-NAM is enabling citizens to make better decisions about prices for farmers by improving

accessibility, simplicity of use, transparency, and operational efficiency.

- Direct Benefit Transfer allows funds from the **PM KISAN Scheme** to be transferred directly into the bank accounts of eligible farmers. The PM-KISAN Mobile App was introduced to increase the program's reach. It allows farmers to check the history of credits to their bank accounts, update or modify their name based on their Aadhaar card, and monitor the status of their application.
- **Integrated Scheme for Agricultural Marketing schemes (AGMARKNET)** portal is a govt. of India portal on agricultural marketing backed by a wide area information network connecting agricultural markets, State Marketing boards/Directorates and also providing linkages to the websites of the important National and International Organizations.
- Over **1,000 agri-tech start-ups** are based in India, and various venture capital funds, loan funds, and angel investors have long supported the sector.
- To provide farmers with real-time data and the necessary advice, **NITI Aayog has teamed up with International Business Machines (IBM)** to create a crop production forecast model supported by AI. It aids in enhancing crop output, soil quality, agricultural input control, and early disease outbreak warning.
- **Kisan Credit Card (KCC):** In order to make loan facilities easily accessible to farmers, the KCC scheme adopted technology. For farmers, the KCC card serves as a credit line. They can take out money based on what they need. Farmers may obtain loans more quickly, skip laborious paperwork, and improve their financial management by digitizing this process.

- **Cross-industrial Collaborations:** Together, IBM and NITI Aayog have developed an AI-based crop production prediction model that will help with early disease outbreak detection, crop productivity, soil quality, and agricultural input control. Data from ISRO, the current soil health card database, the Indian Meteorological Department's weather prediction, and other sources will be gathered in order to give farmers accurate and timely recommendations.
- In order to empower farmers, the **Jio Agri (Jio Krishi) platform** was launched in February 2020 and digitalized the agricultural ecosystem throughout the whole value chain. The platform gathers information from multiple sources, feeds it into AI algorithms, and then provides targeted, accurate advice.
- **Climate-smart farming techniques** are being progressively adopted by India, helping to reduce greenhouse gas emissions from agricultural activities and change the nation's ecosystem. For example, farmers in the village of Dhundi in Gujarat have started using solar power and other renewable energy sources for irrigation.
- In order to assist India's small-holder farmers, Microsoft and the Indian government have partnered to launch the **"Unified Farmer Services Interface"** pilot initiative. The collaboration wants to raise agricultural productivity using AI sensors and manage prices better to increase farmers' incomes. The partnership would hasten the application of AI in agriculture.
- The **SENSAGRI program**, which stands for Sensor-based Smart Agriculture. In this design, drones would be used to survey over land tracts effectively, gather invaluable information, and provide the data to farmers promptly.

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Development of Beetroot Laddu Enriched with Dry Fruits for Human Health and Diet

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Abstract

There are many health-based nutritional benefits to be gained from Beetroot laddu, which is a highly nutritious sweet dish. In addition, it provides a bright, tempting colour to the laddu, which has anti-oxidant properties. Beetroot is effective in lowering blood pressure and improving blood flow, as well as reducing obesity and overall mortality. 200g of beetroot has 86 calories, while desiccated coconut has 99 calories. The laddu contains jaggery that will help detoxify the liver and enhance immunity.

Beetroot is considered a food that promotes health because it contains essential components like vitamins, minerals, phenolic, carotenoids, nitrate, ascorbic acids, and Betalains that promote health. Betalains come in two varieties: betacyanin (red-violet pigment) and Betaxanthin (yellow-orange pigment). Their non-precarious, non-toxic, non-carcinogenic, and non-poisonous properties make them a popular food dye in the commercial world. The food industry is greatly benefited from beetroot, which can be utilized as a food colouring or additive in products like ice cream, yogurt, and other foods. Beetroot extract is utilized to elevate the redness of tomato pastes, soups, sauces, desserts, jams, jellies, sweets, and breakfast cereals.

By consuming beetroot laddu daily, boost your immune system, beets are high in fibre and promote the growth of good bacteria in your gut, hence it improves the digestive health and reduces the risk of constipation. Stored at a refrigeration temperature, it has a shelf life of 4 to 5 days.

Introduction

The Indian subcontinent's Laddu or laddoo is a sweet that is shaped like a sphere and contains various ingredients like sugar syrup or jaggery the most universal and ancient Indian sweet has been referred to as perhaps this [1]. Beetroot, known as Beta vulgaris L., is a plant that is part of the Chenopodiaceae family and has a bright crimson colour. Due to its medicinal properties and juice value, it is commonly called beet,

chard, sea beet, spinach beet, garden beet, and white beet. It is abundant in vitamins A, B1, B2, B6, and C, as well as minerals such as calcium, magnesium, copper, phosphorus, sodium, and iron. Increased blood flow and high blood pressure. It is beneficial for tumour reduction, decreasing the risk of obesity and overall mortality, heart disease, diabetes, and promoting healthy hair, increasing energy, and reducing overall weight. The beet root is comprised of several parts that possess a variety of medicinal properties, such as anti-oxidants, antimicrobial, antihypertensive, hepatoprotective, anti-inflammatory, anti-hyperglycemia, anti-cancer, and diuretic.[2].



Fig.1 Different Varieties of Laddu

Laddu is a traditional Indian sweet that is made from cereal and is highly scrumptious. Among all age groups and regions in India, it is a favourite and a perfect choice for value addition. [8,9]. The protein quality, dietary fibre, and mineral content of Bengal gram flour laddu can be improved further by adding germinated pumpkin seed flour. Keeping all this in view, the present study was carried out with the objective of value addition in Indian traditional sweet 'laddu' by supplementing with germinated pumpkin seed flour and study the organoleptic acceptability and nutritional composition of developed product [3]

Red beetroot is the basis of many dietary supplements and functional foods in the market. [4]. beetroot usage for food application have been investigated by various researchers and food industries due to prevailing effect of their colour, flavour and nutritional aspect making it a super food

and a miracle vegetable. Deep red coloured beets can be consumed by humans as a food source, either fresh or as a salad ingredient. Antioxidant activity and bio accessibility of phytochemicals are greatly influenced by the processing methods [5]. Beetroot is a significant source of health-promoting agents in a diet that has the potential to be therapeutic for various pathological disorders. Therefore, it is becoming increasingly popular as a nutritional approach to help manage cardiovascular disease and cancer [6]. Hence, beetroot is being incorporated in the laddu and is been enriched with sesame seeds.

Materials and methods

Materials required: Beet root – 200g, Milk – 10ml, Dry fruits, Shredded coconut – 15g, Shredded Jaggery – 100g, ghee – 15-20ml

Methodology

Step 1	Washing, peeling and shredding Fresh beetroots are washed, peeled and shredded finely and Taken in the clean pan.
Step 2	Mixing and heating Heat and pan and add 3 spoons of ghee and mix with shredded beetroot, cool until its raw smell goes.
Step 3	Cooking After sometime beetroot shrinks well due to heat.
Step 4	Roasting of sesame seeds Take another pan and make dry roast of sesame seeds
Step 5	Mixing of shredded coconut Take 1 cup of desiccated coconut with crushed cardamom and mix well with sauteed beetroot.
Step 6	Addition of milk and jaggery Add little milk for texture and for sweetness shredded or powdered jaggery is added.
Step 7	Making of laddu Make it as the small balls as laddu while making laddu add any of the sliced dry fruits and nuts.

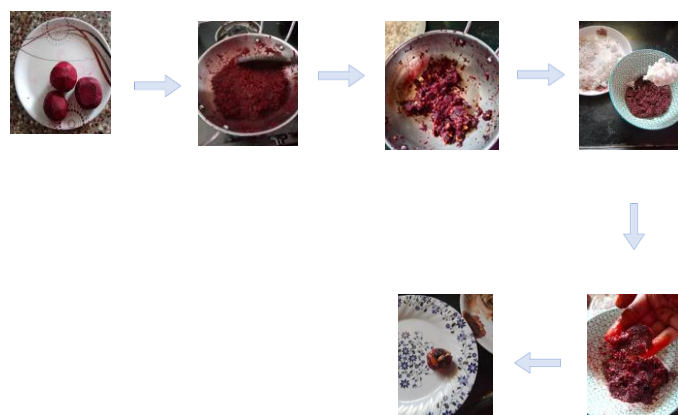


Fig 2. Preparation steps of Beetroot Laddu

Nutritional profile

Nutritive value	
Energy	110 Kcal
Protein	5g
Fat	8g
Carbohydrate	7g
Calcium	25g
Total folate	26.2µg

Benefits of Beetroot Laddu

The root vegetable Beta vulgaris rubra, or red beetroot, has gained much attention as a functional food that promotes health in recent years [7]. Ascorbic acid, carotenoids, phenolic acids, and flavonoids are among the phytochemical compounds found in beetroot. [8,9,10]. Beta-carotene is a group of highly bioactive pigments found in only a few vegetables, including beetroot[11,12]. The Betalains family has two categories: betacyanin pigments that are red-violet in colour or Betaxanthin pigments that are yellow-orange in colour. Each of these pigments is classified by colour [7]

Ghee, a unique fat, adds flavour to food articles and enhances their overall acceptability. Therefore, the flavour is the primary factor in determining its acceptability, and this can be greatly affected by various factors like the fermentation of the cream or butter and the heat treatments employed [13].

Jaggery (Gur) is a product that is made by concentrating the sweet juices from palm trees or sugarcane and making them solid or semi-solid. This natural sweetener can be utilized in numerous sweet dishes and has a sweet, winy fragrance and flavour. Jaggery has a lot of nutrients, including proteins, minerals, and vitamins. Furthermore, it is a powerful source of iron and contains more iron and copper than refined sugar [14].

The milk produced by dairy cows contains water, proteins, fats, lactose, minerals, and other dissolved components (vitamins and white blood cells). Water accounts for approximately 87% of milk, with protein accounting for 3.3%, fats accounting for 3.4%, lactose accounting for 4.9%, and mineral salts accounting for 0.7% [15].

Sesame seeds and their valuable components, such as oil, defatted meal, proteins, and bioactive compounds, and their efficient use deserve consideration. The health benefits of sesame seeds are significant, including lower blood pressure, antioxidant properties, and anticancer properties. In addition, these seeds are commonly utilized to deal with respiratory tract infections, infant cholera, diarrhoea, and other diseases that affect the digestive and bladder system [16].

Magnesium (19.5%), copper (16.0%), phosphorus (13.4%), and fibre (13.2%, insoluble/soluble) are among the nutrients found in almonds that are good sources [12]. Furthermore, almond proteins are digestible and contain an unusually high amount of arginine [17].

Conclusion

Beetroot is grown and consumed in both raw and cooked forms around the world due to their high nutritional and medicinal value. The essential nutrients found in beetroot are valuable and have an adequate amount of beneficial bioactive compounds, which are responsible for promoting health, preventing disease, and treating treatment. The recent years have seen an increase in the antioxidant activity of bioactive compounds and the successful use of beetroot in disease prevention and health promotion. To formulate functional foods, it is important to research and utilize the natural colorants,

antioxidants, and dietary fibre that are present in beetroot. Beetroot pulp's high bioactive compounds can be used as a functional food source to fight many diseases, like diabetes, cancer, cardiovascular disease and various other oxidative stresses induced chronic diseases. The incorporation of Beta vulgaris into food products can provide consumers with health benefits and create value-added products.

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References

1. Sen, C. T., Saberi, H., & Bhattacharyya, S. (2023). The Bloomsbury Handbook of Indian Cuisine. The Bloomsbury Handbook of Indian Cuisine, 1-452.
2. Mudgal, D., Singh, S., & Singh, B. R. (2022). Nutritional composition and value-added products of beetroot: A review. *Journal of Current Research in Food Science*, 3(1), 01-09.
3. Kumari, N., Sindhu, S. C., Rani, V., & Kumari, V. (2021). Development and Evaluation of Indian Traditional Sweet 'Laddoo' Supplemented with Germinated Pumpkin Seed Flour. *Asian Food Science Journal*, 20(2), 48-55.
4. Mudgal, D., Singh, S., & Singh, B. R. (2022). Nutritional composition and value-added products of beetroot: A review. *Journal of Current Research in Food Science*, 3(1), 01-09.
5. Chhikara, N., Kushwaha, K., Sharma, P., Gat, Y., & Panghal, A. (2019). Bioactive compounds of beetroot and utilization in food processing industry: A critical review. *Food chemistry*, 272, 192-200.
6. Clifford, T., Howatson, G., West, D. J., & Stevenson, E. J. (2015). The potential benefits of red beetroot supplementation in health and disease. *Nutrients*, 7(4), 2801-2822.

7. Ninfali, P.; Angelino, D. Nutritional and functional potential of Beta vulgaris cicla and rubra. *Fitoterapia* 2013, 89, 188–199.
8. Georgiev, V.G.; Weber, J.; Kneschke, E.M.; Denev, P.N.; Bley, T.; Pavlov, A.I. Antioxidant activity and phenolic content of betalain extracts from intact plants and hairy root cultures of the red beetroot Beta vulgaris cv. Detroit dark red. *Plant Foods Hum. Nutr.* 2010, 65, 105–111.
9. Kujala, T.S.; Vienola, M.S.; Klika, K.D.; Lopenen, J.M.; Pihlaja, K. Betalain and phenolic compositions of four beetroot (Beta vulgaris) cultivars. *Eur. Food. Res. Technol.* 2002, 214, 505–510.
10. Wootton-Beard, P.C.; Ryan, L. A beetroot juice shot is a significant and convenient source of bioaccessible antioxidants. *J. Funct. Foods* 2011, 3, 329–334.
11. Lee, C.H.; Wettasinghe, M.; Bolling, B.W.; Ji, L.L.; Parkin, K.L. Betalains, phase II enzyme-inducing components from red beetroot (Beta vulgaris L.) extracts. *Nutr. Cancer* 2005, 53, 91–103.
12. Vulić, J.J.; Ćebović, T.N.; Čanadanović-Brunet, J.M.; Ćetković, G.S.; Čanadanović, V.M.; Djilas, S.M.; Tumbas Šaponjac, V.T. In vivo and in vitro antioxidant effects of beetroot pomace extracts. *J. Funct. Foods* 2014, 6, 168–175.
13. Kumar, A., Tripathi, S., Hans, N., Pattnaik, H. S. N., & Naik, S. N. (2018). Ghee: Its properties, importance and health benefits. *Lipid Universe*, 6, 6-14.
14. Hirpara, P., Thakare, N., Kele, V. D., & Patel, D. (2020). Jaggery: A natural sweetener. *Journal of Pharmacognosy and Phytochemistry*, 9(5), 3145-3148.
15. Tyasi, T. L., Gxasheka, M., & Tlabela, C. P. (2015). Assessing the effect of nutrition on milk composition of dairy cows: A review. *Int. J. Curr. Sci*, 17, 56-63
16. Abbas, S., Sharif, M. K., Sibte-Abbas, M., Fikre Teferra, T., Sultan, M. T., & Anwar, M. J. (2022). Nutritional and therapeutic potential of sesame seeds. *Journal of Food Quality*, 2022, 1-9.
17. Kamil, A., & Chen, C. Y. O. (2012). Health benefits of almonds beyond cholesterol reduction. *Journal of agricultural and food chemistry*, 60(27), 6694-6702.

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India is the world's top producer of pulses, paddy, wheat, and wheat, respectively. The National Agricultural Research System (NARS), which includes the Indian Council of Agricultural Research (ICAR) institutes and state agricultural universities, is one of the largest agricultural research systems in the world. Agriculture in India employs over 42 percent of the labour force (2019), contributes 19.9 percent of the Gross Domestic Product (GDP) (2020–21), and provides food security for about 1.3 billion people. Hence, technology and the digitalization of agriculture here play a role as catalysts to improve and increase production.

Prime Minister Narendra Modi launched Digital India on 1 July 2015 to empower rural communities and create digital infrastructure in villages, his initiative enabled digital delivery of services and promoted digital literacy across the country. 68 percent of the country's population lives in villages and agriculture is the main source of livelihood for 58 percent of the population, hence it is very important to pay attention to the role of digital agriculture in India.

Digital agriculture is the use of information technology i.e. IT to provide safe, nutritious and affordable food as well as to make farming socially, economically and environmentally profitable and sustainable. Digital farming is integrating both the concepts – precision farming and smart farming.

Example:

- Agricultural biotechnology is a range of tools, including traditional breeding techniques, that alter living organisms or parts of organisms to make or modify products; Develops microorganisms for improving plants or animals or for specific agricultural uses.
- The discussion aims to increase agricultural productivity through monitoring of soil, plants and environment by harnessing advances in sensing, deep learning and artificial intelligence and the Internet of Things (IoT) to enhance efficiency and environmental sustainability.

- Digital and wireless technologies for data measurement, weather monitoring, robotics/drone technology etc.

Benefits

- Increases agricultural productivity.
- Prevents soil erosion.
- Reduces chemical application in crop production.
- Efficient use of water resources.
- Spreads modern agricultural methods for quality, quantity and low cost of production.
- Brings changes in the socio-economic condition of farmers.

Challenges

High capital cost: This discourages farmers from adopting digital methods of farming.

Smallholdings: Indian farms are very small in size and 1–2-acre farm plots are quite common. Also, leasing of agricultural land is also widely prevalent in India.

Land renting and sharing practices: Due to limited financial resources and small farm plots it is quite common to rent and share land instead of outright purchasing it for equipment and machinery like tractors, harvesters, etc.

Illiteracy in rural areas: Lack of basic computer literacy is a major hindrance in the rapid growth of e-agriculture.

Related government efforts

AgriStack: The Ministry of Agriculture and Farmers Welfare plans to create 'AgriStack', a collection of technology-based interventions in agriculture. It will create an integrated platform to provide end-to-end services to farmers across the agri-food value chain.

Digital Agriculture Mission: This initiative was launched by the government from 2021 to 2025 to promote projects based on new technologies like artificial intelligence, block chain, remote sensing and GIS technology, use of drones and robots in the agriculture sector.

Unified Farmers Service Platform (UFSP): It is a combination of core infrastructure, data, applications and tools that enables seamless interoperability of various public and private IT systems in the agriculture ecosystem across the country. UFSP plays the following roles:

- It acts as a central agency in the agriculture ecosystem (like UPI in e-payments).
- Enables registration of service providers (public and private) and farmer services.
- Enforces various rules and assumptions required during the service delivery process.
- Serves as a repository of all applicable standards, Application Programming Interface (API) and formats.
- To act as a medium for data exchange between various schemes and services to ensure wide delivery of services to farmers.

National e-Governance Plan in Agriculture (NeGP-A): It is a centrally sponsored scheme, this scheme was launched on pilot basis in 7 states in the year 2010-11. It aims to promote rapid growth in India through the use of Information and Communication Technology (ICT) to deliver timely agricultural information to farmers.

In the year 2014-15, the scheme was expanded to all the remaining states and 2 union territories.

Other digital initiatives: Farmer Call Centre, Kisan Suvidha App, Krishi Bazaar App, Soil Health Card (SHC) portal etc.

Way forward

- The use of technology has defined the 21st century. As the world moves towards quantum computing, artificial intelligence, big

data and other new technologies, India has a tremendous opportunity to leverage its IT giant status and revolutionize the agriculture sector. Just as the Green Revolution increased agricultural production, the IT revolution should be the next big step in Indian farming.

- There is a need for satellite imaging, soil health information, land records, cropping patterns and frequency, market data and creation of a strong digital infrastructure in the country.
- Data efficiency can be increased through digital elevation models (DEM), digital topography, land use and land cover, soil maps, etc.

Conclusion

As Indian agriculture and allied sectors embrace new technologies such as IoT and agricultural drones, foreign companies can play an important role in supplying these new technologies to farmers. It is estimated that close to 267 million farmers in India need to be catered to, despite the many Indian companies active in the sector. This enables private and foreign entities to expand their footprint in this part of the globe. However, their technologies also need to be affordable. To cater for them, the government, industry, and Research institutions have to form a consortium so that AgriTech start-ups can flourish and meet the demands of Indian farmer. To reach goals like doubling farmer incomes and sustainable growth, the Indian government is undertaking these initiatives and programmes. The widespread adoption of digital agriculture in India would therefore require a multi-stakeholder strategy in which the government plays a significant enabler's role in the ecosystem.

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Recycling of Wastewater for Agricultural Use in Arid Areas: A Sustainable Approach to Water Management

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Water scarcity poses a significant challenge in arid areas, where limited rainfall and high evaporation rates create unfavourable conditions for agriculture. In these regions, innovative solutions are essential to ensure sustainable water use, and one such solution is the recycling of wastewater for agricultural purposes. This article explores the importance of recycling wastewater, the technology involved, its benefits, and challenges, particularly in arid regions.

Water Scarcity in Arid Areas

Arid and semi-arid regions face acute water scarcity, jeopardizing agricultural productivity and the livelihoods of communities dependent on farming. Traditional water sources, such as rivers and groundwater, often fail to meet the demands of agriculture due to over-extraction and climate variability. As a result, exploring alternative water sources becomes imperative, and recycling wastewater emerges as a viable and sustainable solution.

Recycling Wastewater: A Sustainable Approach

Treatment Processes

Wastewater from domestic, industrial, or agricultural activities can be treated to remove impurities and contaminants. Common treatment processes include physical, chemical, and biological methods to ensure that the recycled water meets acceptable quality standards for agricultural use.

Advanced treatment technologies, such as membrane filtration, reverse osmosis, and ultraviolet (UV) disinfection, play a crucial role in producing high-quality recycled water suitable for irrigation.

Types of Waste water for Recycling

Greywater: Wastewater from household activities like bathing, laundry, and dishwashing can be treated and reused for non-potable purposes, including irrigation.

Treated Industrial Effluent: Industrial wastewater, when properly treated, can be a valuable source of water for agriculture.

Municipal Wastewater: Treated sewage effluent, meeting regulatory standards, is increasingly being used for crop irrigation.

On-site Treatment Systems

On-site treatment systems, such as constructed wetlands and decentralized treatment plants, provide localized solutions for recycling wastewater at the source. These systems are particularly relevant in rural and remote areas.

Benefits of Recycling Wastewater for Agriculture

Water Conservation

Recycling wastewater conserves water resources by providing an alternative and sustainable source for irrigation. This helps mitigate the impact of water scarcity on agricultural activities in arid regions.

Nutrient-Rich Resource

Wastewater often contains essential nutrients, such as nitrogen and phosphorus, which can serve as fertilizers for crops. Recycling this nutrient-rich water contributes to soil fertility and reduces the need for synthetic fertilizers.

Reduced Environmental Impact

Properly treated wastewater reduces the environmental impact associated with the discharge of untreated effluent into water bodies. By recycling water, the risk of pollution and harm to aquatic ecosystems is minimized.

Improved Crop Yields

Adequate water supply, facilitated by the recycling of wastewater, can lead to improved crop yields, providing economic benefits to farmers and contributing to food security in arid regions.

Technological Innovations

Drip Irrigation Systems

Efficient irrigation systems, such as drip irrigation, play a pivotal role in optimizing water use. Drip systems deliver water directly to the plant root zone, minimizing water wastage and enhancing the efficiency of recycled wastewater application.

Smart Water Management

Integration of technology, including sensors and real-time monitoring systems, enables precise control over water distribution. This smart water management approach ensures that crops receive the required amount of water, preventing over-irrigation and optimizing resource utilization.

Decentralized Treatment Units

Decentralized wastewater treatment units, integrated with energy-efficient technologies, allow for on-site treatment and recycling. These units can cater to the water needs of specific agricultural plots, reducing the demand on centralized water treatment facilities.

Challenges and Considerations

Quality Concerns

Ensuring the treated wastewater meets stringent quality standards for agricultural use is a key challenge. Regular monitoring and adherence to regulatory guidelines are essential to address concerns related to contaminants and pathogens.

Public Perception

Overcoming societal apprehensions and ensuring public acceptance of recycled wastewater in agriculture is crucial. Awareness campaigns and education on the effectiveness of treatment technologies can help build trust among stakeholders.

Infrastructure Investment

Establishing the necessary infrastructure for wastewater treatment and distribution requires substantial investment. Governments, NGOs, and private entities must collaborate to fund and implement these projects.

Case Studies

Israel: Israel, a country facing water scarcity, has successfully implemented wastewater recycling for agricultural use. Advanced treatment technologies and strict quality standards have allowed Israel to reuse a significant portion of its treated wastewater for crop irrigation.

California, USA: In response to prolonged droughts, California has embraced recycled wastewater as a

strategic water source for agriculture. The Orange County Water District's Groundwater Replenishment System, for example, purifies wastewater to near-distilled water quality, providing a reliable source for irrigation.

Future Prospects and Policy Implications

Policy Support

Governments need to develop supportive policies that encourage and regulate the recycling of wastewater for agriculture. Clear guidelines on water quality standards, incentives for adopting recycling technologies, and penalties for non-compliance can drive sustainable practices.

Research and Development

Continued research and development in wastewater treatment technologies are essential for improving efficiency, reducing costs, and addressing emerging contaminants. Innovation in decentralized treatment systems can make recycling more accessible to smaller agricultural communities.

International Collaboration

Knowledge sharing and collaboration between countries facing water scarcity can accelerate the adoption of wastewater recycling practices. International partnerships can facilitate the transfer of technology, expertise, and best practices.

Conclusion

Recycling wastewater for agricultural use represents a sustainable solution to address water scarcity in arid areas. Through advanced treatment processes, technological innovations, and supportive policies, recycled wastewater can become a valuable resource for irrigation. As the global demand for water-intensive crops increases, the adoption of wastewater recycling in agriculture becomes not just an option but a necessity for ensuring food security, economic stability, and environmental sustainability in arid regions. By overcoming challenges through technological advancements and international collaboration, we can harness the potential of wastewater recycling to transform water management practices and contribute to a more water-secure future.

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Benevolent Microbial Warriors: Exploring the Role of Entomopathogenic Bacteria in Pest Control

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Various biological control methods, including specific insecticides, have been explored, with a focus on entomopathogenic microbes like bacteria, viruses, protozoa, fungi, microsporidia, and nematodes (Vega and Kaya, 2012). Notably, entomopathogenic bacteria, both spore-forming (e.g., *Bacillus*, *Paenibacillus*, *Clostridium*) and non-spore-forming (e.g., *Pseudomonas*, *Serratia*, *Yersinia*, *Photobacterium*, *Xenorhabdus*), are successful and commercially valuable, initiating infection upon ingestion by susceptible insects. Integrated pest management (IPM) utilizes inundative methods to release these bacteria and fungi effectively. *Bacillus thuringiensis*, crucial for lepidopteran control, faces limitations due to UV light inactivation, necessitating repetitive releases and increased costs. Meanwhile, bacteria like *Pseudomonas* spp. exhibit favourable properties for mass production and environmental stability.

Type of Entomopathogenic Bacteria

Bacterial pathogens used for insect control are spore forming, rod-shaped bacteria in the genus *Bacillus*. Pathogenic bacteria of insects which have potential for use in biological pesticides are limited to three species of spore forms, i.e., *Bacillus thuringiensis*, *B. sphaericus* and *B. popilliae*.

Spore forming (Obligate)

Bacillus popilliae attack only beetles of family Scarabaeidae. It causes milky disease in Japanese beetle, *Popillia japonica*. It produces endospores which upon ingestion by the susceptible host, germinate in the gut and the vegetative cells invade into the haemocoel where they multiply and sporulate. At this point the blood becomes milky white, hence the term "milky disease". After the death, host disintegrates and spores are released into the soil.

Spore forming (Facultative)

In addition to endospores, produces a proteinaceous parasporal Crystal in the Sporangium at the time of sporulation. The crystals contain an endotoxin capable of paralyzing the gut of most lepidopteran larvae. The toxin is known as delta-

endotoxin. It is the most widely exploited microbial control agent. Lepidopteran larvae with a gut pH ranging from 9.0 to 10.5 are most susceptible.

Spore forming (Facultative)- Non-crystalliferous

Bacillus cereus a common spore former and soil inhabitant, effective against Coleoptera, Hymenoptera and Lepidoptera.

Mode of Action I

Bacterial life cycle involves vegetative cell division under optimal growth conditions and sporulation in response to environmental changes. Sporulation produces endotoxin, and when conditions improve, spores germinate, initiating another round of vegetative cell division. For bacterial insecticides to be effective against target insects, ingestion is crucial as they don't act as contact poisons.

The crystal contains a protoxin protein (130 kDa), which, when solubilized in the larval midgut's alkaline pH, is enzymatically cleaved to form an active toxin (60-70 kDa). This toxin diffuses through the peritrophic membrane, binds to midgut receptors, paralyzing the gut and halting feeding. The toxin disrupts the membrane, creating pores that lead to potassium imbalance, microvilli swelling, cell lysis, and potential septicemia, allowing bacterial invasion into the haemolymph.

Mode of Action II

Upon ingestion, Bt toxins are activated in alkaline insect gut conditions, forming pores in midgut cells. This disrupts osmoregulation, causing midgut paralysis and cell lysis. The leakage of gut contents into the hemocoel and hemolymph leads to pH imbalance, septicemia, and eventual insect death. Responses vary based on crystal proteins, receptor sites, exotoxin production, and spore requirements, influencing caterpillar susceptibility to Bt toxins.

Mode of action of Bt, an Entomopathogenic bacteria, adopted from Glare et al., 2017 Basic and applied research: entomopathogenic bacteria. In Microbial control of insect and mite pests.

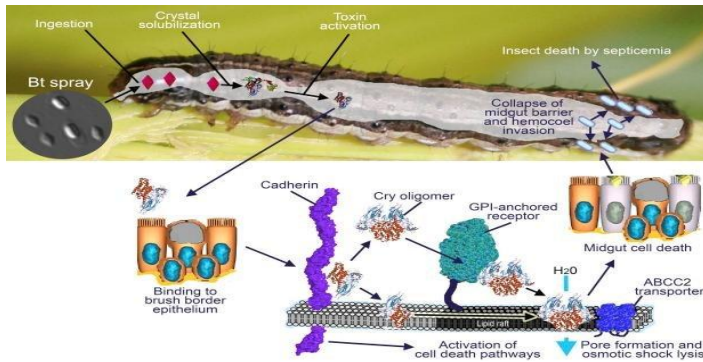


Fig. 1: Mode of action of Bt, an Entomopathogenic bacteria, (Glare *et al.*, 2017)

Table 1. Entomopathogenic bacteria and target insects

Entomopathogenic bacteria	Target Insect(s)
<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>	Caterpillars (larvae of moths and butterflies)
<i>Bacillus thuringiensis</i> subspecies <i>israelensis</i>	Larvae of <i>Aedes</i> and <i>Psorophora</i> mosquitoes, black flies, and fungus gnats
<i>Bacillus thuringiensis</i> subspecies <i>tenebrinos</i>	larvae of Colorado potato beetle, elm leaf beetle adults
<i>Bacillus thuringiensis</i> subspecies <i>aizawai</i>	wax moth caterpillars
<i>Bacillus popilliae</i> and <i>Bacillus lentimorbus</i>	larvae (grubs) of Japanese beetle
<i>Bacillus sphaericus</i>	larvae of <i>Culex</i> , <i>Psorophora</i> , and <i>Culiseta</i> mosquitos, larvae of some <i>Aedes</i> spp
<i>Bacillus thuringiensis</i> subspecies <i>japonensis</i>	Coleoptera: Scarabaeidae
<i>Paenibacillus popilliae</i>	Coleoptera: Scarabaeidae, <i>Popillia japonica</i>

(Source: Usta, 2013)

Bacillaceae

Bacillus thuringiensis

Bacillus thuringiensis (Bt), discovered in 1901, is a well-studied entomopathogenic bacterium known for crystal-producing strains crucial in microbial pest control. Its parasporal bodies contain Cry and Cyt toxins, with Cry proteins causing insect midgut disruption and death. Integration of cry genes into genetically modified plants enhances crop resistance to specific pests (Jurat-Fuentes and Jackson, 2012).

