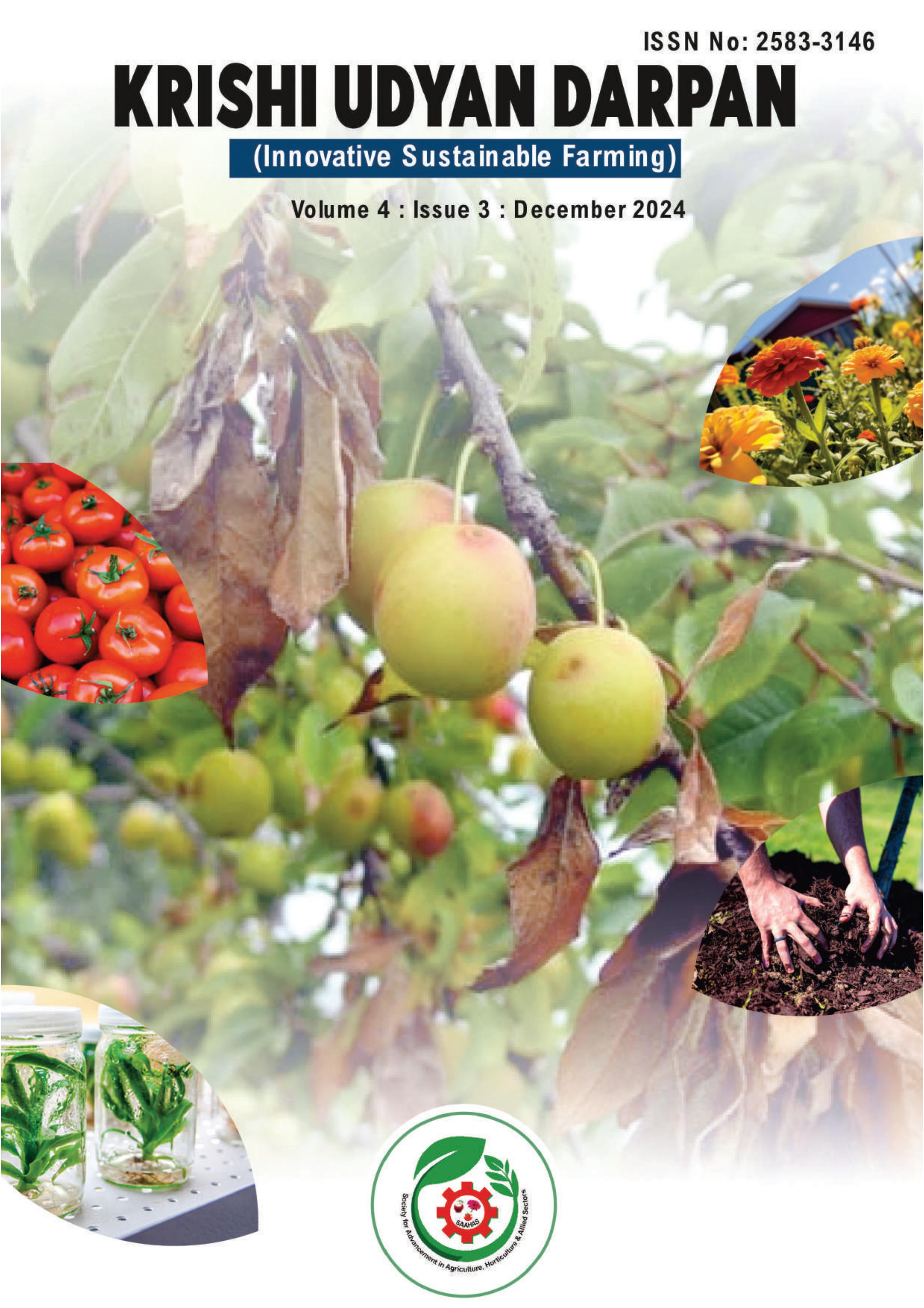
ISSN No: 2583-3146

KRISHI UDYAN DARPAN

(Innovative Sustainable Farming)

Volume 4 : Issue 3 : December 2024



Society for Advancement in Agriculture, Horticulture & Allied Sectors

SAAHAS

ISSN No. 2583-3146

Krishi Udyan Darpan

(Innovative Sustainable Farming)

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ISSN No. 2583-3146

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In This Issue

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ISSN No. 2583-3146

Impact of Change in Climate on Insect Pests

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Introduction

Pests are a significant component of the biotic components, and they are also affected by weather variations and climate change. The interactions between pests, the environment, and natural enemies are all directly impacted by temperature rise, as are the pests' ability to reproduce, survive, disseminate, and maintain population dynamics. Because the circumstances surrounding their occurrence can vary quickly, it is crucial to keep an eye on the appearance and abundance of pests. This essay will examine the effects of some of the projected climate changes, particularly the rise in temperatures and atmospheric carbon dioxide concentrations along with the effects of fluctuating precipitation patterns on the biology and ecology of harmful insects, particularly invasive pest species, which can pose a serious threat to crop production. The presentation will focus on potential solutions for the current problems in plant production, primarily in the form of altered integrated pest management (IPM) strategies. These strategies include IPM, environmentally friendly methods of producing nutritious food, monitoring techniques and modeling prediction tools.

Environmental Change's Effect on Insect Pests

Agriculture is greatly impacted by changes in the global climate, as are agricultural insect pests. Climate change has both direct and indirect effects on crops from agriculture and the pests that accompany them. The reproduction, development, survival and dissemination of pests are directly impacted by climate change, while the interactions between pests, their surroundings and other insect species-such as natural enemies, rivals, vectors and mutualists-are indirectly impacted. Since insects are poikilothermic creatures, the environment's temperature affects the internal temperature of their bodies. Therefore, the most significant environmental element influencing the behaviour, dispersion, development, and reproduction of insects is most likely temperature. Consequently, it is quite probable that the primary causes of climate change-increasing atmospheric CO_2, rising temperatures and declining soil moisture-will have a substantial impact on insect pest population dynamics and consequently, the proportion of crop losses. Due to the creation of new ecological niches brought about by climate change, insect pests have more opportunity to proliferate, dissemin-ate, and move between different geographic areas. The intricate physiological conseque-nces of increasing CO_2 and temperature can have a significant impact on how agricultural crops interact with insect pests.As a result of the changing climate, farmers should prepare for new and severe insect issues in the years to come. Food security is threatened by the extension of crop pests over national and international borders, a worldwide issue that affects all nations and areas.

Insect Pests' Reaction to Increasing Temperatures

Because of their very sensitive physiology, insects typically double in metabolic rate for every 10 degrees Celsius increase in temperature. In this regard, numerous studies have demonstrated that rising temperatures typically hasten the intake, growth, and migration of insects. These effects might have an impact on population dynamics by changing factors such as fecund surviving, time of generation, size of population, and geographic range. It is typically difficult for some species to sustain their populations when they are exposed to higher temperatures; conversely, certain species can reproduce quickly and thrive. In order to control the likelihood of alterations to pest population and dynamics, temperature is crucial for metabolism, metamorphosis, movement and host availability. Elevated temperatures ought to be correlated with more herbivory, based on the distribution as well as behavior of modern insects. It is plausible to hypothesize that changes in the developm-ent rate of insect populations and higher herbivory would accompany temperature increases, considering the distribution and behaviour of insect pests. So, it is anticipated that the expansion of populations of insects in tropical regions will decline. The rate of climate change because the current temperature is almost at the ideal level for pest growth and development, however insects in temperate zones may expect a faster rate of growth. By calculating changes in the rise of insect pests in the production of the world's three primary grain crops-rice, wheat, and maize-under various climate change scenarios, the same authors verified this notion. The study found that warming will hasten the expansion of pest populations in wheat, which is typically farmed in temperate settings. They forecast a decline in pest population increase for rice cultivated in tropical zones and conflicting results for maize planted both in temperate and tropical locations.

Insect Pests' Reaction to Increasing CO_2 Concentration

Herbivorous insect performance, quantity, and distribution can all be impacted by increased atmospheric CO_2 concentratio-ns. The consumption, growth, fertility, and population density of insect pests can all be impacted by such increases. The only data that is currently accessible is that of a specific plant that is not just host but also has a certain effect. The way that rising CO_2 levels affect insect pests depends largely on the plants that serve as their hosts C_3 crops (wheat, rice, cotton, etc.) would be more affected by higher CO_2 levels than C_4 crops (corn, sorghum, etc.). Thus, asymmetric effects on herbivory and a different reaction from insects feeding on C_4 plants compar-ed to C_3 plants could arise from these differential effects of high atmos-pheric carbon dioxide on C_3 and C_4 plants. While C_4 plants are less sensitive to elevated CO_2 and hence less likely to be impacted by changes in insect feeding behavior, C_3 crops will probably be benefited by elevated CO_2 and negatively affected by insect reaction.

Insect Pests' Reaction to Varying Precipitation Patterns

Precipitation variations in terms of quantity, intensity and frequency are crucial markers of climate change. The majority of incidents have shown that while precipitation intensity has increased, precipitation frequency has decreased. The frequency of floods and droughts has been favored by this kind of rainfall pattern. Rainfall patterns that overlap have an immediate impact on insect species that hibernate in the soil. To put it briefly, prolonged water stagnation and flooding can result from severe rains. This incident affects the diapaus of insects and poses a threat to their survival. Furthermore, floods and severe rains have the potential to carry insect larvae and eggs away. Aphids, mites, jassids, whiteflies, and other small-bodied pests can be washed away by strong rains. Insect populations can be greatly impacted by variations in rainfall.

Conclusion

It is generally acknowledged that climate change has a significant impact on the production of agricultural plants and the insect pests that are linked with them, yet there are still many unanswered questions about it. Some of the uncertainties surrounding various components of climate change that are pertinent to insect pests includes small-scale climate variabili-ty, such as changes in relative humidity, temperat-ure, atmospheric CO_2 and precip-itation patterns. Diverse reactions of insect species to warming temperatures are anticipated in various regions of the world due to the great diversification of species of insects, their host plants and the diversity of the global climate. The impacts of climate change on insects are multifaceted, affecting the distribution of their diversity, abundance, development, growth and phenology, as well as favouring certain insects and hindering others. Furthermore, a general increase in the frequency of outbreaks of insects involving a wider variety of insect pests is anticipated. It is likely that insects would spread geographically, particularly northward. The ability to produce more generations and an enhanced overwintering survival rate will lead to an increase in the abundance of some pests. Plant illnesses spread by insects will probably increase, and alien pest species will probably spread more easily to new locations. The decreased efficiency of biological control agents, or natural enemies, could be another unfavourable outcome of climate changeand this could be a major problem in future pest manage-ment programs. We run the danger of suffering large financial losses and jeopardizing the security of human food supplies if climate change-related variables create an environ-ment that is conducive to insect infestation and crop destruction. To address this issue, a proactive and scientific strategy will be needed. Planning and developing adaptati-on and mitigation solutions, such as impro-ved integrated pest management (IPM) techniques, climate and pest monitoring, and the use of modeling tools, are therefore critically important.

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ISSN No. 2583-3146

Role of Drones in Agriculture: Transforming Modern Farming Practices

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Introduction

Agriculture is one of the oldest professions and has always sought to improve productivity and efficiency. Today, advancements in technology are at the forefront of this evolution. Drones, or unmanned aerial vehicles (UAVs) have emerged as a pioneering technology in agriculture, offering farmers unprecedented capabilities to monitor, manage, and enhance their crops and fields. By providing real-time data on crop health, soil conditions, and field variability, drones enable precise decision-making and targeted interventions, which will help in providing the food security to the ever increasing popularity of the country.

What is drone or UAV?

An Unmanned Aerial Vehicle (UAV) or a drone, is an aerial device capable of autonomously following a predetermined path using autopilot and GPS coordinates. It also features manual radio controls for piloting in emergencies or hazardous conditions. The term UAV can encompass the entire system, including ground stations and video systems, although it typically refers to model aircraft-both fixed-wing planes and rotary-wing helicopters.

How a drone works?

Drones, specifically quad copters, operate on the basic principle of four vertically oriented propellers, each with independently variable speeds that enable versatile movement. Key components include

1. Chassis: Chassis is the structure of the drone to which all components are attached. Its design balances strength-especially when carrying additional equipment like cameras and weight, impacting the choice of propeller length and motor strength needed for lift.

2. Propellers: These determine the drone's payload capacity and flight speed. Longer propellers offer greater lift efficiency at lower speeds but have slower acceleration and deceleration. Shorter propellers are more agile but require higher rotational speeds, which can strain motors and reduce their lifespan. Propeller pitch affects speed and hovering efficiency.

3. Motors: Each propeller is driven by a motor rated in "kV," indicating its revolutions per minute under a specific voltage with no load. Faster motors provide more power but consume more battery, reducing flight time.

4. Electronic Speed Controller (ESC): Regulates the current to each motor, controlling their speed and direction based on signals from the flight controller.

5. Flight Controller: An on-board computer that interprets pilot commands and adjusts motor speeds through the ESC to manoeuvre the quad copter.

6. Radio Receiver: Receives control signals from the pilot, enabling manual or autonomous flight modes.

7. Battery: Typically lithium polymer for its high power density and recharge ability. Additional sensors such as accelerometers, gyroscopes, GPS and barometers may be used for precise positioning. Cameras are commonly mounted for navigation and aerial photography purposes.

How to fly a Drone?

A drone is controlled manually with a hand-held radio control transmitter which manually controls the propellers. Sticks on the controller allow movements in different directions and trim buttons allow the trim to be adjusted to balance the drone. Screens on the transmitter can display live video from the on-board camera and sensor data. Additionally, on-board sensors offer useful features such as, Auto altitude mode, keeping a fixed altitude during flight and GPS hold mode, keeping the drone at a specific GPS position.

Applications of Drones in Agriculture

a) Crop Monitoring and Management: Drones equipped with high-resolution cameras and sensors provide real-time, detailed images of crops. This aerial perspective allows farmers to monitor crop health, detect diseases, and identify pest infestations early. Example: A drone can capture multispectral images to assess the health of crops by detecting variations in plant colour, which might indicate issues like nutrient deficiencies or disease.

b) Precision Agriculture: Drones enable precision agriculture techniques, where specific areas of a field are treated based on detailed data rather than blanket application. **Example:** Drones can map out areas of a field that require more or less fertilizer, leading to more efficient and environmentally friendly use of resources.

c) Soil Health and Analysis: Drones can assist in analysing soil composition by collecting data on organic matter, pH levels, and nutrient content. **Example:** Combining drone data with ground samples, farmers can adjust their soil management practices for improved crop yields.

d) Field Mapping and Planning: Drones create detailed and accurate maps of agricultural fields, which are essential for planning crop rotations, planting schedules, and resource management. **Example:** A drone can produce high-resolution Orth mosaic maps showing field boundaries, obstacles, and variations in topography.

e) Crop Spraying and Fertilization: Drones can be equipped with spraying systems for the efficient application of pesticides, herbicides and fertilizers. **Example:** Drones can cover large areas more quickly and precisely than traditional methods, reducing chemical usage and improving safety.

f) Precision Application of sprays: With advanced GPS and navigation systems, drones ensure that sprays are applied uniformly and only where needed. **Example:** Variable rate application systems allow drones to adjust the amount of spray based on real-time data about crop health.

g) Appropriate irrigation: Drones equipped with hyper-spectral, multispectral, or thermal sensors can identify areas in a field that are dry or require attention. Furthermore, during crop growth, drones enable calculation of the vegetation index, which indicates the relative density and health of the crop, and display the heat signature, revealing the crop's thermal energy emissions.

Benefits of Drones in Agriculture

Drones offer several benefits in agriculture, revolutionizing traditional farming practices. Those are-

a) Increased Efficiency and Productivity: Drones streamline various agricultural tasks, leading to more efficient operations. **Example:** Aerial surveys that used to take hours can now be completed in minutes, freeing up time for other important tasks.

b) Cost Savings: By reducing the need for manual labour and optimizing resource use, drones help farmers save money. **Example:** Automated crop spraying can reduce chemical waste and labour costs, leading to significant savings.

c) Enhanced Data Collection and Analysis: Drones provide detailed, high-resolution data that improves decision-making. **Example:** Farmers can access precise information on crop health and soil conditions, leading to better management practices.

d) Environmental Sustainability: Drones promote environmentally friendly practices in agriculture. **Example:** Precision agriculture reduces over-application of fertilizers and pesticides, minimizing environmental impact.

Pic: Drone used in agricultural operations

Pic: Spraying by drone

Challenges and Limitations

On the other hand, beside the advantages it has few limitations

a) High Initial Costs: The upfront cost of purchasing and maintaining drones can be high, which may be a barrier for small-scale farmers.

Solution: Government subsidies and cooperative purchasing models can help mitigate these costs.

b) Technical Expertise Required: Operating drones and interpreting the data they collect requires specialized knowledge and skills.

Solution: Training programs and user-friendly software are becoming more available to help farmers develop these skills.

c) Regulatory Issues: Drone use in agriculture is subject to various regulations, which can vary by region and may be complex.

Solution: Staying informed about local regulations and working with legal experts can help navigate these challenges.

d) Data Management and Security: Managing and protecting the vast amounts of data generated by drones can be challenging.

Solution: Investing in secure data storage solutions and data management software is essential for handling this information.

Future Prospects

The future of drones in agriculture is promising, with ongoing advancements and emerging technologies poised to further enhance their role in farming.

a) Integration with AI and Machine Learning: Future drones will increasingly integrate with artificial intelligence (AI) and machine learning technologies to automated data analysis and decision-making.

Example: AI-powered drones could automatically identify plant diseases and recommend treatments.

b) Advanced Sensing Technologies: Innovations in sensor technology will provide even more detailed data on crop and soil conditions. **Example:** New sensors might offer insights into plant health at the cellular level, allowing for more precise interventions.

c) Expanding Applications: Drones will continue to find new applications in agriculture, including advanced crop breeding and automated harvesting systems. **Example:** Future developments might include drones that can perform complex tasks like planting seeds or managing large-scale farms autonomously.

General Indian Laws for Drone

There are several general rules in India that must be followed for flying a drone-

- Operator must be aged more than 18 years.
- Weight of the drone must be more than 250 grams.
- The drone can't be used within 5 km of airport and it can't be used in restricted areas by the Government along with military area.
- It should be used in day time, not in the night.
- Drones must have a license plate attached with it, which carries the details of the operator and contact details.
- It can't be flown over the visual line of sight.

Conclusion

Drones are redefining the future of agriculture by offering innovative solutions for crop management, soil analysis, and resource optimization. Drones not only improve efficiency and productivity but also promote sustainable farming practices by reducing environmental impact through targeted interventions. As agriculture continues to evolve, drones play a crucial role in enhancing yield, profitability and environmental sustainability in the farming sector.

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ISSN No. 2583-3146

Improving Litchi Production through Double Hedge Row Planting System

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Introduction

Double Hedge Row Planting system is one of the modern fruit cultivation technique allowing dwarf cultivars to plat densely with canopy modification for abundance solar radiation to improve the fruit quality. It involves regular training, pruning and orchard mechanization for maintaining proper shape and size of the plants. With the orientation of rows from east to west and developing stereo fruiting by enabling plant architecture through open centre pruning to allow the maximum photo-synthetically active radiation on both sides of the hedge-row. This technology is viable to increase the yield by 2-3 times in comparison to traditional system of planting. This technology is been needed to adopted in commercial scale and interest of progressive farmers can fulfil the role of on field demonstration or training regarding this modern fruit cultivation.

Litchi (*Litchi chinensis* Sonn.) is commonly praised as 'Queen of fruits' due to its attractive colour, juicy aril, limited availability and unique flavour. It belongs to family Sapindaceae. Though it is a Chinese origin crop but occupies major area in India with annual production of more than 764.6 thousands MT from an area of about 98.6 thousands ha. The average productivity of litchi in the India is only 7.8 MT/ha. Mainly due to use of wider spacing under traditional planting system (8 × 8 m or 10 × 10 m) and poor orchard managem-ent practices. With continuous rise in population there is continuous rise in pressure on expansion of cultivable land for commercial litchi cultivation and it is very difficult to increase area under litchi cultivation. To meet the increasing demand, it is necessary to enhance the per unit area production. High density planting with appropriate planting system has played a crucial role in enhancing orchard productivity in many crops. To increase the litchi production and optimize fruit quality, it is very important to choose the correct planting system and optimum plant spacing to obtain good light interception and to exploit photosynthetic area. This combination tends to increase profitability by improving yield and fruit quality. By changing the planting pattern from square (5 x 5 m or 6 x 6 m) to rectangular hedge row (8 x 4 m or 6 x 4 m) system of planting, the higher productivity can be ensured up to 100% and 50% more in comparison to traditional planting system, by reducing 4-10% land area on per tree basis with better interception of light. Thus, the new technology of hedge row planting under rectangular system accommodates more plants per unit area, gives more yield and better quality than square system practiced traditionally in major litchi growing areas. Hedge row system of planting also allows more interception and uniformity in distribution of light on most of the arboreal branches, i.e., under and above canopy. This permits easy cultural operation in the orchard. In this system of planting, the light falling on floor of the orchard, during morning and in the afternoon hours, leads to reduced humidity, partial soil solarisation and overall reduction in built up of insect pests and diseases which ultimately curtails the cost on plant protection measures.

Methodology

The orchard layout should aim to accommodate maximum number of trees per hectare, adequate space for proper canopy development and ensuring convenience in cultural practices of the orchard. In rectangular system, trees are planted on each corner of a rectangle in single hedge row and the distance between any two rows is more than the distance between any two trees in a row. The wider row spaces permit easy intercultural and mechanical operations. The status of rows and trees over the years needs to be maintained through proper annual pruning and clearing the duct and centre spaces of plants every year after harvesting. For this, the tree frame needs to be developed on two primaries orienting towards wide space and subsequent secondary and tertiary branches may be allowed. In litchi, hedge row (rectangular system) planted at 8 m x 4 m and 6 m x 4 m results quality fruit production due to moisture retention near root zone (due to shade during mid day), higher light interception (below and above part of canopy) and air circulation between free spaces in rectangular system (Nath *et. al.*, 2022).

Management canopy in rectangular system

For development of canopy with higher yield, use of different important training and pruning techniques is mandatory. Selection of two branches with wider crotch angle orienting towards north and south at 50-60 cm above ground with clear and vertical stem which will later develop into main trunk of tree is necessary. Allowing secondary (two on each primary) and tertiary (two on each secondary) will make skeleton frame of eight branches with open centre of nearly ‘V’ or ‘Y’ shaped on which whole canopy of tree develops (Nath *et. al.*, 2022). Hedging with keeping the centre open should be done regularly in rectangular system. Open centre system of litchi plant helps in the development of low spreading tree canopy. This also results uniform distribution of fruit and fruit colour by allowing maximum light penetration.

Conclusion

The hedge row planting system has been found as most ideal option to harvest higher yields as compared to traditional systems to produce higher yield and quality fruits in litchi from small area. High level extension programme is needed to increase the income from per unit area by adopting the techniques in farmers’ field.

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ISSN No. 2583-3146

Nano-Urea: A Sustainable Approach to Boost Pearl Millet Yields

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Introduction

Pearl millet (*Pennisetum glaucum* L.) is the fifth most significant cereal crop globally, following rice, wheat, maize and sorghum. It plays a crucial role in the agricultural landscape of arid and semi-arid regions, particularly in Africa and Southern Asia, where it is predominantly cultivated as a rainfed crop. These regions often face inadequate rainfall, which limits the cultivation of other cereals such as maize and sorghum. In India, pearl millet ranks fourth among cereal crops, following rice, wheat, and sorghum, with an annual production of 10.28 million tonnes from an area of 7.52 million hectares, and productivity of 1,368 kg ha^{-1} (Sharma *et. al.*, 2022).

Pearl millet is highly valued for its exceptional physiological traits, including its drought resistance, tolerance to low soil fertility, and resilience to high salinity and extreme temperatures (Arya *et. al.*, 2022). These characteristics make it a viable alternative crop in environments where other cereals struggle to thrive. Furthermore, pearl millet is rich in essential nutrients, making it an important food source in regions with challenging growing conditions.

However, the widespread use of conventional nitrogenous fertilizers, such as urea, to enhance pearl millet productivity presents significant environmental challenges. The application of urea, while effective in promoting crop growth, leads to substantial nitrogen losses through processes such as ammonia volatilization, contributing to soil acidification and environmental pollution. To address these challenges, the development and application of nano urea represent a promising innovation. Nano urea is a groundbreaking agricultural input derived from nanotechnology, characterized by its ultra-small particle size ranging from 20 to

50 nanometers (nm). This innovative formulation offers a significantly larger surface area compared to conventional urea prills, thereby enhancing its reactivity and effectiveness as a nitrogen source. Nitrogen is a critical macronutrient necessary for plant growth, development, and yield. However, the hydrolysis of urea in soil often results in elevated soil pH, leading to significant ammonia volatilization losses.

The application of nano urea typically sprayed at a rate of 2 to 4 ml per litre of water during key crop growth stages, has been shown to initiate a positive crop response, meet nutritional demands, and enhance nutrient availability within the rhizosphere. The potential of nano fertilizers to reduce fertilizer nutrient losses through leaching, thereby increasing their availability to plants, offers a sustainable approach to improving crop yield, quality, and overall agricultural productivity. Additionally, the reduced environmental impact and lower cost of cultivation associated with nano fertilizers make them an attractive alternative to traditional fertilizers in modern agriculture.

This study aims to explore the efficacy of nano urea in enhancing the productivity of pearl millet while addressing the environmental and economic challenges associated with conventional nitrogen fertilization.

Comparison between Nano and Conventional Urea (Lakshman *et al.*, 2022)

Characteristics	Nano-urea	Conventional Urea
Year of Invention	2021	1823
Technology	Nano-technology	Conventional method
Particle size	32 nm	1 mm
Use efficiency (%)	85-90	30-40
Price (Rs.)	240/- per bottle (500 ml)	266.50/- per bag (45 kg)
Storage area requirement	Very less area	Very high area
Pollution	No	Air, water and soil
Vaporization	No	Yes
Soil residual	NO	Yes
Effect on soil	Enhance quality	Acidifies soil
Availability in plant	Throughout the life cycle	3-4 days
Effect on crop maturity	Maturity on time	Early maturity
Intake medium	Direct through leaves	Through roots
Method of use	Only for foliar spray	Soil application as basal and top dressing and foliar spray

Limitations of Nano Urea

Despite its numerous advantages, nano urea also presents certain challenges. The high reactivity of nano-materials due to their small size and large surface area raises safety concerns for farm workers who might be exposed to these materials during application. Additionally, there is a lack of standardized regulations governing the use of nano-fertilizers, leading to uncertainties about their safety and potential environmental impact.

Concerns also exist regarding the possibility of nano-materials entering the food chain, which could have implications for human health. Comprehensive safety assessments are required to fully understand the environmental fate of nano-materials in soil and water, as well as their potential accumulation in the ecosystem, which could have long-term ecological conseque-nces (Konate *et al*., 2018; Ranjan *et al*., 2018).

Effect of Nano Urea on Different Aspects of Pearl Millet

Effect on Growth Parameters

The application of nano-fertilizers, including nano urea, significantly enhances the availability of nutrients to plants, leading to improved growth parameters in pearl millet. Nano-fertilizers release nutrients gradually, which facilitates steady nutrient absorption and promotes robust photosynthesis. This enhanced photosyn-thetic activity results in increased cell division and overall plant growth (Kumar Sharma *et al*., 2022). The nanoparticles in nano-fertilizers are easily absorbed through the epidermis of the leaves, allowing for efficient translocation throughout the plant. This effective uptake of active molecules directly contributes to improved growth in millets (Shree *et. al*., 2024).

Nitrogen, a key component of nano urea, plays a crucial role in the synthesis of amino acids, proteins, vitamins, hormones, and enzymes, all of which are vital for plant growth and development. The availability of nitrogen, facilitated by nano urea, directly impacts the physiological and biochemical processes in plants, further enhancing growth parameters in pearl millet (Udapudi *et. al*., 2024).

Effect on Yield and Economic Aspects

Improved nutrient availability resulting from nano urea application leads to accelerated plant growth and an increase in the photosynthetic assimilation rate. This increased efficiency in converting sunlight into energy, along with enhanced chlorop-hyll production, boosts the overall energy production in plants. Consequently, this catalyzes a significant increase in crop yield (Arya *et. al*., 2022).

The foliar application of nano urea not only enhances yield but also reduces the overall cost of cultivation, contributing to a higher benefit-to-cost (B:C) ratio. In a study conducted by Dayanand *et. al*., 2023, it was observed that the grain yield of pearl millet in plots treated with nano urea was approximately 8.96% higher than in plots where conventional urea was applied. The B:C ratio for nano urea-treated plots was reported to be 1.19, indicating a substantial economic advantage.

Conclusion

The excessive and disproportionate use of conventional fertilizers has resulted in severe global environmental challenges, including irreversible damage to soil structure, disruption of mineral cycles and harm to soil microflora, plants and ecosystems. These practices have led to the disruption of food chains and the potential for inherited mutations in future generations. Moreover, the overuse of fertilizers has caused groundwater contamination, water eutro-phication, chemical burning, soil degrada-tion, and air pollution (Gade *et. al*., 2023).

To fully realize the potential of nano fertilizers like nano urea, it is essential to conduct comprehensive assessments of their health implications, environmental fate, and safe disposal methods. Future research should focus on determining the optimal field application rates for commer-cial use and developing user-friendly guidelines for farmers. Demonst-rating the superior performance of nano fertilizers compared to traditional chemical fertilizers can drive industry growth and garner policy support for their widespread adoption.

The advancement of nano fertilizers presents an opportunity to address the challenges posed by conventional fertilizers and contribute to the development of more sustainable agricultural practices. By prioritizing research and policy initiatives that promote the safe and effective use of nano fertilizers, the agricultural sector can move towards a more environmentally sustainable and economically viable future.

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ISSN No. 2583-3146

"Transforming Agriculture with Digital Payment Systems: Enhancing Efficiency and Financial Inclusion"

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Introduction

Digital payments, also known as electronic payments, are transactions made through digital channels, eliminating the need for physical currency or traditional payment methods. Digital payment refers to financial transactions made through electronic channels, eliminating the need for physical currency, checks, or traditional payment methods. Digital payments enable users to make transactions remotely using various devices, such as smartphones, laptops, or tablets.

Digital payments are becoming increasingly significant in the agricultural sector, transforming how transactions are conducted and impacting various stakeholders, from farmers to consumers Digital payments refer to transactions that are made electronically, without the use of physical cash. They have become an integral part of modern economies, enabling faster, safer, and more convenient transactions. Here's an overview of how digital payments are influencing agriculture:

1. Financial Inclusion

- **Access to Banking Services:** Digital payment platforms, such as mobile money, are providing unbanked and under banked farmers access to financial services. This includes the ability to save, borrow, and transfer money without the need for a traditional bank account.
- **Microfinance:** Digital platforms enable microfinance institutions to reach rural farmers more effectively, offering loans and financial products tailored to their needs.

2. Improved Efficiency

- **Reduced Transaction Costs:** Digital payments reduce the cost and time associated with physical cash transactions. This is particularly important in rural areas where access to banking infrastructure is limited.
- **Streamlined Supply Chains:** By digitizing payments, agricultural supply chains become more transparent and efficient. Farmers can receive payments directly from buyers, reducing the need for intermediaries.

3. Risk Mitigation

- **Insurance Products:** Digital payments facilitate the distribution of agricultural insurance products. Farmers can pay premiums and receive payouts through digital platforms, protecting them against risks like crop failure due to weather conditions.
- **Price Transparency:** Digital platforms often provide farmers with real-time information on market prices, helping

them make informed decisions about when and where to sell their produce.

4. Access to Markets

• **E-commerce and Digital Marketplaces:** Farmers can access broader markets through digital platforms, selling their products to buyers beyond their immediate geographic area. This can lead to better prices and higher income.

• **Direct-to-Consumer Sales:** Digital payments enable farmers to sell directly to consumers through online platforms, bypassing traditional middlemen and retaining a larger share of the profits.

5. Data-Driven Decision Making

• **Credit Scoring:** Digital payment histories can be used to create credit profiles for farmers, enabling them to access credit more easily. Financial institutions can use this data to assess the creditworthiness of farmers.

• **Precision Agriculture:** Payments linked to digital platforms can integrate with data on inputs like seeds and fertilizers, helping farmers optimize their operations based on real-time data.

6. Benefits of digital payments in agriculture

• **Increased efficiency:** Faster payment processing and reduced paperwork.

• **Improved accessibility:** Reach remote or underserved areas with mobile or online payment options.

• **Enhanced transparency:** Clear and traceable transactions.

• **Reduced costs:** Lower transaction fees and reduced need for intermediaries.

• **Financial inclusion:** Increased access to financial services for smallholder farmers and rural communities.

• **Data generation:** Digital payments can provide valuable insights into agricultural market trends and behavior.

7. Challenges and Barriers

• **Digital Literacy:** Many farmers, especially in developing regions, may lack the digital literacy needed to effectively use digital payment platforms.

• **Infrastructure:** Reliable internet and mobile network coverage are essential for digital payments. In many rural areas, this infrastructure is still lacking.

• **Trust Issues:** Trust in digital payment systems can be a barrier, particularly in regions where cash transactions have been the norm for generations.

• **Security:** Ensuring secure transactions and protecting sensitive information.

• **Regulatory frameworks:** Adapting existing regulations to accommodate digital payments in agriculture.

• **Interoperability:** Ensuring compatibility between different digital payment systems.

8. Government and Policy Support

• **Subsidies and Incentives:** Governments can promote the adoption of digital payments by providing subsidies or incentives to farmers and other stakeholders in the agricultural value chain.