Lysinibacillus sphaericus

Lysinibacillus sphaericus, exhibits a distinctive phenotype characterized by the production of spherical spores within swollen sporangia. Entomopathogenic strains within this species group produce equimolar ratio binary protein toxins (BinA and BinB) in parasporal crystals, targeting midgut cells in host larvae. Mosquitocidal activity depends on Bin and/or Mtx toxins, akin to *B. thuringiensis*, causing damage to midgut microvillar epithelial cells. While non-mosquitocidal insecticidal toxins exist, *L. sphaericus* is mainly employed in commercial pesticides targeting mosquitoes, blackflies, and non-biting midges. Activity varies based on toxin specificity and mosquito species sensitivity, with *Culex* mosquitoes being the most susceptible, followed by *Anopheles*, *Mansonia*, and some *Aedes* species (Nishiwaki *et al.*, 2007).

Paenibacillus spp.

The genus *Paenibacillus* comprises various species, including the pathogenic *Paenibacillus* larvae subsp. larvae responsible for American Foulbrood (AFB) in honeybees. However, due to their limited potential as microbial pesticides, the discussion excludes these causative agents of bee diseases. Instead, focus is on spore-forming species like *P. popilliae* and *P. lentimorbus*, which cause milky disease in coleopteran larvae. *P. popilliae*, used successfully in the first documented bacterial entomopathogen control program, produces parasporal inclusions, showing homology with Bt Cry toxins. Upon ingestion, spores germinate in the host's midgut, leading to insect control (Genersch, 2010).

Brevibacillus laterosporus

Brevibacillus laterosporus is a versatile pathogen with broad-spectrum antimicrobial properties, targeting various invertebrates including insects (Coleoptera, Lepidoptera, Diptera), mollusks, nematodes, and phytopathogenic bacteria and fungi. Its genome, recently published, indicates the potential to produce diverse toxins, with certain strains exhibiting insecticidal secreted proteins (ISPs) like Bt's Vip proteins, effective against corn rootworms and other coleopteran larvae. Additionally, strains toxic to mosquitoes produces parasporal inclusion bodies akin to *B. thuringiensis*, with reported mosquitocidal action.

Notably, a crystal-lacking strain demonstrates high toxicity to house flies, causing histopathological changes in the midgut. (Ruju *et al.*, 2012).

***Photorhabdus* spp. and *Xenorhabdus* spp.**

Photorhabdus and *Xenorhabdus*, endosymbionts of entomopathogenic nematodes, primarily associated with *Heterorhabditis* and *Steinernema* species, respectively, employ a pathogenic strategy upon entering insect hosts. After nematode entry, symbiotic bacteria are released into the insect hemocoel, where they proliferate and produce antimicrobial compounds, creating a favourable environment for nematode development. Bacterial virulence factors, including insecticidal toxins complex (Tc) and *Photorhabdus* insect related (Pir) proteins, mimic *B. thuringiensis* delta-endotoxins, affecting insect development regulation. Additionally, these endosymbionts employ diverse mechanisms, such as lipopolysaccharide modifications and interference with host antimicrobial peptide expression, to counteract the insect immune response (Waterfield *et al.*, 2005; Ji *et al.*, 2004)

Enterobacteriaceae

***Serratia* spp**

Serratia spp. exhibit associations with insects and entomopathogenic nematodes, with *S. entomophila* identified during population collapses in field larvae. Various species in this genus produce toxin complexes resembling those of *Xenorhabdus* spp. and *Photorhabdus* spp. *S. entomophila*, targeting the grass grub *Costelytra zealandica*, produces Sep toxins (SepA, SepB, SepC) akin to *P. luminescens*. The sep gene cluster, found in *S. proteamaculans*, *S. liquefaciens*, and *Yersinia frederiksenii* plasmids, suggests horizontal mobility (Hurst *et al.*, 2011). While *S. marcescens* has limited research in human infections, a new strain demonstrates activity against the diamondback moth, and *S. nematodiphila*, associated with *Heterorhabditinoides* sp., hints at further microbial control agents. *S. marcescens* Bizio's pathogenicity is enhanced by a secreted serralyisin metalloprotease, suppressing insect host cellular immunity through decreased adhesive properties of immunosurveillance cells (Castagnola *et al.*, 2014).

Yersinia entomophaga

Yersinia entomophaga, a non-spore-forming bacterium within the Enterobacteriaceae family, exhibits substantial diversification in its evolutionary history. Derived from the New Zealand grass grub, *C. zealandica*, this entomopathogenic bacterium produces an insecticidal toxin complex (Yen-Tc), akin to those found in *Photorhabdus* spp. (Hurst *et al.*, 2011). With potential as a microbial control agent, *Y. entomophaga* demonstrates activity against various pests including *C. zealandica*, diamondback moth (*Plutella xylostella*), small white butterfly (*Pieris rapae*), locust (*Locusta migratoria*), and cotton bollworm (*Helicoverpa armigera*). The toxin complex comprises three Yen protein families (A, B, and C) and two chitinases (Chi1 and Chi2). Upon ingestion by *C. zealandica* larvae, *Y. entomophaga* prompts a swift halt in feeding, subsequent regurgitation of gut contents, and degradation of gut epithelial membranes, leading to hemocoel invasion, septicemia, and death within 2–5 days (Marshall *et al.*, 2012).

Pseudomonadaceae

Pseudomonas entomophila

Pseudomonas entomophila, a widespread entomopathogenic bacterium, induces extensive gut cell damage in insect larvae across multiple orders. Host-pathogen interactions were elucidated through experiments with *Drosophila melanogaster*, revealing a distinctive post-ingestion immune response (Vodovar *et al.*, 2006). Genome sequencing of *P. entomophila* uncovered a unique secretion system and toxins, likely underpinning its entomopathogenic properties (Dieppois *et al.*, 2015).

Clostridiaceae

Clostridium bifermentans

Clostridium bifermentans, a gram-positive, anaerobic, spore-forming bacillus, isolated in Malaysia exhibits high toxicity against mosquitoes and black flies, particularly through the production of three major proteins during sporulation. Notably, the strain, identified as *C. bifermentans* subsp. *malaysia*, demonstrates insecticidal activity with the mosquitocidal protein Cbm71, akin to *B. thuringiensis* delta endotoxins, and utilizes a four-toxin operon (Cry16A, Cry17A, Cbm17.1, and Cbm17.2) for specific toxicity against *Aedes* spp. and heightened

susceptibility in *Anopheles* mosquitoes (Edagiz *et al.*, 2015; Qureshi *et al.*, 2014).

References

- Boets, A., Arnaut, G., Van Rie, J., & Damme, N. (2011). Toxins. Patent No. US 7919609B2.
- Castagnola, A., & Stock, S. P. (2014). Common virulence factors and tissue targets of entomopathogenic bacteria for biological control of lepidopteran pests. *Insects*, 5(1), 139-166.
- Dieppo, G., Opota, O., Lalucat, J., & Lemaitre, B. (2015). *Pseudomonas entomophila*: a versatile bacterium with entomopathogenic properties. In *Pseudomonas: volume 7: new aspects of Pseudomonas biology* 25-49.
- Edagiz, S., Lagace-Wiens, P., Embil, J., Karlowsky, J., & Walkty, A. (2015). Empyema caused by *Clostridium bifermentans*: a case report. *Canadian Journal of Infectious Diseases and Medical Microbiology*, 26, 105-107.
- Genersch, E. (2010). American Foulbrood in honeybees and its causative agent, *Paenibacillus larvae*. *Journal of invertebrate pathology*, 103, 10-19.
- Hurst, M. R., Becher, S. A., Young, S. D., Nelson, T. L., & Glare, T. R. (2011). *Yersinia entomophaga* sp. nov., isolated from the New Zealand grass grub *Costelytra zealandica*. *International journal of systematic and evolutionary microbiology*, 61(4), 844-849.
- Ji, D., & Kim, Y. (2004). An entomopathogenic bacterium, *Xenorhabdus nematophila*, inhibits the expression of an antibacterial peptide, cecropin, of the beet armyworm, *Spodoptera exigua*. *Journal of insect physiology*, 50(6), 489-496.
- Jurat-Fuentes, J. L., & Jackson, T. A. (2012). Bacterial entomopathogens. *Insect pathology*, 265-349.
- Marshall, S. D., Hares, M. C., Jones, S. A., Harper, L. A., Vernon, J. R., Harland, D. P., ... & Hurst, M. R. (2012). Histopathological effects of the Yersinia entomophaga toxin complex from *Yersinia entomophaga* MH96 (Enterobacteriaceae) on the *Costelytra zealandica* (Coleoptera: Scarabaeidae) larval midgut. *Applied and environmental microbiology*, 78(14), 4835-4847.
- Nishiwaki, H., Nakashima, K., Ishida, C., Kawamura, T., & Matsuda, K. (2007). Cloning, functional characterization, and mode of action of a novel insecticidal pore-forming toxin, sphaericolysin, produced by *Bacillus sphaericus*. *Applied and environmental microbiology*, 73(10), 3404-3411.
- Qureshi, N., Chawla, S., Likitvivatanavong, S., Lee, H. L., & Gill, S. S. (2014). The Cry toxin operon of *Clostridium bifermentans* subsp. *malaysia* is highly toxic to *Aedes* larval mosquitoes. *Applied and environmental microbiology*, 80(18), 5689-5697.
- Ruiu L, Satta A, Floris I. 2012. Observations on house fly larvae midgut ultrastructure after *Brevibacillus laterosporus* ingestion. *J Invertebr Pathol* 111:211-216
- Vega, F. E., & Kaya, H. K. (2012). Insect pathology. Academic press, p. 504.
- Vodovar, N., Vallenet, D., Cruveiller, S., Rouy, Z., Barbe, V., Acosta, C., and Boccard, F. (2006). Complete genome sequence of the entomopathogenic and metabolically versatile soil bacterium *Biological pest control*-a review (bacterial toxin application and effect of environmental factors). *Current Progress in Biological Research*. 2013;287-317.
- Waterfield, N., George Kamita, S., Hammock, B. D., & Ffrench-Constant, R. (2005). The *Photobacterium* Pir toxins are like a developmentally regulated insect protein but show no juvenile hormone esterase activity. *FEMS microbiology letters*, 245(1), 47-52.
- Glare TR., Jurat-Fuentes J, O'Callaghan M. (2017). Basic and applied research: Entomopathogenic bacteria. In *Microbial control of insect and mite pests*. Academic Press Academic. 2017:47-67

From Field to Fork: Understanding the Journey of Wheat

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Wheat, scientifically known as *Triticum aestivum* ($2n = 42$), is one of the most important cereal grains worldwide and a staple food for a significant portion of the global population. It belongs to the grass family Poaceae and is cultivated in diverse climates across the world. This versatile grain comes in various forms, the most common being bread wheat *Triticum aestivum*, macaroni wheat *Triticum durum*, and emmer wheat *Triticum dicoccum*. It serves as a fundamental ingredient in a wide array of food products, including bread, pasta, couscous, cakes, pastries, and various other baked goods.

The journey of wheat from field to fork is as follows:

Soil tillage and land preparation

Wheat which is usually grown after paddy, maize, sorghum, pearl millet and other kharif pulses requires a well pulverised soil for good germination. The soil is ploughed with mould board plough after kharif crop harvest to bring to a fine tilth as the seed is small. The field is deeply ploughed followed by 2-3 times harrowing or 4-5 inter-cross ploughing with country plough. Planking is done after ploughing to retain the moisture. The number of ploughings depends upon the nature and type of weeds in the field. More number of ploughings is required if there are perennial weeds.

Manures and fertilizer application

Organic manure application in the soil helps in building a good soil structure besides increasing the water holding capacity of the soil. As organic manures do not provide the required amount of nutrients, additional application of fertilizers is required. The recommended dose of fertilizer is about 80-100 kg N, 50-70 kg P₂O₅ and 30-40 kg K₂O/ha depending on the type of wheat. Nitrogen is applied in splits i.e. 2/3rd or half of it is applied at the sowing time and the remaining 1/3rd or half is top dressed at the first irrigation. Phosphorus and potash are applied at the time of sowing in full dose, as the nutrients are less mobile and takes more time to dissociate and delayed availability to the crop.

Seed rate

Seed rate depends on the variety, soil moisture status, sowing method, tillering ability, time of sowing etc. The seed rate for different situations are given below:

- (a) Line sowing behind plough: 90-100 kg/ha
- (b) Sowing by Kera/pora method: 80-100kg/ha
- (c) Sowing by seed dibbling: 25-30 kg/ha
- (d) Late sowing by seed drill: 125-155 kg/ha

Seed treatment

Wheat seed should be treated with fungicides like Agrosan GN, Thiram or Vitavax @ 2.5g/kg seed before sowing to protect the seed from the associated diseases.

Sowing method

Bi-directional sowing (second direction sowing cutting across the first sowing direction at right angles) gives yield advantage. Wheat is sown by different methods as below:

(a) Broadcasting: Scattered throwing of the seed followed by harrowing to cover up the seed with soil. This method has several drawbacks like irregular seed establishment and should be avoided.

(b) Behind plough: Seeds are dropped by hand at a depth of 5-6 cm into the furrow created by the country plough by hand (kera method) or by a special attachment to the plough (pora method). Most of the Indian farmers use this method which gives satisfactory germination.

(c) Seed drill: Seeds are sown with seed drills or seed cum fertilizer drill which gives uniform germination and plant stand.

(d) Dibbling: Seeds are dropped into the hole/hill created by a wooden or iron frame with pegs called 'Dibbler'. One or two seeds are dropped by hand into the hole which is time and labour consuming method.

Cropping system

Cropping system is a critical aspect in developing an effective ecological farming system to

manage and organize crops so that they best utilize the available resources (soil, air, sunlight, water, labour, equipments). Wheat is grown mainly in cropping sequences with Rice, Jowar, Bajra, Maize, Pulse, Cotton, Soybean etc. in different parts of the country under irrigated condition. Under rainfed condition, fallow-wheat is most common, but sometimes short duration pulse crops may precede wheat in assured rainfall areas.

Water management/Irrigation

The various functions of water in plants includes maintaining cell turgidity for structure and growth; transporting nutrients and organic compounds throughout the plant; comprising much of the living protoplasm in the cells; serving as a raw material for various chemical processes, including photosynthesis; and, through transpiration, buffering the plant against wide temperature fluctuations. Irrigation is given to wheat at the most critical stages of the wheat crop. The critical stages of wheat are Crown root initiation/CRI (25-30 DAS), tillering (45 DAS), jointing (65 DAS), booting (75 DAS), flowering (85 DAS), milk stage (90-110 DAS). If farmers afford to give 1 irrigation, it should be at CRI stage, if 2, it should be at CRI and Booting stage, if 3, it should be at CRI tillering and booting stages, if 4, it should be at CRI, tillering, booting and milk stages and if 5, it should be at CRI, tillering, jointing, flowering and milk stages.

Weed Management

Wheat fields are commonly infested with both grasses and broad-leaved weeds. To realize the full yield potential of the wheat crop, proper weed control is essential. Being an irrigated crop, weeds equally have the potential to emerge from the field. The common weeds are grassy weeds (*Phalaris minor*, *Cynodon dactylon*, *Avena fatua*, *Lolium temulentum*), broadleaved weeds (*Chenopodium album*, *Fumaria parviflora*, *Melilotus alba*, *Vicia sativa*, *Lathyrus aphaca*) and perennial weeds (*Cyperus rotundus*, *Cirsium arvense*, *Convolvulus arvensis*). *Phalaris minor* is the most dreaded weed in most of the wheat growing belts of the country morphologically similar to wheat. Among various methods of weed controls, chemical control can be effective. Pre emergence application of

Pendimethalin (Stomp 35% EC) @ 0.75-1 kg a.i./ha just after sowing followed by hand weeding at 25-30 DAS controlled broadleaved weeds while grassy and perennial weeds are effectively suppressed/controlled by post emergence application of 2,4 D (Ester), Bladex C@, 34% EC) @ 1.4 litre/ha in 800-1000 litre water or Isoproturon/Isoguard @ 0.75 kg a.i./ha in 800-1000 litre water at 30-35 DAS followed by one hand weed weeding would be a suitable integrated weed management system in wheat. Stale seed bed, crop rotation, crop geometry, timely sowing, rouging etc are crop husbandry required for avoiding weeds as a cultural weed control method.

Insect-pest and diseases management

The common insect-pest in wheat are termites, aphids, jassids, rodents etc. Rodents are controlled by mechanical traps or rodenticides like rataphin/warfarin (as a bait). Wheat suffers from several diseases including rust, alternaria leaf blight, powdery mildew, loose smut and karnal bunt. For diseases, precautionary measures are more important than control measures. The following measures are to be taken up before sowing:

- (i) Grow resistant varieties as far as possible.
- (ii) Treat the seed before sowing with any fungicide (Cerasan, vitavex, Agrosan.
- (iii) If the diseases still appears, spray 0.2% Zineb, Dithane M 45 or Bordeaux mixture.
- (iv) Keep the field clean (field sanitation) as many of the diseases are soil borne and superficial diseases.
- (v) Timely sowing of the crop is mandatory to escape from insect-pest diseases.

Harvesting

When the wheat is fully grown it turns from green to gold – the bright, iconic color wheat is best known for. The plants have dried out and become brittle. This means it is time to harvest the wheat. The crop is harvested before it is dead ripe to avoid yield loss. If it is not harvested in time, grain may be lost/damaged by field rats, birds, insects and through shattering and lodging. The right time to harvest the crop is when the moisture content in grain is 20-25%. Harvesting is usually done by serrated sickle by hand.

Bullock driven reapers, machine driven reapers, combined harvester (cutting, threshing, winnowing at the same time) are also employed.

Threshing

Wheat is threshed after drying the harvested crop for 3-4 days on the threshing floor. Threshing is done by trampling with bullock feet or by power driven thresher. This is used to save time and labour which also has a better output. After threshing, the grains are cleaned winnowed and properly dried for storage in a gunny bag or other suitable materials.

Yield of Wheat

There are research findings that, a high yielding variety of wheat under proper and improved package of practice would give a grain yield of 45-55 q/ha under irrigated and 20- 25 q/ha under rainfed conditions.

Storage

Harvested grains should be stored in a well-constructed storage bin with well aerated structure to avoid damply situation. Insect-pest and diseases are encouraged under such conditions. Storage structures with aluminium/tin roofs are preferable as the heat accumulated help in further drying of the stored grains.

Milling

Once wheat arrives at a flour mill, it is cleaned to remove impurities such as sticks, stones and other coarse and fine materials. Then it is sent to conditioning bins, where it is soaked in water for easy

removal of the bran. The bran is the protective outer shell of the wheat kernel. Conditioning ensures moisture content is uniform throughout the grain because moisture helps to prevent the bran from breaking during milling. Next, different wheat is blended – known to millers as wheat grist. At this stage different wheat batches are mixed to create the specific kind and quality of flour to meet the miller's needs. The wheat is ground by a flour mill machine that crushes it into pieces. It is then put through sifters that separate the endosperm, wheat germ and wheat bran. These can be sold separately or used to produce different flours. For example – wheat bran, wheat germ and white flour blended together creates whole wheat flour.

Consumption

Finally, consumers prepare and consume wheat-based foods as part of their daily meals, snacks, and culinary creations. Wheat products contribute to a diverse array of cuisines worldwide, serving as staples in many cultures.

Conclusion

Throughout this journey, quality control measures, food safety regulations, and industry standards are implemented to ensure that the wheat and wheat-based products meet the required quality, nutritional, and safety standards for consumers. Additionally, technological advancements and sustainable practices are increasingly being adopted across the wheat supply chain to improve efficiency, minimize waste, and reduce environmental impacts.

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Unveiling Plant defence Strategies: Exploring Induced Systemic Resistance in the Battle Against Pathogens

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Plants are continuously exposed to pathogen attack, but successful infection is rare because plants protect themselves against pathogens using a wide range of response mechanisms. Although all plants have physical and chemical barriers which provide first line of resistance in the form of protection, but when the protection fails and pathogen get succeed in getting entry into the plant a dynamic or active defence mechanism is pressed.

There are two main mechanism which induce resistance in the plant SAR (Systemic Acquired Resistance) and ISR (Induced Systemic Resistance). Brief about the Induced Systemic Resistance are discussed below.

The term induced resistance is a generic term for the induced state of resistance in plants triggered by biological inducers, which protects nonexposed plant parts against future attack by pathogenic microbes and herbivorous insects.

The term induced systemic resistance was given by Van loon in 1997 and suggested as a novel type of induced resistance. Induced systemic resistance is an activated resistance process which is activated by biological or biotic factors. Induced systemic resistance is mediated by jasmonic acid and ethylene signalling pathway which is triggered by non-pathogenic micro example pgpr, *Trichoderma*, *Bacillus*, *Pseudomonas* etc.

The induced state of resistance is characterized by the activation of latent defence mechanisms that are expressed upon a subsequent challenge from a pathogen or insect herbivore. Induced resistance is expressed not only locally at the site of induction but also systemically in plant parts that are spatially separated from the inducer, hence the term ISR. Generally, induced resistance confers an enhanced level of protection against a broad spectrum of attackers, induced resistance is regulated by a network of interconnected signalling pathways in which plant hormones play a major regulatory role. The signalling

pathways that regulate induced resistance elicited by beneficial microbes.

Beneficial microbes in the microbiome of plant roots improve plant health. Induced systemic resistance (ISR) emerged as an important mechanism by which selected plant growth-promoting bacteria and fungi in the rhizosphere prime the whole plant body for enhanced defence against a broad range of pathogens and insect herbivores. A wide variety of root-associated mutualists, including *Pseudomonas*, *Bacillus*, *Trichoderma*, and mycorrhiza species sensitize the plant immune system for enhanced defence without directly activating costly defences.

Besides microbial pathogens and insect herbivores, plants also nurture a vast community of commensal and mutualistic microbes that provide the plant with essential services, such as enhanced mineral uptake, nitrogen fixation, growth promotion, and protection from pathogens these plant microbiota are predominantly hosted by the root system, which deposits up to 40% of the plant's photosynthetically fixed carbon into the rhizosphere, rendering this small zone around the roots one of the most energy-rich habitats on earth several genera of the rhizosphere microbiota, which are referred to as plant growth-promoting *rhizobacteria* (PGPR) and fungi (PGPF), can enhance plant growth and improve health.

Wei *et al.*, (1991) demonstrated that colonization of roots by different beneficial *Pseudomonas* and *Serratia* PGPR strains resulted in a significant reduction in disease symptoms after challenge inoculation of leaves with the anthracnose pathogen *Colletotrichum orbiculare*. In both seminal studies, PGPR and pathogen were demonstrated to have remained spatially separated during the experiments, which allowed the authors to conclude that the enhanced level of disease resistance was caused by a plant-mediated immune response called *rhizobacteria-induced systemic resistance* (ISR).

Role of induced systemic resistance

- ✓ Plants treated with PGPR or biological agent supposed to be more rapidly to the pathogen attack due to activation of new system resistance in plant.
- ✓ Reduce the negative effect of the pathogen and promotes positive response in plant.
- ✓ Improve photosynthetic efficacy.
- ✓ Increase nutrient absorption and nitrogen use efficiency.
- ✓ Enhance growth and yield by eliminating harmful microorganisms.

Root Colonization and stimulation of ISR

Initiation of ISR requires beneficial microbes to efficiently colonize the root system of host plants. For the establishment of a successful mutualistic association, host plants and microbes need to respond to reciprocal signals and accordingly prioritize their responses to develop a lifestyle that provides mutual benefits. In the well-studied mycorrhizal and rhizobial symbioses, host-secreted strigolactones and flavonoids stimulate the production of symbiotic Sym and Nod factors by the microbes, which in turn activate a common symbiosis (Sym) signalling pathway in plant roots that is necessary for the establishment of a successful symbiotic relationship. How nonsymbiotic PGPR and PGPF establish a prolonged mutualistic interaction with plant roots is less well characterized, but a picture is emerging that a molecular dialog is also essential for these mutualistic interactions.

Jasmonic acid and ethylene are the signalling molecules for ISR, which act in a sequence in activating the induced systemic resistance response. These bacteria are referred as PGPR because they improve plant growth and yield by suppressing deleterious rhizobacteria (DRP) seed bacterization with PGPR results in colonization of emerging roots and shoot by the introduced rhizobacteria. Once the induction of ISR has occurred, the number of introduced bacteria may decline without loss of their protective effect against DRB. Beside seed bacterization, direct application of PGPR to roots

during transplantation, or transplanting seedling in bacterized soils, are also used for inducing ISR.

The signalling pathway are dependent on the positive regulatory protein NPR1, which moves to the nucleus and interact with TGA transcription factors to induce defense gene expression. The NPR1 differentially regulates ISR related gene expression, depending on the signalling pathway. ISR must depend on a different induced state, whose effector defense compounds are yet not known.

Jasmonic Acid and Ethylene in Control of Induced Systemic Resistance

Along with SA, the plant hormones JA and ethylene (ET) are also important regulators of the plant immune system. By using Arabidopsis mutants impaired in JA or ET signalling, it was demonstrated that JA and ET are central players in the regulation of rhizobacteria-mediated ISR. JA signalling mutants *jar1*, *jin1*, and *coi1* and diverse ET signalling mutants, including *etr1*, *ein2*, *ein3*, and *eir1*, were shown to be defective in *P. fluorescens*. For many other PGPR, such as *Serratia marcescens*, *Pseudomonas protegens*, and *P. fluorescens*, and PGPF, such as *Penicillium* sp, *Trichoderma harzianum*, and *P. indica*, genetic evidence in Arabidopsis pointed to a role for JA and/or ET in the regulation of ISR. The same holds true for other plant species, such as tomato and rice, supporting the notion that JA and ET are dominant players in the regulation of the SA-independent systemic immunity conferred by beneficial soilborne microbes. In accordance with its dependency on JA and ET signalling, rhizobacteria-mediated ISR was shown to be effective against attackers that are sensitive to JA/ET-dependent defenses, including necrotrophic pathogens and insect herbivores.

Plant signaling pathways induced by Beneficial Microbes

when plant interact non-pathogenic or pathogenic micro-organism it triggers wide range of defense mechanism. Two main mechanisms are recognized: systemic acquired resistance (SAR) and induced systemic resistance (ISR).

SAR is usually triggered by local infection, provides long-term systemic resistance to subsequent pathogen attack, is correlated with the activation of PR

genes, and requires the involvement of the signal molecule salicylic acid (SA).

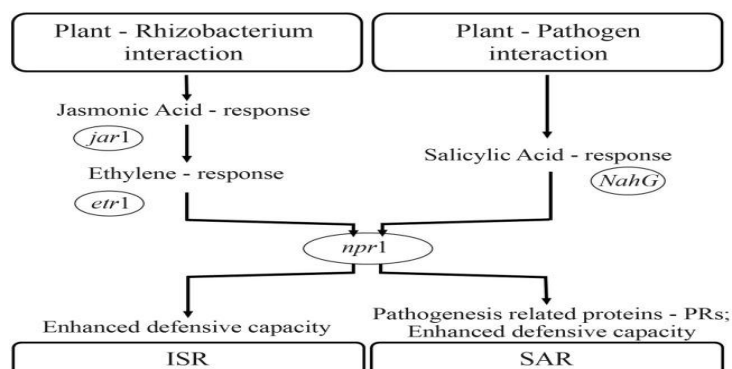


Fig 1. Signal Transduction leading to rhizobacteria-induced and ISR pathogen-induced SAR

(Source: Van Loon, 1998)

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ISR is not SA-dependent, but rather requires components of the jasmonic acid (JA) signaling pathway followed by the ethylene signaling pathway. when we apply *Trichoderma spp.* It regulates Pal-1 which in-codes for phenylalanine ammonia lysate, further Pal-1 activates the JA and ethylene signaling pathway which Catalyze phenyl propanoid Pathway leading to the production of Phenolic compound like phytoalexins in the form of defense against the pathogens (Shores and Harman, 2010).

Is Induced Systemic Resistance Constitutively Active in the Field?

The microbial community in the rhizosphere is extremely diverse, and members of many genera have the potential to elicit ISR. On top of that, many different microbial determinants have been implicated in eliciting ISR. Thus, the question of whether all plants in the field are already in the state of ISR seems reasonable, and it may explain some observations of

inconsistent performance of induced resistance in the field. However, there are many examples of PGPR or PGPF that induce ISR under field conditions when introduced to soil or planting material. This suggests that untreated plants do not constitutively express ISR or at least that they are not induced up to their full potential.

This apparent contradiction may be explained by the relatively high population densities of introduced bacteria that are required for effective elicitation of ISR. For example, the threshold population density of *P. fluorescens* required to elicit ISR in radish is 105 colony-forming units per gram of root. The occurrence of such a high density of a single bacterial genotype in the rhizospheres of field-grown plants seems unlikely, apart from the situation in some disease-suppressive soils. For example, in take-all decline soil, population densities of DAPG-producing *Pseudomonas spp.* are consistently above the 105 thresholds. Given the observation that DAPG production by *P. fluorescens* is a major determinant of ISR may be operative in take-all decline soils in which DAPG-producing *Pseudomonas spp.* A demonstration that suppressive soils not only control a single target soilborne pathogen or disease but also stimulate the plant immune system would greatly enhance their standing as an important approach to managing diseases and insects in conventional and organic crop production system.

PGPF and PGPR

PGPF

The definition of plant growth-promoting fungi, or PGPF, is like that of PGPR except that the organisms in question are fungi (here including true fungi as well as oomycetes) rather than bacteria. While mycorrhizal fungi are known to improve the growth of plants and affect the expression of plant defense responses (Lambais and Mehdy, 1995), a comprehensive discussion of the interactions between mycorrhizal fungi and plant. Fungi reported in the literature as PGPF primarily include ascomycetes (*Penicillium*, *Trichoderma*, *Fusarium*, *Phoma*, *Gliocladium*) and oomycetes (*Pythium*, *Phytophthora*). Interestingly, some reported PGPF are non-pathogenic or hypo virulent strains of phytopathogenic fungi.

PGPR

PGPR have include Firmicutes or Gram-positive bacteria (e.g., members of the *Actinomycetales*, including *Frankia* and *Streptomyces*, and *Bacilli*, including *Bacillus* and *Paenibacillus*), as well as Gram-negative organisms in various subdivisions of the Proteobacteria: Rhizobiaceae (*Rhizobium*, *Bradyrhizobium*), Rhodospirillaceae (*Azospirillum*), and Acetobacteraceae (*Acetobacter*) in the α -Proteobacteria; members of the Burkholderia group (Burkholderia) in the β -Proteobacteria, and members of the Enterobacteriaceae (*Enterobacter*, *Pantoea*, *Serratia*) and Pseudomonaceae (*Pseudomonas*, *Flavimonas*) in the γ -Proteobacteria.

References

Hermosa, R., Viterbo, A., Chet, I., Monte, E. (2012). Plant-beneficial effects of *Trichoderma* and of its genes. *Microbiol* 158 (1), 17–25.

Lambais, M. R. and M. C. Mehdy. 1995. Differential expression of defense-related genes in arbuscular mycorrhiza. *Can. J. Bot* 73, 533–540.

Shoresh M, Harman GE, Mastouri F. 2010. Induced systemic resistance and plant responses to fungal biocontrol agents. *Annu. Rev. Phytopathol.* 48, 21–43

Van Loon, L. C., Bakker, P. A. H. M., and Pieterse, C. M. J. (1998) Systemic resistance induced by rhizosphere bacteria. *Annu. Rev. Phytopathology.* 36, 453–483.

Wei G, Kloepper J. W., Tuzun S. 1991. Induction of systemic resistance of cucumber to *Colletotrichum orbiculare* by select strains of plant-growth promoting rhizobacteria. *Phytopathology* 81, 1508–12.