• **Regulation:** Ensuring that digital payment systems are secure and reliable requires supportive regulatory frameworks that protect both farmers and consumers.

9. Examples of Digital Payment Solutions in Agriculture

• **E-Choupal (India):** An initiative by ITC Limited that uses digital platforms to provide farmers with market information, weather forecasts, and payment solutions.

• **Agri-wallet (Africa):** A digital wallet designed specifically for smallholder farmers, allowing them to save, borrow, and receive payments for agricultural products.

• **M-Pesa:** A mobile payment service used by farmers in Africa to receive payments and make transactions.

- **PayPal:** Used by agricultural businesses to make and receive payments online.
- **Farm-to-Table:** Digital platforms connecting consumers with local farmers, facilitating online payments.
- **Agricultural e-marketplaces:** Online platforms enabling farmers to sell products and receive digital payments.
- **Blockchain:** based agricultural platforms: Platforms utilizing blockchain for secure and efficient transactions in agricultural supply chains.

10. Future of Digital Payments

- **Contactless and Mobile Payments:** With the ongoing development of NFC technology and mobile wallets, contactless payments are expected to continue growing.
- **Biometric Payments:** Payments using biometric authentication, such as fingerprint or facial recognition, are likely to become more prevalent.
- **Cryptocurrency and Blockchain:** As blockchain technology matures, cryptocurrencies may become more widely accepted for everyday transactions.
- **AI and Machine Learning:** These technologies will likely be used to improve fraud detection, personalize payment experiences and optimize transaction processes.

Conclusion

Digital payments are revolutionizing the agricultural sector by enhancing financial inclusion, improving efficiency, and providing farmers with better access to markets and financial services. However, the success of these technologies depends on addressing challenges such as digital literacy and infrastructure development. As digital payment solutions continue to evolve, they hold the potential to significantly uplift the agricultural sector, particularly in developing regions.

Digital payments are reshaping the way individuals and businesses handle transactions, offering numerous benefits such as convenience, speed, and security. However, they also present challenges that need to be addressed, particularly regarding security, privacy, and access. As technology continues to evolve, digital payments are expected to become even more integral to the global economy.

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ISSN No. 2583-3146

Ornamental Plants: Sustainable Approach for Phytoremediation

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Introduction

Growing ornamental and flowering plants based on their habitat, landscape utility and phytoremediation potential not only makes the environment colourful but also remediates the contaminants in terrestrial and aquatic environments. Management and disposal of phytoremediating plants with high contaminants are an important concern. However, ornamental plants will add a new dimension to the field of phytoremediation and phytomanagement of contaminated environments. Ornamental and flowering plants are not optional, but are actually necessary to added advantage of enhancing the environment's aesthetics besides cleaning up the environment and generating additional income, including additional employment opportunities and contribute to 'Swachh Bharat Abhiyan'.

Due to the extreme consequences, environmental contamination with heavy metals is a significant concern that needs an effective and affordable technological solution. Heavy metals are conventionally defined as group of toxic metals and metalloids, having density more than 6 Mg/m^3 and atomic weight more than that of Iron. Heavy metals not degraded biologically in soil but are only transformed from one oxidation state or organic complex to another. The most common toxic metals are Cd, Cr, Pb, Cu, As, Hg, Ni, Co and Zn. Metals are present in trace amount in nature. Contamination, however, has increased concentration of heavy metals due to long-term use of commercial inorganic fertilizers, pesticides and other agrochemicals, industrial emissions, mining, smelters, tanneries, sewage sludge, and waste disposal in particular areas. The rising level of toxic metals poses serious threats to all living organisms as they continue to violate health guidelines in many parts of the world. Exposure to these harsh metals to the human body can occur through multiple pathways, including ingestion, inhalation or skin. Excessive metals exposure can cause keratosis, brown's disease, plumbism , minamata disease, young's syndrome, Itai-itai, Parkinson's disease, selenosis and aggravate existing cancer problem. Heart and chronic lung diseases are some other due heavy metal pollution are not uncommon. Infants and foetus are also exposed to metals through breast milk or trans-placental transfer.

Remediation of metal contaminated soils and water is an important concern. Several technologies viz., excavation, immobiliz-ation, vitrification, soil flushing, etc., are already being used to clean up the environment from these kinds of harsh contaminants, but most of them are costly and far away from their optimum performance. It prohibits the use of these technologies in sustainable and eco-friendly remediation of metal contaminated sites in many part of world. Phytoremedi-ation has emerged recently as a promising in situ method, cost effective, environme-ntal friendly alternative to the conventional approaches. It also helps in reducing soil erosion, enriching soil organic matter leading to enhanced soil fertility and is a sustainable technology for site restoration. Furthermore, the use of plants for remedi-ation preserves the ecosystem by removing carbon dioxide from air. Phytoremediation utilizes physical, chemical and biological processes to remove, degrade, transform or stabilize contaminants within soil and groundwater.

Phytoremediation of heavy metals includes processes such as phytostabilization, phytoextraction, phytovolatilization and rhizofiltration. Phytostabilisation involves absorption and precipitation of metal contaminants by plants, reducing their mobility and preventing their migration by leaching and wind transport or entry into the food chain. Phytoextraction includes the extraction and accumulation of contaminant in harvestable plant tissues including roots and surface shoots. The absorption, concentration and precipitation of heavy metals by plant roots called rhizofiltration.

The key factor for successful phytoremediation is the identification of a plant that is tolerant and suitable for the specific area and conditions. Plant selected for successful remediation in a chosen contaminated area should not have an adverse effect on the local biodiversity. Other important aspects for the success of phytoremediation are economic benefits, functional utility and by-product generation in order to generate interest in people and government. Therefore, ornamental plants are consid-ered as ideal for phytoremediation and phytomanagement of heavy metal. Use of ornamental and floweri-ng plants for remediation of a contaminated environm-ent would also change the landscape for ecoto-urism which provides improved human use of land, aesthetic enjoyment and a positive influence on the enviro-nment of the society.Most of ornamental plants are not an edible crop, which will prevent accu-mulated heavy metals from entering the food chain. They grow with high shoot biomass when exposed to heavy metals. They have wide adaptability to different soils and climate conditions. Some flower-ing plants secrete photo-chemicals from root tissues and therefore can serve as a nematicide for the control nematodes. Ornamental and flowering plants are not optional, but are actually necessary part of sustainable and eco-friendly remedia-tion of metal contaminated areas in all around the world.

Terrestrial Ornamental Plants	Phytoremediation of Metals
Lonicera japonica, Panicum maximum, Cosmos sulphureus, Tagetes erecta, Helianthus annuus	Cd
Nerium oleander	Pb
Mirabilis jalapa, Amaranthus hypochondriacus, Tagetes erecta, Chrysanthemum indicum, Gladiolus grandiflorus	Cd
Erica andevalensis, Erica australis	Al, As, Fe, Mn
Chrysantemum maximum	Cd, Cu, Ni, Pb
Calendula alata, Impatiens balsamina, Calendula officinalis,	

Terrestrial Ornamental Plants	Phytoremediation of Metals
Althaea rosea, Tagetes erecta	Cd, Pb
Coleus blumei	Al
Helianthus annuus	Cr, Zn, Cd, Cu
Mirabilis jalapa, Impatiens balsamin, Tagetes erecta	Cr
Tagetes patula	Cd, Cu, Pb, Fe
Nugget marigold	As
Tagetes erecta	Cu

Depending on type of heavy metals and its intensity, selection of plants and their number to be planted, will vary. Evergreen plants having long life span with dense foliage will be the ideal choice. Urban and industrial sewerage which contain huge quantity of toxic metals judicious planning and selection is needed with tolerant plants to particular heavy metal. Studies have revealed that ornamental and flowering plants such as *Lonicera japonica, Nerium oleander, Mirabilis jalapa, Erica andevalensis, Erica australis, Chrysantemum maximum, Calendula officinalis, Panicum maximum, Cosmos sulphureus, Tagetes* spp., water hyacinth, water lily etc. can be grown for remediation of various heavy metals (Table 1). The majority of ornamental and flowering plants concentrate heavy metal in roots; for example, *Nerium oleander, Quamoclit pinnata, Antirrhinum majus, Erica andevalensis, Erica australis, Calendula officinalis, Tagetes patula. Chlorophytum comosum, Amaranthus hypochondriacus* and A. *caudatus* had application value in the treatment of Cd-contaminated soils. *Gynura pseudochina*, a perennial herbal plant, has the potential to accumulate chromium cadmium and zinc. *Panicum* spp. and *Cyperus rotundus* have properties that make them beneficial for covering the terrestrial area contaminated with cadmium. Studies suggests that fast-growing trees with short rotation coppice systems like eucalyptus and willow should be grown to create green belts around metal contaminated land. Fern foliage is in great demand for floral bouquets and arrangements; as pot plant and in landscape design. *Pityrogramma calomelanos* and *Pteris vittata*, hyperaccum-ulating fern species, are well known for their Arsenic phytoremediation potential.

The extraction of heavy metals by plants is usually limited by the availability of heavy metals in soils. However the use of chelators, chemicals, etc. viz., EDTA, EGTA, Thiosu-lfate, KCl, Citric acid and SDS could be increases heavy metals bioavailability in shoots to facilitate phytoextraction. Application of soil amendments and organic manures (Cow manure extract and poultry manure extract), AM fungi (*Glomus intraradices*, G. *constrictrum* and G. *mosseae*), PGPB, chemical fertilizers (NPK), and plant hormones (cytokinins) also have an effect on metal uptake and/or plant growth and provides an attractive way to advance the phytostabilization and/or the phytoextrac-tion of many terrestrial ornamental plants.

Ornamental and flowering plants are grown for decorative purposes in gardens and landscape design projects for cut flowers and landscape beautification not only make the environment colourful but also remediate the contaminated environment. They will visually decorate the environment of metal impacted areas. Since many of them are not edible plants, the risk to the food chain is reduced.

Landscaping in and around industrial and

Aquatic plants	Phytoremediation of metals
Iris lactea and Iris tectorum	Cd, Pb
Iris pseudacorus	Cr, Zn, Pb
Nymphaea, Nuphar variegate	Cd
Nymphaea odorata	Pb
Nymphaea spontanea	Cr
Zantedeschia aethiopica	Fe
Talinum triangulare (waterleaf), *T. cuneifolium*	Cu
Typha domingensis	Al, Fe, Zn, Pb

heavy metal contaminated sites with hyperaccumulator plant species is an effective way to minimise the level of heavy metal pollution. A hyperaccumulator is a plant capable of growing in soils with very high concentrations of metals, absorbing these metals through their roots, and concentrating extremely high levels of metals in their tissues Landscape design should also plan according to load of heavy metal contaminants in effluent. Dwarf trees should be planted in the front followed by medium and-tall trees in the back of contaminated so that all plants are well exposed to the heavy metals. Plantation should be done across the direction of the effluent flowing from source of pollution. For contaminated effluent flowing around roadside, double row planting is recomme-nded as heavy metals passes through absorbing roots, the heavy metals are either get absorbed or settled. Textile industries or factories and other industries which release appreciable quantity heavy metals are serious concern. To overcome this problem, the remedy is green belt by planting trees and shrubs having heavy metal trapping quality and ability. The width of green belt and density of plantation will depends on source of metal pollutants and their intensity. It has been observed that heavy metal concentration is reduced by 2-3 times with the help of green belt of hyperaccumulator.

Conclusion

Phytoremediation has emerged recently as a promising in-situ method, cost effective, environmental friendly alternative to the conventional approaches. Ornamental plants are considered as ideal for phytorem-ediation and phytomanagem-ent of heavy metal as they suits to the local biodiversity and also provide economic benefits and functional utility and by-product generat-ion potential. Use of ornamental and flowering plants for remediation of a contaminated environm-ent would also change the landscape for ecotourism which provides improved human use of land, aesthetic enjoyment and a positive influence on the environme-nt of the society. Ornamental and flowering plants are not optional, but are actually necessary to added advantage of enhancing the environment's aesthetics besides cleaning up the environment and generating additional income, including additional employment opportunities and contribute to 'Swachh Bharat Abhiyan'.

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ISSN No. 2583-3146

Enhancing Marigold (*Tagetes erecta* L.) cv. 'Siracole' Flower Production Through Jeevamrit Application

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Introduction

Marigold (*Tagetes erecta* L.), a member of the Asteraceae family, holds significant commercial importance as a widely cultivated loose flower globally. Its vibrant loose flowers are extensively utilized in garlands, floral rangolis, decorations, religious ceremonies and social functions. In India, marigold cultivation covered approxi-mately 73.15 ('000 ha) with a production of 728.53 ('000 MT) for the year 2021-2022, while in Himachal Pradesh, an estimated area of about 0.05 ('000 ha) with a production of 0.78 ('000 MT) during the same period (Anonymous, 2022). Marigold cultivation serves as a prominent commercial endeavour in the landscape of Himachal Pradesh. However, the success of marigold cultivars is dependent upon the specific agro-climatic conditions in which they are grown. Presently, farmers in this region are cultivating a diverse range of commercial varieties, with a notable focus on the 'Siracole' variety, commonly referred to as 'Laddu Gainda' originating from Eastern India. This day-neutral cultivar exhibits better performance and wider adaptability, holding substantial potential for year-round flower production (Ghosh & Pal, 2008). The significant characteristics of the 'Siracole' variety include the uniform size of its flowers and the dense growth of its foliage. It is primarily propagated through cuttings to ensure the preservation of true-to-type plants. The variety is in high demand in the market as it fetches high prices owing to its uniform flower size and enhanced yield. Thus, it is imperative to establish standardized nutrient dosage schedules to facilitate the quality production of flowers from the marigold cv. 'Siracole' within the mid-hill conditions of Himachal Pradesh.

In recent years, there has been an escalating interest in the application of jeevamrit within flower crop cultivation. This liquid fertilizer provides easy dispersal in water and instant uptake by plants, which is beneficial for the growth of plants. Jeevamrit, a liquid fertilizer prepared from natural ingredients, significantly influences microbial populati-ons and soil fertility and eventually enhances productivity (Lunagariya & Zinzala, 2017).

Cultivation Practices

Field preparation

Marigold prefers well-drained soil and a sunny situation. Raised beds of 1.0 m x 1.0

m should be prepared for cultivation. These beds should be demarcated with a 30 cm-wide and 20 cm-deep channel.

Climate

This cultivar can be cultivated year-round in subtropical conditions in Himachal Pradesh, except for December and January due to the cold winters.

Propagation

To propagate marigold, take 5-7 cm terminal cuttings from the healthy mother plant and treat the cuttings with a fungicide solution for 15-20 minutes. Then, remove the lower leaves and dip the cut end in a solution containing NAA 500 ppm following the quick dip method. Plant the cuttings in protrays filled with a mixture of cocopeat, sand and perlite (1:1:1 v/v). The protrays are then placed in a mist chamber maintained at a temperature of 20 to 30°C and a humidity of 70-80% for rooting. It takes about 12 to 15 days for the cuttings to develop roots.

Manures and Fertilizers

Proper manure and fertilization are essential for the successful cultivation of marigold. Before planting, applying a basal dose of well-rotted farmyard manure at a rate of 5 kg/m^2 is recommended.

Jeevamrit Preparation

To prepare the jeevamrit, begin by combining 10 kg of fresh cow dung and 10 litres of cow urine in a plastic drum. Then, mix 1 kg pulse flour, 2 kg jaggery and a handful of soil. After that, water was added to the mixture to achieve a total volume of 200 litres. Thoroughly stir the mixture for 4 days in the morning and evening. The solution will be ready for spraying by the fifth day. Ensure all the ingredients are mixed in a plastic drum, covered with a damp jute bag, and kept in the shade (Sreenivasa *et.al*., 2011).

Application of jeevamrit should be started by foliar application after one month of planting. This foliar spray should be repeated every twenty days until the last harvest. For every 1 square meter of area, it is recommended to dilute 1 litre of jeevamrit with 2.5 litres of water and apply it as a foliar spray. This application method facilitates the efficient absorption of nutrients by the leaves, thereby promoting growth. Moreover, the use of jeevamrit via foliar spraying serves as a deterrent against insect pests and diseases.

Planting Material

It is imperative to utilize pure, healthy and disease-free plant material. The plants of marigold cv. 'Siracole' are approximately 90 cm-100 cm in height, characterised by their bushy and hardy nature. This cultivar has gained popularity among flower growers in West Bengal. The leaves of this particular variety are pinnately arranged, with lanceolate and serrated leaflets. The flowers are of the double type exhibiting large, globular orange heads that are both uniform and compact.

Spacing

Rooted cuttings should be planted at a density of 9 plants per square meter on raised beds, 30 x 30 cm. For a higher yield, planting should be done during February.

Pinching

Pinching is the removal of terminal portions or new growth of plants. This technique is essential for promoting the development of lateral shoots and maximizing the plant's flowering potential. In the case of this cultivar, pinching should be done by removing the 2-3 cm apical or terminal growing portion of the plant after 15-20 days of transplanting.

Disbudding

The unique characteristic of this variety is that the plant frequently produces flower buds after it has been established. As a result, to keep the plant in a vegetative growth stage, it is necessary to regularly remove the flower buds until the plants reach the desired vegetative stage, which typically takes around 2.5 months.

Staking

The plants have a wider spread and more flower weight, so staking individual plants with bamboo sticks before the flowering stage is necessary to support the branches and prevent lodging.

Conclusion

Jeevamrit is a liquid organic fertilizer employed to enhancesoil fertility and promote healthy plant growth. It is prepared by fermenting a mixture of natural ingredients. The fermentation process stimulates the proliferation of advantageous micro-organisms, particularly bacteria and fungi. The foliar application of jeevamrit resulted in a yield of 8.40 kg per square meter from 9 plants with uniformly shaped flowers under naturally ventilated polyhouse conditions, potentially leading to higher market prices.

Peak flowering in marigold cv. 'Siracole'

Loose flowers (Laddu gainda)

Rooted cuttings of marigold cv. 'Siracole'

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ISSN No. 2583-3146

Tissue Culture: A Breakthrough for the Orchid Propagation

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Introduction

Orchids, with their diverse forms and captivating beauty, have long been cherished by botanists, horticulturists and plant enthusiasts worldwide. However, their propagation poses significant challenges due to their complex reproductive mechanisms, slow growth rates, and specific environmental requirements. Traditional methods of orchid propagation, such as seed sowing and division, often result in low success rates and are time-consuming. The advent of tissue culture technology, specifically micro propagation, has revolutionized the way orchids are propagated. Tissue culture involves the aseptic *in vitro* cultivation of orchid tissues, such as meristems, leaves, seeds, or even single cells, in a controlled environment. This method not only accelerates the propagation process but also ensures genetic uniformity, disease-free plants, and the ability to produce large quantities of orchids in a relatively short period. Tissue culture has become a vital tool in commercial orchid production, conservation efforts, and research. It allows for the rapid multiplication of rare and endangered species, helping to preserve biodiversity. Moreover, this technique enables the mass production of hybrids with desirable traits, meeting the growing demand in the global orchid market.

Orchids are a diverse and widespread group of flowering plants that belong to the Orchidaceae family, one of the largest families in the plant kingdom. They are known for their unique and often complex flowers, which are prized for their beauty and variety. There are over 25,000 species of orchids, with thousands of hybrids, making them one of the most diverse groups of plants on earth.

Characteristics of Orchids

Orchids are distinguished by several unique characteristics

- **Flowers:** Orchid flowers are typically bilaterally symmetrical, meaning they have a single plane of symmetry. They often have three petals and three sepals, with one of the petals (the labellum or lip) being highly modified to attract pollinators.
- **Pollination:** Many orchids have evolved intricate pollination mechanisms, often forming specialized relationships with specific pollinators such as bees, butterflies, moths, or birds. Some orchids even mimic the appearance or scent of female insects to lure male pollinators.
- **Roots:** Many orchids are epiphytes, meaning they grow on other plants rather than in the soil. Their roots are adapted to absorb moisture and nutrients from the air and surrounding environment.
- **Seeds:** Orchid seeds are incredibly small and lack the nutrient-rich endosperm found in many other plant seeds. To germinate, orchid seeds typically require a symbiotic relationship with mycorrhizal

fungi, which provide the necessary nutrients.

Habitat and Distribution

Orchids are found in a wide range of habitats across the globe, from tropical rainforests to temperate woodlands and even arid deserts. While many orchids are epiphytic, growing on trees in tropical regions, others are terrestrial, growing in soil, or lithophytic, growing on rocks.

Significance of Orchids

- **Ecological Importance:** Orchids play a crucial role in their ecosystems, particularly in pollination networks. Their flowers provide food for pollinators and in return, these pollinators help orchids reproduce by transferring pollen between flowers. In some reports it states that it is the indicator of natural pollution; it cannot thrive well in polluted areas.
- **Cultural and Economic Value:** Orchids have been cultivated for centuries for their beauty and fragrance. They are highly valued in the horticultural industry, with some species and hybrids being popular as ornamental plants and in floral arrangements.
- **Medicinal values:** Orchids have been cultivated not only for commercial uses but for the medicinal purposes also. Numbers of bioactive compounds are present like alkaloids, phenolics, terpenoids and derivatives highly beneficial for human health.
- **Conservation:** Many orchid species are threatened by habitat loss, climate change, and over-collection from the wild. Conservation efforts focus on protecting their natural habitats, regulating trade, and using propagation techniques like tissue culture to maintain populations.

Threats to Orchids

Among flowering plants, orchids are the most vulnerable species worldwide. Orchid species face several threats due to a variety of factors, including overexploitation, illegal trading, encroachment on private property and climate change. The illegal collecting of medicinal orchids for commerce and use, habitat deterioration, and fragmentation pose a serious danger to these plants. The majority of these species are classified as uncommon, severely endangered or included in CITES Appendix II (IUCN status). Certain species, including *Liparis olivacea*, have already vanished from the wild. The demand and availability of medicinal orchids differ greatly. It is common practice for rural communities to collect and sell wild orchids from orchid-rich areas; nevertheless, doing so results in the extinction of many species. A significant quantity of these orchids is sold to both domestic and foreign dealers. A number of economically significant plants in alpine meadows have continued to disappear as a result of these different degrees of disturbance. One such plant is *Dactylorhiza hatagirea*, a highly valued medicinal orchid that has been classified as critically endangered and is listed in CITES Appendix I. Its natural population is found in the Himalayas. The use of traditional medicine is becoming more and more popular in our nation and western nations as a result of this tendency. Since the wild is being rapidly depleted, immediate conservation action is needed.

Conservation Measures

It is urgent to implement practical conservation methods to save important orchids across all geographic regions, as many species are currently in threat of becoming extinct. The government and corporate sectors of the concerned country should give careful thought to orchid conservation since it is a significant issue. They should collaborate internationally as well as with research institutes, non-governmental organizations and local farmers. Both in-situ and ex-situ methods, together with local community involvement, can be used to conserve medicinal orchids.

***In-situ* conservation**

The best method for preserving biodiversity is seen to be in situ conserv-ation, or the preservation of species in their native environments. The most crucial in situ conservation tactics for orchids may involve protecting their habitat. It is strongly advised to provide intense care and habitat management for their in situ conservation because of their limited population size and restricted range. Therefore, the Protected Areas (PAs) are a key component of any national biodiversity conservation plan. But because of insufficient enforcement and inadequate legislative regulation, illegal species collections from their native environment persist even inside PAs in many parts of the world. Furthermore, in situ conservation is not always a viable option because of the modification of habitat and migration or absence of the pollinators due to unfavorable modification of the environment. There is no substitute for conservation of

Fig.1 ***Pleione formosana***

Fig.2 ***Panalia bractescens***

threatened medicinal orchid species in their natural habitat by natural propagation method as their propagation rate is very slow.

***Ex-situ* conservation**

The preservation of biological diversity components away from their native environments is known as *ex situ* conservation. Since ex-situ conservation strategies offer an "insurance policy" against extinction, they can be used in combination with in situ methods. These actions are also highly important for endangered species rehabili-tation programs. Within this framework, *ex situ* conservation which encompasses seed banks and collections of plant tissue cultured *in vitro* is a crucial component of orchid conservation. Consequently, the development of a long-term conservation and recovery program, particularly for medicinal orchids in the endangered region, is urgently needed.

Tissue culture: a potential alternative for conservation of orchids.

It has been acknowledged that after discovering the threats of the orchidaceous, the plant tissue culture approach offers an acceptable alternative for large-scale orchid multiplication and conservation of rare, endangered and threatened species. Commercial orchids were primarily produced by tissue culture following the development of a protocol for *in vitro* micro propagation by Morel (1960), who cultivated shoot tips for the production of a large number of virus-free Cymbidiums. Orchid growers routinely use this technique globally for the mass production of orchids (Wimber, 1963). The last fifty years have seen a great deal of use of tissue culture techniques with various explants, both for the large-scale and quick multiplication of orchids as well as for their *ex situ* conservation. The numerous orchids that grow naturally have been preserved by the development of the *in vitro* propagation technology, which has also led to a decrease in the amount of wild orchids collected. A significant number of identical clones may be generated from a single protocorm or shoot tip explants using an *in vitro* propagation approach, owing to the growing popularity of orchids for cut flowers and therapeutic purposes.

Fig.3 Healthy shoots and roots of *in vitro* grown Dendrobium nobile Lindl.

Tissue culture

↓

Cleaning of glasswares with detergenes.
↓
Oven drying of glasswares.
↓
Packing of grasswares with brown papers.
↓
Carefully packed in autoclave bags.
↓
Autoclave the glasswares at 121^{O}C and 15 PSI pressure for 20 minutes.

Preparation of Media (MS, KN, N5 etc) with 3% sucrose.
↓
Enriching the media with hormones (BAP, NAA).
↓
Maintain the pH at 5.8 and add 8% agar (w/v) to gel the media.
↓
Autoclave the media at 121^{o}C and 15 PSI pressure for 20 minutes.
↓
Under laminar chamber media is plated in Petri plates.

Healthy explants is collected
↓
Surface sterilized with detergens and water.
↓
Again sterilize the explants under laminar chamber with HgCl2, NaCIO at different concentration.
↓
Inoculate the explants in sterile condition with autoclaved foreceped and blades.
↓
Incubate the cultures in culture room at controlled environment.
↓
Subculturing of in vitro grown planties in another media.
↓
Acclamitization of established healthy plantlests outside the growth chamber

Fig. 4 : Basic steps of Tissue Culture

Thus, techniques for orchid multiplication at a rapid rate are crucial to fulfilling the market need and mainly conservation of the species. Propagation from seed or a variety of explants (any plant part used for regeneration), such as shoot tips, stems, rhizomes, protocorms, etc., is one aspect of the many *in vitro* culture operations. The composition of the nutritional medium has a major role in the success of plant tissue cultures. Numerous modified media, some of which had pH adjustments prior to release, were standardized and brought to market with the introduction of Knudson medium(first discovered media by Knudson (1884-1958)). Vacin and Went medium (Vacin and Went, 1949); MS medium (Murashige and Skoog, 1962); Knudson C medium (Knudson, 1922, 1925, 1927, 1946); and several additional media (Arditti, 1968; Ernst, 1974; Mitra, 1986; Jonn, 1988) are the most widely used media for orchid cultivation. Auxins and cytokinins are examples of plant growth regulators that are given to the medium to improve seed germination in some orchid species. Numerous diverse modifications, including as peptone, tomato juice, coconut water, banana pulp, salep, honey, and beef extract, have been tested in various mediums to demonstrate their impact on the germina-tion of orchid seeds The genotype, seed maturity, and culture conditions all affect the rate of seed germination, protocorm production, and full development of seedlings. After establishment of seedlings, acclimatization is a crucial step in the successful transfer of *in vitro*-grown plants to ex vitro conditions.

Conclusion

Tissue culture has revolutionized orchid propagation, offering a breakthrough in cultivating these exquisite plants. This method allows for the mass production of orchids from small tissue samples, enabling the rapid multiplication of rare or endangered species. By using tissue culture, growers can produce genetically identical plants, ensuring consistency in quality and

traits. The technique also circumvents the challenges of traditional propagation methods, such as slow growth rates and susceptibility to diseases. Additionally, tissue culture provides a controlled environment, reducing the risk of contamination and enhancing survival rates. This innovative approach has not only expan-ded the availability of orchids but also contributed to their conservation, preserv-ing biodiversity. Furthermore, tissue culture has opened new avenues for research, enabling the study of orchid biology and the developm-ent of new hybrids. Overall, tissue culture represents a significant advancement in orchid propagation, combining scientific precision with practical benefits, and paving the way for the sustainable cultivation of these plants.

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ISSN No. 2583-3146

Vertical Farming: A Promising Solution for Year-Round Vegetable Production

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Introduction

Despite the imminent global population surge, a critical dilemma looms regarding food provision. Diminished land per capita intensifies the challenge of meeting escalating food demands. In regions like India, stagnation in arable land exacerbates the issue, as skyrocketing prices of landhinder agricultural expansion. Extra demand is placed on resources when perishable food is transported from rural to urban regions. A potential remedy lies in vertical farming, a concept first envisioned by Gilbert Ellis Bailey in 1915. This innovative approach involves cultivating crops in stacked layers or on inclining surfaces within controlled indoor environments. By maximizing spatial efficiency, vertical farming is tailor-made for urban landscapes like skyscrapers or repurposed shipping containers. Employing state-of-the-art techniques such as hydroponics and aeroponics, this method prioritizes plant growth optimization and soilless farming practices. The modern-day interpretation of vertical farming underscores its role in utilizing every inch of land, be it urban or rural, to address food scarcity for a burgeoning population. This pioneering agricultural technology, gaining importance worldwide, is now being embraced in India too, with several forward-thinking entrepreneurs exploring its promising yield potential across various settings like buildings, warehouses, rooftops, and balconies (Montero *et al.*, 2015).

Fig. 1 Hydroponics systems

Various Forms of Vertical Farming

1. Hydroponic Systems: These systems grow plants in a nutrient-rich water solution without soil, using techniques like nutrient film technique (NFT) or deep-water culture (DWC).

2. Aeroponic Systems: This technique involves growing plants in an environment with air and mist, providing nutrients directly to the roots without using soil or a growing medium.

3. Aquaponic Systems: This method involves combining aquaculture (fish farming) with hydroponics and using waste from aquatic animals to nourish the plants.

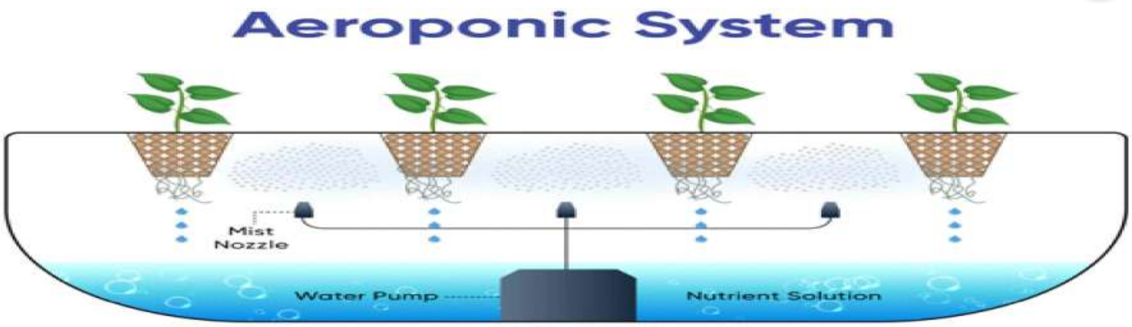

Fig. 2 Aeroponics

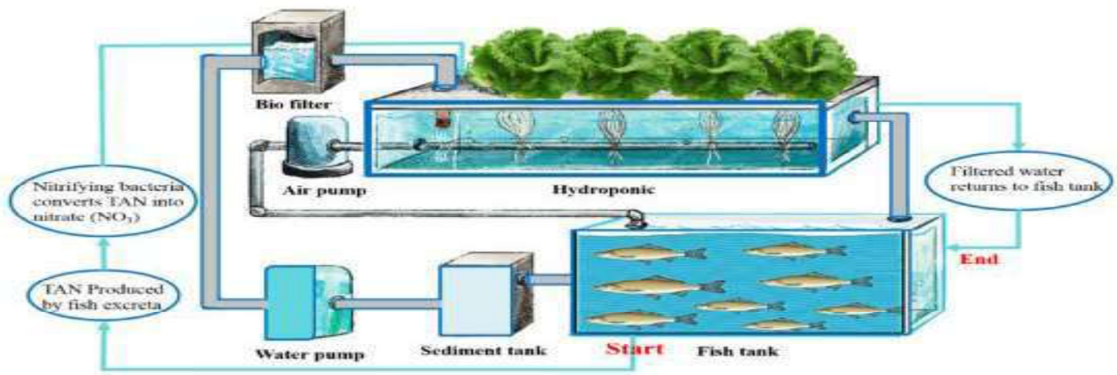

Fig. 3 Aquaponics system (Taha *et al.*, 2022)

4. Tower Gardens: Plant containers are stacked vertically to save space, often using LED lights to support plant growth. These vertical towers are versatile for cultivating a variety of crops such as lettuce, Swiss chard, herbs, spinach, kale, and broccoli. When equipped with overhead lighting, they become suitable for indoor gardening, particularly popular in congested urban settings. Customizable in design, the towers can be suspended from the top,

Fig. 4 Vertical Tower gardens

allowing drainage into a central tank for nutrient collection as per individual preferences (Dunn, 2017).

5. Modular Farming Units: Using enclosed vertical structures, these units often incorporate automation, LED lighting, and tailored climate control systems to maximize efficiency.

Vertical Farms Types Based on Their Structure and Location

1. Building-based Farms: These utilize existing buildings or newly constructed ones designed specifically for vertical farming.