Table: 1 *Trichoderma* MAMPs identified in different species

SI	MAMP/Effector	<i>Trichoderma</i> species	Activity	References
1.	Protein Xylanase Xyn2/Eix	<i>T. viride</i>	A xylanase that elicits ET biosynthesis and hypersensitive response in tobacco leaf tissues	Rotblat <i>et al.</i> (2002)
2.	Cellulases	<i>T. Longibrachatum</i>	Activated and heat denatured cellulase elicit melon defences through the activation of the SA and ET Signalling pathway respectively	Martinez <i>et al.</i> (2001)
3.	Cerato platanin	<i>T. virens/ T. atroviride</i>	Hydrophobin like SSCP orthologous that can induce expression of defence responses in cotton and maize	Djovonic <i>et al.</i> (2006)
4.	Swollelin	<i>T. asperelloide</i>	Expansion like protein with cellulose binding domain capable of stimulating local defence responses in cucumber roots and leaves and affording local protection against <i>B. cineria</i> and <i>P. Syringae</i>	Brotman <i>et al.</i> (2008)
5.	Endo polyglacturonase (ThPG-1)	<i>T. harazianum</i>	Involved in colonization of tomato roots and ISR like defence in Arabidopsis.	Moran-Diez <i>et al.</i> (2009)

(Source: Hermosa *et. al.*, 2012)

Farming for Wellness: A Comprehensive Approach to Medicinal and Aromatic Plant Cultivation

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Throughout human civilization, agriculture has played a pivotal role, sustaining and supporting livelihoods across numerous generations. In contemporary society, there is a rising fascination with the cultivation of medicinal and aromatic plants (MAPs) owing to their multifaceted utility in pharmaceuticals, cosmetics, and culinary sectors. This article seeks to furnish farmers with thorough knowledge on the cultivation of these precious plants, presenting advice and methodologies to elevate both productivity and quality. The guide serves as a valuable resource for those interested in optimizing their agricultural practices, with a focus on the intricacies of growing plants with medicinal and aromatic properties. As the agricultural landscape evolves, embracing the cultivation of MAPs not only aligns with historical practices but also taps into the burgeoning demand for natural products in various industries, contributing to sustainable and diversified agricultural practices.

Selecting Medicinal and Aromatic Plants

Selecting the appropriate plants for cultivation is the initial and pivotal stage in the growth of Medicinal and Aromatic Plants (MAPs). Farmers must carefully assess variables like climate, soil composition, and market demand to make informed choices. A comprehensive exploration of the medicinal attributes and market dynamics associated with various plants aids in decision-making. Varieties like lavender, chamomile, mint, and aloe vera, among others, stand out as favoured options, each presenting distinctive advantages and market prospects. By aligning cultivation choices with these considerations, farmers can optimize their yields and meet the demands of both consumers and the market. This strategic approach ensures that the cultivation of MAPs not only thrives but also contributes positively to the economic and health sectors.

Planning and Designing the Medicinal and Aromatic Garden

Creating a thriving Medicinal & Aromatic Plants (MAPs) garden demands meticulous planning and deliberate design. Farmers must analyse the available space, sunlight exposure, and accessibility to ensure optimal conditions for plant growth. Strategic arrangement of plants, considering their unique growth patterns, water needs, and compatibility, is crucial for maximizing space and fostering a conducive environment. This thoughtful organization not only enhances efficiency but also contributes to the overall health of the garden. Furthermore, the inclusion of well-planned walking paths and designated work areas adds an extra layer of functionality. These features not only facilitate easy access for maintenance but also streamline the cultivation process, transforming the MAP garden into a harmonious and productive space for the cultivation of valuable medicinal and aromatic plants.

Soil Preparation and Nutrient Management

Establishing an optimal soil environment is paramount for cultivating robust medicinal and aromatic plants. The initial step involves conducting thorough soil tests to assess crucial factors such as pH, nutrient concentrations, and organic content. Armed with this data, farmers can tailor their approach, enriching the soil with essential organic matter, compost, and targeted fertilizers. This meticulous adjustment ensures a harmonious nutrient profile, fostering the plants' vitality. Continuous vigilance through regular soil monitoring is key, allowing farmers to fine-tune conditions in response to changing needs. This proactive approach not only sustains plant health but also enhances productivity, as the soil becomes a fertile foundation for the flourishing of medicinal and aromatic crops. The symbiotic relationship between soil quality and plant well-being underscores the significance of informed cultivation practices in the realm of agriculture.

Planting Techniques

Selecting the appropriate planting technique is paramount for fostering the optimal growth and development of Medicinal and Aromatic Plants (MAPs). The intricacies of seed selection, precise spacing, and planting depth are pivotal determinants of success. Depending on the plant species, propagation methods vary—some thrive through seeds, while others flourish through cuttings or transplants. Adhering to recommended planting guidelines tailored to each species is essential for establishing a conducive environment. Moreover, incorporating companion plants strategically can augment natural pest control mechanisms and contribute to the overall well-being of the plants. By embracing these considerations, farmers can cultivate MAPs with precision, harnessing their medicinal and aromatic properties to their fullest potential, while fostering a sustainable and harmonious agricultural ecosystem.

Irrigation and Water Management

Effective irrigation plays a crucial role in the successful cultivation of Medicinal and Aromatic Plants (MAPs), given their unique water needs. Employing methods such as drip irrigation and soaker hoses not only conserves water but also guarantees precise water delivery to the plant roots, optimizing growth and medicinal properties. Constant vigilance is necessary for farmers who must regularly assess soil moisture levels. By staying attuned to weather conditions, they can fine-tune irrigation schedules to avert potential issues like overwatering or drought stress. This meticulous approach not only enhances MAP yields but also promotes sustainable farming practices by minimizing water wastage. In the delicate balance of nurturing these valuable plants, proper irrigation emerges as a cornerstone for maximizing both quantity and quality in MAP cultivation.

Pest and Disease Management

Effective pest and disease control is paramount in ensuring the prosperity of a Medicinal and Aromatic Plants (MAP) cultivation enterprise. Employing integrated pest management (IPM) techniques is pivotal, encompassing strategies like introducing beneficial insects, practicing companion

planting, and utilizing natural pesticides. These methods not only mitigate reliance on chemical interventions but also foster a sustainable and environmentally friendly approach to cultivation. Regular and vigilant scouting for signs of pests and diseases serves as a proactive measure, facilitating early detection and swift action to safeguard the crop. By embracing a holistic and preventive approach, cultivators can not only enhance the health and yield of their MAPs but also contribute to the overall sustainability and resilience of agricultural ecosystems.

Harvesting and Post-Harvest Handling

Harvesting Medicinal and Aromatic Plants (MAPs) demands precision in timing to unlock their full therapeutic and aromatic potential. Each plant species has a distinct harvesting window that aligns with the peak concentration of active compounds. Farmers must be well-versed in these specific timelines, employing knowledge that goes beyond mere cultivation. Utilizing proper harvesting tools is equally essential to minimize damage, safeguarding the delicate structures that house the plants' beneficial properties. Beyond the field, post-harvest care plays a pivotal role. Delicate processes like drying, meticulous processing, and careful packaging become crucial steps. These measures ensure the preservation of potency and quality, subsequently influencing the shelf life of the harvested MAPs. In this delicate interplay of timing and technique, farmers secure not only a bountiful yield but also the optimal efficacy of these valuable botanical resources.

Marketing and Selling Medicinal and Aromatic Plants

Bringing Medicinal and Aromatic Plants (MAPs) to market requires a holistic approach that blends strategic marketing with effective sales strategies. Farmers play a pivotal role in this process, first by identifying target markets and comprehending consumer preferences. To maximize reach and profitability, a diverse array of marketing channels should be explored. Online platforms offer a global reach, enabling farmers to connect with a broader consumer base. Local farmers' markets provide opportunities for direct engagement with local

communities, fostering trust and brand recognition. Collaborations with herbalists and pharmaceutical companies can leverage expertise and enhance product credibility. A well-rounded marketing strategy that incorporates these elements not only expands the market presence of MAP products but also ensures sustained success in the competitive landscape of herbal and medicinal offerings.

Conclusion

Cultivating medicinal and aromatic plants provides farmers with a multifaceted opportunity, encompassing economic prosperity and community well-being. This endeavour aligns with sustainable agricultural practices, fostering a harmonious

relationship between farmers and the environment. The guide not only equips farmers with essential tips for cultivation but also emphasizes the broader impact on the herbal and aromatic agriculture sector. As consumers increasingly seek natural and sustainable products, farmers engaging in the cultivation of these plants position themselves at the forefront of a burgeoning market. Diversifying crops with medicinal and aromatic plants not only boosts economic resilience for farmers but also contributes to a healthier agricultural landscape. This holistic approach ensures a symbiotic connection between economic prosperity, environmental sustainability, and community health, reflecting a promising and rewarding trajectory for those venturing into this field.

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Alternate Hosts and Off-Season Survival Strategies of Groundnut Bruchid *Caryedon Serratus* (Olivier)

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During storage, groundnut bruchid *Caryedon serratus* (Olivier) severely damages groundnut pods and kernels. *C. serratus* is an important and primary storage pest of groundnut. The beetles lay their eggs on groundnut pods, grubs bore into the pods and feed on the kernels, causing economic damage (Fig. 1). Mature grubs make an exit hole and come out of the pod and then pupate in thin silken cocoons. Within a span of two to three months of storage, bruchids can cause more than 50% of the economic damage to groundnut. Protecting the seeds from damage caused by insect-pests requires the information on the bioecology of insect-pests and favourable factors that are responsible for their establishment and infestation. The level of damage caused by the bruchid beetle varies with the seasons. The infestation of bruchids starts from the field, which later becomes critical during storage. The most favourable factors for the growth and development of bruchids are temperature ($28\pm 2^{\circ}\text{C}$), relative humidity ($70\pm 5\%$), seed moisture content ($>9\%$) and the presence of previously infested/broken seeds in produce. The bruchid infested pods and kernels including broken seeds are highly prone to damage by the secondary insect-pests. Hence the damage is more when temperature and relative humidity is higher and damage to the stored groundnut pods is less when temperature and relative humidity is low. In winter season the bruchid take more time to complete its life cycle on the contrary during *Kharif* it completes its life cycle within a month (Ranga Rao et al., 2010).

Bruchids normally occur during June to December in areas where warm humid condition prevails. Further, the bruchid population increases with the increase in temperature and humidity. However, the combination of $28\pm 2^{\circ}\text{C}$ and $70\pm 5\%$ RH is highly conducive for growth and development of bruchids. The increase in temperature from 25 to 40°C results in shortening the time required for generation doubling by three times. The total span of life cycle varies from 65 to 80 days. The adult longevity for males is 20 days, whereas for females is 17 days. The

pre-oviposition period is 2-3 days, the oviposition period is 5-7 days and the post-oviposition period is 8-9 days. Maximum number of eggs will be laid during first four days after the adult emergence and the average fecundity per female is 67 eggs. The incubation period of egg is 4 days; the grubs upon hatching scrape the pod or kernel surface and penetrate the pod to feed on kernels. The grubs pass through four larval instars before pupation, viz., first, second, third and fourth which complete in 13, 9, 13 and 17 days, respectively finishing total larval period in 52 days. The fully grown grubs emerge out by making an exit hole and construct a tough silken cocoon on the surface of pods or kernels. Grubs pupate inside silken cocoons, where pupation lasts for 12 days. Generally, sex ratio in bruchids is recorded being 1: 0.7 (female: male). Irrespective of egg density (number of eggs laid), only two adults emerge out of one-seeded pod/kernel, however four and five adults can emerge out of two- and three-seeded pods, respectively.

In India, groundnut bruchid is reported from Gujarat, Karnataka, Tamil Nadu, Rajasthan, Maharashtra, Uttar Pradesh, Kerala, Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh and Orissa (Arora and Singal, 1978; Fletcher, 1914; Mital and Khanna 1974). The hosts are *Acacia nilotica*, *A. pinnata*, *A. ontana*, *A. tortilis*, *A. arabica*, *A. chundra*, *A. donaldi*, *Albizia lebbek*, *Bauhinia monandra*, *B. tomentosa*, *B. malaborica*, *B. racemosa*, *Caesalpinia pulcherrima*, *C. bocalla*, *Cassia fistula*, *C. grandis*, *C. nodosa*, *C. renigera*, *C. auriculata*, *C. ontana*, *Casuarina equisetifolia*, *Hardwickia binata*, *Helianthus annuus*, *Pongamia pinnata*, *Prosopis cineraria*, *P. juliflora*, *P. spicigera* and *Tamarindus indica* (Fig. 2) were reported as the alternate hosts of *C. serratus* (Arora and Singal, 1978; Bagheri-Zenous, 1995; Beeson, 1918; Chatterjee, 1916; Fletcher, 1914; Mital and Khanna, 1974; Purthi and Singh, 1950; Radadia, 1995; Raina, 1972; Rangarajan et al, 1978; Satya Vir and Jindal, 1996; Singh and Bhandari, 1991; and Singal and Tokky, 1990).

The Saurashtra region of Gujarat is known as the 'Groundnut bowl of India' and contributes significantly to the production, processing and export of groundnut. Therefore, there are a large number of storage godowns exist and operate in Gujarat to cater to the needs of groundnut processors and exporters. Concern for bruchid infestation of groundnut among the groundnut processors and exporters of Saurashtra are at a higher level compared to those of other states or regions. In Saurashtra, groundnut is mainly grown in the *kharif* season and harvesting/post-harvest operations for groundnut begin in the months of October-November. Bruchids survive in the wild during the off-season (i.e. April-September) on alternate hosts. For example, *Prosopis* sp. pods are available for bruchid survival and multiplication during the time-periods of February-March and August-September; likewise pods of *T. indica*, *Acacia* sp., *Bauhinia* sp. and *A. lebbek*, will be available for bruchids respectively in the time-periods of February-June, April-May, August-October and November-December.

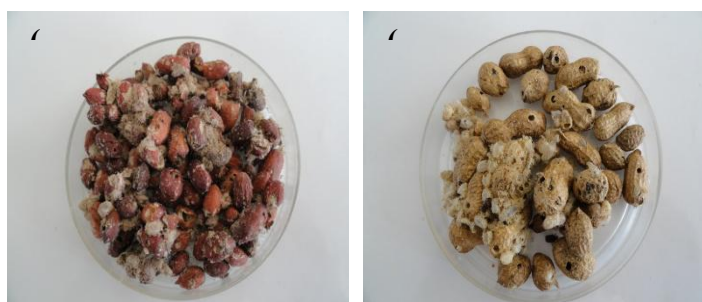


Fig. 1: Groundnut bruchid, *Caryedon serratus* infested (A) kernels and (B) pods.



Fig. 2: Bruchids on an alternate host, (A) tamarind tree in the field and (B) egg on tamarind pod (inside red circle).

The eco-friendly management of the insect-pests of stored groundnut could be achieved by targeting the weak points in the life cycle or by altering

the favourable factors responsible for infestation and establishment of the pest. Bruchids can be effectively managed in the field, thereby reduce the carry-over of infestation to storage godowns through strategic sanitation of the field before the harvest of groundnut. Strategies include: (i) collecting and destruction of the fallen, damaged or leftover pods or seeds of alternate hosts; (ii) Ensure earthing-up soil around the plants before peg initiation (iii) Harvest the produce at right maturity stage (iv) Avoid heaping the produce in the field itself (v) employing quicker sun-drying of groundnut pods to a safe moisture level, i.e. 7%; (vi) trapping of beetles using semiochemicals; and (vii) early detection of bruchid infestations in groundnuts for curative measures. Insights into off-season survival and alternate hosts of groundnut bruchids will help in formulating both preventive and curative strategies for management.

References

- Arora G N and Singal S K 1978. *Oryza sativa* Linn (paddy) as a new host plant recorded for *Caryedon serratus* (Olivier) (Coleoptera: Bruchidae) from India. *Indian Journal Entomology*, 40, 86.
- Bagheri-Zenous E 1995. The groundnut seed beetle (*Caryedon palaestinus* Sttut. Coleoptera, Bruchidae): A new pest in Iran. *Iranian Journal of Agricultural Sciences*, 26, 65-69.
- Beeson C F C 1918. Forest Entomology. Reprint Annual Report of Scientific Advice for India 1916-17, Culcutta, *Economic Zoology*, 1-3.
- Chatterjee N C 1916. Forest Entomology. Reprint from Annual Report of Scientific Advice for India 1915-16, Culcutta, *Economic Zoology*, 1-4.
- Fletcher T B 1914. Some south Indian insects and other animals of importance. Superintendent, Government Press Madras. 308-309p
- Mital S and Khanna S S 1974. A note on tamarind bruchid *Caryedon gonagra* Fab. (Bruchidae : Coleoptera) a serious pest of stored tamarind (*Tamarindus indica* L.) and other Leguminous seeds of economic importance *Agra University Journal Research*, 16, 99-101.

- Purthi H S and Mohan Singh 1950. Pests of stored grains and their control. Manager of publication, Government of India, New Delhi. 88 p
- Radadia G G 1995. Biology and Management of groundnut bruchid, *Caryedon serratus* (Oliver) in stored groundnut PhD Thesis submitted to Gujarat Agricultural University, SardarKrushinagar.
- Raina A K 1972. Observations on bruchids as field pests of pulses. *Indian Journal of Entomology*, 33, 194-197.
- Rangarajan A V, Mahadevan N R and Iyemperumal S 1978. Pest complex of sunflower (*Helianthus annus* Lin) in Tamil Nadu. *Indian Journal of Entomology*, 37, 188-191.
- Ranga Rao G V, Rameshwar Rao V and Nigam SN 2010. Postharvest insect pests of groundnut and their management. Information Bulletin No. 84. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. ISBN 978-92-9066-528-1. 20 pp.
- Satya Vir and Jindal S K 1996. Field infestation of *Caryedon serratus* (oliver) (Coleoptera: Bruchidae) on the pods and seeds of *Acacia nilotica* in the Thar desert of India. *Journal of Tropical Forest Sciences*, 9, 189-193.
- Singal S K and Tokky O P 1990. Carryover of bruchid, *Caryedon serratus* (Oliver) (Coleoptera) from field to stores through seeds of *Acacia nilotica* (L) in India. *Tropical Pest management*, 36, 66-67.
- Singh P and Bhandari R S 1991. Insect pests of *Acacia tortilis* in India. *Indian Forester*. 113, 734-743.

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Role of Traps in Sampling of Stored Product Insects

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The objectives of insect trapping programs in stored product protection are to document presence or absence of a particular insect species, monitor changes in species composition, and estimate changes in insect density over time or space. Data from trapping programs are used to justify changes in pest management practices or to investigate the efficacy of a particular treatment. Trapping data should be used to complement ongoing pest management inspections, not to replace them. Trap use and interpretation of insect captures provide the foundation for integrated pest management programs and may be considered a method of sampling the insect population.

Types of Sampling:

1. Direct sampling
2. Indirect sampling

Direct sampling:

Direct sampling is defined as enumeration of insects present per defined unit of space or volume of a particular commodity. For example, counting the number of beetles in a grain sample.

Although direct sampling methods provide the most reliable estimates of insect density, it is unrealistic to use them with finished goods because products cannot be sold with adulterated packaging.

Direct sampling for insects that accumulate in cracks and crevices is not feasible, nor is it likely that a manager could identify every insect harborage.

Indirect sampling:

Indirect sampling is any method of capturing insects or estimating damage that is not directly tied to a unit of area, volume, or weight.

Trapping is considered indirect sampling because it is not known from how far away insects were drawn into the trap. Insect trapping programs can be operated in all types of commercial storage, processing, warehousing, and retail establishments without jeopardizing product appearance or customer confidence. Traps also can show the absence of insect activity, precluding the need for pesticide application or fumigation.

Types of Traps:

Commercial traps for capturing stored product insects in grain storage and food-processing facilities are widely available. New trap designs are continuously being introduced. Traps intended for stored product insects generally fit into five categories:

Light traps

- ❖ Light traps are wall-mounted, corner-mounted, or ceiling-suspended traps that utilize ultraviolet light (315 to 400 nm wavelength) as the insect attractant. The principle of operation is that flying insects are attracted to the light and are captured or killed when they enter the trap.
- ❖ Traps typically have a low current immobilizing electrical pulse or an electrocuting grid around the light source to kill insects and replaceable sticky cards to hold the insects.
- ❖ Located above the line of sight, they are commonly used for fly control in food preparation and pharmaceutical production facilities. Some models look like normal lights and can be mounted discretely in canteen, office, and reception areas where presence of flying insects is a sensitive issue.
- ❖ Light traps attract a wide variety of adult flying insects, including stored-product insects, but are limited in ability to detect and monitor key stored product insect species.
- ❖ For proper performance, light traps should be cleaned frequently, and light bulbs replaced every 6 to 12 months.

Aerial traps

- ❖ Aerial traps are intended to capture flying insects attracted by a pheromone lure or food that then become entangled in a sticky coating or are collected in an escape-proof chamber.
- ❖ Rather than being placed on a flat surface, traps are suspended in the air from poles, conduit, structures, or equipment.

- ❖ This category includes bucket traps, funnel traps, and any of the sticky traps made of laminated cardboard coated with a sticky material.
- ❖ Aerial traps are intended for capturing adults of economically important species.
- ❖ When properly baited with a pheromone lure, aerial traps are effective in capturing adult moths such as Indian meal moth, Mediterranean flour moth, raisin moth, tobacco moth, and almond moth, and beetles such as the warehouse beetle, cigarette beetle, and lesser grain borer.

Pitfall traps

- ❖ Surface traps are small, low profile traps intended to rest on horizontal surfaces to capture crawling insects such as stored-product beetles.
- ❖ Surface traps will capture adults of a wide variety of insect species and occasionally wandering immatures.
- ❖ Surface traps vary greatly in appearance but are typically constructed to take advantage of an insect's preference for seeking shelter and hiding in dark crevices.
- ❖ Traps that contain corrugated cardboard are particularly effective at attracting wandering moth larvae.
- ❖ Plastic pitfall traps are molded in the shape of a cone with a hollow center where attractants can be attached and insects can accumulate.
- ❖ These traps usually include a dust cover. Pitfall traps are unique because they are baited with both pheromone lures and food attractants. This combination is important because some insect species are more attracted to pheromone plus food odors than either component alone. Food odors may attract immatures such as warehouse beetle larvae. Although several species may be present in the trap, pheromone baiting tends to bias the capture frequency toward the insect for which the pheromone lure is intended.

Bulk grain traps

- ❖ Bulk grain traps are specialized pitfall traps for use in grain stored in facilities such as concrete silos, steel bins, and flat storages. These traps are constructed of a perforated cylinder with a

collection vial attached on the bottom. The trap is inserted just below the top surface of a grain mass and left in place for several days.

- ❖ Insects wander into the traps and fall into the collection tip where they cannot escape.
- ❖ Pheromone lures are not recommended for use in probe traps, but research in this area is lacking.
- ❖ Bulk grain traps are placed near the surface because research shows that there are more insects in this portion of the grain mass.

Water trap

- ❖ As an alternative to pheromone lures as attractant for moths in food facilities, water by itself or water in conjunction with food and antifreeze have been proposed.
- ❖ An important advantage of using water as attractant is that it is equally attractive to male and female moths.
- ❖ Water as a moth attractant does not perform well in environments where water is available.
- ❖ It should only be considered a possible attractant for use in stored grain silos/ warehouses and or dry food processing facilities with high ambient temperature and low relative humidity.
- ❖ Water-baited traps for moths also may be considered as part of evaluating the performance of mating disruption programs.

Factors That Affect Trap Capture Rate:

1. Environmental conditions of the facility and general sanitation level around the trap will have a profound effect on the number of insects that can be trapped. For example, dust accumulation in both sticky traps and surface traps is a common problem in facilities that move or process grain.
2. Trap position will affect capture rate. Research shows that traps positioned under refugia, in corners, along walls, and near food sources capture more insects.
3. Indoor conditions such as air temperature, air movement, light, and photoperiod (light and dark cycles) affect insect captures in traps.

Limitations

- Pheromones are specific for specific pest.
- Lures should be replaced regularly.
- Traps should be clean without any dust or debris for effective monitoring.
- For proper performance, light traps should be cleaned frequently, and light bulbs replaced every 6 to 12 months.
- Water as a moth attractant does not perform well in environments where water is available.

Conclusion

The use of traps and subsequent interpretation of insect captures for monitoring and population estimation are the most efficient and cost effective tools available. Practical, economic, and ecological considerations require pest management professionals to conduct some level of experimentation each time a new trapping program is initiated. Data generated using traps and interpretation provides the best pest management decision support.

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Thorns and Roses: Navigating Challenges in Rose Cultivation and Marketing

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Roses belong to the genus *Rosa* and encompass a diverse range of species, hybrids, and varieties. Roses, often referred to as the "Queen of Flowers," have captivated the hearts of humanity for centuries with their exquisite beauty and enchanting fragrance. The cultivation of roses is an art and a science that requires careful attention to detail and a deep understanding of the plant's needs. This technical bulletin aims to provide a comprehensive guide for individuals interested in cultivating roses, whether for personal enjoyment, commercial purposes, or landscaping projects. They are cultivated for various purposes, including cut flowers, ornamental gardens, and the production of essential oils. Successful rose cultivation involves a combination of horticultural knowledge, proper site selection, soil management, pest and disease control, and post-harvest care.

Area and distribution

Major production of cut roses in India are West Bengal, Karnataka, Gujarat, Chhattisgarh, Maharashtra, Uttar Pradesh, Tamil Nadu, Madhya Pradesh, Andhra Pradesh and Orissa. The production of rose showed a decreasing trend from 1982-83 to 2020-21. As per estimates of National Horticultural Board (NHB, 2021), roses are cultivated in 30,000 ha in open-fields and in 650 ha in polyhouses in India.

The estimated area under the cultivation of rose in Tamil Nadu is around 3080.51 Area in hectares with the production of 30805.09 tonnes per annum and the productivity is 10.00 tonnes/ha. The crop is cultivated mostly in Tamil Nadu in the districts of Ariyalur, Cuddalore, Dharmapuri, Krishnagiri, Pudukottai, Theni, Thiruvannamalai, Trichy, Thirunelveli, Tenkasi and Villupuram.

Soil

Fertile loamy soil with pH of 6 – 7.

Climate

Protected cultivation: Day temperature of 25 to 28°C and night temperature not below 15°C; relative humidity of 60-65%. Open field cultivation:

Moderately cooler places (like Hosur) and sub-tropical climatic conditions (foot hills) are suitable.



Propagation

The Rose can be propagated by rooted cuttings or by budding on Briar root stocks in hills and on Edward Rose and *Rosa indica* in plains. One year old budded plants are planted in July - August.

Preparation of Field

Prepare the soil by repeated ploughing. Roses can be planted on beds or ridges and furrows. One year old budded plants are planted. While planting, keep the budded portion 5 cm above the soil. Plant in such a manner that the budded branch is oriented towards the centre of the bed.

Spacing

Protected cultivation: 40 X 15 cm (7 plants/m²)

Open field cultivation: 60 x 60 cm (27,777 plants/ha) to 60 x 75 cm (22,222 plants/ha)

Time of transplanting

6–18-month-old budded plants may be planted during May-June. The soil should be loose and humid but not too wet nor muddy.

Irrigation

- Protected cultivation: Drip irrigation with fertigation
- Open field cultivation: Irrigate once in 5 to 7 days depending upon the soil moisture.

Manures and fertilizers

The best time to add organic manure is at the time of pruning. FYM, leaf mould and oil cakes are

good sources of nitrogen. It is better to apply fertilizers in a mixture such as 'rox mix'.

Rose Mix can be prepared as: Neem cake - 5 kg, Bonemeal - 5 kg, Ammophos - 2 kg, Sulphate of Ammonia - 1 kg, Superphosphate - 2 kg, Potassium Sulphate - 1kg. 100g of this mixture can be used per plant. The chelated compounds of iron, magnesium and manganese are available in the market under names like 'Sequestrene Plus' which are helpful in bringing out the full colour of flowers. In general, for each rose plant urea 20-30g, superphosphate 30-50g, Potassium Sulphate 20-30g and Cakes ½ kg to 1 kg, in two to three split doses is recommended.

Cultural operations

Training: Early training is essential for plants under polyhouse conditions. Some of the first growth which consists of blind shoots must not be cut or bent, but left upright. Buds appearing at early stages are removed. The second growth will come to flower again in four to five weeks. By then, the plants will be 50 to 60 cm high, which is necessary to have enough growing speed in the plant and to have enough foliage for bending.

Bending: The first bending (basal formation) is done on 35th day after planting. The main shoot is bent down so that lateral branches grow. The second bending is done after 2 years to strengthen the plants.

Shoot thinning: Periodically remove unproductive shoots and water suckers.

Pruning: Pruning is followed only under open conditions during the months of March and October.

Pinching: Pinching is done to regulate flowering. Most of the commercial cultivars take about five-and-a-half to six weeks from pinching to produce flowers during summer and about eight weeks during winter.

Bud capping: To regulate the shape of the buds. Some varieties should be covered with bud nets.

Disbudding: Varieties produce some side buds below the centre bud. These side buds have to be removed or disbudded. The disbudding must be done regularly and also as soon as possible in order to avoid large wounds in the upper leaf axil.

Defoliation: The removal of leaves is known as defoliation. It is done mainly to induce certain plant

species to flower or to reduce transpiration loss during periods of stress. Defoliation may be done by removal of leaves manually or by withholding water. The shoots are defoliated after pruning.

Harvest

Harvest the buds at tight bud stage with 60-90 cm long stems at Early morning/late evening. Ensure that the foliage on the cut stem is healthy. Stage of harvest depends on variety /consumers demand. Flowers kept in water with preservatives and transported to cold store (2 to 4°C).

Yield

1st year: 100-120 flowers/m²

2nd year: 200-240 flowers/m²

3rd year: 300-360 flowers/m²

Post harvesting

- ✓ **Pre-cooling:** Pre-cooling is usually done for 6-8 hours in winter and 8-12 hours in summer.
- ✓ **Pulsing:** Treat the cut flowers with 2-4% sucrose solution for 3-4 hours. This improves the quality of the flowers.
- ✓ **Grading:** Flowers that are of uniform stem length and flower buds are developing, should be grouped together and kept in a separate container at the time of cutting.

Value added products

Rose water, Rose oil, Rose concrete, Gulkand, Pankhuri, Rose attar, Rose otto, Rose Petal Jam, Rose syrup, Rose floral tea, Rose RTS, Rose Wine.

Marketing

- **Auction Houses:** Many rose producers sell their flowers through auction houses, where buyers, including wholesalers and retailers, bid for the flowers.
- **Wholesale Markets:** Roses are also sold in wholesale markets, where bulk quantities are purchased by retailers or event planners.

Distribution:

- **Wholesalers:** Wholesalers purchase roses in large quantities and distribute them to retailers.

- **Retailers:** Florists, supermarkets, and other retail outlets sell roses to individual consumers.
- **Online Platforms:** The rise of e-commerce has opened up opportunities for online flower delivery services, allowing consumers to order roses for delivery to their doorstep.

Transportation

- **Cold Chain Logistics:** Roses are often transported using cold chain logistics to maintain the required temperature and humidity levels, preserving their freshness.
- **Road and Air Transport:** Roses are transported by road and, in some cases, by air to ensure timely delivery to various markets.
- **Last-Mile Delivery:** For online orders, a network of delivery services ensures roses reach consumers' homes or desired locations.

Challenges

- **Perishability:** Roses are highly perishable, making efficient transportation and logistics crucial to maintain quality.
- **Seasonal demand:** Demand for roses is often seasonal, with peaks during events like Valentine's Day and weddings.

Market trends

Keeping up with changing market trends and consumer preferences is essential for producers, wholesalers, and retailers. The success of the rose supply chain in India depends on effective coordination among farmers, distributors, and retailers, along with adapting to market dynamics and consumer preferences.

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How Are Turmeric and The National Turmeric Board (NTB) Important?

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Turmeric is a member of the Curcuma, which is part of the ginger family, known as Zingiberaceae. Its botanical name is *Curcuma longa*. Native to southern India and Indonesia, turmeric is widely cultivated on the mainland and in the islands of the India. The handsome diversity of Curcuma species by number alone is in India, at around 40 to 45 species. Various species currently utilized and sold as 'turmeric' in other parts of Asia have been shown to belong to morphologically similar taxa, with common vernacular names. Species belonging to the genus Curcuma, namely, *Curcuma caesia* (Black turmeric), *Curcuma rubescens* (Wild turmeric), *Curcuma amada* (Mango Zinger), *Curcuma leucorrhiza*, *Curcuma montana*, *Curcuma aromatica* (Wild turmeric), *Curcuma zedoaria*, *Curcuma angustifolia*, *Curcuma pseudomontana*, and *Curcuma longa* are of high medicinal value.