2. Shipping Container Farms: Repurposed shipping containers equipped with climate controls and LED lighting offer a compact farming solution.

3. Underground Farms: These farms exploit subterranean environments, benefiting from stable temperatures and humidity levels, which can lead to higher yields

Benefits of Vertical Farming

1. Space Efficiency: Vertical farms can yield significantly more food per square foot compared to traditional farms, with potential yields up to 240 times greater. They offer high productivity per unit area, with nearly 80% more harvest per unit area. Unlike traditional farms that need fertile land, vertical farms can be built in any climate and location, regardless of weather conditions. This method allows for higher productivity in a smaller space, with one hectare of vertical farm equating to 10 to 20 hectares of traditional farmland, depending on the crop.

2. Water Conservation: Vertical farming can use up to 98% less water than conventional farming, thanks to closed systems that recirculate water.

3. Year-round Production: Controlled environments in vertical farms enable continuous crop production, unaffected by seasonal changes or adverse weather. This ensures fresh produce can be grown year-round, avoiding risks from natural events like floods, droughts, extreme temperatures and pest outbreaks.

4. Reduced Environmental Impact: Vertical farming helps prevent land degradation and deforestation, supporting environmental conservation. It also reduces the distance food travels, lowering costs, energy use, and carbon footprint.

5. Higher Quality Produce: Produce from vertical farms is of higher quality, more nutritious, and has a longer shelf life since it doesn't require toxic herbicides or pesticides. The shorter food supply chain ensures consumers receive fresh produce with its original nutrient qualities intact.

6. Growing Higher Quality Produce: Vertical farming produces higher quality, more nutritious food with a longer shelf life, as it eliminates the need for toxic herbicides or pesticides. The shorter supply chain ensures consumers receive fresh produce with all its original nutrients. Additionally, vertical farming requires 90% less or no soil, reducing pest and disease infestations, and resulting in pesticide-free or organic food.

7. More Sustainable Than Traditional Farming: Indoor farming is more environmentally friendly as it reduces the reliance on fossil fuels for farm equipment. Although utility bills can be high, solar power can mitigate environmental costs. Vertical farming also enhances biodiversity without disturbing the land surface, supporting the population of native animals around farms.

8. Reducing Resource Waste: Proper management in vertical farms can eliminate the need for pesticides, as pests cannot easily infiltrate controlled environments, and fungal diseases are less likely to thrive with regulated humidity. Vertical farms use significantly less water than traditional farms, with water being reused and minimal waste generated.

9. Reduced Transportation Costs: One major advantage of vertical farming is the ability to grow crops closer to where consumers live, reducing transportation costs and associated environmental impacts.

Crops Suitable for Vertical Farming in India

As a farmer, selecting the right crops is crucial. This involves analysing market demand and production costs. Vertical

Small Vertical Plants	Medium-Sized Vertical Plants	Large Vertical Crops
Lettuce Broccoli Amaranthus Tubers	Cabbage Cauliflower Tomato Eggplant	Corn

Herbs and Microgreens	Leafy Greens	Other crops
Basil Cilantro Mint Bell peppers Oregano Rosemary	Lettuce Kale	Tomato Strawberry Spinach

farming is well-suited for a variety of crops, particularly those that grow quickly and efficiently in controlled environments.Here are some crops suitable for vertical farming:

Challenges and Limitations

The challenges of vertical farming in India include public awareness, inclusiveness of the farming community, technical know-how, managing and maintaining the systems, and economic viability (Sonwane, 2018).

- **High Initial Costs:** Setting up and operating vertical farms can be more expensive than traditional farming, especially in urban areas with high real estate costs.
- **Energy Demands:** The need for artificial lighting and climate control systems results in high energy consumption, which can offset some environmental benefits if non-renewable energy sources are used.
- **Limited Crop Variety:** Vertical farms mainly produce leafy greens, herbs, and certain fruits, with difficulties in growing larger crops like grains and root vegetables.
- **Technical Expertise:** Successful vertical farming requires knowledge of plant biology, environmental controls, and technology management.

Future Prospects

With the rise in urban populations, vertical farming offers a promising solution to food security issues. Technological advancements, including automation and better energy efficiency, are vital for making vertical farms more profitable and sustainable. Collaboration among researchers, policymakers, and industry stakeholders is crucial to overcoming current challenges and integrating vertical farming into mainstream agriculture.

Conclusion

Vertical farming is a groundbreaking innovation in agriculture, with the potential to revolutionize food production in urban areas while tackling significant issues like land scarcity and environmental degradation.

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ISSN No. 2583-3146

Jeevamrit: The Exilir of Sustainable Farming

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Introduction

The recent sharp rise in chemical fertilizer prices has made them too costly for small and marginal farmers. Additionally, the excessive use of synthetic fertilizers has harmed soil health. As a solution, natural alternatives such as Jeevamrit, Beejamruth and Panchagavya are becoming popular. These liquid mixtures offer essential nutrients, boost soil health and improve nutrient availability for crops. Among these, Jeevamrit is particularly noteworthy in natural farming circles. Known for its exceptional benefits, it supplies vital nutrients and assists in pest control. Formulated from traditional ingredients such as desi cow dung and urine, Jeevamrit can significantly impact agricultural productivity, with a single cow's contribution being sufficient to support up to 12 hectares of land. This shift towards natural solutions presents a promising path towards sustainable farming practices.

Jeevamrit

Jeevamrit is a natural fertilizer and crop growth enhancer, rich in microorganisms that improve soil fertility and boost crop productivity. The name Jeevamrit is derived from two words: "Jeevan," meani-ng lifeand "Amrit," meaning medicine. Often referred to as the "elixir of life" for soil. Jeevamrit is a low-cost preparation that enriches the soil, promotes microbial growth and improves soil mineralization. It is made using easily available ingredients like desi cow dung, cow urine, jaggery and horse gram. This preparation is especially beneficial in natural farming, as it helps control fungal infections and other pests without relying on chemical fertilizers or pesticides.

Types of Jeevamrit

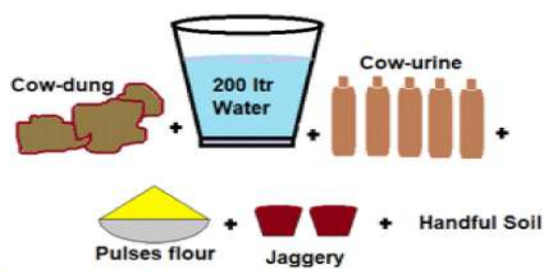
1. The liquid state: It is also called DhravaJeevamrita. The liquid content is high in this form of Jeevamrita.

2. Dry state: It is also called Ghana Jeevamrita. Very less amount to water is used in preparation. The Jeevamrita, after preparation, is sun-dried and made into powder.

Preparation of DhravaJeevamrit (liquid state)

Jeevamrit is a fermented microbial culture that supplies nutrients to plants and enhances microbial activity in the soil. The preparation process is simple and can be done with the following ingredients:

1. Water - 200 liters



2. Desi cow dung - 10 kg
3. Desi cow urine - 10 liters
4. Jaggery - 2 kg
5. Pulse flour - 2 kg
6. Handful of soil from the bund/forest

Step by step process to prepare Jeevamrit

1. Take a 200-liter container and fill it with water.
2. Add 10 kg of desi cow dung and mix it thoroughly.
3. Add 10 liters of desi cow urine.
4. Mix 2 kg of powdered jaggery and 2 kg of pulse flour, ensuring no clumps form.
5. Finally, add a handful of soil from the bund or forest and stir the mixture well.
6. Cover the container with a cloth/jute bag and stir the mixture with wooden stick twice daily, morning and evening, in a clockwise direction.
7. Let the mixture ferment for 9 to 12 days. After fermentation, Jeevamrit is ready to use.

Note: During fermentation, the poisonous gases like Ammonia, Methane, Carbon - monoxide, Carbon dioxide, are emitted through the holes of jute bag these gases are evacuated in the atmosphere which facilitates aerobic fermentation process at high speed. Stir this solution with thick wooden stick twice a day.

Precautions

1. The solution should be kept in a shaded area.
2. Stir the solution regularly.
3. Avoid direct exposure to sunlight.
4. Do not store the prepared solution for an extended period.
5. Cow urine should not be stored in iron containers.

This preparation can be applied through irrigation water or as a foliar spray. The beneficial microorganisms in the cow dung and urine multiply during fermentation, enriched by jaggery and pulse flour, while the forest soil adds microbial diversity to the solution.

Application of Dhrava Jeevamrit

Use the prepared Jeevamrit solution within 14 days of making it. For each acre of land, apply 200 liters of Jeevamrit during irrigation. This mixture should be applied every two weeks, starting 15 days after sowing.

Jeevamrit is an effective organic fertilizer that enhances plant growth, improves grain qualityand increases the microbial content in the soil. After preparation, it is diluted with water in a 1:4 ratio (1 liter of Jeevamrit to 4 liters of water) and then applied to the plants. Whether you have an irrigation system or potted plants, Jeevamrit can be easily used to nourish crops without the risk of over-application.

Foliar Spray

Jeevamrit can also be used as a foliar spray following these steps

1. One month after seed sowing, mix 5 liters of strained Jeevamrit with 100 liters of water and apply it as a foliar spray.
2. The second foliar spray should be applied 21 days after the first, using 10 liters of strained Jeevamrit mixed with 150 liters of water.
3. The third foliar spray should be done 21 days after the second, using 20 liters of strained Jeevamrit mixed with 200 liters of water.

Crops like rice, wheat, sugarcane and maize, which typically require high doses of fertilizers, can benefit greatly from Jeevamrit. It not only improves productivity and quality but also helps in maintaining soil health over time.

Preparation of Ghanjeevamrit (Dry State)

1. Spread 100 kg of well-dried cow dung uniformly on the ground in a thin layer.
2. Sprinkle 10 liters of prepared Jeevamrit (10% of the dry cow dung) evenly over the cow dung layer.

3. Mix the sprinkled Jeevamrit thoroughly with the dried cow dung using a spade.
4. Gather the treated cow dung into a heap and cover it with a jute bag.
5. Allow the heap to dry in sunlight for 16 hours.
6. After drying, crush the dried cow dung into a powder using a thick wooden stick.
7. Store the powdered Ghanjeevamrit in jute bags.
Ghanjeevamrit can be stored for up to 6 months.

Application of Ghanjeevamrit

Use 200 kg of Ghanjeevamrit per acre, either by broadcasting it during field preparation or at the time of seed sowing. Additionally, apply 50 kg of Ghanjeevamrit to the soil between crop rows during the flowering stage.

Benefits of Jeevamrit

Jeevamrit offers numerous benefits, making it an invaluable tool for sustainable agriculture:
1.Enhanced Soil Fertility: Jeevamrit enriches soil with essential nutrients and organic matter, improving nutrient uptake and leading to healthier crops.
2. Pest and Disease Management: The beneficial microorganisms in Jeevamrit help control pests and diseases naturally, reducing the need for chemical pesticides.
3.Sustainable Farming: By reducing dependency on synthetic fertilizers and pesticides, Jeevamritpromotes sustainable farming practices, minimizes environmental impactand supports biodiversity.

Jeevamrit: A Farmer's Ally for Sustainable Agriculture

Jeevamrit is not just good for the soil and crops; it's also great for farmers. It's a low-cost alternative to chemical fertilizers, helping farmers save money while boosting crop yields and improving soil health. Jeevamrit supports long-term farming and is easy to make and use, especially for farmers with livestock. This makes it a practical and eco-friendly choice for sustainable agriculture.

Conclusion

Jeevamrit is truly a miracle in natural farming. It's easy to prepare, rich in macro and micronutrients and full of beneficial microorganisms that support plant health. The maximum microbial activity is observed around the 10th day after preparation, making this the ideal time for application. By using Jeevamrit, farmers can promote healthier soils, reduce chemical inputsand move towards more sustainable agricultural practices.

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ISSN No. 2583-3146

Plantix: Where Technology Meets Agriculture

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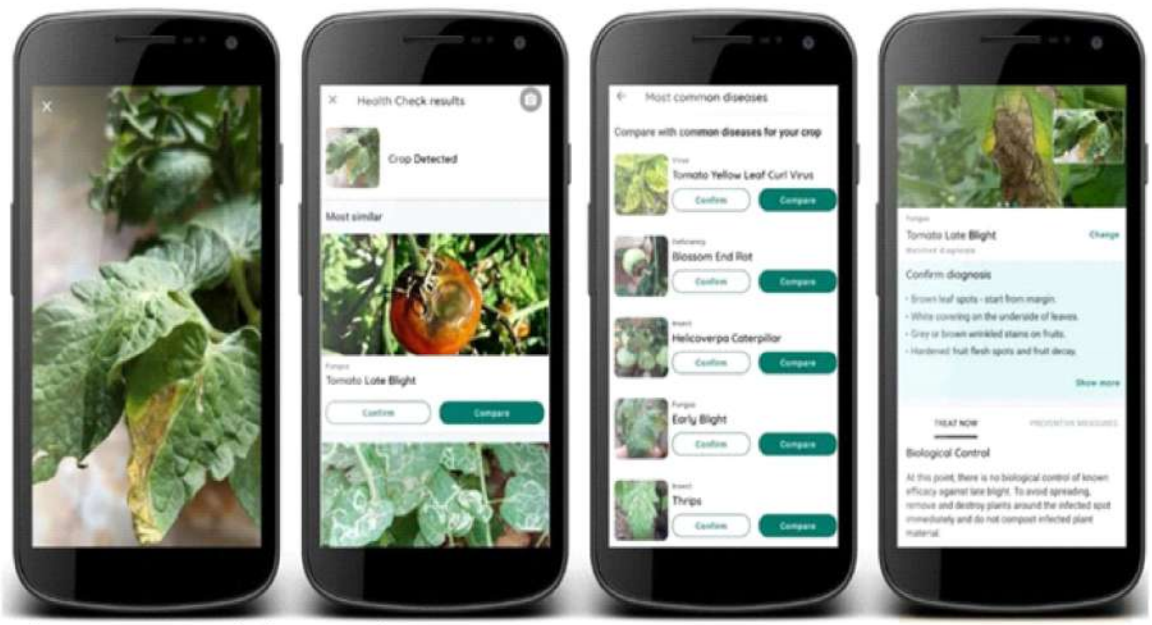
Introduction

Plantix is a highly regarded mobile application specifically designed to assist farmers and agricultural professionals in managing crops and diagnosing plant health issues. Developed by the German-based startup PEAT GmbH, Plantix leverages advanced technology, including Artificial Intelligence (AI) and image recognition, to provide accurate and timely advice to farmers worldwide.



Plantix is a mobile app that uses AI-powered technology to help farmers and gardening enthusiasts diagnose and treat crop diseases, pests and nutrient deficiencies.

Here's what Plantix offers

- **Heal Your Crop:** Detect pests and diseases on crops and get recommended treatments.
- **Disease Alerts:** Be the first to know when a disease is about to strike in your district.
- **Farmer Community:** Ask crop-related questions and get answers from 500+ community experts.
- **Cultivation Tips:** Follow effective agricultural practices throughout your whole crop cycle.
- **Agri Weather Forecast:** Know the best time to weed, spray and harvest.
- **Fertilizer Calculator:** Calculate fertilizer

demands for your crop based on the plot size.

Plantix covers 30 major crops and detects over 400 plant damages, and is available in 18 languages. It's been downloaded over 10 million times, making it the number one agricultural app for damage detection, pest and disease control, and yield improvement for farmers worldwide.

Key Features of Plantix

1. Plant Disease Diagnosis

• Plantix uses AI and machine learning to analyze images of plants uploaded by users. The app can accurately diagnose plant diseases, pest infestations, and nutrient deficiencies by comparing the images to a vast database of plant health issues.

2. Personalized Crop Advisory

• Based on the diagnosis, Plantix provides farmers with personalized recommendations for treating the identified issues. This may include suggestions for pesticides, fertilizers, or specific farming practices to improve crop health.

3. Weather Forecasts

• The app offers localized weather forecasts, which help farmers plan their activities, such as sowing, irrigation, and harvesting, according to the predicted weather conditions.

4. Soil Health Monitoring

• Plantix offers insights into soil health, guiding farmers on the appropriate use of fertilizers and soil amendments to enhance crop productivity.

5. Community and Support

• The app has a strong community feature where farmers can connect with each other and agricultural experts to share experiences, advice, and best practices. This peer-to-peer support network enhances knowledge sharing and problem-solving.

6. Localized Content

• Plantix is available in multiple languages and is tailored to different regions, making it accessible to farmers in various parts of the world. It also provides region-specific advice based on local farming conditions.

7. Crop Diagnosis

• Take a photo of your affected crop, and Plantix's AI algorithm will identify the issue and provide recommended treatments.

8. Disease Alerts

• Receive real-time notifications when diseases are detected in your area, allowing you to take proactive measures.

9. Global Network

• Connect with a global network of farmers and experts to ask questions, share knowledge, and learn from others.

10. Weather Forecast

• Get location-specific weather updates to plan planting, spraying, and harvesting.

11. Fertilizer Calculator

• Calculate the optimal amount of fertilizer needed for your crops.

12. Personalized Advice

• Receive tailored guidance on cultivation, pest management, and disease prevention.

Benefits of Using Plantix

1. Enhanced Crop Management

• Plantix helps farmers detect problems early, allowing for timely intervention and reducing crop losses.

2. Cost Efficiency

• By offering precise recommendations, the app helps farmers use inputs more efficiently, reducing costs and minimizing environmental impact.

3. Knowledge Access

• Farmers gain access to expert knowledge and can continuously learn and adapt their practices to improve their farming outcomes.

4. Increased Productivity

• The use of Plantix leads to better crop yields by optimizing plant health and reducing the impact of diseases and pests.

5. Reduced Chemical Usage

• Implement eco-friendly treatment

options and minimize chemical application.

6. **Improved Crop Quality**

• Enhance the health and quality of your crops through data-driven decision making.

7. **Global Community**

• Connect with fellow farmers, share experiences, and learn from experts worldwide.

Global Reach and Impact

Plantix is used by millions of farmers around the world, particularly in regions like India, where agriculture is a primary livelihood. The app's ability to provide instant, reliable information has made it a valuable tool in both developed and developing agricultural markets.

Availability

Plantix is available for both Android and IOS devices, with versions in multiple languages.

Downloads

With over 10 million downloads worldwide, Plantix has established itself as a leading agricultural app for farmers and gardening enthusiasts.

Conclusion

Plantix is an innovative agricultural mobile application that empowers farmers by providing them with the tools and knowledge needed to improve crop health and productivity. Its combination of AI-driven diagnostics, personalized advice, and community support makes it a vital resource for modern agriculture.

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ISSN No. 2583-3146

Emerging Trends to Manage Pest

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Introduction

For thousands of years, farmers have worked to reduce the negative effects of crop pests. Significant crops can be severely damaged by insects, nematodes, bacteria, fungi, viruses, and other pathogens. This damage can have a significant negative economical impact. Certain plant pests, such those brought on by fungus mycotoxins, not only have socioeconomic consequences but also provide health risks to humans. Pest management is a never-ending effort because pests adapt to these methods of control when new chemical pesticides or pest-protected plants are created. IPM is an approach which manages pests by biologically integrated alternatives for pest control and is "a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks. While it examines emerging trends and technologies, the review of recent advancements in environmentally friendly pest control highlights the crucial role that legislation and education play in encouraging its adoption. The chapter encourages switching from traditional to more environmentally friendly practices, making current developments in Plant Health Sciences crucial for environmentally friendly agriculture.

Role of Genetic Engineering in Pest Control

In agriculture, genetic engineering is utilized to create crops with altered genetic makeup. The purpose of these crops is to prevent pest infestations by acting as barriers. It promotes the growth of crops resistant to fungus and viruses. Genetically modified crops are beneficial to agriculture. As a result, there is less need for insecticides. Although there have been research and development efforts for a variety of Bt crops, commercialization and cultivation permits for these crops are contingent upon public acceptance and regulatory procedures. Requires thorough safety evaluations, regulatory permissions, and public consent before Bt technology may be adopted in various crops to ensure that these genetically engineered crops are safe for the environment and human health. It could be applied to the development of drought- and disease-resistant crops.

Sr. No.		Crops
1.	*Bt* Brinjal	Fruit and shoot borer (FSB) resistance is provided by the *Bt* brinjal, a genetically modified eggplant species that expresses the *Bt* toxin, especially Cry1Ac. While *Bt* brinjal is permitted for commercial production in Bangladesh, commercial cultivation of *Bt* brinjal is not approved in India.
2.	*Bt* Rice	India has produced genetically engineered *Bt* rice to provide protection against pest insects as leaf folders and stem borers. Although several organizations and research centers have labored to create *Bt* rice varieties, the nation has not yet allowed the commercial production of *Bt* rice.
3.	*Bt* Tomato	Research has also been done on genetic engineering to create *Bt* tomato cultivars that are resistant to particular insects like fruit borers. Although studies on *Bt* tomatoes have been carried out in India, commercial *Bt* tomato growing has not been authorized.
4	*Bt* Chickpea	The Cry1Ac protein, which confers sensitivity towards the pod borer pest, is expressed in *Bt* chickpeas, a genetically modified type of chickpea. Though commercial production has not yet been allowed, studies and developments are underway to create *Bt* chickpea cultivars with greater resistance to pests.
5.	*Bt* Pigeon pea	Red gram, often called pigeon pea, is a significant pulses crop in India. Improved immunity to pod borers in *Bt* pigeon pea types has been achieved through genetic engineering. But *Bt* pigeon pea commercial production is still in its research and development stages.
6.	*Bt* cotton	In India, it was first made available for purchase in 2002. It was created by introducing a gene into cotton plants through the soil bacterium Bacillus thuringiensis. With the help of this gene, cotton plants may create the *Bt* toxin, which kills bollworm insect larvae exclusively. India is home to the genetically engineered cotton crop known as *BtBt* Cotton.

The only genetically engineered *Bt* crop that is currently authorized for commercial production in India is *Bt* cotton. As a result, the only *Bt* crop that is extensively cultivated in India is *Bt* cotton. In an effort to provide resistance against specific pests like bollworms, genetic modification initiatives in the nation have primarily focused on *Bt* cotton.

Insects that are specifically targeted by *Bt* proteins in genetically modified crops include the pink bollworm, Pectinophora gossypiella and the European corn borer, Ostrinia nubilalis. Because *Bt* crops have insecticidal properties that are selective, they tend to encourage the emergence of secondary pests that are not harmed by the pesticide. Due to constant exposure, many insect species have become resistant to pests. Neonicotinoid pesticides have been used on crops because of insect resistance and secondary pest invasion; however, these pesticides pose a risk to beneficial insects, birds and bees.

Conclusion

Globally, there is an urgent need for pest modeling and elimination due to the annual food losses brought on by pest populations. In addition to guaranteeing the security of the world's food supply, controlling the insect population is also necessary to drastically reduce the financial losses that farmers incur. Chemical solutions are one of the many choices available for pest management, and they have shown to be very successful in the past. On the other hand, synthetic pesticides are also widely known for their dangerous consequences. Modern sustainable and environmentally friendly methods of reducing the number of pests are being used to reduce the harmful effects of chemical pesticides. In addition to having the ability to reduce pest populations, methods like mechanical traps, biological predators, resistant plant types, pheromone traps, etc. also have less of an effect on the environment, biodiv-ersity and human health. These contemp-orary methods have shown to be environm-entally friendly and a superior substitute for chemical pesticides that harm the ecosystem.

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ISSN No. 2583-3146

Impact of Climate Change on Poultry Production

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Introduction

Poultry is one of the most important components of a farmer's economy. It provides additional income and job opportunities to a large number of rural populations in the shortest possible time. Poultry farming has assumed much importance due to the growing demands for poultry products, especially in urban areas, because of their high food values. It also involves small capital investments and provides useful employment to a large number of people. The Indian Council of Agriculture Research (ICAR) is playing an important role in poultry improvement in the country. It has established two institutes in the country, *viz*., the Central Avian Research Institute (CARI), Izatnagar, Bareilly, and the Project Directorate on Poultry, Hyderabad, to provide necessary research training and extension support to the growing Indians.

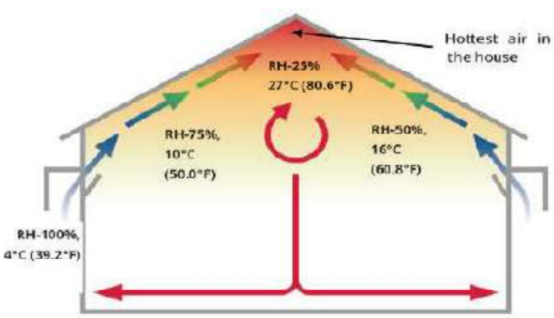
Global warming and climate change processes is predicted to alter many geographical events, like changes in rainfall patterns and more frequent incidences of drought, which will impact agricultural output and consequently the availability and price of feed ingredients. Ambient temperature projections for this century indicate an increase between 3ºC and 6ºC. This increase will lead to heat stress in chickens, causing high morbidity and mortality. The productivity of the heat stressed birds will decline, and the birds will be more susceptible to diseases. Under these circumstances, the feeding strategy, housing and other management practices followed presently have to be modified to overcome the adverse conditions. The selection strategy for both layers and broilers has to be oriented to produce heat tolerant lines or varieties. Genes responsible for conferring better adaptability may be introgressed into high-performing, low-adaptive lines through traditional as well as molecular breeding tools. Consumer awareness about the welfare of chicken raised for human consumption has been high in recent times, both in our country and abroad. This welfare awareness has led to the elimination of cage rearing of birds in some western nations. Adopting housing systems that are less stressful and prioritize animal welfare will address these welfare concerns. This will also become a necessity for exporting poultry products to overseas markets. Different housing types have to be evaluated for the maintenance or improvement of productivity, behavioral responses, and stress levels. Climate can be defined as the sum of environmental factors that influence the functioning of man and animals.

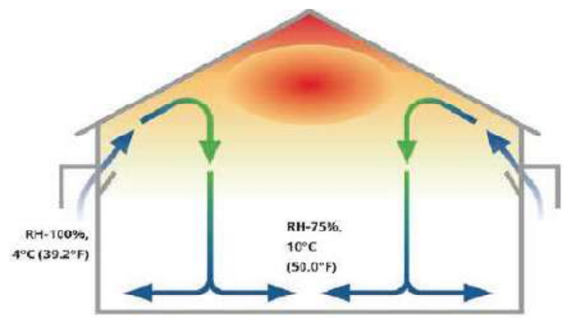
Impact of climate change on poultry production

Growth	Egg production	Reproduction	Health & immunity	Adaptation
1. Feed intake 2. Weight gain 3. Metabolic rates 4. Feed digestibility 5. Feed efficiency 6. Dressing%	1. Hen-day production 2. Egg mass 3. Egg quality 4. Shell Weight & thickness 5. Haugh Unit 6. Clutch Number	1. Fertility 2. Hatchability 3. Embryonic 4. Chick quality 5. Reproductive hormones 6 Gametogenesis	1. Morbidity 2. Mortality 3. Respiratory alkalosis 4. Viral and bacterial Infections 5. Immunity	1. Respiratory 2. Body Temperature 3. Corticosterone 4. Heat shock protein 5. Water consumption 6. T3, T4

House management

Poultry house should be designed in such a way to provide all the comfort required by birds during winter. Orientation of a building with respect to wind and sun consequently influence temperature, and light on different external surfaces. In winter the arc of the sun's visible path is shortened, an east west alignment of a rectangular house provides a maximum gain of solar energy in winter. House should be designed in a way that maximum sunlight enters the shed during day time. Birds should be protected from chilled winds, for this gunny bags should be hanged at the places from where the cold air enters. These gunny bags should be hanged down as soon as sunlight goes in the evening till the arrival of sunlight next morning.





Ventilation

During winter season it is necessary to keep the hose draft free but with plenty of ventilation. Birds release a lot of moisture in their breath and droppings which adversely affects their health, if there is restricted ventilation it causes ammonia build up in the air which causes respiratory problems. So, they need plenty of fresh air circulating around the house. For the purpose sliding windows are useful as they can be opened during day and closed during night.

There should also be arrangement of exhaust fans to remove impure air.

Feed Management

Poultry uses food for two main purposes i.e., as an energy source to maintain body temperature and to carry on normal physiological activities and as building material for development of bones, flesh, feather, egg etc. The variation in feed consumption is smaller for each degree Fahrenheit change in temperature when the weather is cold than when it is hot. Low temperature causes more feed intake and higher oxygen demand. Therefore, when the weather gets colder, it is essential to give the chicken plenty of food as they require extra energy for maintaining body temperature. Consumption of calories of ME/bird/ day varies as the ambient temperature changes. Normally these differences are as follows: When bird eats more feed, along with energy, other nutrients are also consumed more which are actually not needed and they become a waste. To avoid this wastage during winter energy rich sources like oil/fat should be added to the diet or level of other nutrients may be reduced keeping the energy at same level.

In winter number of feeders should be increased as compared to summer. Feed should be available to the bird whole of the day. It has been experimentally proved that for proper growth of broiler during summer, diet containing 23% protein and 3100 Kcal ME/kg diet is needed. While in winter 3400 Kcal/kg ME and 23% protein is needed.

Litter Management

Prior to chick being placed in house, the surface of floor should be covered with a bedding material called litter. It gives comfort to the birds. A good quality litter serves as an insulator in maintaining uniform temperature, also absorbs moisture and promotes drying. It dilutes fecal material thus reducing contact between birds and manure. It also insulates the chicks from the cooling effects of the ground and provides protection cushion between bird and floor. Around 6 inches of litter is needed in houses during winter. The litter gives warmth to the birds during winter. If litter management is proper, it will be felt quite warm when taken in hand.

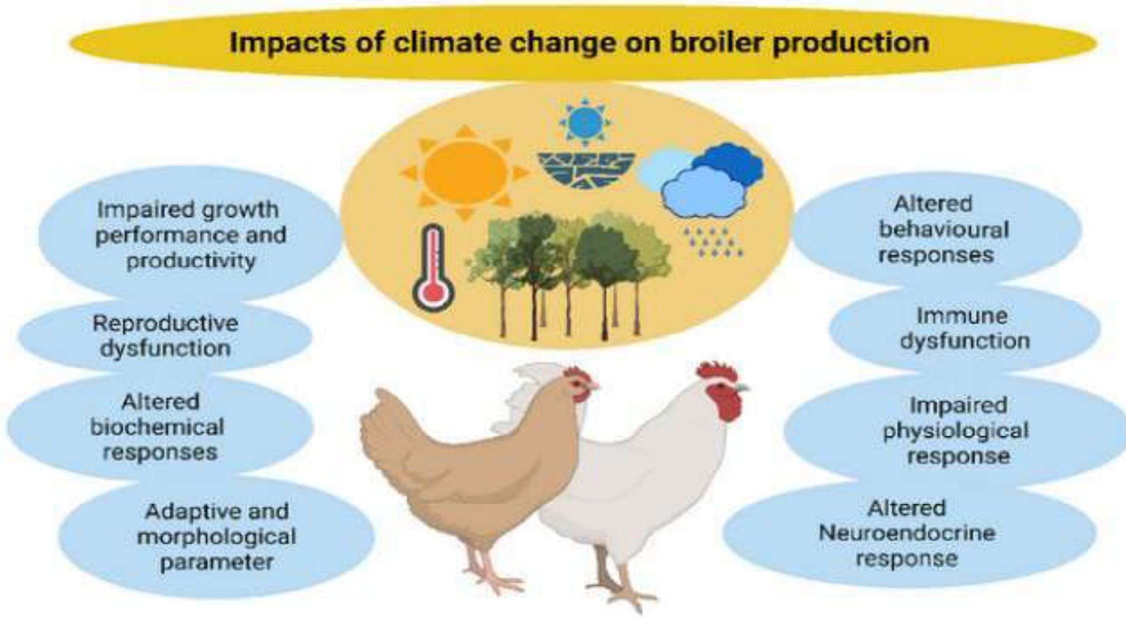
Water Management

- During winter season birds take less water so far maintenance of water in the body, it is necessary to give continuous supply of fresh water which can be taken by the bird.
- Water must be fresh and clean. If water is cold enough, then it should be given to chicken after adding hot water to it, so that the water comes to normal temperature.
- In ice falling areas, blockage of pipe is a big problem due to freezing of water during winter season. When temperature goes below 0°C routine inspection of pipe line should be done to avoid blockage of water.

1. Impact of summer season on poultry performance: During summer, the feed consumption by birds is reduced, which leads to reduced body weight, egg production, egg size, poor feed conversion efficiency, decrease in weight gain of birds, lowers resistance to diseases, prostration due to heat stroke, decrease in feed intake and reduces hatchability percentage. So a proper feeding strategy is required. In summer sessions of most common infections occur are from Bacterial, Viral, Fungal and Parasitic. Newcastle and bronchitis vaccine reactions can occur in birds hyperventilating because of heat stress. Vaccination failure is mainly because of stress like extreme temperature or relative humidity causing immune suppression.

2. Effect of winter session on poultry birds: Cold weather poultry farming poses several challenges, such as shorter daylight hours that greatly affect chicken feeding patterns, elevated humidity, and an increased risk of infections.

3. Effect of rainy session on poultry birds: The rainy season significantly affects poultry birds, influencing their health, productivity, and overall well-being. Increased humidity and wet conditions can lead to a rise in diseases, particularly respiratory infections, and parasites, which can compromise the birds' immune systems. Additionally, feed availability may be impacted due to soggy conditions,



potentially leading to nutritional deficiencies. Proper management practices are essential during this period to mitigate these risks and ensure the birds remain healthy and productive.