India's Scenario in turmeric production

In India, the use of turmeric dates back to nearly 4000 years, when it was used as a culinary spice and had some religious significance. India is the largest producer, consumer, and exporter of turmeric in the world. India has shared more than 62% of the world trade in turmeric. As per the sources, in the year 2022-23, an area of 3.24 lakh ha was under turmeric cultivation in India, with a production of 11.61 lakh tonnes (over 75% of global turmeric production). As per the available information, during 2022-23, India dominated the turmeric market, and 1.534 lakh tonnes of turmeric and turmeric products valued at 207.45 million USD were exported by more than 380 exporters. The leading export markets for Indian turmeric are Bangladesh, the UAE, the USA, and Malaysia. More than 30 varieties of Turmeric are grown in India, and it is grown in over 20 states in the country. The largest producing states of Turmeric are Maharashtra, Telangana, Karnataka and Tamil Nadu. With the focused activities of the Board, it is expected that turmeric exports will reach USD 1 billion by 2030.

There is no doubt that India will earn more revenue in this sector in the days to come.

High-value medicinal plant: Turmeric contains curcumin, an antioxidant that may have anti-inflammatory properties. It may be helpful in treating arthritis, cancer, metabolic syndrome, and depression. Turmeric is an intrinsic part of our Indian cooking. From curries to dals and sabzi, turmeric is literally added to anything and everything. Turmeric can reduce inflammation, heal internal injuries and shield the body from the flu during the winter season. Also called the Golden spice, turmeric can be found in a number of age-old remedies in Ayurveda. As per the scientific report, the "Lakadong" variety of turmeric originates from the Lakadong area of the Jaintia Hills district of Meghalaya. This variety is considered to be one of the world's best varieties of turmeric, with a curcumin content of about 6.8 - 7.5 %.

A few popular turmeric in India:

Black turmeric (*Curcuma caesia*): It is a perennial herb with bluish-black rhizome. The rhizomes are traditionally used in treatment of stomachache, typhoid and wounds by the indigenous communities of north east India. The rhizomes are used as stimulants, anti-diarrheal, diuretic, anti-emetic, wound cleanser and in treating various skin disorders.

Wild turmeric (*Curcuma aromatica*): It is a kind of wild turmeric that is often used as a beauty aid. Unlike conventional turmeric, it is often considered to be the superior form of the spice for topical use. The rhizomes have antibacterial, anti-inflammatory, wound-healing, and anti-melanogenic qualities provide it several uses in skin and facial care.

White turmeric (*Curcuma zedoaria*): It is a perennial herb found in tropical countries, such as India, Japan and Thailand. The different parts of this plant are used in Ayurveda and other folk medicines for the treatment of different ailments such as diarrhoea, cancer, flatulence and dyspepsia.

Mango ginger (*Curcuma amada*): It is a rhizomatous aromatic herb and is cultivated throughout in India, Sri Lanka, Bangladesh and in many South-East Asian countries for its rhizomes.

The rhizome of mango ginger is a popular spice and vegetable due to its rich flavour.

Narrow leaf turmeric/wild turmeric (*Curcuma angustifolia*): It is a rhizomatous herb well known as narrow-leaved turmeric. The rhizomes are used as a source of colouring and flavouring agents ethnomedicine, spices, dyes and perfumes in many south Asian countries.

Establishment of National Turmeric Board (NTB)

The Government of India notified the establishment of the National Turmeric Board, which is aimed at the development and growth of turmeric and turmeric products in the country. The objectives of the Board are to increase awareness and consumption of turmeric and develop new markets internationally to increase exports. Board to promote research and development into new products and develop on our traditional knowledge for value-added turmeric products. The National Turmeric Board will provide leadership on turmeric related matters, augment the efforts, and facilitate greater coordination with Spices Board and other Government agencies in the development and growth of the turmeric sector. In this regard, Honourable PM Modi said "it is important to pay more attention professionally and take an initiative in the value chain of turmeric, from production to exports. He further added "After Covid,

awareness about turmeric has increased and global demand has also increased. Today it is important to pay more attention professionally and take an initiative in the value chain of turmeric, from production to export".

Significance of the Turmeric Board

There is significant potential and interest world over on the health and wellness benefits of turmeric, which the Board will leverage to further increase awareness and consumption, develop new markets internationally to increase exports, promote research and development into new products, and develop on our traditional knowledge for value-added turmeric products. It will especially focus on capacity building and skill development of turmeric growers for harnessing greater benefits out of value addition. The Board will also promote quality and food safety standards and adherence to such standards. The Board will also take steps to further safeguard and usefully exploit turmeric's full potential for humanity.

The activities of the Board will contribute towards greater well-being and prosperity of the turmeric growers through their focussed and dedicated attention to the sector and the larger value addition closer to the farms, which would provide better realisation to the growers for their produce.

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Vermicompost as a Means of Income Generation for Annadatas (Food Provider)

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Abstract

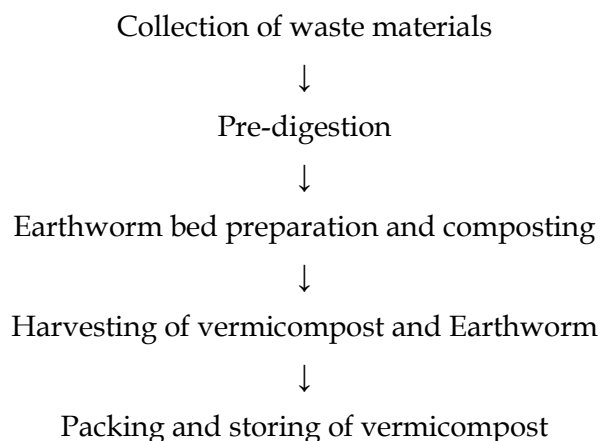
Vermicomposting is a mesophilic biooxidation and stabilization process of organic materials that involves the joint action of earthworm and micro-organism. Compared with composting, vermicomposting has high rate of stabilization and it is greatly modifying its physical and biochemical properties, with low C:N ratio and homogenous end product. It is also cost effective and ecofriendly waste management. Composting is the process of aerobic decomposition of organic waste through micro-organisms whereas vermicomposting involves the combination of both the micro-organisms and the earthworms. Vermicomposting is a chemical and biological process for recycling nutrients with the aid of earthworms and micro-organisms. Thus, vermicompost is considered as a high nutrient biofertilizer with diverse microbial communities.

Introduction

Vermicomposting is the process of conversion of organic wastes into finely degraded peat like substances using earthworms. All composting methods can be used for the vermicomposting instead earthworms are used in vermicomposting after partial decomposition of the waste materials (Pathma and Sakthivel, 2013). Vermicompost biofertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K. Vermicompost that is prepared through conventional method has standard values of total nitrogen (1.94 %), phosphorus (0.47 %) and potassium (0.70 %). It is also enriched with various micronutrients such as Mg (0.46 %), Fe (7563 ppm), Zn (278 ppm), Mn (475 ppm), Bo (34 ppm), Cu (27 ppm). Thus, eliminate usage of any further artificial chemical inputs. Further, nutrients in vermicompost are often much higher than traditional garden compost (Alam *et al.*, 2007). Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, flower and fruit crops. It is a natural organic fertilizer prepared using earthworms that convert organic compounds into manure. Earthworms help to decompose complex

organic matter by reducing the C:N ratio into manure. They enhance the soil exposed to the micro-organisms, making it favourable for microbial activity and improving soil properties.

Simplest Steps of Vermicomposting



Methods: Two most commonly followed are bed method and pit method

Bed method: Composting is done on the pucca/kachcha floor by making a bed (dimension: 6x2x2 feet) of organic mixture. This method is easy to maintain and to practice.

for maintaining aeration and for proper decomposition

Pit method: Composting is done in the cemented pits, wooden boxes, plastic buckets, silpaulin bag, baskets etc. The unit is covered with thatch grass or any other locally available materials (ICAR, Umiam)

Preventive measures

- ❖ The floor of the unit should be compact to prevent earth worms migration into the soil.
- ❖ 15 to 20 days old cow dung should be used to avoid excess heat.
- ❖ The organic wastes should be free from plastics, chemicals, pesticides and metal.
- ❖ Aeration should be maintained for proper growth and multiplication of earthworms.
- ❖ Optimum moisture level (3- to 40 %) should be maintained.
- ❖ 18-25°C Temperature should be maintained for proper decomposition.

The specific **species of earthworms** used for vermicomposting includes:

- ✓ *Eisenia foetida*
- ✓ *Eudrillus euginiae*
- ✓ *Perionyx excavates*

(Joymati *et al.*, 2019)

Advantages

- ✚ Pathogen suppression
- ✚ Nutrient delivery
- ✚ Water retention
- ✚ Increased microorganism populations
- ✚ Pest suppression
- ✚ Plant growth regulation and higher yields
- ✚ Polluted soil remediation.

Disadvantages

- ✚ Odour: If not done properly, it releases a bad odour. Filling the compost bin with green plants forms ammonia and produces the smell. Adding carbon sources like paper helps to neutralize the smell
- ✚ Time: It is a time-consuming process and usually takes 2-3 months for completing the process.
- ✚ Maintenance- Temperature needs to be maintained for better action by earthworms. The bad odour attracts rodents and flies. So, the bin should be covered properly (Kiran *et al.*, 2019)

Conclusion

Vermicompost is a process based on earthworms and micro-organisms, whose joint action

provides degradation and detoxification of organic waste as well as conversion into a product to be used for crop purposes. This eco-friendly method is cost effective and is the best among other remediation processes. Therefore, Fertilizers feeds the plant while vermicompost feeds the soil.

References

- Alam, M. N., Jahan, M. S., Ali, M. K., Ashraf, M. A. and Islam, M. K. (2007). Vermicompost and chemical fertilizers on growth, yield and yield components of potato in barind soils of Bangladesh. *Journal of Applied Sciences Research*, 3(12):1879-1888.
- <https://urbanwormcompany.com/plant-and-soil-benefits-of-vermicompost/>
- <https://www.farmpractices.com/vermicomposting-methods-advantages>
- <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/vermicomposting>
- ICAR Research Complex for NEH Region, Umiam-793103, Meghalaya.
- Joymati, L., Samarendra, H., Burhan, U. C. and Ramesh, T. (2019). A guide to vermicomposting-production process and socio economic aspects. Tribal sub plan.
- Kiran, P., Jaison, M. and Durgam, S. (2019). Vermicomposting and its uses in Sustainable Agriculture.
- Pathma, J. and Sakthivel, N. (2013). Molecular and functional characterization of bacteria isolated from straw and goat manure based vermicompost. *Applied Soil Ecology*, 70:33-47.

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Importance of Irrigation in Pomegranate

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Pomegranates are one of the world's oldest fruits. They are thought to have originated in Iran, Afghanistan, and parts of southwest Pakistan as early as 2500 BCE. Mesopotamian sources say that pomegranates were part of the diet of humans 5,000 years ago. Pomegranates were introduced to other parts of Asia, Africa, and Europe, including Spanish America in the late 16th century and California by Spanish settlers in 1769.



Fig 1. Pomegranate Fruit

The fruit and leaves are used to treat inflammation, cardiovascular disease, and gastrointestinal issues. The seeds are a good source of potassium, vitamin A, C, and E, as well as various antioxidants, calcium, and iron. The word "garnet" and "grenade" come from the word "pomegranate". This is because a shrapnel-scattering grenade imitates the seed-scattering explosion of a smashed pomegranate.

Pomegranate (*Punica Granatum*) is commercially planted in Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat and Madhya Pradesh. This fruit crop can tolerate soil salinity and saline irrigation water and does well even in shallow stony soils. It can also tolerate drought. Pomegranate makes an excellent choice under arid and semiarid condition. The plant is hardy and bushy

growing to a height of 2 to 4 m and is deciduous in cool climates. It can grow from sea level to 1850 m altitude.

Table No. 1 Production of Pomegranate in India

Pomegranate Production in India		
State	Area (ha)	Production (t)
Andhra Pradesh	5600	56400
Chhattisgarh	100	400
Gujarat	4400	45600
Himachal Pradesh	1300	500
Karnataka	13200	138500
Maharashtra	98900	555500
Nagaland	100	300
Orrisa	200	800
Rajasthan	800	4800
Tamil Nadu	400	17500
Total	125000	820300

Irrigation in Pomegranate Crop

Irrigation and fertilizers are the most important inputs which directly affect the plant growth, development, yield and quality of produce. Application of irrigation water and fertilizers through drip are the most effective ways of supplying water and nutrients to the plant roots. Farmers generally irrigate the pomegranate through surface method of irrigation, which needs more water to irrigate the crop and huge quantity of water losses occur through leaching and evaporation. Similarly, farmers are using solid fertilizers for fruit crop production but these are not totally water soluble and hence are less available to plants and some of the fertilizers contain salts of sodium and chloride which not only affect the quality and quantity of crop production but they are also harmful to the soil. The drip irrigation method is an appropriate answer, particularly for horticultural and cash crops as it permits the irrigator to limit the watering as per water requirement of plants and optimum application of fertilizers through drip irrigation system.

Advantages of Drip Irrigation in Pomegranate Crop

- **Water Efficiency:** Drip irrigation delivers water directly to the root zone of the pomegranate plants, minimizing evaporation and runoff. This targeted approach reduces water wastage and ensures optimal water use efficiency, crucial in areas where water resources are limited or expensive.
- **Improved Nutrient Management:** Along with water, drip systems can also deliver fertilizers and nutrients directly to the root zone, ensuring that the plants receive the necessary nutrients for healthy growth. This precision in nutrient delivery helps in better crop yield and quality.
- **Reduced Weed Growth:** Drip irrigation only waters the area around the plant roots, reducing moisture in the inter-row spaces where weeds tend to grow. This can significantly lower weed pressure, leading to reduced competition for water, nutrients, and sunlight, ultimately benefiting pomegranate growth and yield.
- **Minimized Disease Spread:** By avoiding overhead watering, drip irrigation helps keep the foliage dry, reducing the spread of foliar diseases that thrive in moist conditions. This can contribute to better overall plant health and reduced need for chemical treatments.

Irrigation Management

In arid and semi-arid regions pomegranate is grown with limited irrigation facilities. It requires regular irrigation to get optimal yield and fruit quality. In commercial production, irrigation should be scheduled as per the requirement of crop growth stage. The most sensitive phase of a plant growth cycle occurs during pollination, fruit set and development. Further water deficits, at fruit maturity and ripening

stages results in fruit cracking and such fruits become unsuitable for the fresh market. The water requirement of plants depends on age, season, location and management practices.

Drip irrigation has great potential due to high water use efficiency and increased yield. Besides water saving (60%), yield can be increased up to 30-35% by drip irrigation. Drip irrigation system with 2-4 adjustable drippers per plant should be installed depending upon age of the tree. For one- to three-year-old plants, 2 drippers/plant may be enough to provide required irrigation to the plant whereas from fourth year onwards 4 drippers/plant found better. Even fertilizers and chemicals can be applied through drip irrigation. In general, for non-bearing trees, about 5-25 litres/plant/day and 20-65 litres/plant/day for bearing trees are needed. For conventional tree spacings (15' x 10' or 12' x 12') online drip system with 4 or 8 lph drippers based on soil texture is better. Six 4 lph drippers per tree is the best lay out for trees above 3 years of age. Two lateral lines one on either side of the tree is found to wet the tree basin uniformly. For high density (10' x 10') and ultra-high density (7' x 10') inline system with two laterals with 4 lph emitters at 60 cm is recommended and it is best.

References

- Chanadra, R., Suroshe, S., Sharma, J., Marathe, R.A. and Meshram, D.T. 2011. Pomegranate growing manual. National Research Centre on Pomegranate, Solapur-413 255 (MS), India, pp.29.
- JAINART/ TC Pomegranate_12pg_Eng/1112/YP_V1 Mahesh Kumar Dhakar, Ram Avtar Kaushik, Deepak Sarolia and Mahan Lal Bana (2010). Effect of fertigation using low-cost drip irrigation system on physicochemical characteristics in pomegranate cv. Bhagwa. Indian J. Hort. 67, 432-435.

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Apical Root Cutting in Potato for High-Quality Seedlings

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Potato (*Solanum tuberosum* (L.)) is one of the world's most vital staple crops, contributing significantly to global food security. Producing high-quality potato seedlings is a pivotal aspect of sustainable agriculture, directly influencing crop yield, quality, and disease resistance. Among the various methods of potato propagation, the utilization of apical root cuttings has gained prominence for its efficiency and reliability in producing robust seedlings.

Apical root cutting (ARC) involves carefully selecting and preparing specific portions of the root system, emphasizing the apical (terminal) regions. This method offers advantages in disease management, genetic preservation, and accelerated multiplication of desired potato varieties. As agricultural systems strive for increased efficiency and sustainability, understanding the intricacies of apical root cutting becomes crucial for farmers, researchers, and stakeholders in the potato industry.

ARC, a novel technique to produce quality seed potatoes, involves using tissue culture plantlets as mother plants, from which apical cuttings are produced. These cuttings are then rooted and transplanted to produce seed potatoes. This method can potentially transform potato seed systems due to its rapid and high multiplication rate [1, 2].

Rationale for Apical Root Cutting:

- **Disease Management:** Apical root cutting provides a unique advantage in disease management by allowing the production of seedlings in a controlled environment. Disease-free material can be selected, reducing the risk of carrying pathogens to the next generation [3].
- **Genetic Preservation:** The apical regions of the roots contain meristematic tissues with genetic information crucial for plant growth and development. By focusing on apical root cuttings, the desired genetic traits of the parent plant can be effectively preserved and propagated.

- **Accelerated Multiplication:** Apical root cutting enables the rapid multiplication of potato seedlings compared to traditional methods like seed propagation. This accelerated multiplication contributes to meeting the increasing demand for high-quality planting material.
- **Uniformity in Seedlings:** Through the careful selection and preparation of apical root cuttings, uniformity in seedlings can be achieved. This uniformity is essential for consistent crop development, maturation, and improved yield.
- **Resource Efficiency:** Apical root cutting minimizes resource requirements compared to traditional seed propagation methods, such as using true potato seeds. This approach optimizes resources and contributes to sustainable agricultural practices.
- **Adaptability to Tissue Culture Techniques:** Apical root cutting complements modern tissue culture techniques, allowing for seamless integration with advanced propagation methods. This adaptability facilitates the incorporation of biotechnological approaches in potato seedling production.

Methodology

There usually are two stages in rooted apical cuttings systems: production of cuttings in a lab and greenhouse, followed by sale to seed multipliers or potato farmers who plant the rooted cuttings to produce seed tubers [2]. Each cutting produces 7 to 10 tubers, multiplied further for a season or two, and the harvest is sold as seed [1]. The different steps in producing apical root cuttings are:

1. **Selection of Parent Plants:** Healthy and disease-free potato plants with desirable characteristics for the target crop must be chosen.
2. **Harvesting Apical Root Cuttings:** ARC is selected from the chosen parent plants. These

cuttings are ideally taken from the ends of healthy, disease-free roots.

- **Cutting Preparation:** Apical root sections are to be cut into pieces, each containing at least one bud (or "eye") and a portion of the root. Each cutting is around 2-4 inches long.
 - **Disinfection:** Cuttings are treated to prevent the spread of diseases. Cuttings may be treated by dipping them in a fungicide solution or disinfectant.
 - **Callus Formation:** They are allowed to form a callus by letting them air dry for a short period, which helps reduce the risk of rotting during planting.
3. **Planting in a Nursery Bed:** The treated cuttings are planted in a well-prepared nursery bed or seedling tray filled with a suitable growing medium. Make sure the eyes are facing upward.
- **Proper Spacing:** The cuttings are planted at appropriate distances to ensure good air circulation and prevent the spread of diseases. The spacing may vary depending on the specific potato variety.
 - **Watering and Care:** Optimal moisture levels must be maintained in the nursery bed. Over-watering should be avoided to prevent water-logging, which can lead to diseases.
 - **Fertilization:** A balanced fertilizer should be applied to promote healthy growth. The specific nutrient requirements may vary based on soil conditions and the type of growing medium used.
 - **Weed Control:** The nursery bed is to be kept free from weeds that can compete with the potato seedlings for nutrients and water.
 - **Disease and Pest Management:** The seedlings should be monitored regularly for signs of diseases and pests. Take appropriate measures, such as applying pesticides or organic controls, to manage any issues.
 - **Hilling or Earthing Up:** As the seedlings grow, soil should be periodically added around the base of the plants to provide support and

encourage the development of a robust root system.

4. **Transplanting:** Once the seedlings have reached a suitable size and are free from diseases, they can be transplanted to the main field for further growth and development.
- **Field Management:** Proper field management practices, including irrigation, fertilization, and pest control, should be implemented to ensure the continued health and productivity of the potato plants.
 - **Adaptability:** The soil and environment in many parts of the eastern and southern regions are suitable for cultivating potato seed in the *rabi* season (October-March), and in some areas like Hassan in Karnataka and Koraput in Odisha, it can be grown in *kharif* season (July-October) also. Specifically, the northeastern states could be potato seed hubs supplying seeds to West Bengal, Odisha, and Bihar [1].

Following these steps carefully increases the chances of producing high-quality potato seedlings from apical root cuttings (**Figure 1**). Adjustments may be needed based on specific environmental conditions and potato varieties.

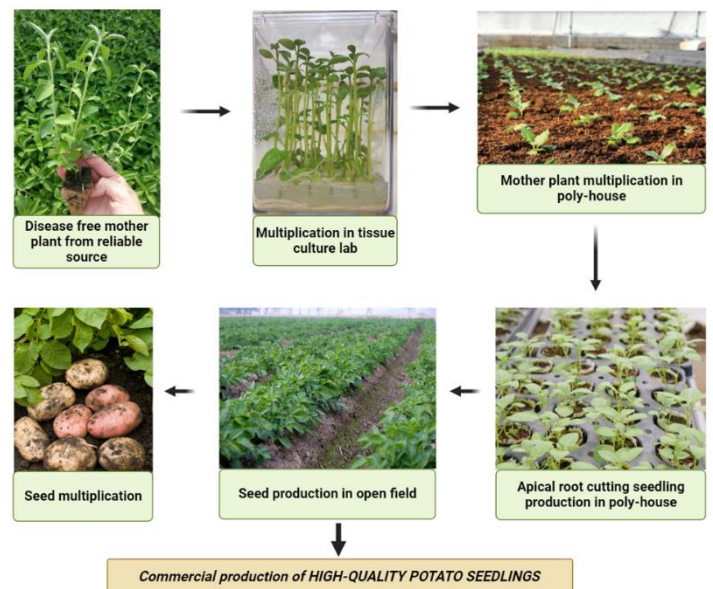


Figure 1: Illustration of different steps involved in producing high-quality potato seedlings through apical root cuttings.

Recent Advancements

ARC is effective in producing high-quality seedlings. Handayani *et al.* 2023 found that apical-

rooted cuttings from various potato varieties can produce tubers suitable for seed purposes [6]. Basavaraj *et al.* 2023 concluded that potato varieties Kufri Himalini and Kufri Jyoti apical rooted cuttings with 45 × 20 cm spacing showed optimal growth and leaf length for high-quality potato tuber production [7]. Nikmatullah *et al.* 2018 further demonstrated that these cuttings can be used for mass propagation of G1 seed tubers, with the best results obtained from cuttings derived from 2 to 3-week-old mother plants [8].

This technology was recently standardized for the first time at ICAR-Central Potato Research Institute Shimla, India. The remarkable results suggest that local growers can use the technology to produce quality planting material at low cost [1].

Comparison of apical root cutting and other methods of potato propagation

Apical root cutting (ARC) is a significant advancement in potato propagation, offering several advantages over traditional methods (**Table 1**). Hence, ARC is a promising alternative to traditional potato propagation methods, offering a cost-effective and speedy supply of clean starter material for the onward multiplication and bulking of early-generation seeds (EGS) [5]. Here is a comparison:

Conclusion

Apical root cutting is a transformative technique that has the potential to enhance the quality of seedlings significantly. It is a promising alternative to the current aeroponic seed production system. This method, which involves producing rooted transplants from tissue culture plantlets, offers a rapid and high multiplication rate. It offers a cost-effective and speedy supply of clean starter material for the onward multiplication and bulking of Early Generation Seeds (EGS), which results in high-quality seeds, equivalent to basic or certified seeds in seed certification systems. Adopting this technique could significantly contribute to reducing seed potato shortages, improving productivity, and lowering the cost of production.

With the rapid adoption of ARC by seed producers, smallholder farmers, and youths, the ARC revolution brings great excitement and promise of prosperity to remote, poor highland communities.

Therefore, apical root cutting is a promising, speedy solution for producing quality seed potatoes, boosting food security.

References

1. Buckseth, T., Singh, R. K., Challam, C., Tiwari, J. K., Sharma, A. K., & Chakrabarti, S. K. (2019). Apical root cutting: A novel technique for the production of quality seed potato. *Indian Horticulture*, 64(6).
2. Fornkwa, V., Harahagazwe, D., Nkengla, D., Teguefouet, P., & Nkuidjin, G. J. (2023). Best practices for producing rooted apical cuttings and minitubers in a screenhouse. Yaoundé, Cameroon: International Potato Center. 24 p.
3. Singh, R. K., Buckseth, T., Tiwari, J. K., Sharma, A. K., & Chakrabarti, S. K. (2019). Recent advances in production of healthy planting material for disease management in potato. *Biotech Today: An International Journal of Biological Sciences*, 9(1), 7-15.
4. VanderZaag, P., Pham, T. X., Demonteverde, V. E., Kiswa, C., Parker, M., Nyawade, S., ... & Barekye, A. (2021). Apical rooted cuttings revolutionize seed potato production by smallholder farmers in the tropics. *Solanum tuberosum-A Promising Crop for Starvation Problem*, 1-19.
5. Tsoka, O., Demo, P., Nyende, A. B., & Ngamau, K. (2012). Potato seed tuber production from in vitro and apical stem cutting under aeroponic system. *African Journal of Biotechnology*.
6. Handayani, T., Sahat, J. P., & Pertiwi, M. D. (2023, May). The utilization of apical rooted cuttings for the seed production of potato varieties for processing. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1172, No. 1, p. 012012). IOP Publishing.
7. Basavaraj, T., Hanchinamani, C. N., Vishnuvardhana, Meenakshi, S., Mohan, Kumar, S., & Amruta, S. B. (2023). Standardization of spacing and varieties for production of tubers from apical rooted cuttings. *The Pharma Innovation Journal*.

8. Nikmatullah, A., Ramadhan, I., & Sarjan, M. (2018). Growth and yield of apical stem cuttings of white potato (*Solanum tuberosum* L.) derived from disease-free G 0 plants. Journal of Applied Horticulture, 20(2).

Table 1. Advantages of Apical Root Cutting (ARC) over conventional methods in the production of high-quality seedlings

Serial No.	Feature	Apical Root Cutting (ARC)	Conventional methods
1.	Rate of Multiplication	ARC has a faster regeneration potential and is true to type. A single shoot can yield 125 copies in just three months.	Traditional methods have a slower rate of multiplication.
2.	Cost-Effectiveness	The cost of an apical cutting is USD 0.10.	The cost of a mini tuber ranges from USD 0.15-0.30
3.	Quality of Seedlings	ARC from juvenile simple rounded leaf mother plants is a novel approach to transplanting and field cultivating seed potatoes.	It may not always produce high-quality seedlings.
4.	Adaptability	The technology was first developed in warmer climates at lower elevations less than 1,500 meters above mean sea level. However, it was gradually successfully developed in East Africa's cooler climates. It is well established in the highlands of Vietnam and the Philippines.	Traditional methods may not be as adaptable to different climates.
5.	Time Efficiency	Using cuttings as starter material for seed production takes one year less than mini tubers to produce commercial seed	It takes longer to produce commercial seeds.

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Fertilizing Naturally: Embrace Organic Liquid Manures

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Abstract

Liquid organic manures emerge as a boon for farmers, countering the prevalent reliance on chemical fertilizers in modernized Indian agriculture. Despite the longstanding tradition of using organic liquids in crops, contemporary practices favour tripled quantities of chemical solid or liquid fertilizers, disregarding associated health risks. The rapid environmental degradation and health hazards necessitate a return to liquid organic manures, a practice deeply rooted in India's agricultural history. Revitalizing this tradition becomes crucial for preserving both human health and the environment. Liquid organic manures serve as a potent solution, enhancing soil physical, chemical, and biological properties to boost soil fertility and elevate crop productivity, offering a sustainable alternative to conventional farming practices.

Introduction

In the wake of urbanization and industrialization the surge in population has emerged as a pressing concern for both the environmentalists as well as the government. To meet the needs of this burgeoning population adoption of intensive chemical farming is being embraced rapidly in order to amplify the crop yield posing threats to our soil, water, plants, health, biodiversity and above all, environment. In the current context of growing demand for chemical-free goods, there exists a significant opportunity for organic crop production both within India and internationally. In the framework of organic farming practices, along with adopting enhanced agronomic methods and applying various composts, the role of liquid manures like Compost tea, Vermiwash, Himsol, Himslurry, Matkakhad becomes exceptionally crucial as these substances play a pivotal role in upholding the microbial activity and also act as good growth prompters when used in given along with drip irrigation or used as foliar sprays. The easy solubility of liquid organic manures in water allows for efficient absorption by plants, in contrast to the slower and less effective absorption of nutrients from bulky organic

manures. The effective absorption of nutrients by plants can be impeded by the use of bulky organic manures. Liquid manures offer a solution to this issue, acting as a protective measure to alleviate temporary and acute nutrient shortages in crops. Here are a few examples of organic liquid manures, each with its own composition. These formulations play a crucial role in promoting crop growth by enhancing various physiological and biochemical processes within plants. By increasing nutrient availability and aiding in the tolerance of both biotic and abiotic stresses, these organic liquid manures contribute significantly to overall plant health and productivity.

Organic liquid manure and their preparation

Amritpani

It a cost-effective formulation, serves as both organic fertilizer and a remedy for seed rots. Classified as a bioenhancer, it comprises diverse microbes, macro and micronutrients, plant growth-promoting hormones, enzymes, and vitamins. This composition not only enhances crop production but also improves the physical, chemical, and biological properties of the soil. Furthermore, Amritpani accelerates the decomposition process. To prepare it, a paste is prepared by mixing jaggery or honey with fresh cow dung, and then cow ghee added to it. This mixture is added to 200 liters of water, stirred thoroughly and left with the container sealed. After 7-10 days, it is ready for use.

Compost Tea

It serves as a natural fertilizer comprising soluble nutrients and beneficial microorganisms such as bacteria, actinomycetes, filamentous fungi, oomycetes, and yeasts. These microorganisms work synergistically to combat plant diseases, sustain soil fertility, and enhance agricultural productivity. In the preparation of compost tea, well decomposed compost (5 kg) is wrapped in a muslin cloth, submerging it into water (15 litres) for a period of 7-15, stirring it daily. This process fosters the development of a nutrient-rich concoction teeming with beneficial microorganisms. It

can be used as bio stimulant agents for promoting plant growth. The end product, compost tea, is versatile and can be applied directly through spraying or incorporated into fertigation methods, offering a holistic solution to enhance soil fertility and promote optimal agricultural productivity.



Himsol

This liquid manure is prepared by mixing water (200 l) and ash (250 gm) which is kept for 24 hrs. Later vermicompost (90 kg), cow dung (75 kg), cow urine (10 l) and ash (remaining 250 g) are added to this solution (consisting of water and ash) and kept in an airtight plastic container for around 3 months. Following this period, the resulting himsol, a liquid organic manure, is ready for use as a spray. This application not only safeguards soil health but also significantly contributes to improving both the quality and quantity of crops.