Conclusions

Poultry production faces various issues due to climate change, including heat stress, water scarcity, disease outbreaks, and feed insecurity. Proactive adaptation techniques, however, can assist chicken farmers in reducing these difficulties and enhancing their capacity for long-term output. Poultry producers can manage the challenges posed by climate change and maintain the well-being and productivity of their flocks by allocating resources towards cutting-edge technologies, genetic enhancements, and sustainable farming methods.

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ISSN No. 2583-3146

Urban Farming: A Fast Pace Way to Food Security

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Introduction

According to the United Nations, by 2050, approximately 68% of the world's population is projected to live in urban areas (FAO, 2018). This rapid urbanization poses a significant challenge for food production and distribution systems as agricultural land becomes scarce and transportation distances increase. The World Health Organization also estimates that more than 820 million people worldwide suffer from chronic hunger, highlighting the urgent need for innovative solutions to enhance food access and security (WHO, 2022).

Vertical farming

The rapid pace of urbanization and population growth presents an unprecedented challenge to global food security (Kookana *et al*., 2020). As traditional agricultural practices struggle to keep pace with the increasing demand for fresh produce, innovative solutions are imperative to sustainably feed urban populations. Vertical farming, an emerging agricultural paradigm, has gained considerable attention for its potential to revolutionize food production in urban environments. This method addresses the intricate relationship between vertical farming, architectural integration, and its pivotal role in addressing the critical issue of food security (Konou *et al.*, 2023).

India became the world's most populous country with nearly 140 crore people. On one hand, this would mean higher demographic dividends which is advantageous for the economy while on the other hand, the problem of resource scarcity looms large especially food security. Mitigating this is an arduous task since there is no scope for an increase in the cultivable area. So the only solution is to maximize the productivity in the available area.

Importance

Vertical farming is an ingenious solution to food security concerns. It is one of the best ways to maximize production in small areas making vertical farming in India a profitable venture. In this article, we will be describing vertical farming in India, vertical farming investment costs in India, crops suitable for vertical farming in India and the top vertical farming companies in India.

Urban agriculture attempts to advance sustainable agricultural methods, such as composting, the use of organic fertilizers, and water conservation. It involves a multidisciplinary approach, combining knowledge of soil science, plant physiology, sustainable agriculture and technology. Crop rotation and companion planting are two other methods urban farmers can utilize to lessen the demand for pesticides and herbicides. The crops are managed using advanced technology involving sensor-based monitoring, automated irrigation systems, and data analysis to maximize crop output. Urban crop farming is regarded as an important agricultural activity for the modern and circular economy, as it can also improve the urban residents' income and reduce agricultural waste.

Vertical farming can be implemented in various structures and using different techniques, including; tower farms, atrium farms, sky farms, green houses, shipping containers farm. Each technology involves different elements yet the similar outcomes. Every type has its own strengths and weaknesses. Still this farming is a good choice to make for a sustainable future. This might cost a little initially but later on it pays back well in both the scenario whether it is for a family's personal consumption or for commercial growth.

According to the National Institute of Agricultural Economics and Policy Research (NIAPER), the cost of setting up a vertical farm in India can range from Rs. 50 lakhs to Rs. 1 crore per acre, depending on the technology used. This includes the cost of infrastructure, technology and automation.

Requirements for vertical farming system

1. Infrastructure: This includes building construction, growing racks, climate monitoring systems, and irrigation systems.

2. Technology: Modern technology such as automation equipment, cooling systems, fertigation equipment, hydroponics, and aeroponics are needed for vertical farming. For instance, depending on the location, the kind of material utilized, and market prices, aeroponic farming might cost anywhere from Rs. 60 lakhs to Rs. 2.2 crore.

3. Operational costs: These include the cost of electricity, water, labor and other inputs required for crop maintenance and harvest. Operational costs can range from Rs. 5 lakhs to Rs. 10 lakhs per acre per year.

Barriers

The high costs for vertical farming can be prohibitive for small-scale farmers or entrepreneurs. However, actual profit calculations may vary depending on various factors such as crop selection, technology used, and market conditions.

Scope of Urban Agriculture

Urban agriculture implies the growing

and marketing (when applicable) of food in urban areas. Urban agriculture often takes place in community gardens, building balconies and rooftops, residential yards, and sometimes in vertical structures. This is seen as supporting food security and promoting individual productivity, community building, and environmental and economic sustainability. Urban farming may take the form of traditional agriculture, hydroponics, aquaponics, vertical farming and animal raising in space-efficient systems.

Traditional agriculture relies heavily on large-scale, industrialized farming methods that often require extensive land use, significant water resources and chemical inputs. These practices contribute to deforestation, soil degradation, water pollution and greenhouse gas emissions, exacerbating the challenges posed by climate change. Moreover, the transportation of food over long distances from rural areas to cities further contributes to carbon emissions and energy consumption (Sarabia *et al.*, 2021). In this context, urban agriculture has emerged as a promising alternative that can transform cities into more self-sufficient and sustainable systems (Abusin & Mandikiana, 2020).

Emerging technologies integrated Urban and peri-urban agriculture (UPA), such as Smart controlled environment agriculture (SCEA), an innovative form of crop cultivation that encourages sustainable, localized food production and security. However, due to perceived barriers by stakeholders, the adoption of SCEA initiatives is constrained in India. Many researches explored the barriers to the smart transformation of UPA, examined them and constructed framework to assist decision-making and found that cultural barriers, supply chain uncertainty, policy and regulations and institutional support were driving barriers; technology and infrastructure, cold chain logistics and environmentally sustainable practices were dependent barriers.

Conclusion

The utilization of cutting-edge technologies such as vertical farming and hydroponics is transforming the landscape of agriculture, offering solutions to the pressing issues that the industry faces. These technologies enable farmers to control the growing environment with precision, resulting in superior crop quality and increased yields while using fewer resources. With the global population growing at an unprecedented rate, it is essential to explore sustainable and efficient methods of producing sufficient food to meet the needs of everyone. Vertical farming and hydroponics offer a promising answer to these challenges, with the potential to completely transform the way we grow crops.

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ISSN No. 2583-3146

Advances In-storage Pest Management

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Introduction

Some of the most crucial phases between food grain harvesting, processing, and direct eating is storage. Storage is crucial in emerging economies since the majority of small and medium sized farmers rely on on-farm storage. However, post-harvest insect damage causes India to lose 14 million tons of storage each year, or over 7000 crores. The extent of contamination and spoiling caused by body parts, excrement and hoarding is in addition to consumption as the reason for the economic loss caused by storage pests. Large losses are mostly caused by incorrect storage methods and a lack of understanding about pests in storage and the harm they may do. The activities that must be carried out in tandem to minimize storage losses include the development of suitable storage structures that are easily managed and equipped, as well as the enforcement of stringent hygienic regulations in shops and effective pest control measures.

Storage structures

Farmer and government frequently store food grains in order to use them later. Typically, the grains are kept in large storage facilities or at residences. On the other hand, different kinds of buildings for storing grains are commonly used in different regions. As time goes on, they are created as tribal wisdom and used for the benefit of artificial structures.

The structures may be classified as (a) below-ground and above-ground structures or (b) traditional and improved structure Men used to dig pits and store grain close to where they lived in the past. However, the majority of the time, either microbiological deterioration or rodent damage caused them harm. They eventually began storing in bamboo baskets, above-ground mud bins, wood elevators, and other containers. Many writers have published thorough lists of various storage arrangements in the past, however, many of these are out of date and barely visible. The development and adoption of automated storage buildings, large warehouses, lofty stairs, silos and other better structures are indicative of the advancements in human knowledge and skills. On the other hand, these buildings facilitated the creation of complex microclimates and storage conditions. In due course, insects also become accustomed to these systems and eventually disperse to new areas. Hermetic and low-pressure conditions prevail storage arrangements are rather common nowadays.

Hermetic storage

Hermetic seals are a result of the idea of putting a wall between the grain and the commodity. The concept of de-oxygenation within the container's interior is used in tight storage to lessen aerobic conditions because many conventional constructions have internal oxygenation. The carbon dioxide (CO_2) concentration rises as a result of this decrease in oxygen (O_2) concentration, adversely affecting the insects' metabolic processes and ultimately resulting in their death. One new area of agricultural engineering research is the storage of seeds in hermetic seal storages.

Because an airtight or gastight closure encloses the volatile material and raises grain temperature and desiccation, it is excellent for managing storage pests. It also prevents immigration. On the other hand, grains that were kept suffered from the gas-tight state as well. Nonetheless, further benefits and effectiveness with hermetic store structure are provided by regulated aeration, adjusting the gas adequate, or incorporating an insect-proof barrier in modern manage-ment procedures. There are numerous academic studies on the creation of different configurationally altered hermetic storage systems.

When made of metal, they are more costly than bags. Nonetheless, they are marketed as cutting-edge storage facilities globally. Better subterranean storage systems for cereals pulses and seed oils were still in use in Asian and African locations because lower O_2 concentrations indicate the desired insect mortality. Hermetic cocoons (ranging in size from a few kilograms to tons), metal drums, hermetic bags and various polymeric bags and containers are some of the most widely used types of hermetic structures. These hermetic structures come in various sizes and capabilities.

Low-pressure storage

Low-pressure storage refers to the planning and creation of a grain storage facility with a lower internal pressure. This represents one of the storage structure's innovations, which relies on changing the physical environment-typically accomplis-hed by applying vacuum and producing low-oxygen environments. Physiological functions are impacted by this reduced O_2 concentration. In this approach, dehydrat-ion and hypoxia are the main causes of insect mortality. The development of flexible and transportable warehouses made of polyvinyl chloride (PVC) liners is illuminating the field, despite the restricted possibility of their implementation in uniform treatment.

Entomopathogenic nematodes (EPNs)

The application of entomopathogenic nematodes for controlling insects is becoming a unique strategy in pest manag-ement as nematode science advances. Heterhorhabditis and Steinernema, two significant genera, have been shown to be efficient against stored-grain insects as well as field crop pests. All insect species were shown to be susceptible to the inoculation strains, according to the results of the micro-tube bioassay. Compared to adults, the stages of larvae were more sensitive. Their restricted capacity to thrive in arid environments and limited climatic adaptat-ions hindered advancement in this subject for a very long period. On the other hand, the number of successes increased with the extraction of local virulent strains, effective-ness assessment of lab hosts, and formulati-on technologies. Due to their species-specific behaviour, nematodes cannot effectively manage a broad variety of insects. While creating a blend of strains can offer the anticipated protection for stored grains. Since these studies are all lab-based bioassays, there hasn't been any field testing of these EPNs on a large scale. To advance EPN techniques for storage management, large-scale field trials and mass culture might be carried out.

Nanotechnology in stored-grain protection

Studies on nanotechnology are becoming more prevalent in both fundamental and practical scientific domains, such as stored-grain protection. The unique features of the nanoparticles, like variations in conductivity of electricity, surface chemistry, and reactivity, increase their significance. A number of metallic oxides, including silica, silver, aluminum and zinc, were typically prepared as nanoparticles. Zinc oxide nanoparticles, on the other hand, were extensively employed due to their increased catalytic and photochemical activity, UV filtering, antibacterial and antifungal properties. To apply this unique technique to stored product preservation, in-depth, field-level studies of nanoparticle applications are needed.

Molecular interventions

One new method of controlling the insects is to interfere with their normal gene expression. It made use of two molecular techniques: CRISPR (clustered routinely interspaced short palindromic repeats) and RNA interference (RNAi). *T. castaneum*, also known as the rust-red flour, was used as model insects for these investigations. The majority of the data found in published articles primarily related to this insect, which was chosen as the preferred host due to its robust RNAI response throughout all developmental stages and ease of multiplication in laboratory settings. RNA interference (RNAI) usually targets DSRNA, while CRISPR inactivates the DNA binder Cas9 to prevent additional gene activation. Only after thorough investigation can these methods be applied successfully in the management of stored grains for pests. One first step and area of concern is identifying particular genes in insects that infest stored grains. These cutting-edge technologies, along with others like genome editing and

gene modification, give the impression of being futuristic.

Conclusion

For after harvest engineers and entomologists, one of the main areas of research is the safe handling and protection of products in storage. Both industrialized and developing nations are currently concerned about food safety and security. Preventive management techniques, like safe storage and adequate drying, were rationalized and as a result, numerous controlled storage structures and dryers were developed and widely used. The most popular among them are low-pressure and hermetic storages, however there aren't many uses for bulk storage. Although biological solutions including viruses, parasitoids, predators and EPNS are safer for the environment, their widespread adoption is hampered by their composition, mass manufacturing and field-level application. Cutting-edge scientific fields like biotech-nology and nanotechnology are developing quickly and helping to secure stored products. However, there have been advancements in a number of disciplines as a result of the growing concern for secure storage and non-chemical pest managem-ent. Modernized and integrated pest management techniques for bulk storage must be periodically changed while taking into account dynamic post-harvest syste-ms. Grain loss can be significantly prevented and reduced by pest manage-ment interventions during grain harvesting, drying out, handling, packaging and transportation till secure storage.

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ISSN No. 2583-3146

Exploring the Basics of Artificial Intelligence and Machine Learning with their Applications in Agriculture

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Introduction

Artificial Intelligence (AI) and machine learning (ML) has significantly changed various industries, introducing agricultural AI and ML, offer powerful capabilities addressing complex challenges and improving traditional farming methods. These technologies heavily rely on data, making them important for leveraging data to make informed agriculture decisions. The foundation lies in accurate and reliable data collection, preprocessing and choosing suitable algorithms to optimize model performance. Bringing all these stages together result in AI and ML models that are poised to transform agriculture.

The use of AI and ML in agriculture has a wide range of applications, including predicting crop yields, and detecting diseases. Precision farming, along with decision support systems, improves efficiency through intelligent practices. Real-world examples highlight their impact, such as using convolutional neural networks (CNN) for crop disease detection, employing Decision Trees and Internet of Things (IOT) devices for precision agriculture. However, ethical concerns relating to data privacy and algorithmic transparency need to be carefully considered and it's important to ensure to these technologies for all agricultural stakeholders.

Fundamentals of AI and ML

The basics of AI and ML include important concepts that form the foundation for their use and progress across different industries, including agriculture. AI involves the development of intelligent systems that can mimic human behaviours, while ML focuses on creating algorithms that allow machines to learn from data and enhance their performance as time progresses.

Artificial Intelligence (AI)

AI includes various techniques and approaches that, aim to create machines or systems capable of simulating human-like intelligence. These systems can complete tasks, such as problem-solving, decision-making, understanding natural language and recognizing patterns. AI techniques encompass rule-based systems, expert systems, neural networks, and natural language processing (NLP).

AI in Agriculture

AI in agriculture is leading a revolutionary change in how we grow crops. By using advanced technologies such as agriculture robots and intelligent spraying systems, farmers can precisely manage their fields, improving crop yields while reducing resource consumption. These AI-driven solutions provide real-time crop and soil monitoring, allowing proactive responses to changing conditions and predictive insights into weather patterns and pest outbreaks. AI also plays a vital role in disease diagnosis, swiftly identifying and addressing potential threats to crop health. Additionally, AI-driven price forecasts offer farmers valuable information for strategic decision-making. In summary, AI is not only transforming agriculture; it's also paving the way for a more sustainable, efficient, and economically viable future for the industry.

Machine Learning

ML is a part of AI that is focused on creating algorithms to enable computers to learn from data and utilize that learning to make predictions or decisions. ML algorithms are divided into supervised, unsupervised and reinforcement learning, for different types of tasks. Supervised learning involves training the model on labeled data, unsupervised learning involves identifying patterns in unlabeled data, and reinforcement learning involves training agents to take actions to maximize rewards.

ML in Agriculture

Machine learning (ML) is transforming the agriculture industry by improving crop and livestock management. ML algorithms analyze large datasets and real-time sensor data, empowering farmers to make informed decisions. In crop management, ML predicts yields, disease outbreaks and optimal planting times, leading to increased productivity and resource efficiency. Water management benefits from ML by determining precise irrigation schedules, conserving water and reducing the risk of drought. ML also enhances soil management by evaluating soil health and nutrient levels to create tailored fertilization plans. Livestock management uses ML to monitor animal health, optimize feed distribution and improve breeding programs, leading to increased efficiency and sustainability in modern agriculture.

AI and ML Concepts in Agriculture

AI and ML concepts are transforming agriculture by combining advanced technology with traditional farming methods to improve efficiency and sustain-ability. These technologies provide real-time insights into soil health and crop conditions through monitoring, helping farmers make informed decisions. By monitoring crop maturity and livestock health, AI and ML systems offer timely feedback on crop development and livestock well-being, allowing for precise interventions when necessary. Intelligent spraying systems and automatic feeding mechanisms also enhance precision agriculture, reducing resource waste and promoting the judicious use of fertilizers and pesticides. In summary, these concepts are revolutioni-zing the industry by promoting a more informed, efficient, and eco-conscious approach to farming.