Himslurry

Him slurry, an organic liquid fertilizer, is composed of ingredients such as cow dung (40 kg), along with eggshells (200 gm), basalt powder (100 gm), and jaggery (50 gm). This blend is then mixed with matkakhad (200 ml) and undergoes a fermentation period of approximately 3 months. After the fermentation concludes, water is introduced at a ratio of 1 kg per 40 litres of water. The resulting slurry is continuously stirred for a minimum of 10 minutes to provide oxygen, fostering the growth of beneficial aerobic microbes within it.

Kunapajala

It stands out as an effective liquid organic fertilizer, offering two distinct preparation methods—one involving the fermentation of animal remnants

such as bone marrow, animal flesh, and skin, yielding a strong odour, and the other utilizing a vegetarian base. This organic fertilizer significantly contributes to the growth and development of plants at various stages while enhancing soil fertility with its rich composition of macro and micro nutrients, sugars, fatty acids, and amino acids. For the vegetarian-based Kunapajala, a mixture of black gram (50 gm), groundnut oilcake (100 gm), rice husk (100 gm), soybean meal (100 gm) along with paneer (100 gm) and tofu (from soybean) (100 gm) is prepared by cooking in 1-1.5 litres of water for at least half an hour, followed by cooling. Cow dung (1 kg), cow urine (1 litre), honey (25 gm), milk (100 ml), and 20 litres of water are added to the cooked mixture, and the resulting blend is transferred to a 50-liter drum. Stirring this mixture twice daily is crucial throughout the fermentation period, which spans 20, 40, and 60 days. Upon completion of the fermentation process, the mixture is filtered using a cotton cloth.

Matkakhad

Matkakhad as the name suggests, is crafted within a earthen pitcher (20 l), containing cow dung (5 kg), water (5 l), cow urine (5 l), and jiggery (250 gm). This earthen vessel is then buried underground for 7-10 days, with only the mouth of the pitcher exposed above the ground and covered with a lid. The solution undergoes regular stirring during this period and becomes ready for use through drenching after 10 days. This organic liquid fertilizer not only enhances nutrient absorption but also serves as an excellent natural stimulant for promoting both vegetative and reproductive growth in plants.

Seaweed extract

It serves as a liquid organic fertilizer with dual benefits as a soil conditioner and a natural pest control method, while also fostering accelerated germination. This solution contributes to enhanced soil fertility and increased plant growth, owing to its abundant micronutrients and plant growth hormones. The preparation involves collecting washed-up seaweed, which is then immersed in tap water for a minimum of four weeks, with the bucket securely covered. Alternatively, the extract can be produced by crushing shade-dried seaweeds for five days, grinding them



into a coarse powder, boiling the powder in distilled water for at least 60 minutes, and subsequently straining the mixture.

Sasyagavya

It is an organic fertilizer, plays a vital role in boosting immunity against diseases throughout different crop growth phases. Additionally, it serves as a soil drenching agent before sowing, effectively preventing termite attacks on crops. To prepare Sasyagavya, combine fresh cow dung, cow urine, chopped organic waste, and wastewater in a ratio of 1:1:1:2. Allow the mixture to ferment in a container for 10-12 days, stirring it intermittently during this period.

Vermiwash

Vermiwash functions as an organic tonic obtained by passing water through a column of worm culture or vermi beds. This liquid incorporates excretory by-products, colemic fluid (secreted by earthworms for body moisture) and micronutrients sourced from soil organic molecules which helps to improve the physiochemical properties like soil structure, bulk density, soil aeration, water holding capacity of soil etc. With a wealth of micronutrients, macronutrients, various plant growth hormones like gibberellins, cytokinin etc, vermiwash supports optimal plant growth and enhances the absorption of nutrients.

Advantages

1. Providing a sustained source of nutrients in the soil, it fosters long-term and sustainable crop production.
2. It is a low-cost production approach which has demonstrated increased and superior yields.
3. Enhancing soil physical, chemical, and biological characteristics, it encourages the proliferation of beneficial microbes, thereby contributing to soil health.

Disadvantages

1. The supply of nutrients is constrained.
2. There is a strong and disagreeable odour.
3. If fermentation is not carried out thoroughly, it may lead to the accumulation of particular pathogens, posing a threat to plants and causing health problems in animals and humans

Conclusion

In the realm of modern agriculture, there is a clear prioritization of environmental sustainability. The utilization of organic liquid manures presents a sustainable livelihood alternative for small and marginal farmers as it is low-cost production technology which can be easily prepared from naturally and locally available inputs. The escalating reliance on chemical fertilizers and pesticides to meet the food demands of a growing population is adversely impacting crop quality and yield while posing potential risks to human health. By adopting eco-friendly, traditional, and affordable agricultural inputs for crafting organic liquid manures, there is an opportunity to revitalize age-old agricultural practices. This not only contributes to the production of safe and healthy food but also ensures environmental well-being, offering a balanced and sustainable approach to farming.

References

- Chadha S, Rameshwar, Ashlesha, Sainin JP and Paul YS. Vedic Krishi: Sustainable livelihood option for small and marginal farmers. Indian Journal of Traditional Knowledge 11(3): 482-484.
- Jani S, Harisha CR, Prapati PK and Patel BR (2017). Kunapajala: A liquid organic manure:

preparation and its quality parameters. World Journal of Pharmacy and Pharmaceutical Sciences 6(8): 1990-1991.

Kavya SR and Ushakumari K (2020). Effect of organic liquid manure of kunapajala on growth and yield of Bhindi (*Abelmoschus esculentus* (L.)

Moench.). Agricultural Science Digest 40(3): 270-274.

Rameshwar, Saini JP, Kaushal S and Upadhyay RG (2017). Effect of liquid manures on the growth and yield of rice through SRI system under organic conditions. International Journal of Tropical Agriculture 35(4): 982-983.

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Case Study of Soil Fertility Improvement by Practising Green Manure Crop in Different Soil Conditions

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Organic farming plays an important role in maintaining the soil fertility status. Because of the excess use of chemical fertilizers, fungicides and insecticides, we are facing a lot of issues concerning health and malnutrition status in the country. With the growing population of the country, we need to produce food and sustain food security. Every year there is always an increasing trend in the population and also the land suitable for agricultural production is decreasing. This forced us to use new innovative technologies in agricultural production and the use of chemicals in the production cycle is drastically increasing.

Eliminating synthetic or chemical-based inputs is, however, only one aspect of the organic production system. More importantly, it emphasizes a whole-system approach in which all the individual components (soil minerals, organic matter, micro-organisms, insects, plants, animals, and humans) create a sustainable and self-regulating ecosystem.

The government of India has introduced several schemes concerning organic farming. Schemes like the National Project on Organic Farming (NPOP), Paramparagat Krishi Vikas Yojana (PKVY), Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), Capital Investment Subsidy Scheme (CISS) under the Soil Health Management Scheme, National Horticulture Mission (NHM) and One District-One Product (ODOP).

Paramparagat Krishi Vikas Yojana promotes cluster-based organic farming with PGS (Participatory Guarantee System) certification. Cluster formation, training, certification and marketing are supported under the scheme. The assistance of Rs. 50,000 per ha /3 years is provided out of which 62 per cent (Rs. 31,000) is given as an incentive to a farmer towards organic inputs.

Rameshwara and Santhebennur clusters from the Davanagere district were selected by ICAR Taralabalu Krishi Vigyan Kendra, Davanagere to implement the components of Paramparagat Krishi Vikas



Fig 1: Green Manure Velvet beans as intercrop in Arecanut garden

Yojana. One of the components is increasing soil fertility by growing green manure crops in the field and incorporating them into the soil.

Velvet bean (*Mucuna pruriens* (L.) DC. var. *utilis*) is a leguminous vine. It is an annual or sometimes short-lived perennial. Velvet bean is vigorous, trailing or climbing, up to 6-18 m long. It has a taproot with numerous, 7-10 m long, lateral roots. The stems are slender and slightly pubescent. The leaves are generally slightly pubescent, alternate, and trifoliate with rhomboid ovate, 5-15 cm long x 3-12 cm broad, leaflets. The inflorescence is a drooping axillary raceme that bears many white to dark purple flowers. After flower pollination, the velvet bean produces clusters of 10 to 14 pods. They are stout, curved, 10-12.5 cm long, with between two and six seeds, covered with greyish-white or orange hairs that may irritate the skin. The velvet bean seeds are variable in colour, ranging from glossy black to white or brownish with black mottling. Seeds are oblong ellipsoid, 1.2 to 1.5 cm long, 1 cm broad and 0.5 cm thick.

Velvet bean is a valuable fodder and feed legume. Vines and foliage can be used as pasture, hay or silage for ruminants while pods and seeds can be ground into a meal and fed to both ruminants and monogastrics. Pods with their seeds can be ground into a rich protein meal and can be fed to all classes of livestock though in limited amounts in monogastric.

Each farmer is provided with 5 kg of velvet beans to grow as intercrop in the existing Arecanut garden (50 Farmers), maize fallow field (50 Farmers) and Onion fallow field (50 Farmers). Soil testing was done for each farmer's field for parameters like pH, EC, and NPKS before sowing of velvet beans crop. The crop was sown during the Kharif season to enable it for good establishment in the season. After 120-130 days of sowing the crop is mulched in the field by ploughing in the disc harrow. After two months of incorporating again the soil testing was done for the same crops to know the any improvements in the soil fertility status.

The pH of the soil ranged between 7.21 to 7.48. The three different demonstrations under the study. The pH of the soil remained unaltered irrespective of either following farming or intercropping with Velvet Beans. In the same way, the electrical conductivity of the soil in all three demonstrations was found reduced but not affected significantly. The EC ranged between 0.16 to 0.36 ds m^{-1} among three different demonstrations.

The organic Carbon of the three demonstration plots ranged between 0.53 to 0.61%. There will be an increasing trend in the organic carbon status after the incorporation of Velvet Beans in all the demonstrations.

The Mean available nitrogen before the sowing of velvet beans was 192.1 kg ha^{-1} , whereas it ranged between 216.4 kg ha^{-1} to 239.1 kg ha^{-1} in three demonstration plots. The soil's available Nitrogen content is significantly influenced by the intercropping with velvet beans.

The mean available phosphorus content before the sowing was 11.85 kg ha^{-1} . Whereas the highest per cent accumulation was noticed on velvet beans intercropped Arecanut plot (16.8) and lowest in onion fallow field. There has been significant improvement in potassium uptake in the soil in all three demonstrated plots. The increase in the content is on par with all the demonstrations. The range of improvement was from 536.1 kg ha^{-1} to 583.4 kg ha^{-1} . The available sulphur content in the initial soil sample was 13.5 kg ha^{-1} . However, the sulphur content also showed an increasing trend in all three demonstrations with a mean value of 15.2 kg ha^{-1} .

Conclusion and Future Aspects

It is concluded from the above study that, growing green manure crops and incorporating them with the soil will certainly help in restoring the soil fertility status. Also, the physicochemical changes in the soil will improve drastically to facilitate the easy availability of nutrients to the plants. Green manures thus play a vital role in improving the soil ecosystem and also improving soil microflora.

Table 1: Soil chemical parameters as influenced by Velvet Beans cultivation

Sl. No	Demonstration	pH		EC		OC		N		P		K		S	
		Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter
01	Arecanut + Velvet Beans	7.81	7.43	0.32	0.16	0.41	0.61	184.6	216.4	13.48	16.8	484.1	536.1	14.1	16.8
02	Maize Fallow field	7.74	7.21	0.56	0.31	0.34	0.53	198.1	241.6	11.26	15.1	416.7	583.4	13.8	14.9
03	Onion fallow field	7.96	7.48	0.68	0.36	0.31	0.59	193.6	239.1	10.81	14.8	456.9	568.7	12.6	13.9
04	Mean	7.83	7.37	0.52	0.27	0.34	0.57	192.1	232.3	11.85	15.56	451.5	562.7	13.5	15.2
05	SEM (+)		0.04		0.01		0.03		5.1		0.9		6.1		0.3
06	DCP=0.05		NS		NS		0.11		16.8		1.9		21.8		1.4

EC-Electrical Conductivity (ds m^{-1}); OC-Organic Carbon (%); N-Nitrogen, P-Phosphorus, K-Potassium, S-Sulphur (kg ha^{-1})

Empowering Agriculture: Harnessing Technology and Crop Insurance to Mitigate Climate Change

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Agriculture stands as the cornerstone of the Indian economy, sustaining over 58 per cent of the population and contributing significantly to economic stability. However, the vulnerability of this vital sector has been underscored by the changing climatic patterns and the uncertainties of weather. In the face of these challenges, the threat to food security and economic stability has escalated dramatically. Recognizing the urgent need for resilience, climate-resilient agriculture emerges as a key imperative. Coupled with effective risk mitigation options such as crop insurance, it becomes pivotal in safeguarding our agricultural system and ensuring food security for the nation. Today, the agricultural landscape is witnessing transformative opportunities, driven by advanced technologies and financial support. The swift impact of climate change, marked by rising temperatures, recurrent heat waves, droughts, floods and intense cyclonic activities, has outpaced conventional mitigation efforts. In response to present scenario, the Ministry of Agriculture and Farmers Welfare has introduced Pradhan Mantri Fasal Bima Yojana (PMFBY) after replacing various previous insurance schemes. Several pioneering technological initiatives have been introduced under this scheme to enhance its efficiency. These initiatives aim not only to empower farmers but also to streamline operations for a more resilient agricultural sector.

Evolution of crop insurance in India

Crop insurance in India has a rich history, starting with J.S. Chakravarti proposing a rain insurance scheme in the early 1900s to protect farmers against drought. During post-independence period, Prof. Dandekar introduced the 'homogeneous area' approach in the mid-seventies. Significant milestones in crop insurance include the pioneering First Individual Approach Scheme (1972) and the Pilot Crop Insurance Scheme (1979). Subsequent developments include the Comprehensive Crop Insurance Scheme (1985) and the National Agricultural Insurance Scheme (1999-2000).

Innovations continued with the introduction of the Weather-Based Crop Insurance Scheme (2007) and enhancements in the Modified National Agricultural Insurance Scheme (2010-11), expanding coverage and effectiveness. Presently, two government-subsidized schemes, the Weather-Based Crop Insurance Scheme and the Pradhan Mantri Fasal Bima Yojana (PMFBY) are operational. The Pradhan Mantri Fasal Bima Yojana (PMFBY), inaugurated in 2016 and revamped in 2020, extends its protective umbrella over a diverse range of crops. Designed with the primary objective of stabilizing farmer's income, this innovative scheme represents a crucial stride towards fortifying the agricultural sector. Thus, this evolution reflects the adaptation of crop insurance in India to changing needs and challenges in the agricultural landscape.

Pradhan Mantri Fasal Bima Yojana

In a major move, the Indian government launched the Pradhan Mantri Fasal Bima Yojana (PMFBY) in February 2016, aligning with the One Nation-One Scheme vision (Singh and Singh, 2019). Going beyond its predecessors, PMFBY covers all crops with a capped premium of 2 per cent, 1.5 per cent and 5 per cent for Kharif, Rabi and commercial/horticultural crops, respectively (Inderjeet, 2019). PMFBY isn't just insurance; it is a catalyst for stabilizing farmer's income and fostering innovative agricultural practices. Tailored for the backbone of the nation, its primary goal is to support sustainable production by providing financial assistance to those facing crop losses due to natural calamities. Extending coverage beyond the expected, PMFBY addresses localized risks and post-harvest losses. It aims to boost crop insurance penetration by raising farmer awareness and maintaining low premium rates. Recognizing the need for improvement, PMFBY underwent a significant revamp in 2020, making the scheme voluntary for all farmers (Anonymous, 2023a). This reflects a commitment to flexibility and inclusivity, ensuring the

benefits of PMFBY reach a broader spectrum of farmers across the nation.



Source: <https://www.bajajallianz.com/blog/knowledge/bytes.html>

Integration of technology in crop insurance

Incorporating cutting-edge technology into crop insurance brings transformative initiatives to the forefront. Notably, the technology-driven Yield Estimation System (YES-TECH) manual under PMFBY emerges as a game-changer. Rigorously developed through extensive testing, it serves as a comprehensive guide for accurate yield assessments, empowering farmers with crucial insights. Another pioneering effort in this scheme is the WINDS portal, revolutionizing risk assessment by centrally managing hyper-local weather data. This not only informs decisions in crop insurance but also enhances capabilities in agricultural advisories and disaster mitigation. The YES-TECH Manual, crafted through extensive testing in 100 Indian districts, provides a robust guide for implementing the technology-driven yield estimation system at the Gram Panchayat level. In parallel, the WINDS Portal serves as a centralized hub for processing hyper-local weather data, empowering precise risk assessment and decision-making in crop insurance, agriculture advisories and disaster mitigation for the rural economy (Anonymous. 2023b). Adding to the innovation, the AIDE Android app streamlines the enrollment process, making crop insurance more accessible by bringing it directly to farmer's doorsteps.

Constraints

Inadequate compensation structures: The current compensation provided under the PMFBY is often

insufficient to cover the actual losses incurred by farmers in case of crop failure.

Protracted claim settlement process

Delays in processing and settling insurance claims significantly impede the timely financial assistance required by farmers.

Lack of awareness and information dissemination

Many farmers are unaware of the facilities available under crop insurance schemes, leading to a lack of participation and understanding.

Limited trust and farmer engagement

The negative attitude and lack of trust among farmers towards the insurance scheme hinder its success rate.

Suggestions

Creation of Awareness

Promoting awareness about insurance is essential to foster its widespread adoption, as it empowers individuals to comprehend the significance of financial protection, encourage informed decision-making and resilience in the face of unforeseen events.

Timely Payment of Compensation

Timely payment of compensation is imperative for the effective success of crop insurance, ensuring that farmers receive prompt financial support during adverse events, thereby strengthening the resilience of the agricultural sector.

Adequate Compensation

Ensuring adequate compensation is crucial to help farmers effectively mitigate crop losses, providing essential support for their livelihoods and fostering resilience in the face of unforeseen challenges.

Efforts by Government and Non-Governmental Organizations

The collaborative efforts and initiatives by both government and non-governmental organizations can enhance the success of PMFBY.

Active Participation of Stakeholders

Active engagement of stakeholders, including farmers, local authorities and community leaders in decision-making processes can significantly contribute to the success of crop insurance programs.

Along with that leveraging technology is pivotal for enhancing crop insurance. Integrating remote sensing, such as satellite imagery, enables accurate risk assessment and real-time crop monitoring. Advanced analytics can facilitate precise yield predictions, while the incorporation of block chain technology will enhance transparency and efficiency in the insurance process, collectively improving the overall effectiveness of crop insurance programs.

The Road Ahead

The future prospects of technology-driven crop insurance, particularly in the context of climate change, hold immense potential. Advanced technologies like satellite imagery, data analytics and machine learning offer the potential to adapt insurance models to evolving climate patterns, providing more accurate risk assessments and timely compensation for farmers affected by climate-related challenges. This intersection of technology and insurance stands as a crucial pillar for building resilience in agriculture amidst the uncertainties posed by climate change.

Conclusion

Addressing persistent challenges such as inadequate compensation and prolonged claim settlements, the narrative presents practical solutions while highlighting the essential roles of both governmental and non-governmental efforts. The significant technological advancements, demonstrated by the innovative YES-TECH manual, WINDS portal, and AIDE Android app within PMFBY, serve as catalysts for positive change. Additionally, the article underscores the urgent issue of climate change and explores how technologies like

satellite imagery and blockchain can assist farmers in adapting to changing weather patterns. In conclusion, while crop insurance and technological advancements are commendable steps towards securing India's agriculture, obstacles such as insufficient compensation, delayed claims, and limited awareness necessitate targeted solutions. Collaborative efforts from stakeholders, both governmental and non-governmental, along with increased awareness and prompt compensation payment, are crucial for the program's success. Looking ahead, integrating cutting-edge technologies holds promise for adapting insurance models to climate change. A comprehensive strategy, encompassing technology, stakeholder engagement, and streamlined policies, is essential to strengthen India's agricultural resilience and ensure food security amidst evolving challenges.

References

- Anonymous. (2023a). Revamped operational guidelines of Pradhan Mantri Fasal Bima Yojana. <https://pmfby.gov.in> (5.00 PM, 5 December, 2023)
- Anonymous. (2023b). Ministry of Agriculture & Farmers Welfare. <https://pib.gov.in> (8.00 PM, 15 December, 2023).
- Inderjeet. (2016). Study on the benefits of Pradhan Mantri Fasal Bima Yojna for farmers. *International Journal of Multidisciplinary Research and Development*, 6, 384-387.
- Singh AK. and Singh A. (2019). Pradhan Mantri Fasal Bima Yojna (PMFBY): A bunch of Benefits. *International Journal of Multidisciplinary*, 4, 1031-1035.

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Value Added Baked Products Aid a Home Maker Generating Employment Countryside

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Name	of	Mrs. Ramandeep Kaur Sandhu
Entrepreneur		
Husband's Name		Mr. Gurwinder Singh Sandhu
Address		Village Jindawala, Patti, Tarn Taran
Contact Number		9478900023
Age		41 Years
Education		M.A., B. Ed.
Size of land holding (in acre)		Nil

Journey Towards Establishing Bakery Unit

Mrs. Ramandeep Kaur Sandhu W/o Mr. Gurwinder Singh Sandhu, Village Jindawala, District Tarn Taran, was a home maker. Occasionally, she used to try cooking as her hobby. Her family has been involved into horticulture, particularly, pear cultivation. After Covid-19 pandemic, pear crop was getting decayed due to temperature variation and no facility available for its post-harvest management. Then, to mitigate the loss, she tried to prepared pear jam which was not up to the mark to meet its desired specifications in terms of different sensory characteristics such as appearance, taste, aroma and mouth feel. It happened due to non-scientific processing techniques applied in processing of pear. In July, 2021, Mrs. Ramandeep called up Home Scientist at Krishi Vigyan Kendra, Booh, Tarn Taran and shared her problem. After detailed discussion, the Scientist visited her whereabouts to diagnose the problem faced. In first week of August, 2021, a skill-

oriented vocational training course entitled "Value addition of cereals, millets and pear through different processing techniques" at village Jindawala, for 20 trainees, was organized by KVK, Tarn Taran. Under this training programme, the beneficiaries have obtained hands on experiential learning on diverse value-added technologies for pear and developed technologies for value added baked products, by method demonstration given by Home Scientist, KVK, Tarn Taran.



Fig 1: Exposure Visit to Sanbroz Foods Industry

An exposure visit to Food Industry Incubation Centre, Department of Food Science and Technology, Punjab Agricultural University, Ludhiana was organized to hone their skill in pear and cereal, millet value addition through various techniques such hot and cold extrusion using multi grain flour. Further, KVK Home Scientist also visited their prospective location of Bakery unit and guided her regarding know-hows of setting up a food venture. Simultaneously, knowledge on marketing practices and fruit waste utilization in value added bakery products was promulgated to the potential entrepreneur. Under this training course, various value-added technologies such as pear jam, candy, squash etc. and baked products such as biscuit using diverse combination of flours (peanut+wheat, gram

flour+wheat, maize+wheat etc.) was disseminated by KVK, Booh, Tarn Taran. On successful completion of training course, Mrs. Ramandeep Kaur Sandhu established a bakery unit named "Sanbroz Foods" and motivated the other trainees to join her venture to secure their livelihoods at local level.

Table1. Detailed economics of Bakery unit

1	Name of Intervention	Food Processing	
2	Area under intervention	Home Science (Food and Nutrition)	
3	Crop Rotation followed	Value added baked products	
4	Gross Income (Rs.)	a) Bakery unit	6,82,500.00
		Total	6,82,500.00
5	Cost of Production (Rs.)	a) Raw Material Cost	69,900.00
		b) Labour Cost	1,16,000.00
		c) Electricity/ Water	54,020.00
		d) Transportation	40,000.00
		Total Expenditure	2,79,920.00
6	Net income (Rs.)	a) Bakery unit	4,02,580.00

In November, 2021, Sanbroz Foods started supplying its value-added biscuits of different varieties *viz.* peanut+wheat, gram flour+wheat, dry fruit biscuits etc. to nearby markets such as Tarn Taran and Shri Amritsar Sahib as bulk supplier. Efforts of

Sanbroz Foods was applauded by KVK, Tarn Taran during launch of their value-added biscuits during Farmer's Fair. Hence, by adopting scientific value-added techniques, this enterprise has attained net income of Indian Rupees 4,02,580/- per annum, along with provision of livelihood security of resource poor (scheduled caste) families at the village.



Fig 2: Jindawala and All beneficiaries during training

Conclusion

To recapitulate, it is pertinent to mention that a farmer entrepreneur is efficacious to contribute towards amelioration of resource poor community through further implications of value addition to an organized baking sector. Therefore, awareness on fruit waste utilization and millet consumption should be imparted among the farming community, at large scale.

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Use of Artificial Intelligence in Agriculture and Allied Sectors

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Artificial intelligence is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to those that are even more complex. The goals of artificial intelligence include learning, reasoning, and perception. By 2050, the world population is expected to reach 10 billion. According to the Food and Agriculture Organization of the United Nations (FAO), crop yields need to increase by 60% to meet the demand for food by 2050. But the growing population is putting considerable pressure on the agricultural sector to increase crop production and increase yields. To address the looming food shortage in the coming days, two approaches are in sight. One is to expand land use and encourage large-scale farming and the other is to adopt innovative practices and leverage technological advances to increase productivity in existing agricultural lands. Only if these two programs reach the farmers at the field level can we provide food to the people in the coming days. Every season new technologies are designed to improve crop efficiency and capitalize on the crop. Apart from this, using the power of artificial intelligence in agriculture, cultivation methods, innovative machines and technologies are becoming available to the farmers. Such artificial intelligence should also reach small and marginal farmers, which will be more favorable to cultivation of crops and everyone will get enough food.

Benefits of Artificial Intelligence in Agriculture

Day by day the cultivation sector breaks new ground. Every industry has opportunities for innovative ideas. The world is making rapid progress in agricultural technology. In addition to this, artificial intelligence is also coming closer to cultivation, and revolutionary changes are being seen in cultivation. Analysts predict that the introduction of this artificial intelligence will solve many farming challenges and helps to reduce many of the disadvantages of traditional agriculture.

Planning in agriculture with artificial intelligence data base

Artificial intelligence based predictive analytics is already paving the way for agri-based businesses. It predicts the prices of national and international markets by processing more data in less time with the power of artificial intelligence. Ensures access to precision agriculture products to farmers. It advises the farmers from time to time on the right from seed sowing to harvesting. It also helps in monitoring weather conditions and recommending doses of fertilizers and pesticides. Irrigation, timing of harvest, pesticides, helps identify areas in the crop that require treatment. Minimizes resource usage along with innovative agricultural practices, reduced use of herbicides, improved crop quality and significant cost savings will contribute to higher profits.

Cost savings through artificial intelligence

Artificial intelligence aims to improve agricultural yields. Combined with AI, precision agriculture can help farmers grow more crops with fewer resources. In agriculture, Ux uses best soil management practices, technology and highly effective data management techniques to increase yield and reduce cost.

Impact of Automation in Agriculture

Labor shortage is not new as agricultural work is difficult. Automation provides a solution without the need to hire more people. The new wave of digital automation will once again revolutionize the sector.

AI systems are being used from cultivation to harvesting

There are many benefits of implementing an artificial intelligence programme. Implementation of already developed programs will facilitate many tasks in the agricultural sector. AI can collect and process big data to determine and initiate best practices in cultivation through AI. Let's look at some common use cases for AI in agriculture, for example.

Optimizing Automated Irrigation Systems

Combined with AI (Internet of Things) sensors that monitor soil moisture levels and weather conditions, they can determine how much water to provide to crops at what time. An autonomous crop irrigation system is designed to conserve water while promoting sustainable agricultural practices. Analyzing the data through an AI algorithm, the leak can be quickly detected to reduce water losses to a large extent. Machine learning models can detect specific signatures of leaks, such as changes in water flow or pressure. AI incorporates weather data along with crop water requirements to identify areas of high-water use. By automating leak detection and providing alerts, AI technology can help farmers conserve resources by increasing water efficiency.

Role of Artificial Intelligence in Crop and Soil Monitoring

Excessive use of fertilizers harms not only the soil, but also the crops and the people who eat them. AI knowledge of such imbalances in soil and cultivated crops can identify nutrients and determine their effects on yield so that farmers can easily make necessary adjustments, computer vision models can monitor soil conditions to collect accurate data. Recently, AI has been able to accurately track the stages of wheat growth and the ripeness of tomatoes with a speed and accuracy that no human can match.

Detection of diseases and pests in cultivation by AI

A computer vision of soil quality and crop growth can detect the presence of pests or diseases. AI is used to scan images to find threats to crop health such as pests, diseases and viruses. It also helps farmers to eradicate or prevent the spread of disease. But for this to work, first of all, detailed images of all kinds of insects, diseases and pests are required.

AI helps to spray fertilizers and pesticides

Recently, pesticides and fertilizers can be sprayed, helping to target specific areas. Powered by AI, drones use computer vision to indicate how much pesticide and liquid fertilizer to spray in each area.

Weeding and harvesting

Robots can be programmed for robotic process automation (RPA) tasks such as weeding, using

computer vision to analyze the size, shape and color of leaves to identify and separate weeds in cultivated crops through machine learning. The robot is already used effectively.

Method of reporting crop yields

Yield mapping uses your algorithms to analyze large datasets in real time, helping to understand crop patterns and characteristics. 3D mapping takes techniques like data from sensors and drones and provides more accurate analysis with the use of algorithms. Where and when to sow seeds for future farmers. Also helps in knowing how to allocate resources for best return on investment.

Processing and Grading

After achieving the yields, good quality must be graded to fetch higher prices in the market. But it's sorting and grading processes are time consuming and costly. However, AI can make this process more precise. Computer vision can grade crop products based on shape, size and color. It enables farmers to divide their produce into grades.

Challenges of AI in Agriculture

AI and computer vision technologies are changing the way we grow crops and improving crop yields. While potentially revolutionary, there are also challenges and limitations to consider. Many people believe that AI only applies to the digital world, regardless of physical farming tasks. This assumption is usually based on a lack of understanding of AI tools. I believe many people don't fully understand how AI works, especially those in technology-related fields, leading to slow adoption of AI across the agricultural sector.

Monitoring Livestock Health with Artificial Intelligence

Health problems are easier to identify in livestock than in crops. Yes, it is possible through AI. For example, a company called Jeff Srivajueva has developed a solution that uses drones, cameras, and computer vision to remotely monitor livestock health. It uses Cattle Eye AI and ML solutions to identify typical cattle behavior, calving, environmental conditions on cattle as well as the impact of feed and provide valuable insights. This knowledge can help

farmers improve livestock welfare to increase milk production. Cattle Eye is the world's first hardware-independent autonomous cattle monitoring platform. It uses a low-cost security camera to capture video footage and provide insights into the health and productivity of your livestock.

Challenges and limitations

- ✓ High cost of technology system. This is burdensome for small farmers.

- ✓ Significant investments in technology, infrastructure and training are required.
- ✓ Data on crop growth and weather conditions are not available in all regions. This limits the effectiveness of AI-based solutions.
- ✓ For example, it can be used to track farmers' activities as drones and satellite imagery are used to collect data on crop health and growth. Thus, raising privacy concerns.

* * * * *

Natural Farming a Promising Sustainable Farming for Soil Health- A Case Study

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Details of the farmer

Name of the farmer Shri. Bharatbhai Nanubhai Patel farm name: Nandanvan Prakrutik krushi Kendra, At. Sanvalla, Faliya- kumbhar faliya, Ta. Mahuva, Di. Surat, Via- satem, Pin code- 396466 Mob. no. 9979909708, 9265654104.

Area under NF: 1.05 ha, Field Crops: Mango, Sapota, Ginger, fodder grass, Sugarcane Back yard- fish aquarium, indigenous cow husbandry, Gir cow: 15 cows

New Initiative in Natural farming

Enhancement of soil health through incorporation of decomposed farm inputs materials;

- Crop rotation, mixed crop, inter crop, cover crop, trap cropping and recycling of crop residues;
- Mulching with farm residue wastes whenever and wherever possible;
- Encouraging proper soil aeration;
- Priority to locally adopted seeds and varieties
- Frequent use of specific catalysts to boost soil fertility, crop vigour and induce immunity in crops

New Practices Natural in Farming

- *Bijamrita* and *Jeevamrita*
- *Ghanjeevamrith*, *Achadan*, *mixed cropping* etc.
- Use of these *Jeevamrita* is a best model in natural farming agriculture which is becoming popular among farming community. In fact these preparations, obtained by active fermentation of desi cow urine (Indigenous cow) & pulse flour over specific duration. The basic components are cow dung, forest soil and water. For enhancing their affectivity pulse flour are used.

Results

Improved Soil texture and soften the soil, Cost of cultivation is reduced, Farming income increased, Production of good & quality agriculture products,

Currently; In his area (Village “Sanavalla” and surrounding area) about 300 farmers adopted Natural farming and gain good farm production.

Technology modified

Indigenous cow products are the basic components are used to improve its efficacy and also minimize the off odour.

Mulching pertains to covering of soil surface, tree basin with a thick layer of locally available biomass. This prevents soil erosion, water loss, suppress weeds, maintain soil temperature fluctuation, and improve organic carbon content of the soil. Mulching modify the micro-climate of rhizosphere soil conducive for plant growth and better activity of soil microbes.

Table 1: Cost of cultivation- Rs/ ha., Total production-q/ ha., Gross Income- Rs/ ha, Net Income. Rs/ ha

Year	Production	Cost	Income	Net profit
2015	1000*50	25,000	50,000	25,000
2016	1350*60	17,000	81,000	64,000
2017	1770*65	15,300	1,05,600	90,300
2018	1800*70	13,000	1,26,000	1,13,000
2019	2050*65	13,000	1,33,250	1,20,250
2020	2010*70	13,000	1,40,700	1,27,700

Table 2: Production quantity of Intercrops

Year	Turmeric (kg)	Brinjal (Kg)	Fodder grass (Kg)
2015	210	500	1100
2016	300	600	1700
2017	350	600	2000
2018	470	620	2200
2019	550	650	2500



Fig 1: Activities At Nandanvan Gir Cow Savrdhan Kendra-Sanvalla

Improvements: For good productivity; butter milk and other bio insecticides, bio control use for production and improve quality of product example: Tulshi Ark, Neem Ark, Drumstick ark, Bramastra, Javaran, Udhai (Termite) Niyantaran, Agniashtra, Gauv mutra ark, Sarpghandha ark.

Horizontal effect: New innovative farming system in south Gujarat more than 300 farmer's successful trial has been conducted in our area. Recently our prakrutik krushi kendra conducted with five Krushi Kendra Gosthies viz., Tankal, Bodvank, Anaval, Velanpur etc.

New package of practices/ management strategies:

Saving of resources / inputs:

- (i) Recently in Gujarat state position free farming according mandate of Natural farming concepts standard example.
- (ii) Agri astra pungent base ingredients like chilli and garlic 5 kg paste and 10-liter guava mutra boil and make make Ark. quantity: in 15-liter pump 100ml ark.
- (iii) **Use: Agniashtra-** In vegetable crops it minimized pest attack and also basil plants leaf solution 1 pump (15 Lit capacity) to 100 ml results better leaf size and fruit quality.

- (iv) **Javaran-** various fruits juices and gauv mutra mixture: – javaran prepared fruit juices viz., mango, sapota, Guava, papaya 1 kg in 10 liter gau mutra (Cow urine) mixed thoroughly and keep it for fermentation and ready to use after fermentation.
- (v) **Use:** In 15 Liter pump use 100 ml for spray. It attracts honey bees and other pollinators so fruit's setting is good.
- (vi) Cow based farming's is new method of farming it requires dedicated work, natural farming products are preferred by the consumers and fetching good prices for the farmers. farmers are selling their products on their own brand name
- (vii) Soil health and nutrient status improved, microbes developed in soil, indigenous earth worm develop in soil and honey bees and other pollinators activity increased in the farm.
- (viii) Earlier high cost was incurred due to use of chemical pesticides and fertilizers.
- (ix) 7-8 years ago farming was burden due to high cost incurred in chemical, but now use of indigenous cow dung, cow urine, butter milk, jiggery, natural fruit juice use of bio wastes as fertilizer be much helpful for farming.

Extent of publicity of his innovations

Advertisement through mass media (Print and TV) Nandanvan Gauvshala Gir cow culture has been widely covered in the area, groups like Gujarat mohuva prakrutik krushi group, Anaval prakrutik group etc. and many Whatsapp group used for advertisement and we received good feedback for our work and information of new innovation has been appreciated lot and many shared new skill activities through mobile. Nandanvan Gir gauv shala "Sanvalla" B. N. Patel named on you tube channel we are posting different farming and husbandry experiments, video documentary film regularly. Our innovative prakrutik krushi method article, newspaper South Gujarat and Divyabhaskar, Gujarat mitra newspaper publisher took note of our activities.

Mechanization and Automation in Fruit Harvesting: Challenges and Opportunities

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The process of use of artificial power operated devices to control movement and performance specific action is usually called as mechanization. When operations of these devices are controlled by computers and sensors, it termed as automation. The mechanization and automation of horticultural operations is perceived imperative today as not only yield could be increased by this but also losses can be prevented to a greater extent. The future prosperity of fruit growers thus heavily relies on the improvement of production and processing practices by integration of mechanization and automation in orchard management. The shift towards mechanization is also a need due to alarming rate of rural migration which is creating larger shortage of labour in the horticulture production systems. Additionally, the growth of urban employment and enhancements in quality of life is further underscoring the necessity for mechanization in the horticultural landscape.

Challenges in mechanization of fruit orchards

Mechanization and automation have brought significant advancements to fruit orchards, especially in the developed world by revolutionizing the way, the tasks are performed and efficiency in production is achieved. However, despite the numerous benefits, there are challenges that come with the implementation of mechanization in fruit orchards. One of the major challenges is the variability and delicacy of fruit. Different fruits require different handling processes. The diverse shapes and sizes of fruit trees make it challenging to develop machines and equipment that can effectively harvest fruits without damaging fruit trees. A critical consideration when developing harvesting machines is to ensure the detachment and collection of fruit from the tree with standards necessary for market acceptance. The sensitivity of tree fruits further complicates this task, as they are prone to damage, and any harvested fruit must adhere to strict market acceptance criteria regarding size and external defects, such as bruising and punctures. Thus, mechanized harvesting is more

difficult to implement for fresh market fruit because of the lower tolerance for bruising and external defects. Mass mechanized harvesting has not therefore yet reached commercial viability for fresh market tree fruit, primarily because of excessive fruits damage.

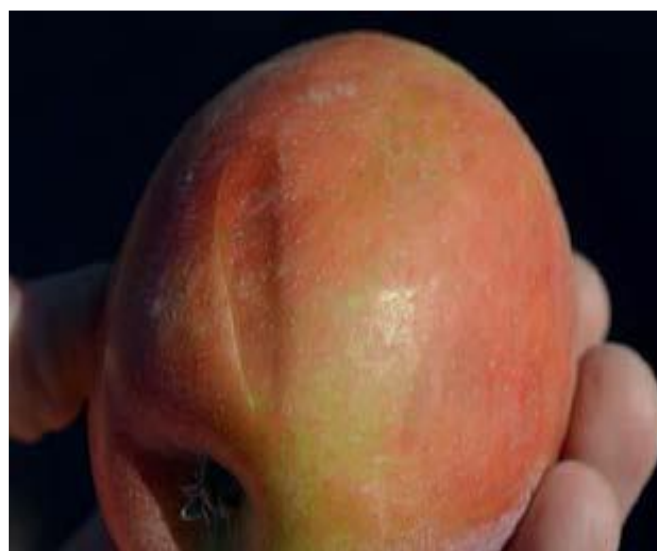


Figure 1: Harvest-induced fruit damage in apples.

(Source: De Kleine and Karkee, 2015)

Orchard Physiographic and environmental Challenges

Challenges in mechanization and automation

in fruit orchards are also often rooted in the complexity of orchard physiography and environments. The uneven orchard terrain and changing weather creates problems for the consistent operation of machines. Under the natural growing conditions, many of the robotic machines do not perform. Further, non-uniform lighting ranging from direct sunlight to overcast & twilight conditions, variable

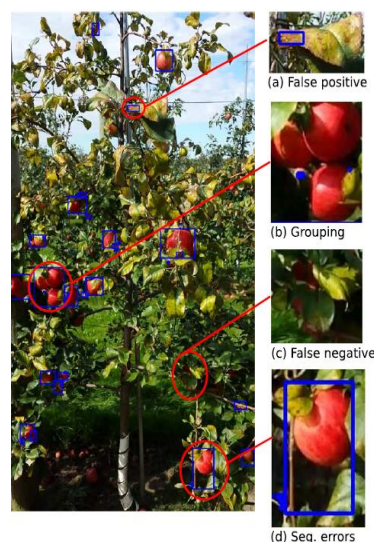


Figure. 2: Errors in fruit detection

(Source: Häni et al., 2020)

sunlight to overcast & twilight conditions, variable

temperature & humidity, wet & dry conditions, variable fruit sizes and fruit maturity, non-uniform plant size, fruit position, fruit occlusions and limb obstacles affects the automation aspects of the mechanically automated machines or robots that otherwise tend to perform well in controlled environment, where the position and orientation of the target are known or targets can be set up in the desired position and orientation. Lack of appropriate cultivation practices further cause canopy occlusions and harvesting failure for mechanized/robotic activities.

Economic implications of mechanization and automation

One of the biggest hindrances in mechanization and automation is high initial investment cost for specialized machinery and equipment. It makes the implementation of mechanization and automation in fruit orchards unaffordable. The introduction of mechanization and automation in fruit orchards also brings about challenges related to the workforce. As automated systems and machinery begin to take over repetitive and physically demanding tasks may occur concerns about the displacement of manual labor and the re-training and re-skilling of the existing workforce. This transition requires significant investment in human resource management and training programs to ensure a smooth shift to mechanized and automated orchard environment.

Opportunities

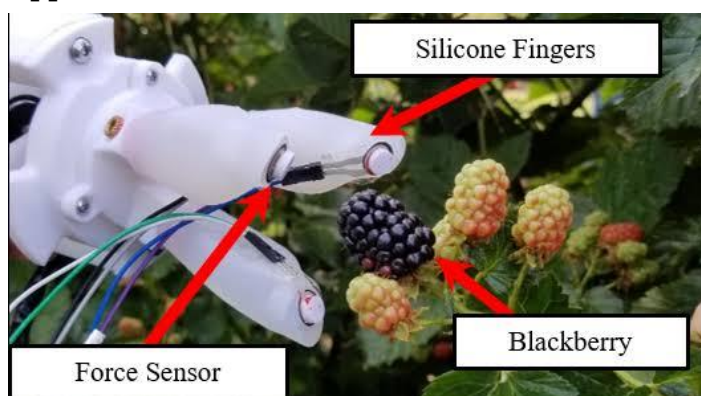


Figure 3: Soft robotic gripper for berry harvesting.
(Source: Gunderman et al., 2022)

The challenges associated with the orchard mechanization and automation also present

opportunities for innovation and advancement in the horticultural industry. For example, the development of specialized robotic arms and grippers designed to handle delicate fruits can lead to more efficient and gentle harvesting processes. Moreover, advancements in machine learning and artificial intelligence can be utilized for improving the accuracy of fruit detection, sorting and increasing overall productivity by reducing losses. Furthermore, the development of modular and adaptable equipment allows for the customization of machinery for different types of fruits.

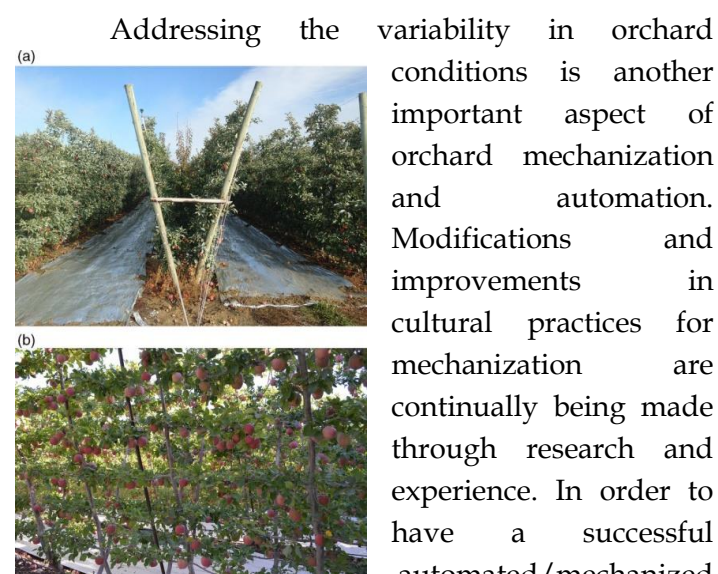


Figure 4: (a) V-trellis and (b) vertical trellis
(Source: Silwal et al., 2016)

Addressing the variability in orchard conditions is another important aspect of orchard mechanization and automation. Modifications and improvements in cultural practices for mechanization are continually being made through research and experience. In order to have a successful automated/mechanized system, the cultural practices need to be in machine friendly manner. Other major aspects related to cultural practices that affect fruit mechanical harvesting include plant population & spacing, and plant shape & size of the trees. Modern orchard system such as V-trellis; the branches are fixed on the trellis wire, allowing for the fruits to be distributed along the same wire can significantly avoid the occlusion of the fruits by branches and leaves thereby improving the reorganization efficiency and accuracy. Also, precision agriculture technologies, such as GPS-guided machinery and drones need to be integrated into orchard operations to improve the efficiency and accuracy of tasks like pruning, spraying, and harvesting. These technologies may help to optimize the use of resources and reduce the impact of orchard variations on farm operations.

The way forward

Recently, there has been a major breakthrough in development of electronic nose which can sense the aromatic compounds emitted by a ripening fruit through the use of volatile sensing of chemical markers. Such devices can be deployed for deciding the optimal maturity index of different fruits. For example, in mango, the level of limonene, pinenes, carenes, terpenes etc. associated with fruit ripening is being detected by the use of Molecular Imprinted Polymer (MIP) based sensors. Further, Quartz Crystal Microbalances (QCM) is now being tested for distinguishing the different volatile gases emitted by the ripening fruit. For development of input and resources efficient fruit production, need is there to find new ways to utilize information technology, sensors, bio-informatics and autonomous machines. Mechanization and automation module has the potential to take horticulture to new heights but it can be achieved with right coding of the machines and that right coding require precise information in plant function and responses to variable growing conditions. Therefore, integration of STEM (Science, Technology, Engineering and Mathematics) disciplines with pomology is needed to become competent in producing more while leaving smaller

environmental foot prints. Additionally, investment in research and development to continually improve and adapt technologies to the unique requirements of orchard operations is crucial. By investing in ongoing innovation and collaboration, the challenges in orchard mechanization and automation can be effectively translated into fruitful future.

References

- De Kleine, M. E., & Karkee, M. (2015). A semi-automated harvesting prototype for shaking fruit tree limbs. *Transactions of the ASABE*, 58(6), 1461-1470.
- Gunderman, A. L., Collins, J. A., Myers, A. L., Threlfall, R. T., & Chen, Y. (2022). Tendon-driven soft robotic gripper for blackberry harvesting. *IEEE Robotics and Automation Letters*, 7(2), 2652-2659.
- Häni, N., Roy, P., & Isler, V. (2020). A comparative study of fruit detection and counting methods for yield mapping in apple orchards. *Journal of Field Robotics*, 37(2), 263-282.
- Silwal, A., Karkee, M., & Zhang, Q. (2016). A hierarchical approach to apple identification for robotic harvesting. *Transactions of the ASABE*, 59(5), 1079-1086.

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Bee Keeping in Intensive Agriculture: Impact of Agrochemicals

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Abstract

Application of agrochemicals for the management of pests, diseases and weeds are inevitable in the intensive agriculture. These agrochemicals applied on the crop land cause adverse effect to the bees and bee keeping practices. Since honey bees considered as ecological indicator, complete eradication of honey bees intern leads to miserable failure of agriculture and pose threaten to food security. Review on impact of agrochemicals is necessary to know the status of beekeeping in intensive agriculture area and to derive the concrete decision or policy decision on use of agrochemicals in the intensive cropping area.

Introduction

One-third of the total human food supply depended on animals and insects, including honey bees pollination. Farmers use different external inputs, including pesticides, to grow subsistence and commercial crops of different varieties for agricultural crop maximization. Honeybees are economically essential insect pollinators in all over the world. Production of agriculture crops is increasing up to 50 through pollination processes by the honeybees. In addition, the unpredictable vagaries of weather parameters that could affect flower production. Further, another threat is agrochemicals which are regularly used over large areas of crops, fruit groves, forests and other environments for the management of weeds, insect pests and plant diseases. Broad spectrum fungicides and neonicotinoids are commonly used in agriculture and have been found in bee bread, beeswax and foraged environment. There was no doubt, the chemical insecticides could represent a serious threat to bees for the simple reason that bees are insects and, therefore, susceptible to any poison designed to kill insect pests. The decline of beneficial insects includes honeybees is a side effect of the practice of protecting crops against undesirable insects through pesticide use.

Flowers and foraging

The expansion of cultivation areas, especially fields planted with a single plant species, promotes the emergence of pests and diseases which make agriculture even more dependent on agrochemicals. These products enter the soil-water-plant chain and represent a direct and indirect dangerous source of contamination to bees, which, in their turn, contaminate their products. Bees are the most prolific pollinators in nature. They spend the majority of their time searching for pollen and nectar as they are the main sources of food for themselves and their young. Foraging honey bees may fly 2–5 miles (3.2–8 km) from their colony in any direction in search of resources. Flowers that have evolved to attract bees as their main pollinators often are full of nectar and colored bright white, yellow, or blue. Temporal and spatial variation of flower resources affects foraging decisions of wild and honey bees. Field bees are the individuals most likely to be exposed to pesticides because they forage outside the hive. While foraging, honey bees collect pollen from flower anthers and nectar from plant blossoms and extra-floral nectarines. Honey bees typically forage during daylight hours when temperatures are above 55°F (12.8°C), and they reduce their activity at dawn and dusk and during inclement weather.

Influence of agrochemicals

Honey bees play a vital role in crops, wildflowers pollination. Pesticide refers to a wide range of compounds including insecticides, herbicides, fungicides, rodenticides, molluscicides and plant growth regulators. In recent years, honey bee populations have been declining worldwide due to regular exposure to various agrochemicals such as herbicides, fungicides, acaricides and most importantly insecticides. A single droplet of insecticide may be sufficient to kill a bee because the spray solutions contain concentrated doses of these chemicals. The more attractive yellow flowers are

canola (rape seed oil), sunflowers and many weeds that grow in and around the crops compared to flowers of potato. Pesticide sprayed on the above-mentioned crops have residues in pollen and nectar are taken by the forager bees to their colonies and remain in the beebread and honey for quite some time. These residues are then fed to the larvae and the queen, which are affected in similar ways as the forager bees. Honey bees, bumblebees and wild bees like to drink from puddles, irrigation ditches, ponds and streams, and if these waters are contaminated with pesticide residues, the forager bees ingest them as well. In this case, bees come in contact with the high residue levels present on the waxy cells of the comb, affecting mainly the developing larvae and presumably the adult honey bees and the queen. Despite, many studies have revealed that honey bee (*Apis mellifera* L.) larvae are posing a high risk on exposure to pesticides. As a fungicide, chlorothalonil may affect the fungal community in the honey bee gut. Bees are very vulnerable to agrochemical stress because they have a limited number of detoxifying enzymes compared to other insects. Even if agrochemicals do not cause the immediate death of bees, they may have sub-lethal effects on them, such as disrupting their foraging ability and making it more difficult for them to return to the colony, or they may bring agrochemicals back with them, weakening or even causing territorial mortality. Different classes of insecticides namely neonicotinoids, pyrethroids, chlorantraniliprole, spinosad, flupyradifurone and sulfoxaflor not only negatively affect the growth and development of honey bee but also decrease their foraging activity and pollination services by influencing their olfactory sensation, memory, navigation back to the nest, flight ability, and dance circuits etc

Toxicity of pesticide

The term biocide is reserved for broad-spectrum poisons that kill any organism, mainly microbes, but also large animals. Beekeepers should be wary of any insecticide application in the vicinity of their hives because spray drift could certainly inflict a heavy toll on the bees because by their nature, insecticides are the most toxic compounds to honey

bees. Like other animals, bees are endowed with detoxification mechanisms that transform, eliminate most toxic chemicals. The majority of organic pesticides are degradable either in the organisms themselves or in the environment some exceptions are organochlorine pesticides (DDT and lindane), which are very persistent and recalcitrant. Due to their application in large quantities during past decades, their residues are still present although at low levels in the soils. Systemic insecticides, such as neonicotinoids (e.g. imidacloprid) and fipronil, are more toxic and persistent than the majority of organophosphorus (e.g. malathion), carbamates (e.g. carbofuran) and pyrethroids (e.g. cypermethrin). The toxicity of certain insecticides can be enhanced in the presence of ergosterol-inhibiting fungicides (e.g. propiconazole, myclobutanil), which act as synergists.

Given the enormous variety of agrochemicals used in crop production, it is not surprising that, to date, residues of 173 different compounds have been found in apiaries. It should be realized that through the various routes of exposure to pesticides in the environment, bees are not threatening by one or two chemicals alone but by cocktails of many agricultural compounds. The activity of some pyrethroids is enhanced by fungicides classified as ergosterol biosynthesis inhibitors while the fungicide propiconazole increases the toxicity of the pyrethroid insecticide, lambda-cyhalothrin, when the two are mixed. Chronic exposure to acetamiprid was found to have an effect on the expression of genes related to immune, detoxification, and memory in larvae and adults of bees.

Chronic pesticide exposure may include lethal and sublethal effects on the brood, workers, drones, and queens, who may be killed or rendered infertile. Sublethal effects of pesticides include physiological effects that impact enzyme activity and brain activity that led to impairment of olfaction, learning, and memory. Fipronil's high toxicity is due to the mechanism which interferes with the functioning of the neurotransmitter GABA (amino-butyric acid) and which breaks the normal neuronal influx (chloride ions passage), causing excessive excitation, severe paralysis and death. Commercially known as Regent,

the insecticide fipronil belongs to the pyrazole class used to control agricultural pests. Nevertheless, the agrochemical affects non-target insects and causes the mortality of important pollinators such as *Apis mellifera* L.

Decline of pollinators

Over the past few decades, we have seen a measurable loss in the number of both managed and native bee populations, along with a decline in butterfly populations. We depend on pollination for many of our staple foods, as do many other organisms. Approximately one-third of the food produced globally is dependent on pollinating insects. It is estimated that pollinators contribute \$24 billion to the agricultural economy. The decline in pollinators can be attributed to many different factors. Land development often greatly reduces or eliminates habitats needed by pollinators. Insecticides are highly toxic to bees and butterflies. Herbicides used by farmers and homeowners kill many of the flowering plants bees and butterflies depend on. Inadequate diets, loss of genetic diversity, and parasitic mites in managed honey bee colonies may also play a role in their decline.

Bees poisoning may occur by contact or ingestion during flower visiting. During forage, bees get in touch with different groups of agrochemicals, such as insecticides, fungicides, acaricides and herbicides. However, the effect of insecticides on the pollinator fauna of agroecology systems has been well shown and is directly responsible for the decline of bee populations and indirectly for economic losses owing to the population decline of pollinators. Agrochemical group of insecticides acts directly upon the nervous system and causes over activity of neurons, or rather, those connected to learning and memory, and, as a consequence, may change brain structures with paralysis of leg, wings and digestive tract. Insects stop consuming water and food and, consequently, die from starvation or dehydration. The effect of insecticides on the agro-ecosystems pollinator wildlife

has been well evidenced, being directly responsible for the reduction of bee populations and indirectly for economic losses as a result of the insects' population decline.

Conclusion

Farmers should minimize the contamination of insecticide, fungicide and herbicide (higher doses, repeated use, combined application) to the surrounding landscapes, including water bodies, because not only affect the honey bees but also a large array of pollinator species (e.g. butterflies, bumblebees, hoverflies, etc.).

References

- Francisco Sanchez-Bayo and Koichi Goka. 2016. Impacts of Pesticides on Honey Bees. Beekeeping and Bee Conservation - Advances in Research.
- Bergero, M.; Bosco, L.; Giacomelli, A.; Angelozzi, G.; Perugini, M.; Merola, C. Agrochemical Contamination of Honey and Bee Bread Collected in the Piedmont Region, Italy. Environments 2021, 8, 62.
- Lu Y, Gao J, Wu T, Han B, Qian B, Shi M, Yang S, Diao Q, Bu C and Dai P (2023) Exposure of chlorothalonil and acetamiprid reduce the survival and cause multiple internal disturbances in *Apis mellifera* larvae reared in vitro. Front. Physiol. 14:1114403.
- Hang Zhao, Guilin Li, Xuepei Cui, Hongfang Wang, Zhenguo Liu, Yuewei Yang, Baohua Xu, 2022, Review on effects of some insecticides on honey bee health, Pesticide Biochemistry and Physiology, 188, 105219, ISSN 0048-3575.
- Marcela Pedraza Carrillo, Thaís de Souza Bovi, Adriana Fava Negrão and Ricardo de Oliveira Orsi. 2013. Influence of agrochemicals fipronil and imidacloprid on the learning behavior of *Apis mellifera* L. honeybees, Acta Scientiarum Animal Sciences Maringá, 35, (4): 431-434.

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From Small Farmer to Dairy Entrepreneur: Saga of Assiduousness

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Name of Farmer Mr. Chanan Singh
Address Village Gharyala, Patti, Tarn Taran
Contact Number 9814511190
Age 46 Years
Education 10th
Size of land holding (in acre) 3 Acres

Journey Towards Establishing Dairy Venture

Mr. Chanan Singh, Village Gharyala, District Tarn Taran, was a traditional farmer, practising Rice-Wheat crop cycle in his 3.0 acres land. Besides, his family has been involved into dairy farming at small scale. However, the expected profit level was not attained by the farmer, since lower market price for selling raw milk produced at his household as well as the family was not familiar with scientific milk processing techniques. During Covid-19 Pandemic in August, 2020, this farmer visited to Krishi Vigyan Kendra, Booh, Tarn Taran and discussed his problem with Home Scientist. After assessing the background, the Scientist organized a need-based vocational training course entitled "Insight different techniques for value addition of Dairy Produce for self-employment" at Home Science Laboratory, KVK, Tarn Taran for 10 trainees, following the Covid-19 guidelines. Under this training programme, the beneficiaries have obtained hands on experiential learning on diverse value added technologies for milk,

as per the recommendation of Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana and developed their skill in dairy value addition. Further, KVK Home Scientist also visited their prospective location of dairy processing unit and guided them regarding various critical points to be considered during the processing of milk, as being the highly perishable food commodity. She also motivated the group to augment their income by dairy waste utilization by preparing value added whey drinks.

Table 1. Detailed economics of Milk processing unit

1	Name of Intervention	Dairy Processing	
2	Area under intervention	Home Science (Food and Nutrition) Animal Science (Livestock Production)	
3	Crop Rotation followed	Processing of raw milk to value added dairy products	
4	Gross Income (Rs.)	a) Farm Income	2,91,526.00
		b) Milk Sale Income	87,884.00
		c) Dairy Processing Income	24,70,520.00
		Total	28,49,930.00
5	Cost of Production (Rs.)	a) Agricultural cost	87,750.00
		b) Milk production cost	46,135.00
		c) Dairy processing cost	19,54,520.00
		Total Expenditure	20,88,405.00
6	Net income (Rs.)	a) Farm Income	2,03,776.00
		b) Milk Sale Income	41,749.00
		c) Dairy Processing Income	5,16,000.00
		Total	7,61,525.00

In December, 2020, Mr. Chanan Singh started preparing a variety of value-added milk products *viz.* Paneer, Badaam Milk, Flavoured Whey, Flavoured Milk, Butter, Ghee etc. and selling these at his village in a retail milk outlet named as "Kisan Milk Trading Company". In February, 2021, the farmer had improved raw and processed milk quality under the guidance of Animal Science and Home Science experts

through adopting scientific dairy farming and dairy processing techniques. By end of the year 2021, a proposal on "Formation of Farmer Producer Organisation (FPO) of Dairy farmers at border area of district Tarn Taran Sahib, Punjab, India" was submitted to National Bank for Agriculture and Rural Development by Animal Scientist and Home Scientist, which got sanctioned to KVK, Tarn Taran. Under this project, Kisan Milk Trading Company was converted into FPO and now, registered as "Gharyala Dairy Producer Company Limited" including Mr. Chanan Singh and other trainees as Board of Directors for their advanced training in Dairy Farming and value addition. Thus, following the KVK Home Scientist and Animal Scientist's recommendations, this farmer has achieved additional net profit of Indian Rupees 5,16,000/- per annum. Now, he is willing to expand his entrepreneurship venture with inclusion of heat desiccated milk products and frozen dairy desserts, in which KVK Scientists will abet this group for further reconciliation of demanded technologies, through having their orientation at different departments of the College of Dairy Science and Technology at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana.



Fig. 1: S. Chanan Singh's and team during training and at their established FPO

Conclusion

It can be scrutinized from above description that scientific guidance has been proven as an asset in augmenting income of small and marginal farmers. Hence, on large scale, awareness programmes can be organized among the farming community and Farmer Producer Organization should be initiated at certain village clusters to promote Scientific Dairy Farming and Organized Dairy processing sector. It brings an ecstasy to mention that this collaborative initiative undertaken by Krishi Vigyan Kendra, Tarn Taran and Gharyala Dairy Producer Company Limited will, further, contribute towards the welfare of dairy farmers and unemployed rural and semi-urban youth.

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Fall Army Worm- A Devastating Pest of Sorghum Crop

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Sorghum (*Sorghum bicolor* L. Moench) is the fifth most important cereal crop after rice, wheat, maize and barley. It constitutes the main food grain for over 750 million people who live in the semi-arid tropics of Africa, Asia, and Latin America. India ranks fifth in total sorghum production with 4.23 million tones grown in area of 3.90 million hectares in 2021-22. (agricoop.nic). Sorghum grains are used for human consumption purposes (55%) and also for livestock feed (33%). Few cultivars of Sorghum are also employed in ethanol and fuel production (www.icrisat.org). This is the main source of income for the marginal farmer in many parts of the Indian country who cannot invest much in other commercial crop cultivation. During the year 2018 due to the invasion of alien destructive pest fall armyworm (FAW) *Spodoptera frugiperda* (J.E. Smith) (Order: Lepidoptera; Family: Noctuidae) in India, excessive loss has been reported in the country. It is considered to be a serious pest which feeds on more than 80 crop species. Next to maize, sorghum is the most affected crop by fall armyworm. It is a major pest of sorghum crops and can cause severe damage to the crop if not controlled in time. In this article, we will explore the different methods of integrated pest management that can be used to control sorghum fall army worms.

Most Affected States

The pest is found throughout the country, but the most affected states are Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Telangana

Life Cycle of Fall Army worm

The life cycle of a fall armyworm consists of four stages: egg, larva, pupa and adult. The larva or nymphal stage is the most damaging stage of the pest. The adult moth is able to move over 100 km per night. It lays its eggs on plants, from which larvae hatch and begin feeding. The female moth can lay up to a total of 1000 eggs in her lifetime. The eggs of FAW are white in color and later turn into brown. They hatch in 2-3 days. The larvae has six stages initially larvae are green in color, but as they grow, they become brown with longitudinal stripes. Inverted “Y” shaped

marking can be seen on the face of the mature larva. Pupation normally takes place in the soil, at a depth 2 to 8 cm. The larva constructs a loose cocoon, oval in shape by tying together particles of soil with silk. Cool, wet and spring weather favors the growth and development of fall armyworm.

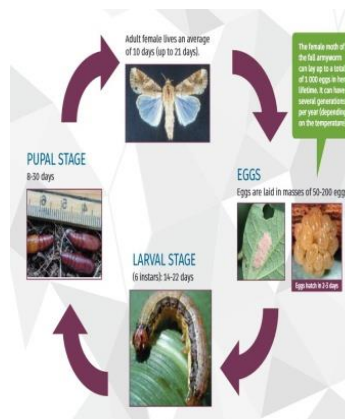


Fig 1: Life Cycle of Fall Army worm



Fig 2: Fall Army worm damage in Sorghum

Type of Infestation

Sorghum army worm infestation can be classified into two types: sporadic and epidemic. Sporadic infestations occur in isolated areas and are generally not widespread. Epidemic infestations, on the other hand, are widespread and can cause significant damage to the crop by feeding on all parts of the plant.

Symptoms of Sorghum Fall Army Worm

The damaging symptoms of Sorghum army worm infestation are as follows:

- **Elongated papery windows:** Initially larvae of sorghum fall armyworm feeds on leaf tissues, leaving only a thin translucent layer of tissue intact known as window feeding.
- **Ragged edged leaves:** As the larva grows, its feeding habits result in the development of ragged edged holes on the leaves that vary in shape from round to oblong.
- The larvae of sorghum FAW excrete a large amount of frass, which can accumulate on the leaves.

- Severe infestation of sorghum fall armyworm can result in defoliation.
- They can also damage the reproductive parts of the sorghum plant.

Control Measures

A combination of different control measures is often important to effectively manage fall armyworm infestation in sorghum plants. The following are some of the commonly used IPM practices for controlling fall armyworm,

Cultural Measures

- Deep summer ploughing of fields exposes larvae and pupa of sorghum fall armyworm, which are located in the soil, to birds and high temperatures.
- Crop rotation with non-host crops helps to reduce the fall armyworm population.
- Early planting can avoid peak populations of sorghum fall armyworm.
- Removing the weeds and other debris can reduce the incidence of armyworms.
- Harvesting early can avoid consistent damage.
- Proper nutrition management, including balanced fertilization and irrigation can also help to reduce the susceptibility of sorghum plants to fall armyworm attacks

Physical Measures

- Light Traps play a major role in trapping adult fall armyworm insects. Install light trap @ 1 number/ha at early stage of crop in the sorghum

Mechanical Measures

- Handpicking and destroying egg masses and larvae by crushing or immersing in kerosene water can reduce FAW damage.
- After the detection of FAW infestation in the field, the affected sorghum plants can be treated by applying dry sand to the affected whorl.
- Install FAW pheromone trap @ 5 numbers/ac can be used to attract and trap insects.

Biological Measures

- In situ protection of natural enemies by habitat management: Increase the plant diversity by intercropping with pulses, oil seeds and ornamental flowering plants which help in build-up of natural enemies
- Augmentative release of egg parasitoid *Trichogramma pretiosum* or *Telenomus remus* @ 50,000 per acre at weekly intervals or based on trap catch of 3 moths/trap.
- Spray Bio-pesticides like NPV 100 LE/acre or *Bacillus thuringiensis* var. *kurstaki* formulations @ 5g/l or *Nomuraea rileyi* 1g /lit of water in evening hours.
- Apply Azhadirachtin 1% EC @ 10,000 ppm or neem oil @ 5 mL/lit. as oviposition deterrent on one week after sowing.
- Erect bird perch @ 25-50 numbers/ha to attract predatory birds during early stage of the crop (up to 30 days) on feeding various larval stages of FAW

Chemical Measures

Chemical measures include the application of commercial insecticides to control sorghum fall armyworm.

- To manage 2nd and 3rd instars larvae having more than 10% foliar damage the following chemicals may be used up to early ear head stage: Emamectin Benzoate 5% SG 0.2 g or Chlorantraniliprole 18.5% SC 0.5 ml or Lambda cyhalothrin 5 EC 0.5ml per lit of water
- **Poison baiting:** Poison baiting is recommended for late instar larvae to prepare the bait, a mixture of 10 kg of rice bran or wheat bran and 2 kg of jaggery should be left to ferment in 2-3 litres of water for 24 hours. Half an hour before application in the field, 100 g of Thiodicarb or 250 ml of monocrotophos should be added to the mixture. The bait should then be applied to the whorl of the plants in the evening time.

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The sequence is assembled based on reference sequence available in the database. The process is easy and less tedious.

Binning

After assembly the process of binning can be done. Here we compare the unknown sequence to the already known gene sequence of the database and annotate them accordingly based on its close relationship. This helps to determine the group of microbes and its functional classification.

Gene Prediction and Annotation

Binning gives the rough idea about gene. Further computational analysis requires such as functional analysis and it helps to determine performance of a community in the ecosystem. Subsequently, the predicted protein sequence and function is matched to the protein database to predict its relatedness based on functional analysis for its functional classification.

Application of metagenomics

Metagenomics is useful for investigation of microbes in their natural environment. Various microbial community from environmental samples such as ocean, river, soil, glaciers and other samples can be studied. The study of genomics on a large scale has great advantages in medicine, agriculture, energy production and bioremediation.

Biotechnology studies

The massive uncultured microbes present in the environment can be tapped for new therapeutic molecules and biotechnological applications. The broad spectrum antibiotic Turbomycin A and Turbomycin B was retrieved from soil metagenomics library (Gillespie et al., 2002). Many microbes are useful for the development of novel genes, enzymes and chemical compounds for use in biotechnology. The extremophiles which survive in the various environments cannot be cultured artificially. These are used to derive unique enzymes. These active compounds can be identified by direct sequencing, sequence alignment, with database and functional analysis. These compounds can be used for the commercial development.

Ecological studies

These microbes are key players for maintenance of environmental stability. The microbes are key players of metabolic pathway gene such as energy acquisition, carbon and nitrogen metabolism. All the plant and animals have closely associated host which make necessary nutrients (Carbon, Nitrogen, Oxygen, and sulphur), metals, and vitamins available to them (Nadeem et al., 2018). We also rely on microbes for remediation of various endogenous toxins produced by them as well as the pollutants from exogenous sources (Dvořák et al 2017). Metagenomics explores new functional microorganisms and genes with high degradation efficiency of pollutants, their broad applicability and stable expression. Even in sewage treatment, it is being used for degradation of organic matter as well as removal of nitrogen and phosphorous. A variety of proteolytic enzyme can be used to degrade the pesticides (Zhang et al 2021). The microbial gene responsible for anaerobic degradation of aromatic compounds has been isolated from black sea sediment (Widdel et al 2007).

Healthcare and medical

The metagenomics could be applied in the field such as, identification of pathogenic microorganism and other infection. Various study has revealed the involvement of intestinal microbe with a variety of disease, autoimmune disease and tumour (Holmes et al 2011). At present, it is widely used for identification of antibiotic resistance bacteria and genes. Overall it is useful for high throughput gene level study of microbial community.

The metagenomics plays a vital role in diversity study, species composition identification, and evolutionary study. It is also being applied for wine making, farming. Various electroactive bacteria is being used for production of electrical energy from organic waste (Basu et al 2023).

References

- Alves L. D. F., Westmann C. A., Lovate G. L., de Siqueira G. M. V., Borelli T. C. and Guazzaroni M. E. (2018). Metagenomic approaches for understanding new concepts in microbial science. *International journal of genomics*, 2312987: 15.

- Basu A., Manna S. and Sil A. K. (2023). A new electro-active bacterium, *Paraclostridium* sp. AKS46, converts waste efficiently into electricity in microbial fuel cell. *Chemical Engineering Journal*, 475: 145626.
- Cavicchioli R., Ripple W. J., Timmis K. N., Azam F., Bakken L. R., Baylis M., et al. (2019). Scientists' warning to humanity: microorganisms and climate change. *Nature Reviews Microbiology*, 17(9), 569-586.
- Dvořák P., Nikel P. I., Damborský J. and de Lorenzo V. (2017). Bioremediation 3.0: engineering pollutant-removing bacteria in the times of systemic biology. *Biotechnology advances*, 35(7): 845-866.
- Gillespie D. E., Brady S. F., Bettermann A. D., Cianciotto N. P., Liles M. R., Rondon M. R., et al. (2002). Isolation of antibiotics turbomycin A and B from a metagenomic library of soil microbial DNA. *Applied and environmental microbiology*, 68(9): 4301-4306.
- Holmes E., Li, J. V., Athanasiou T., Ashrafian H. and Nicholson J. K. (2011). Understanding the role of gut microbiome-host metabolic signal disruption in health and disease. *Trends in microbiology*, 19(7): 349-359.
- Nadeem F., Hanif M. A., Majeed M. I. and Mushtaq Z. (2018). Role of macronutrients and micronutrients in the growth and development of plants and prevention of deleterious plant diseases-a comprehensive review. *International Journal of Chemical and Biochemical Sciences*. 14: 1-22.
- Widdel F., Musat F., Knittel K., and Galushko A. (2007). Anaerobic degradation of hydrocarbons with sulphate as electron acceptor. *Sulphate-reducing Bacteria*. Cambridge University Press, Cambridge.
- Zhang L., Chen F., Zeng Z., Xu M., Sun F., Yang L., et al. (2021). Advances in metagenomics and its application in environmental microorganisms. *Frontiers in microbiology*, 12: 766364.

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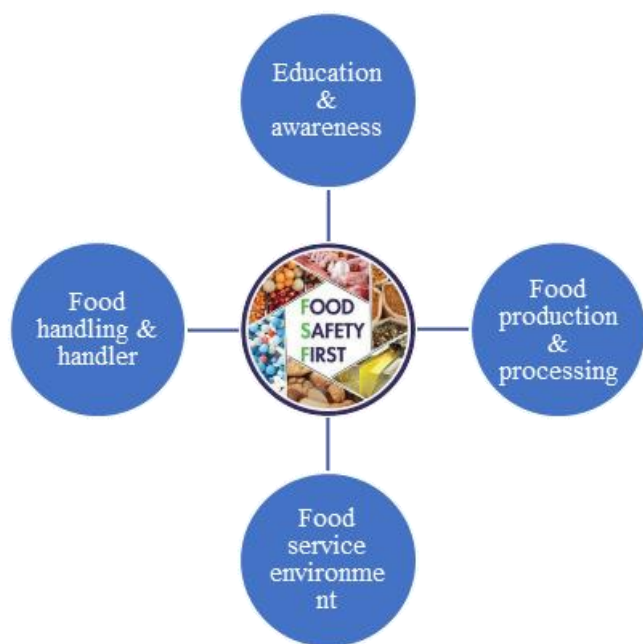
Ensuring Food Safety: A Vital Priority for Public Health

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Food is an essential constituent in human life. However, some foods can have harmful effects on the human body, potentially leading to life-threatening diseases. Food safety is an important component of public health and well-being that refers to the set practices or measures that seek to make ensure that consumed products are free from contamination, hazards among others. Food has the potential to spread diseases among people and also acts as a breeding ground for bacteria that can lead to foodborne illnesses. The global food environment has seen an increase in incidents of foodborne disease and contamination over the past few years, which ultimately leads to more effective ways of ensuring that our foods are protected. Food poisoning symptoms may vary but typically involve nausea, vomiting, diarrhea, abdominal pain, fever and muscle aches. In the worst cases food poisoning causes dehydration, failure of organs and death. Food safety is aimed at preventing foodborne diseases and ensuring the health of consumers. It includes different stages of the food production process, beginning from farm to table and including activities such as handling storage preparation distribution. Thus, effective food safety practices are essential for protecting the health and well-being of individuals.



Key components of food safety are

- **Source and Supply Chain Management:** Food safety starts at the point of origin. First and foremost, it is critical to ensure that raw materials and ingredients are sourced from reputable sources. Hygiene and quality standards should be adhered to by farms, fisheries as well as food processing factories. The traceability implemented in the supply chain allows to determine and quarantine possible sources of contamination. This is particularly important in the case of a food safety problem, as it enables specific recalls and prevents large-scale outbreaks.
- **Storage and Handling:** Storage and handling of food products are important aspects in ensuring that foods remain safe from contamination or spoilage. This includes ensuring that the appropriate temperature is maintained for perishable items, separating raw and cooked foods in different places, and ventilating properly. Freezing and refrigeration are primary means of preserving the freshness of foods, including their ability to maintain a moisture content that controls pathogen growth. There are two critical aspects of food safety, which include the regular monitoring and maintenance of storage equipment.
- **Hygiene Practices:** Personal hygiene is a pillar of food safety involving food handlers. The food industry requires employees to follow high levels of cleanliness, such as regular handwashing; use of personal protective equipment and proper grooming. Food preparation areas and utensils should be routinely cleaned and sanitized to reduce the risk of cross-contamination. Food handlers' adequate education and training on hygiene practices should be considered fundamental elements of a comprehensive food safety scheme.

- **Cooking and Temperature Control:** Thorough cooking of food is an efficient way to get rid of harmful bacteria and parasites. It is necessary to observe recommended temperatures for different types of food. One of the simplest yet effective ways to ensure that food reaches its required internal temperature, ensuring safety for consumption is through use of a thermometer.
- **Education and Awareness:** Food-borne illness can be a serious public health hazard. Thus, promotion of safe food practices among consumers is essential through public awareness campaigns. These campaigns may include issues like storing food properly at home, the interpretation of expiration dates and identifying symptoms of spoiled foods. Food handlers, producers and processors should be periodically trained so as to provide them with current information on safety standards and best practices.
- **Regulatory Compliance and Enforcement:** Governments provide a significant contribution to the provision of food security through regulation. Regular inspection of food establishments by regulatory bodies should be carried out, and compliance with safety standards enforced. Actions, such as recalls and penalties should be taken promptly whenever violations are detected. Transparency in reporting and communication is vital to the preservation of public trust.

Challenges in Ensuring Food Safety

- **Globalization of the Food Supply Chain:** The complexity and global nature of the food supply chain make it challenging to trace the source of contamination. Increased international trade requires enhanced coordination and communication among

countries to address food safety issues effectively.

- **Emerging Foodborne Pathogens:** Developing new pathogens and contaminants calls for continuous research and monitoring to detect the emerging threats. Climate change and evolving agricultural practices may contribute to the emergence of novel food safety challenges.
- **Consumer Awareness and Education:** Consumer awareness regarding proper food handling and safety measures is low, which leads to an increased risk of being infected by contaminated foods. The public should be educated about safe food practices as important for prevention.

Conclusion

In the era of globalization, where food production systems connect borders and countries across continents for a unified supply chain system to ensure safety requires cooperation from producers, regulatory bodies among others as well as consumers. Through enforcing strict safety standards throughout the entire food chain, we can prevent outbreaks of infectious diseases from contaminated foods and maintain health in people and societies. It is not simply a question of compliance but also an obligation to ensure that the health of present and future generations remains intact.

References

- Borchers, A., Teuber, S. S., Keen, C. L., & Gershwin, M. E. (2010). Food safety. *Clinical reviews in allergy & immunology*, 39, 95-141.
- Griffith, C. J. (2006). Food safety: where from and where to. *British Food Journal*, 108(1), 6-15.
- Henson, S., & Caswell, J. (1999). Food safety regulation: an overview of contemporary issues. *Food policy*, 24(6), 589-603.

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Jeevamrut: An Organic Way to Nourish Soil and Plant

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The specialty of Jeevamrut, a traditional Indian biopesticide and organic manure, is the fermentation of a blend of cow dung, cow urine, jaggery, pulse flour, soil, and water. It is not only economical, but also good for the soil and plants. Instead of wasting money on expensive pesticides and fertilizers, farmers may employ this incredible indigenous plant therapy. Jeevamrut is entirely organic and doesn't negatively impact the health of the soil. It consists of the two terms "Jeevan" and "Amrit." Jeevan, the first term, means "life," and Amrit, the second, means "medicinal potion." By encouraging the activity of soil-dwelling microorganisms as well as phyllospheric microorganisms when they are sprayed on leaves, jeevamrut functions as a biostimulant. It boosts the number of native earthworms and serves as a primer for microbial activity.

Jeevamrut is a type of liquid organic manure that is rich in biomass and natural carbon. It also includes the macro and micronutrients that crops need. Jeevamrut has shown to be more effective than other manures and may be used in conjunction with them. The end result of organic liquid fertilizer is intended for use in fermentation, a process that produces effective live soil microorganisms that increase plant production and development while also providing an adequate supply of nutrients. These fertilizers are affordable, environmentally friendly bio-inoculants with significant potential to improve agricultural output in a sustainable manner. It can lessen the overuse of chemical fertilizers in the soil, which lowers the soil's fertility. Jeevamrut is therefore the ideal substitute for chemical fertilizer. Jeevamrut is entirely natural. As a result, it may be utilized in organic farming. It is also a rich supply of carbon, nitrogen, potassium, phosphorus, and several micronutrients. It also acts as a rich source of microorganisms that fix nitrogen and solubilize phosphorus. When it comes to preparation, jeevamrut is an affordable way to enrich soil with native

microorganisms that are necessary for mineralization. It is made with jaggery, pulse flour (besan), cow urine, and dung. When jeevamrut is used, the pH level rises in acidic soil and falls in alkaline soil. It raises agricultural output in a sustainable way.

Inputs

- 10 kg of fresh cow dung
- 5-10 litre cow urine
- 50 gram lime
- 2 kg jaggery
- 2 kg pulses' flour
- 1 kg live soil
- 200 litres water

How to prepare jeevamrut?

In a different container, thoroughly mix together cow urine, cow manure, pulses floor, jaggery that has been dissolved in ten liters of water, and a pinch of dirt. Pour the prepared combination of cow dung, cow urine, pulse floor, jaggery, and dirt into a 200-liter non-metallic barrel filled with water. Stir the contents in the barrel both clockwise and counterclockwise using a wooden stick. For seven days, keep doing this twice a day, that is, once in the morning and once in the evening. The healthy organic manure will be ready for usage after seven days. This liquid manure may be sprayed on your plants for application.

Preparation of ghana-jeevamrut

You may create this solid organic manure in two different ways. The first technique, which calls for Farm Yard Manure (FYM) and liquid jeevamrut, is fairly simple.

Method 1

Take 20 litres of jeevamrut and 100 kilograms of farm yard manure. Combine all of the ingredients, let it dry in the shade, and then cover it with a gunny bag. To produce powder, beat this mixture with your hands once it has completely dried.

Method 2

Gather a handful of dirt, 5 to 10 litres of cow urine, 2 kg of jaggery, 2 kg of powdered pulses, and 10 kg of cow dung. Combine all of these ingredients and stir thoroughly. After drying it in the shade, cover it with a gunny bag. After the mixture has dried, powder it. This organic manure keeps for six to eight months in storage.

Table 1: Nutrient composition of jeevamrut

Nutrient	Concentration
Nitrogen	1.970%
Phosphorus	0.172%
Potassium	0.290%
Manganese	47 ppm
Copper	50 ppm
Acidic character	4.93

Application of jeevamrut

Applying this combination once every two weeks is recommended. It needs to be included into irrigation water or sprayed straight onto the crops. It should be used on individual plants when it comes to fruit plants. You can keep the combination in storage for up to 15 days.

Application of jeevamrut through drip irrigation

Problem

Gomutra and cow dung are well-known fertilizers that our ancestors have long employed. This fertilizer's effects don't require validation. Jeevamrut makes use of these two beneficial substances to improve the soil in which crops are planted as well as their production. Jeevamrut's benefits and goodness are widely recognized. The issue up until this point has been that monitoring daily quantities of sufficient Jeevamrut to the crops has proven to be quite labor- and time-intensive. The issue up until this point has been that monitoring daily quantities of sufficient Jeevamrut to the crops has proven to be quite labor- and time-intensive. Moreover, the tiniest particle in the liquid causes it to clog the sprayers' micropores and leak.

The solution

- Jeevamrut/Slurry by drip irrigation has been made feasible by the application of filters. The filter offers the following benefits.

- Preparation, storage for fermentation, and delivery by drip
- Perfect for subsurface watering as liquid manure reaches the roots immediately
- Electricity is not needed.
- With the aid of the slurry filter, up to 25 acres may be fertilized with just one person.
- After its installation, soil richness may be recovered in a matter of weeks. The number of earthworms has been shown to have multiplied, increasing the soil's porosity.

How does it work

The filter tank is divided into many sections by different types of filters. Fill the main tank with the Jeevamrut materials (Cow Dung, Gomutra, Water, Gram Flour or Besan, and Jaggery) and let it ferment for two to three days. 1600 liters of crystal-clear Jeevamrut are produced as a result.

Benefits of using jeevamrut

Potassium, phosphorus, and nitrogen are abundant in jeevamrut. All other micronutrients necessary for plant growth and development are also present in it. It is totally organic, gives plants all the nutrients they need to flourish, and shields them from pests and illnesses. In a week, you may prepare jeevamrut, in contrast to other organic manure that requires months to create. In addition to being useful for all plants, it increases beneficial bacteria, enhances aeration, and helps to regulate the pH of the soil.

Most farms and rural regions have access to the basic ingredients needed to manufacture this curative medicine that can save lives. A significant profit has been made by the several farmers who have already begun employing this organic traditional manure.

Beneficial effects of jeevamrut on crops

- Enhanced growth of plants
- A higher level of palatability
- Enhanced profitability and production of sustainable crops
- enhances the crop's absorption and content of nutrients

- improved production quality
- Enhanced water productivity, energy efficiency, nutrient efficiency, and resource efficiency

Beneficial effects of jeevamrut on soil health

Jeevamrut has a diverse range of microorganisms. The microbial population peaked between the 8th and 13th day following preparation. Additionally, Jeevamrut promotes the development of bacteria that fix nitrogen in readily available substrates like compost, farm yard waste, biogas slurry, etc. Numerous researchers discovered that an increase in the number of nitrogen-fixing bacteria on day eleven further led to a reduction from day twelve to day twenty. The breeds of cows used to produce the milk, pulses, and urine are the primary determinants of the quality of jeevamrut. When banana peels were added, the nutritional content of jeevamrut increased, which in turn helped to boost the colony count of several beneficial microorganisms, including bacteria that fix nitrogen and dissolve phosphate. notable increase in live microorganisms in a seven-month-old the relevance of employing it as a consortium of microorganisms would be demonstrated by Jeevamrut, who also reported on the incalculable rate of Bacillus species. Because the liquid formulation had a higher microbial population, it was a powerful tool for preserving soil fertility and increasing nutrient availability through the quicker breakdown of large organic manures. High titre value bacteria that solubilize phosphate were discovered in the laboratory investigations.

They have been identified as Bacillus species by gram staining. Organic farming frequently uses indigenous formulations based on the fermentation of cow dung, and the outcomes of these biodynamic preparations serve as a foundation for comprehending the advantageous effects of biodynamic preparation.

Durability of jeevamrut

- Jeevamrut has to be covered and maintained in the shade. It is important to make sure that no

insects land in the mixture or lay their eggs there. The container should always have a plastic cover or wire mesh covering on it to avoid this.

- If kept in the shade and stirred twice a day, it may be preserved for 60 to 75 days without losing any of its quality. Over time, the solution thickens, therefore the right amount of water must be supplied.

Advantage of jeevamrut

- serves as a catalyst for the soil's microbial population and beneficial bacteria to grow
- Raises the soil's pH
- It may be prepared in 4-5 days, making it a useful and regular tool
- Enhances crop output and is appropriate for all crops
- Brings down the price of chemical fertilizers
- Fertigation using irrigation water is a simple application

Disadvantage of jeevamrut

- It is prepared from animal remains and naturally it has a very obscene smell.
- It is in liquid state thus not practice for broadcasting.
- The liquid has a shelf life of not more than 10-12 days beyond which it isn't potent.

Conclusion

Jeevamrut is an inexpensive liquid organic manure that is a great source of organic carbon, as well as macro and micronutrients that are effectively utilized between the eighth and twelfth days of preparation. It also contains helpful microorganisms including bacteria that fix nitrogen and phosphate.

In order to boost soil fertility and raise sustainable crop yield, quality, and profitability as well as nutrient and resource usage efficiency, Jeevamrut is therefore the best organic substitute for chemical fertilizer and a superior bio enhancer.

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Vegetable Cultivation Under Drip and Mulching is Boon for Farmer

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Sri M. Rama chandraiah, s/o Eswaraiah, (36 years) was completed his secondary school education and very enthusiastic in farming. He having 3 acres of irrigated and 1 acre rain fed black loamy soils. He was regularly cultivating field crops like Maize and Redgram in rainy season and Mango from past 10 years. The cropping system has not given better returns and also cost of cultivation has been rising day by day. Then he had to switch over to high remunerative crops with in short period like vegetable crops, where vegetable sales were possible nearby town kollapur which is 20km away.



When he started vegetable cultivation, he has faced many changes like less ground water availability during summer season, high labour cost for manual weeding, fertilizer application and irrigation which were major share in cost of cultivation. He also experienced more fruit rotting (approx. 50%) in Tomato, Brinjal and cucurbits when they contaminated with soil during rainy season and high pest and disease incidence.

Process and method

The Krishi Vigyan Kendra, Palem was adopted chennapuraopally village during 2018-2022 and conducted several training programmes, FLD, OFT and CFLDs on pulses to this village. He undergone training programme on integrated crop management of Mango and vegetables which are organised by the KVK, Palem and he had visited demo unit at KVK, Palem on vegetable cultivation under drip and mulching system during 2018-19. He had interacted with SMS (Horticulture) regarding modern technologies in vegetable and Mango cultivation. Then he became beneficiary farmer while organised

OFT on New Ridge gourd variety Arka Prasan, Tomato variety Arka Abhed and FLD on Foliar spray of Arka mango special in his field during 2018-2022 and attended training programmes given by KVK, Palem, regularly.

Interventions/ initiatives

Sri M. Rama chandraiah had inspired to practice drip and mulching system in vegetables after visiting demo plot at KVK, Palem and also undergone training programmes on vegetable cultivation in drip and mulching system, trellises method in Ridge gourd, Bitter gourd by KVK, Palem. The KVK, Palem have been organised OFT on New Ridge gourd variety Arka Prasan, Tomato variety Arka Abhed and FLD on Foliar spray of Arka mango special in his field during 2018-2022.

He was adopted improved practices, which includes like deep summer ploughing, Farm yard manure application, 3 feet width raised beds, laid inline drip line per each bed, applied basal dose, covered 25-micron thickness 4 feet width mulching film on the bed. The vegetable seedlings like Tomato, Chilli, Brinjal and seeds of bitter gourd, Ridge gourd and Bhendi have planted in paired row system at 60 x 45 cm distance on the beds. The Tomato and cucurbit vines were tide vertically on trellies in row length wise, which are made 12 feet height wooden poles installed at 6 feet distance interval and two GI wire tide horizontal to the ground and made plants creep on this system.



He had used water soluble fertilizers like urea, 19-19-19 and 13-0-45 fertilizers as fertigation as per PJTSAU recommendation. He also followed all agronomical and plant protection measures with technical guidance of SMS (Hort.), KVK, Palem. He was also received subsidy on drip and mulching system from department of Horticulture and sericulture, Nagarkurnool initial years.

Input and outputs

He has been cultivated vegetable crops by adopting drip and mulching system, trellises method in Ridge gourd, Bitter gourd and Tomato for 3 years with technical guidance of KVK, Palem. He reaped better yields & income than earlier farming situation. Sri Rama chandraiah had spent Rs. 16500/- per acre to cover mulching sheet and it is used for two cropping seasons. The cost of cultivation has been reduced about Rs. 27,500/- per acre and yield increased up to 50% more. He had earned about Rs. 8,59,250 gross returns, Rs. 4,57,050 net returns with BC ratio 2.13:1 after production of 755.5 q from 2.5 acre in a year.

Outcomes and Impact

Sri M. Rama chandraiah have been practicing drip and mulching system for 3 years successfully with high net returns over conventional practices. He had doubled farm income after adopting this practice and stood role model among his village and surrounding village farmers. The farmer was very active in whatsapp groups and face book and shared field photographs and experiences to fellow farmers.

In Nagarkurnool district, drip and mulching system have been spread in to about 243 acres under different vegetable cultivation. The main constraint of this technology have been adopted by large group of farmers was initial cost is high and the Govt. have to be assist by giving subsidy regularly for long period to the vegetable growers in the district.



Sri M. Rama chandraiah reported that vegetable cultivation by adopting drip and mulching system with the help of technical guidance of KVK, Palem have changed his life and able to doubled his farm income. Sri M. Rama chandraiah's success story have been documented by KVK, Palem and accolade best farmer award in vegetable cultivation category by Eruvaka foundation on eve of National farmers day 23.12.2022 held at University Auditorium, PJTSAU.

The Drip and mulching system technology have reduced cost of cultivation by 20-40% and increases yield about 33-50% in deferent vegetable crops. This technology is boon for farmer to achieve doubling of farm income.

Table1: Vegetable crops grown in one year using drip and mulching system during 2022-23.

S. No.	Crop	Area	Yield (q)	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net return (Rs.)	B:C Ratio
1	Bhendi (Kharif)	1 acre	116.5	1,74,750	72,500	1,02,250	2.41:1
2	Bitter gourd (Kharif)	1 acre	125.0	2,00,000	98,800	1,01,400	2.03:1
3	Ridge gourd (Kharif)	1 acre	146.0	1,90,000	91,700	98,300	2.07:1
4	Tomato (Rabi)	1 acre	215.0	1,72,000	88,200	83,800	1.95:1
5	Brinjal (Rabi)	1 acre	153.0	1,22,500	53,200	71,300	2.30:1
	Total	5 acre	755.5	8,59,250	4,04,400	4,57,050	2.13:1

Table 2: Contact details of farmer

Name of the farmer	Address	Phone no
M. Rama chandraiah	S/o Mekala Eswaraiah, H. No. 3-143. Chennapuraopally (V), Peddakottapally (M), Nagarkurnool (Dist), Telangana state, PIN Code: 509102.	9440673406

Microgreens: A Nutrient-Packed Revolution in Indian Kitchens

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Microgreens, the tiny, vibrant greens that have taken the culinary world by storm, are making a significant impact in Indian kitchens. These miniature versions of vegetables and herbs not only add a burst of flavor and color to dishes but also pack a powerful nutritional punch. As the popularity of healthy eating continues to rise, microgreens are becoming an essential part of the Indian culinary landscape. Microgreens are young, edible seedlings of vegetables and herbs that are harvested just a few weeks after germination. In recent years, their popularity has surged in India as people seek to enhance the nutritional content of their meals. The trend is driven by a growing awareness of the health benefits associated with these tiny greens, which are known to be rich in vitamins, minerals, and antioxidants. Despite their small size, microgreens are concentrated sources of essential nutrients. These young plants often contain higher levels of vitamins and minerals compared to their mature counterparts. For example, broccoli microgreens are known to have higher concentrations of sulforaphane, a compound with anti-cancer properties. Similarly, microgreens like kale and spinach are rich in vitamins A, C, and K.



Fig. 1: Different types of microgreens

One of the reasons for the increasing popularity of microgreens in India is their ease of

cultivation. These greens can be grown indoors on windowsills, balconies, or kitchen counters, requiring minimal space and resources. Even those with limited gardening experience can successfully grow a variety of microgreens at home. This accessibility has empowered many Indian households to incorporate fresh and home-grown microgreens into their daily diet. With a wide range of flavors – from peppery arugula to earthy radish – microgreens enhance the taste of salads, sandwiches, soups, and more. Their delicate, tender leaves make them an attractive garnish for a variety of Indian dishes, providing both visual appeal and a nutritional boost. The rise of microgreens in India has also led to increased support for local farmers and suppliers. As more people embrace the trend of growing and consuming microgreens, there is a growing demand for fresh, locally sourced produce. This not only benefits local farmers but also promotes sustainable agriculture practices. Microgreens are transforming the way Indians approach nutrition and culinary experiences. With their vibrant colors, intense flavors, and nutrient-rich profiles, these tiny greens are a welcome addition to plates across the country. Whether grown at home or sourced locally, microgreens are a simple yet powerful way to enhance the health and well-being of individuals and contribute to the thriving culinary culture in India.

Importance of microgreens in the Indian economy

- 1. Agricultural Diversification:** The cultivation of microgreens represents a form of agricultural diversification. As farmers incorporate microgreens into their crop portfolios, it provides them with an opportunity to diversify income streams. This can be especially crucial in mitigating risks associated with traditional crops and weather-dependent agriculture.
- 2. Job Creation:** The growing demand for microgreens has the potential to create employment opportunities throughout the

supply chain. From cultivation to distribution and retail, the increased demand for these greens can generate jobs in rural and urban areas alike. This can be particularly beneficial for small-scale farmers looking for alternative and sustainable income sources.

3. **Support for Small-Scale Farmers:** Microgreens cultivation does not necessarily require vast expanses of land, making it accessible for small-scale and subsistence farmers. By encouraging the cultivation of microgreens, the economic benefits are distributed more widely, supporting local and rural communities.
4. **Export Opportunities:** As the popularity of microgreens grows, there is potential for India to tap into international markets. High-quality, locally grown microgreens can be exported, contributing to foreign exchange earnings. The global interest in healthier and diverse food options provides a significant market for Indian microgreens producers.
5. **Value Addition and Agribusiness:** Microgreens represent a value-added product in the agricultural sector. The transformation of seeds into nutrient-rich, flavorful microgreens adds value to the produce. This value addition can lead to the development of microgreen-based agribusinesses, such as processing, packaging, and marketing, thereby contributing to the overall economic growth.
6. **Health and Wellness Industry Growth:** The rise of microgreens aligns with the increasing awareness of health and wellness, driving growth in this industry. As more consumers seek nutrient-dense and locally sourced food options, the demand for microgreens can fuel economic growth within the broader health and wellness sector.
7. **Innovation and Entrepreneurship:** The cultivation and marketing of microgreens provide fertile ground for innovation and entrepreneurship. Entrepreneurs can explore innovative farming techniques, sustainable practices and unique culinary applications,

contributing to economic development through the creation of new businesses.

8. **Sustainable Agriculture Practices:** Microgreens are often cultivated using sustainable and environmentally friendly practices. The adoption of such practices can have positive implications for the overall sustainability of agriculture in India, aligning with global trends and consumer preferences for eco-friendly products.

Health benefits

1. **Rich in Nutrients:** Microgreens are dense in essential vitamins and minerals. Depending on the variety, they can contain high levels of vitamins A, C, E, and K, as well as important minerals like iron, magnesium and potassium. These nutrients are vital for overall health, immune function, and maintaining various physiological processes.
2. **Antioxidant Properties:** Many microgreens are rich in antioxidants, such as beta-carotene, lutein, and zeaxanthin. Antioxidants help combat oxidative stress in the body, which can contribute to the prevention of chronic diseases and support overall well-being.
3. **Anti-Inflammatory Effects:** Certain microgreens, including broccoli and kale, contain compounds with anti-inflammatory properties. These compounds may help reduce inflammation in the body, potentially contributing to the prevention of chronic inflammatory conditions.
4. **Heart Health:** Components like potassium and folate are associated with maintaining healthy blood pressure levels, while antioxidants may help protect against cardiovascular diseases.
5. **Improved Digestion:** Microgreens are a good source of dietary fiber, which is essential for maintaining a healthy digestive system. Fiber helps regulate bowel movements, prevents constipation and supports the growth of beneficial gut bacteria.
6. **Blood Sugar Regulation:** Some microgreens, like fenugreek and cilantro, have been studied

for their potential to help regulate blood sugar levels. Including these microgreens in the diet may be beneficial for individuals managing diabetes or at risk of developing the condition.

7. **Weight Management:** Microgreens are low in calories but high in nutrients, making them a nutrient-dense food. Including microgreens in the diet can help individuals meet their nutritional needs while managing calorie intake, which is essential for weight management.
8. **Supports Immune Function:** The vitamins and minerals found in microgreens, particularly vitamin C, play a crucial role in supporting immune function. A well-functioning immune system helps the body defend against infections and illnesses.
9. **Detoxification:** Certain microgreens, such as cilantro, have been associated with natural detoxification processes in the body. They may help remove heavy metals and other toxins, supporting the body's natural detox mechanisms.
10. **Eye Health:** Microgreens like kale and spinach are rich in lutein and zeaxanthin, which are important for maintaining eye health. These compounds may help protect against age-related macular degeneration and other eye conditions.

Microgreens market

Microgreens Market size is expected to be worth around USD 4.4 Bn by 2032 from USD 1.6 Bn in 2022, growing at a CAGR of 11.0 per cent during the forecast period from 2023 to 2032.

Microgreens are finding use in a wide range of industries, including skincare and cosmetics, in addition to the food industry. These sectors are aware of the many ways that microgreens support and maintain good skin. Microgreens have antioxidant qualities that can effectively protect the skin from the damaging effects of environmental stresses and free radicals. As a result, they are now widely used as essential ingredients in a wide variety of skincare products, such as facemasks, serums, and moisturizers. Microgreens have become popular in the

food industry as well, as many companies are using them in their fresh food product offers and menus. Microgreens are in high demand outside of traditional brick-and-mortar retailers, as seen by the rise in eCommerce food sales. A vast array of microgreen items are now being offered by online shops to satisfy the needs of tech-savvy customers.

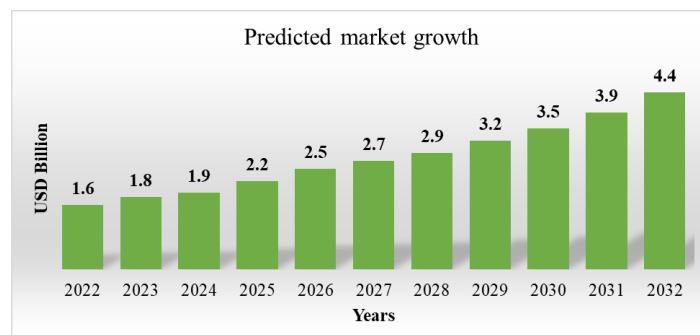


Table 1: Microgreens market size (2022-2032)

Source: Marketresearch.com

Many small and medium-sized business owners now find that operating microgreens firms is a lucrative endeavour. To meet market demand, business owners are putting several business models and strategies into practice. Although there have been worries about market saturation, the fastest-growing market categories don't appear to be slowing down. The market for microgreens is flourishing because of important market trends, rising consumer desire for wholesome, fresh food, creative company ideas, and effective distribution strategies. The microgreens market is expected to have consistent growth over the projected period as people continue to look for healthier dietary options.

Conclusion

The journey of microgreens in Indian kitchens is nothing short of a nutrient-packed revolution. As these tiny greens find their way onto our plates, they bring not only a burst of vibrant colors and exquisite flavors but also a treasure trove of health benefits. The versatility of microgreens, coupled with their ease of cultivation, has empowered households across the country to embrace a new dimension of culinary and nutritional experiences. Moreover, the economic implications are noteworthy, as microgreens cultivation supports local farmers, encourages agricultural diversification, and fosters a sense of

community. The market for microgreens not only contributes to the well-being of individuals but also plays a role in shaping a more sustainable and resilient agricultural landscape.

As we savor the flavors and reap the health benefits of microgreens, we witness a paradigm shift in how we perceive and integrate fresh produce into our diets. This nutrient-packed revolution has not only revitalized our plates but has become a symbol of a healthier, more conscious way of living. In the vibrant tapestry of Indian kitchens, microgreens have earned their place as a culinary delight and a nutritional

powerhouse, leaving an indelible mark on the way we nourish our bodies and savor the essence of good health.

Reference

<https://marketresearch.biz/report/microgreens-market/>

<https://www.insightaceanalytic.com/report/global-microgreens-market/1473>

<https://www.kenresearch.com/blog/2022/12/global-microgreens-market-analysis-future-outlook-and-growth-ken-research/>

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Response of Wheat to Different Sources of Nitrogen

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Abstract

The response of wheat to various nitrogen sources has been the subject of extensive research in agriculture. The uptake and utilization of various nitrogen (N) forms vary in wheat. Hence, providing appropriate N forms could prove effective in enhancing yield, quality, and nitrogen use efficiency (NUE) synergistically. Nitrogen is a crucial element for plant growth and significantly influences wheat yield and quality. This study delves into the diverse impacts of different nitrogen sources, such as urea, ammonium sulfate, and organic fertilizers, on wheat cultivation. It examines their effects on plant growth parameters, grain yield, nitrogen use efficiency, and soil health. Additionally, the research explores the physiological and biochemical responses of wheat plants to these nitrogen sources, shedding light on nutrient uptake, photosynthesis, and nitrogen metabolism. Understanding the nuanced responses of wheat to diverse nitrogen sources is pivotal for optimizing agricultural practices, enhancing productivity, and ensuring sustainable wheat production systems.

Introduction

Wheat stands as a crucial cereal crop, heavily reliant on nitrogen (N) fertilizer for optimal grain protein accumulation, vital for its baking and processing quality (Zorb et al., 2018). Notably, India ranks as the world's second-largest wheat producer, with significant advancements in production as evidenced by the Second Advance Estimates for the agricultural year 2022-23, projecting a notable increase to 112.18 million tonnes compared to previous years (Sendhil et al., 2019). The expansion of wheat cultivation is evident, with harvested areas reaching approximately 31.87 million hectares in 2023/2024, reflecting a marked rise from 30 million hectares in 2022/2023.

Nitrogen's indispensable role in plant growth is underscored by its involvement in critical biochemical constituents such as amino acids, nucleotides, and proteins, as well as its pivotal role in

metabolic functions mediated by essential enzymes (Jan et al., 2007). Additionally, nitrogen plays a fundamental role in chlorophyll synthesis and the formulation of certain plant hormones, exerting significant influence over vegetative growth and ultimately impacting the reproductive cycle of plants. Timing and quantity of fertilizer application emerge as crucial factors in maximizing crop yield, with research indicating that optimal timing can significantly enhance nitrogen utilization efficiency in cereals (Ragheb et al., 1993). Studies by Benziger et al., (1982) further suggest that late nitrogen applications can augment the photosynthetic capacity of the canopy, highlighting the importance of strategic nitrogen management practices in crop production.

Overall, understanding the nuanced responses of wheat to various nitrogen sources is pivotal in devising strategies to optimize its growth, yield, and quality, thereby contributing to sustainable agricultural practices and food security.

Form of Soil Nitrogen

The total N content in soil ranges from 0.03 to 0.4%. Ninety-five percent or more of the N in surface soil usually occurs in organic forms.

- a) **Organic Compounds (Nitrogen):** The organic forms of soil nitrogen occur as consolidated amino acids or proteins or free amino acids, amino sugars and other complexes generally unidentified compounds.
- b) **Inorganic Nitrogen Compounds:** The inorganic forms of soil N includes ammonium (NH_4^+), Nitrate (NO_2^-), Nitrate (NO_3^-), Nitrous oxide (N_2O), Nitric oxide (NO) and elemental nitrogen.

Sources of N for plants

1. Atmospheric nitrogen

- ✓ About 78% of the earth's atmosphere
- ✓ Fixed by bacteria, blue-green algae, leguminous plants etc.

2. Nitrates, nitrites, ammonia in the soil (inorganic nitrogen)

- ✓ Nitrate is the chief form of N taken up by the plants from the soil

3. Amino acids (organic nitrogen) in the soil

- ✓ Many soil micro-organisms make use of this form of nitrogen.
- ✓ Sometimes it may also be taken by some plants.

4. Organic nitrogenous compounds in bodies of the insects

- ✓ Insectivorous plants

Sources of N from Fertilizer

Plants such as legumes “make their own” nitrogen. A symbiotic (positive for both parties) relationship between a legume and rhizobium bacteria develops and the bacteria “fix” nitrogen out of the atmosphere and convert the nitrogen gas into forms that can be used by the plant. Other sources of soil nitrogen include: mineralization of organic matter and nitrogen released as plant residues break down in the soil. Animal manure is a good source of nitrogen as well.

Ammonium nitrate: is 34% nitrogen by weight. The volatilization losses from surface applied ammonium nitrate are usually quite small, especially compared to urea-based fertilizers. Ammonium nitrate can be broadcast as a dry product to the soil surface.

Ammonium sulfate: is 21% nitrogen with little or no surface volatilization loss. One disadvantage is that it is the most acidifying form of N fertilizer (will decrease soil pH). It requires approximately 2 to 3 times as much lime to neutralize the same amount of acidity as formed by other common nitrogen sources.

Urea: is a popular as a nitrogen fertilizer compared to other forms because of its relatively high nitrogen content (46% of total weight is nitrogen). Surface volatilization can be a problem if the urea is not placed in contact with the soil and it is dry for several days after spreading. Rate of volatilization depends on moisture level, temperature and surface pH of the soil. Temperatures greater than 50 degrees Fahrenheit and pH's greater than 6.5 significantly increase the rate of urea conversion to ammonia gases.

Urea-Ammonium nitrate (UAN): is a solution of urea and ammonium nitrate containing between 28 and 32% N. Since half of the solution is urea there is a risk of surface volatilization with UAN. Liquid UAN is popular because of the versatility of a liquid source can often be mixed with herbicides or insecticides. (Refer to pesticide labels before mixing with UAN). Some fertilizers that are applied as a source of phosphorus also contain significant levels of nitrogen.

Diammonium phosphate (DAP): contains 18% N and 46% P₂O₅

Monoammonium phosphate (MAP): contains 11% N and 52% P₂O₅

Conclusion

Nitrogen plays a pivotal role in wheat cultivation, influencing growth, yield, and quality. This study has examined the diverse impacts of different nitrogen sources on wheat production, highlighting their effects on growth parameters, yield, nitrogen use efficiency, and soil health. Understanding wheat's responses to varied nitrogen sources is crucial for optimizing agricultural practices, particularly in strategic nitrogen management regarding timing and quantity of fertilizer application. Moreover, considering physiological and biochemical responses of wheat plants to nitrogen sources is essential for maximizing productivity. Acknowledging the range of soil nitrogen forms and fertilizer sources provides valuable insights for sustainable wheat cultivation. Moving forward, optimizing nitrogen management practices will be key for enhancing productivity, ensuring food security, and promoting environmental sustainability in wheat cultivation.

References

- Bänziger, M., Feil, B., & Stamp, P. (1994). Competition between nitrogen accumulation and grain growth for carbohydrates during grain filling of wheat. *Crop science*, 34(2), 440-446.
- Dong, L., Li, Y., Li, P., Liu, Y., Ma, F., Hao, X., & Guo, L. (2023). Growth Response of Wheat and Maize to Different Nitrogen Supply Forms under the Enrichment of Atmospheric CO₂ Concentrations. *Agronomy*, 13(2), 485.

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| <p>Jan, T., Jan, M. T., Arif, M., Akbar, H., & Ali, S. (2007). Response of wheat to source, type and time of nitrogen application. <i>Sarhad Journal of Agriculture</i>, 23(4), 871.</p> <p>Ragheb, H. M., Dawood, R. A., & Kheiralla, K. A. (1994). Nitrogen uptake and utilization by wheat cultivars grown under saline stresses.</p> <p>Sendhil, R., Kumar, A., Singh, S., & Singh, G. P. (2019). Wheat production technologies and food</p> | <p>security: the nexus and prospects. Ascertaining food security through livelihood enriching interventions: challenges and opportunities, 7-15.</p> <p>Zörb, C., Ludewig, U., & Hawkesford, M. J. (2018). Perspective on wheat yield and quality with reduced nitrogen supply. <i>Trends in plant science</i>, 23(11), 1029-1037.</p> |
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Revolutionizing Urban Agriculture: Vertical Gardening for Sustainable Living

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Due to overpopulation in cities, excessive use of chemicals on crops poses health risks. To combat this, urban residents are turning to establish and maintain small home gardens, even utilizing limited spaces like balconies.

Recognizing the significance of home gardens, people are exploring alternatives like terrace gardening and vertical gardening when space is scarce. Indian Institute of Horticultural Research located at Bengaluru has developed a model vertical system namely Arka Vegetable Garden Structure for growing vegetables, flowers, and herbs in small urban spaces.

This vertical system is designed for apartment-type houses, creating a balcony-like space for growing plants. It comprises three parts: a base, a middle frame

dimensions tailored to their growth. The setup accommodates a variety of vegetables, greens, and herbs.

In a vertical garden, different tiers allow the cultivation of various plants. The top tier is suitable for flowers like marigolds and China aster, while the lower tiers are ideal for vegetables and herbs of varying heights.

To facilitate irrigation, a 25-liter tank is positioned at the top of the vertical system, with pipes distributing water to all levels. The entire system weighs 40 kg, including plants and growing medium, enabling efficient cultivation in limited urban space.

The vertical garden structure is useful for safe growing of the selected vegetable requirement of a family and can be accommodated in sunlit utility area, balcony and terrace. This structure can also be used by anyone who desires to grow vegetables, medicinal and flower crops using vertical space. Pots suitable for growing different vegetables, flowers and medicinal plants can be used with soil or soilless (cocopeat) growing medium.

The advantages of this vertical structure are

- Can be accommodated in floor area of one square meter,
- Fresh vegetables grown can be consumed,
- Different sizes of plant pots/grow bags can be accommodated,
- Consumer also controls the use of fertilizer, pesticide and inspective to its safe limit and he also knows what he consumes,



with supports for holding pots, and a structure for tank placement. The system is movable, allowing easy adjustment.

The vertical garden system offers flexibility in plant placement. Plants are grown in bags or bins with

- v) Structure suitable for handling in terms of height of reach, mobility, requirement light available to all the pots and
- vi) Effective utilization of maximum area for growing plants.

Plants like tomato (pot size- 16" dia. and 12" height), chilli, brinjal, French bean, peas etc., (pot size- 12" dia. and 10" height) which need bigger size pot, grow to a height about 2 feet and require more growing media are placed at the base of the structure.

Leafy vegetables like amaranthus, coriander, palak etc., (pot size- 26" x 8" x 6" (LxWxH)) and medicinal plants like brahmi, pudina, pepper mint, thippili, ashwagandha, shatavari etc., (pots size -14" x 8" x 6" (LxWxH)) are placed upper levels. A 25 litre plastic container at the top of the structure with necessary drip laterals, microtubes and drippers are also provided to water the plants. Yield of 2 kg to 5 kg of produce (depending on the crop) can be harvested per crop cycle. The cost of vertical garden structure is approximately Rs. 22,000.

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Understanding Adolescent Development: Managing the Transition from Childhood to Adulthood

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Abstract

Adolescence, derived from the Latin "adolescere," denotes a pivotal stage marked by profound physical, cognitive, emotional, and social transformations bridging childhood and adulthood. This transitional phase, termed Brahmacharya in Indian culture, encompasses critical developmental dimensions. Physical changes, including puberty's onset, coincide with intricate brain maturation, impacting higher-order thinking and impulse control. Piaget's theory underscores cognitive growth, unveiling abstract thought and multifaceted reasoning. Emotionally, adolescents navigate identity formation amidst peer influences and societal expectations, as Erikson's psycho social theory elucidates. Peer relationships, while central, pose risks alongside opportunities for self-discovery. Notably, adolescence witnesses a surge in curiosity and experimentation, often paralleled by mood swings and egocentric tendencies. Challenges encompass identity crises, peer pressure, body image concerns, academic stress, familial conflicts, and sexual exploration, amplifying mental health vulnerabilities. Addressing these demands necessitates nurturing environments, resource accessibility, and proactive communication to cultivate resilience amidst adolescent complexities.

Introduction

Adolescence is derived from the Latin word "adolescere" which means "to grow up" or "to mature." It is a transitional period between childhood and adulthood characterized by a variety of physical and mental changes.

Adolescence is a critical period of human development, characterized by significant physical, cognitive, emotional, and social changes. It is a period of discovery, identity formation, and the transition from childhood to adulthood. Understanding the complexities of adolescent development is critical for

parents, educators, and policymakers in providing effective support to young people as they embark on this transformative journey.

Adolescence refers to the transition between childhood and adulthood. Life is filled with tremendous energy. Curiosity and experimentation can lead to success while also creating uncertainty. Adolescent experiences, knowledge, and skills have significant implications for adulthood. Adolescence in India is referred to as Brahmacharya (apprenticeship). This is the first ashram (life stage) in the developmental stages. During this stage, children develop basic skills for their future roles as responsible adults. All living beings go through specific developmental stages or phases.

Erikson believed that each stage of life involves a crisis or conflict between competing tendencies. Only if individuals negotiate all of these hurdles. They can develop normally and healthily.

Here we will discuss four dimensions of the adolescents development which are as following:

Physical Development

One of the most noticeable aspects of adolescence is rapid physical growth and maturation. Puberty, typically occurring between the ages of 10 and 14 for girls and 12 and 16 for boys, brings about hormonal changes that lead to the development of secondary sexual characteristics. These changes include the growth of breasts, the onset of menstruation in girls, and the deepening of the voice and facial hair growth in boys.

Alongside these external changes, adolescents experience significant brain development, particularly in regions associated with higher-order thinking, emotional regulation, and impulse control. However, the prefrontal cortex, responsible for executive functions such as planning and decision-making, is still maturing, contributing to risk-taking behavior

and susceptibility to peer influence during adolescence.

Cognitive Development

Adolescence is also a time of cognitive growth and refinement. Piaget's theory of cognitive development posits that adolescents reach the formal operational stage, characterized by abstract thinking, hypothetical reasoning, and the ability to consider multiple perspectives. This newfound cognitive flexibility enables adolescents to explore complex concepts, engage in moral reasoning, and develop their sense of self-identity.

Emotional Development

Emotionally, adolescents grapple with a myriad of feelings as they navigate newfound independence, social pressures, and identity exploration. Erik Erikson's psychosocial theory emphasizes the struggle for identity versus role confusion during adolescence. Adolescents seek to establish a sense of self and develop a coherent identity that integrates their values, beliefs, and aspirations. This process often involves experimentation with different roles, interests, and peer groups.

Social Development

Peer relationships play a central role in adolescent development, providing opportunities for companionship, support, and identity exploration. Adolescents form friendships based on shared interests, values, and experiences, which contribute to their sense of belonging and self-esteem. However, peer influence can also lead to risky behaviors such as substance abuse, delinquency, and early sexual activity. Positive adult relationships, including those with parents, teachers, and mentors, serve as protective factors that promote healthy development and resilience.

Characteristics of adolescence

- **Growth spurt:** Adolescents mature at different rates and are highly sensitive to bodily changes. They are physically vulnerable because of poor health habits or dangerous experimentation with drugs and sex.

- **Physical appearance decides self-image:** They frequently attempt to hide or constantly complain about whatever part of their body makes them most uncomfortable. Teasing and bullying further makes their life miserable.
- **Self-discovery:** Adolescents are in the process of self-discovery, which can fluctuate depending on situations and times. The adolescent finds herself moody and understanding, ugly and attractive, introverted and fun loving.
- **Egocentrism:** Adolescents have heightened self-consciousness, leading them to believe that others are equally interested in them.
- **Emotionally unstable:** Adolescents struggle to separate their emotions from their rational thinking due to their intertwined nature. They frequently experience mood swings, including intense and unpredictable peaks.
- **Curiosity and experimentation:** Adolescents are inquisitive, creative, adventurous, and experimental. They are drawn to "adult" behaviours and may engage in prohibited activities such as reckless driving, sex, and drug use.
- **Peer influence surpasses parental affection.**
- **Changing focus of relationships.**
- **Lack of long-term thinking about life and the world.**
- **Changes in the brain:** The human brain is not fully developed by the time a person reaches puberty, if it ever is. Human behaviour and social immaturity have been linked to the human brain before the age of approximately 30. However, no empirical study has found a link between prefrontal cortex development in adolescence and early adulthood and irrational behaviour.

Challenges and Opportunities

While adolescence is a time of tremendous growth and potential, it is also fraught with challenges and vulnerabilities. Adolescents may struggle with issues such as academic pressure, body image concerns, peer conflict, and mental health difficulties, including anxiety and depression. Furthermore, adolescents from marginalized backgrounds may face

additional barriers related to discrimination, poverty, and lack of access to resources and opportunities. Some are explained below:

- **Identity Formation:** Adolescents struggle with self-identity, attempting to establish their sense of self, values, and beliefs in the face of societal pressures and expectations.
- **Peer Pressure:** Adolescents seeking acceptance and validation may engage in risky behaviours such as substance abuse, delinquency, or unhealthy relationships.
- **Body Image Issues:** Puberty causes physical changes that can lead to body dissatisfaction, eating disorders, or an overemphasis on appearance, affecting self-esteem and mental health.
- **Academic Stress:** Increased academic demands and the transition to higher education can lead to stress, anxiety, and depression, particularly when there is pressure to excel academically.
- **Family Conflict:** Conflicts with parents over independence, decision-making, and rules are common as adolescents strive for autonomy while remaining dependent on family support.
- **Sexual and Romantic Exploration:** As adolescents navigate sexual identity, relationships, and intimacy, they frequently face confusion, peer pressure, and risks associated with sexual activity.

Adolescents may suffer from mood disorders, anxiety, and other mental health problems that are exacerbated by hormonal changes, social pressures, or genetic predispositions.

Addressing these challenges requires supportive environments, access to resources such as mental health services, and effective communication between adolescents, caregivers, and educators to foster healthy development and resilience.

Conclusion

Adolescence is a complex and dynamic period of human development, characterized by physical, cognitive, emotional, and social changes. Understanding the multifaceted nature of adolescent development is essential for supporting young people as they navigate the challenges and opportunities of this transformative stage. By fostering environments that promote positive relationships, provide opportunities for exploration and growth, and address the diverse needs of adolescents, we can empower them to thrive and reach their full potential on the journey from childhood to adulthood.

References

<https://en.wikipedia.org/wiki/Adolescence>

<https://www.nios.ac.in/media/documents/secpsycour/English/Chapter-11.pdf>

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Artificial Intelligence (AI) in Soil Science and Agriculture

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Artificial Intelligence (AI) stands as a pivotal field within computer science, marked by rapid technological progress and broad applications. Its pervasive integration is notably pronounced in agriculture, a sector crucially employing approximately 30.7% of the global population across 2,781 million hectares of agricultural land. However, this domain encounters challenges spanning from sowing to harvest, encompassing issues such as pest and disease infestation, suboptimal chemical usage, inadequate drainage and irrigation, weed control, and yield prediction. Computers started being used in agriculture back in 1983. Over time, different methods have been proposed to tackle problems in farming, ranging from databases to decision support systems. Among these solutions, those employing Artificial Intelligence (AI) have proven to be the most effective in terms of accuracy and reliability. AI techniques help by understanding the unique details of each situation and providing the best-fitting solution for specific problems. As AI advances, it's increasingly solving complex issues in agriculture.

What is AI?

Let's formally define Artificial Intelligence (AI). It's a field in computer science that focuses on creating systems whether tangible or intangible, capable of intelligent behavior equivalent to human thinking and actions. This involves achieving human-like performance in cognitive tasks through logical reasoning. The term "artificial" refers to non-biological aspects, while "intelligence" denotes the ability to accomplish complex goals or tasks. AI encompasses cognitive processes like speech recognition, natural language understanding, translation, knowledge management, image analysis, decision-making, and learning, making systems both powerful and useful.

History of AI

Artificial Intelligence officially entered the historical scene in 1956, marked by the introduction of a dedicated session on AI at Dartmouth College. Marvin Minsky, in his book "The Search for

Artificial Intelligence," expressed optimism, stating that the problem of AI modeling would be solved within a generation. The initial AI applications, developed during this period, focused on logic theorems and chess games. These programs, distinct from geometric forms used in intelligence tests, sparked the notion that intelligent computers were achievable.

Types of AI

AI can be classified in different ways. There are three types of artificial intelligence in terms of functionality.

1. Artificial Narrow Intelligence (ANI)

The machine is extremely good at doing one task but limited to extending its capacity to perform another task. It is widely known as narrow AI or weak AI. Narrow AI is limited to a specific area to perform a single task.

2. Artificial General Intelligence (AGI)

Strong AI is commonly known as Artificial General Intelligence (AGI). It is the Superintelligence that surpasses human intelligence. It can mimic the cognitive abilities of the human brain.

3. Artificial Super Intelligence (ASI)

Artificial Super Intelligence (ASI) is the logical progression of AGI. It is a hypothetical AI that is beyond the human brain. In ASI, decision-making and problem-solving will be superior to human thinking. Artificial Super Intelligence (ASI).

Why AI in Soil Science & Agriculture

Recognizing the transformative potential of artificial intelligence (AI) across various sectors, the Indian government has embarked on leveraging this technology to revolutionize agriculture, a crucial pillar of its economy. Soil science, a fundamental aspect of agriculture, has been significantly impacted by AI advancements. It encompasses a range of applications including soil testing, monitoring, land cover analysis, fertilization assessment, nutrient deficiency identification, carbon sequestration, and more. AI-driven tools such as robotics, drones, predictive

analytics, sensor-based monitoring devices, satellite imagery, and automated irrigation systems hold immense promise in reshaping Indian agriculture. These innovations empower farmers to precisely evaluate soil conditions, monitor weather patterns, and optimize crop management practices, ultimately enhancing yields and sustainability.

Applications of AI in Soil

The Internet of Things (IoT) in the context of Artificial Intelligence (AI) refers to the integration of AI technologies with IoT devices to enhance the capabilities and functionality of connected systems. Different sensors like Time Domain Reflectometry sensor (TDR) this sensor gives the output in the form of the waves and this can be used to calculate the average of moisture content. Amplitude Domain Reflectometry sensor (ADR), can be used to measure the Soil water content. To detect the deficiency of the nutrients Nitrogen (N), Phosphorus (P), and Potassium (K) in the soil NPK sensor is developed. The advantage of these sensors is to reduce the undesired use of fertilizers to be added in the soil.



Fig. 1: Different IoT Sensors

Machine learning (ML) is a subset of artificial intelligence (AI) that focuses on developing algorithms and statistical models that enable computers to perform tasks without explicit programming. With the help of a Machine Learning algorithm, a system will be developed that can select crops, irrigate them autonomously and recommend fertilizers. The increasing availability of soil data that can be efficiently acquired and freely available open-source algorithms, have led to an accelerated adoption of ML techniques to analyse soil data. Several well-

known ML applications in soils science include the prediction of soil types and properties.

IBM devised a compact soil testing system capable of assessing five indicators through colorimetric tests. Embedded within a micro-fluidic chip, the system conducts chemical analyses, while an AI-powered machine vision algorithm provides more accurate estimations compared to human observation. The application of AI in remote sensing data analysis has gained popularity. Supervised learning models trained with ground truth data are commonly employed to classify land cover. Another method involves comparing remote sensing data captured at different times to detect changes, referred to as compound classification. AI-driven autonomous vehicles are also utilized for tasks related to soil, land cover and land management.

Potential of AI in Indian agriculture-

Crop Health Monitoring Systems

Remote sensing methods, hyperspectral imaging, and artificial intelligence (AI) contribute to the development of crop health monitoring systems that efficiently track the well-being of crops, saving time and resources.

Smart Irrigation Systems

By implementing sensor-based automated irrigation systems, the challenges related to the low irrigation efficiency in Indian agriculture (approximately 38%) can be significantly addressed.

Agriculture Risk Management

AI-based technologies assist farmers in mitigating risks and uncertainties by enhancing their readiness to effectively manage crises in agriculture.

Identification of Optimal Agronomic Product Mix

AI assists in producing tailored recommendations for individual farms by analyzing various factors such as soil condition, weather predictions, seed varieties, and pest presence. While these recommendations already offer optimal crop and technology suggestions for each farm.

References

Bannerjee, B., Sarkar, U., Das, S., Ghosh, I. Artificial Intelligence in Agriculture: A Literature Survey. 2018. *International Journal of*

Scientific Research in Computer Science applications and management studies.7(3): 2319-1953.

Maad, M.M . History of Artificial Intelligence. www.researchgate.net/publication/322234922.

Khan, H. 2021. Types of AI, Different Types of Artificial Intelligence Systems. www.researchgate.net/publication/355021812.

Sarkar, A., Maity, P.M., Mukharjee, A. 2021. Applications of AI in Soil Science. *Food and Scientific Reports*. 2 (2): 38-39.

Sinha, N.K., Kumar, J., kumar, D.,Mishra, R., Thakur, J. K., Shinogi, S., Jayaraman, S.,Mohanty, M. 2022. Application of artificial intelligence (ai) in agriculture: an indian perspective. *Harit Dhara*. 5(2): 9-11.

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