Data Collection and Preprocessing

Data collection and preprocessing are crucial steps in integrating AI and ML techniques. This involves gathering diverse datasets related to specific domains, ensuring their accuracy, completeness and relevance for analysis. Data preprocessing is important as it includes activities like data cleaning, transformation and feature extraction to refine raw data into a usable form. These stages are vital for enhancing the quality of input data, which directly impacts the performance and reliability of AI and ML models. Focusing on data quality and preparation helps organizations ensure that subsequent AI and ML processes are based on accurate and meaningful information.

Feature Extraction and Engineering

Feature extraction and engineering play a central role in harnessing the power of AI and ML techniques. These processes involve identifying and selecting relevant attributes or features from the raw data that contribute to the predictive capabilities of models. Feature extraction focuses on transforming the data into a format that is more suitable for analysis, often involving techniques like dimensionality reduction or transformation. Feature engineering, on the other hand, involves creating new features or modifying existing ones to enhance the model's performance. These processes are crucial for optimizing the input data that AI and ML algorithms rely on, leading to improved accuracy and efficiency in model predictions. Effective feature extraction and engineering enable models to capture the underlying patterns in the data, ultimately enhancing the overall performance and capabilities of AI and ML applications.

Application in Agriculture

AI and ML technologies have greatly transformed traditional farming practices by using data-driven insights to address complex challenges in agriculture. These technologies have the potential to enhance various aspects of farming, including improving crop yield predictions and disease detection and management. For example, AI models can analyze historical weather data, soil characteristics, and other variables to provide accurate predictions of crop yields, enabling farmers to make informed decisions about resource allocation and planning. Additionally, AI and ML algorithms can detect and diagnose crop diseases by analyzing images of plants, leaves, or fruits, allowing for timely interventions to minimize losses and optimize crop health. The integration of AI and ML into precision agriculture has facilitated optimized resource utilization through targeted irrigation and fertilization, leading to increased efficiency and sustainability. These applications highlight the transformative potential of AI and ML in revolutionizing the agricultural sector.

Crop Yield Prediction

Crop yield prediction, an important application in AI and ML for agriculture, has received a lot of attention because of its potential to optimize resource allocation and improve food security. This predictive approach relies on combining historical and real-time data, taking into account factors like weather patterns, soil conditions and agricultural practices. By using advanced regression and ensemble techniques, AI and ML models can analyze complex relationships among these variables and accurately predict future crop yields [6]. These predictions offer valuable insights for farmers, helping them make informed decisions about planting strategies, irrigation schedules, and harvest planning. Overall, integrating AI and ML into crop yield prediction doesn't just improve agricultural efficiency, but also supports sustainable practices by reducing resource wastage and bolstering global food supply chains.

Disease Detection and Diagnosis

Integrating AI and ML techniques has significantly transformed disease detection and diagnosis in agriculture. This application is crucial in the early identifica-tion and management of crop diseases, reducing yield losses and ensuring food security. Using image recognition and classification algorithms, AI and ML models can analyze images of plants, leaves, or fruits to identify and diagnose various diseases accurately. These models learn from large datasets of images, enabling them to recognize subtle visual cues that human eyes might miss. Timely and accurate disease detection allows farmers to implement targeted interventions such as precise pesticide application or isolation of infected plants, minimizing the spread of diseases across crops. This application demonstrates how AI and ML are driving innovation in agriculture by leveraging data and automation to address critical challenges in disease management.

Precision Farming and Decision Support

Precision farming, combined with decision support systems, represents an innovative use of AI and ML in modern agriculture. This method uses advanced technologies to optimize resource allocation, improve efficiency, and reduce environmental impacts. By integrating data from sources such as satellites, sensors, and historical records, AI and ML models can offer real-time insights into soil conditions, weather patterns and crop health. These insights empower farmers to make informed decisions about when and where to apply irrigation, fertilizers and pesticides, customizing interventions to specific areas of need. This not only increases yields but also reduces resource wastage and environmental pollution. Additionally, decision support systems equipped with AI algorithms can generate recommendations based on complex data analysis, aiding farmers in making timely and strategic choices for optimal crop management. The integration of precision farming and decision support systems demonstrates how AI and ML are transforming traditional agricultural practices by using data-driven intelligence for sustainable and efficient outcomes.

Soil Health Monitoring and Management

The integration of AI and ML techniques has revolutionized soil health monitoring and management. By using a data-driven approach that incorporates sensor data, historical records and environmental variables, AI and ML models can analyze complex relationships within the soil ecosystem. This enables farmers to make informed decisions about soil quality, nutrient content, erosion risks, soil amendments, irrigation schedules and erosion control strategies. Ultimately, this leads to enhanced crop productivity, long-term soil conservation and improved agricultural sustainability. The use of AI and ML in soil health monitoring demonstrates how technological innovation can empow-er farmers to make precision-driven decisions that optimize land use and resource utilization.

Water Management and Irrigation Optimization

The seamless integration of these key elements will revolutionize our approach and drive our success to new heights. AI and ML have unequivocally revolutionized water management and irrigation optimi-zation in agriculture. Through the utiliza-tion of data from sensors, weather forecasts and soil moisture levels, AI and ML models dynamically adjust irrigation schedules to precisely meet specific crop water requirements, thereby minimizing wastage and enhancing crop yield. This, not only conserves water resources but, also significantly reduces energy consumption while ensuring productive and resilient farming systems.

Challenges and Future Directions

The integration of AI and ML concepts in agriculture presents both opportunities and challenges. Data quality, availability, privacy, security, and ethical use are significant considerations for their effective and sustainable implementation.

Challenges

The interpretability and explain ability of AI and ML models pose challenges in understanding decision-making. Black-box models may hinder adoption, especially in sectors like agriculture. Bridging the gap between technical experts and domainspecific farmers is another challenge, requiring effective communication and education.

Data Quality and Availability

It's essential to have reliable and comprehensive datasets for training AI and ML models in agriculture. The quality and composition of the data directly affect model performance. Incomplete, inconsistent, or biased data can impede accuracy and reliability. Data quality assurance is critical for reliable insights and predictions. Datasets should encompass diverse conditions, scenarios and variables to prevent biased outcomes. Addressing these data challenges is essential for leveraging AI and ML in agriculture.

Privacy and Accuracy

Agricultural data often contains sensitive information about farming practices, land management and personal details of farmers. It's crucial to ensure strong data privacy and security when using AI and ML in agriculture. This not only meets regulatory requirements but also builds trust among farmers, stakeholders and technology developers. Prioritizing data privacy and security helps establish confidence in the responsible use of AI and ML to improve productivity and sustainability in agriculture.

Interpretability and Explain ability

In agriculture, the lack of transparency in AI and ML models makes it difficult to understand decision-making. Transparent models are crucial for stakeholders to understand and trust the technology. Efforts are underway to develop AI and ML models that can be easily interpreted, helping with decision-making and identifying potential biases and errors for responsible AI use in agriculture.

Future Directions

AI and ML algorithms tailored for agricultural challenges show promise. Explainable AI (XAI) can address transpar-ency concerns by providing more interpretable models. Integrating AI with IOT devices, remote sensing and robotics can enhance data collection. Collaborative efforts are essential to create responsible AI deployment frameworks and ensure equitable access to AI benefits.

Conclusion

The rapid advancement of AI-driven solutions in agriculture is expected to improve transparency and adoption through the integration of Explainable AI (XAI) and collaboration between experts and farmers. Efforts are essential to develop frameworks addressing ethical, regulatory and accessibility concerns. Ultimately, this integration points toward a promising trajectory for a more resilient, productive and sustainable agricultural future.

The rapid advancement of AI-driven solutions in agriculture is expected to improve transparency and adoption through the integration of Explainable AI (XAI) and collaboration between experts and farmers. Efforts are essential to develop frameworks addressing ethical, regulatory and accessibility concerns. Ultimately, this integration points toward a promising trajectory for a more resilient, productive and sustainable agricultural future.

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ISSN No. 2583-3146

An Insight Into Beefsteak Tomato

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Introduction

Tomato (*Solanum lycopersicon* L.) belongs to Solanaceae family, native to Peruvian and Mexican region. India ranks second in the area as well as in production of tomato after China. Tomato is an herbaceous sprawling plant growing to 1-3 m in height with weak woody stem. It is one of the most common fruit in India, perhaps more ubiquitous than the banana. Though tomato is rarely placed alongside other fruits, it is one of the low-cost fruits, likely because of the ease in which they grow. Tomatoes are available year-round in India.There are over 10,000 varieties of tomato, these come in a variety of colours including pink, purple, black, yellow and white. The fruit came to India by way of Portuguese explorers during the early 16th century. The flowers are yellow in colour and the fruits of cultivated varieties vary in size from cherry tomato, about 1-2 cm in size to beefsteak tomatoes, about 10 cm or more in diameter. Most of cultivars produce red fruits when ripe. Tomato is one of the most important "protective foods" because of its special nutritive value and one of the versatile vegetable with wide usage in Indian culinary tradition; it is used for soup, salad, pickles, ketchup, puree, sauces and in many other ways. Tomato has very few competitors in the value addition chain of processing. There are two types of tomato plant based on growth habits: determinate and indeterminate. Determinate tomato plants will grow to a genetically specified height and produce all of their fruiting flowers at one time. Indeterminate tomato plants continue to grow and produce fruiting flowers throughout the entire season.

In India several varieties of tomatoes are grown i.e., from the small lively cherry tomato bursting with juice to the large, fibrous beefsteak.

The most common tomato varieties are beefsteak, cherry, heirloom, roma and pear are

1. Cherry tomatoes: The taste of tomatoes varies greatly between cultivars. Cherry tomatoes tend to be both sweeter and sourer than larger varieties. They are also juicy and pulpier than many heirloom and beefsteak tomatoes.

2. Roma: Roma tomatoes share many characteristics with cherry tomatoes: it too is juicy, sweet and tangy. The high pulp makes roams better suited for sauces and purees than for slicing.

3. Heirlooms: Heirlooms are unpredictable in colour and taste, which is one reason for their growing popularity. Indeed, heirlooms have a multifaceted, robust flavor: Many claim they had never tasted a true tomato until they bit into an heirloom.

4. Beefsteaks: Beefsteaks are the dullest and flattest in flavor, but their low juice and ability to maintain their integrity when cut make them prized for sandwiches and for stuffed tomato recipes.

Beefsteak tomatoes: aptly named large, thickly fleshed fruits, are one of the favourite tomato varieties for the home garden especially in Western countries. It is one of the largest varieties of cultivated tomatoes, sometime weighing up to 450 grams/piece or more. Most are pink or red with numerous small seed compartments (locules) distributed throughout the fruit. It is popular among home growers for beef sandwich toppings and other applications requiring a large tomato such as toppings on large steaks. The beefsteaks tomatoes are not grown commercially as often as other types, since they are not considered as suitable for mechanization as smaller slicing tomatoes due to large size. These types of tomatoes have meaty flesh and numerous seeds. This type of tomatoes varieties are late maturing thus it require a long growing season of at least 85 days to harvest, primarily indeterminate, which means the last bud ends with a vegetative bud so that if we require more branching, then remove the auxiliary bud to promote

Cross section of beefsteak tomato fruit

more numbers of shoots. Beefsteak tomato varieties require tying in, as they are trained up a support. Beefsteak tomatoes grow well insandy loam, well drain, slightly acidic soil. The pH should be about 6.2 to 6.8. Rows of tomatoes should be at least 5 feet apart, or wider if space allows. In the row, a plant to plant distance is 18 to 36 inches apart.

In India the beefsteak tomato is not much popular as compare to other type of tomato, it's because of big size of fruit (8-10 cm in diameter) and taste. Usually in India the Roma type of tomatoes are famous because of bright colour, good in taste and optimum size (4-5 cm in diameter) and also growth habit that's accommodate more numbers of plant/unit as compare to beefsteak tomato. Basically tomato is a rabi season crop but it can be grown as spring summer crop in hills. Beefsteak tomatoes are also growing well in Hills of Chamba district of Himachal Pradesh where it is grown as a summer and rabi season crop. In India tomatoes are grown for fresh consumption as well as soup, salad, pickles, ketchup, puree and sauces but in Chamba district of Himachal Pradesh beefsteak tomatoes are grown for culinary, salad and for drying purposes. The local people of Chamba dry beefsteak tomato under sun and keep it for off season especially when there is less or no supply of tomato in high altitude or snow bond areas. The beefsteak tomato is very suitable for drying purpose because of its very meaty flesh, thick wall and high dry matter content as compare to other type of tomatoes. The beefsteak tomatoes are easily dried under sun without any much effort and preservative.

After harvesting wash them properly and cut in thin slices. After cutting thin slices of tomato, they are sun dried for 5-4 days. After drying tomatoes pieces are crushed, powered and packed in air tight containers or polybags.

Benefits of beefsteak tomato

1. Usefulness for people: Beefsteak tomato is very useful for people or farmer of high altitude where there is no availability of tomato during winter months, they can easily use dried beefsteak tomatoes after water soaking for 5-10 minutes. The powdered tomato become a tomato puree and can be used in culinary or to make fresh tomato chatni purpose.

2. Easy to preserve: Specific preservation method is not required to preserve this beefsteak tomato, it is easily dried under sun without any tool or machinery. Country like India there is an ample sunshine throughout the year; hence sun drying is the easiest economic method of preservation as compare to other preservation method.

3. Easy to store: Beefsteak tomatoes kept easily in stores with a very less space after drying and can be reuse when there is no availability of tomato in the market or in fields especially in winter in high altitude areas.

4. Usefulness for Army: Indian army mostly work in border areas especially in Gujarat, Rajasthan, J & K, Himachal Pradesh, Utrakhand and Arunachal Pradesh, the border lines are very far from main markets. Some of the army are as have very harsh climatic condition like higher altitude and desert where availability of fresh tomato is very problematic and to transport fresh tomato or tomato's product is a very tedious job; with this spoilage of product is a major problem. To over come all these problems if we supply dried tomato product instead of fresh tomato to our army, we can save lot of money, time, space and valuable hard work of our soldiers. The most important thing is that they are able to enjoy the taste of fresh tomato.

5. Usefulness for processing industries: Earlier processing industries produce only pickles, ketchup, puree and sauces but if we start drying of tomato in large scale it may add one more product in their processing industries.

Difficulties withof beefsteak tomato

1. Taste of beefsteak tomato: The taste of tomato is slightly acidic in nature and when we use tomato in culinary it may alter the original item, if used in large quantity.

2. Commercial cultivation: Beefsteak tomato is restricted only up to kitchen garden, it is not cultivated as a commercial crop. That's a major problem with beefsteak tomato.

3. Shape and Size: The shape of beefsteak tomato is irregular and very big size weight up to 400-450 gms/piece. That sometime creates problem of plant/wine breakage.

4. Plant canopy: The plant of beefsteak tomato have a big canopy, require a lot of space, hence accommodate less number of plant/m^2, that's may result low yield.

Conclusion

Beefsteak tomato is not commercially cultivated in India, but it is a main vegetable of kitchen garden in one or another part of India right from North-South and East-West. In future with the advancement of processing industries it may become a major processed product of tomato like tomato sauces and ketchup. It may become a good source of income for farmers of interior areas where market is very far. Drying of beefsteak tomato minimized the post-harvest losses. If we commercialize dried tomato product it may become a tool for women empowerment in rural area through self-help group, because most of rural women are perfect in homemade dried items.

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• Wikipedia, en.wikipedia.org/wiki/beefsteak_tomato.

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ISSN No. 2583-3146

Protected Cultivation of Ornamental Plants

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Introduction

Protected cultivation is a process of growing crops in a controlled environment. This means that the temperature, humidity, light and such other factors can be regulated as per requirement of the crop. This assists in a healthier and a larger produce. There are various types of protected cultivation practices. Some of the commonly used practices are forced ventilated greenhouse, naturally ventilated poly house, insect proof net house, shade net house, plastic tunnel and mulching, raised beds, trellising and drip irrigation. These practices can be used independently or in combination, to provide favorable environment to save plants from harsh climate and extend the duration of cultivation or off-season crop production.

Major states that grow floriculture include Tamil Nadu, Karnataka, Madhya Pradesh, West Bengal, Chhattisgarh, Andhra Pradesh, Gujarat, Uttar Pradesh, Assam and Maharashtra. The Government of India's Agriculture Statistics 2020 report states that, for the 2018-19 growing season, 303 thousand hectares were planted to flower crops. India has the second-largest total area dedicated to floriculture worldwide, after China. An estimated 2910 thousand MT of flowers were produced, of which 2263 thousand MT were loose flowers and 647 thousand MT were cut flowers. India leads the world in floriculture exports of both fresh and dried cut flowers. India's floriculture industry is thriving because of the great demand for its products both domestically and internationally. The Indian flower export industry will soon soar to new heights and expand globally. The floriculture export status of India is shown in the table below, which shows that both the quantity share of export and the money received in terms of export are rising. The entire floriculture production in 1999-2000 was 84342.90 M.T., and the export earnings were 105.16 core rupees. By 2023, the production had climbed to 21024.41 M.T., and the export earnings had increased to 707.81 core rupees during the same period.

Principle of protected ornamental crop production

The productivity of a crop is influenced not only by its heredity but also by the microclimate around it. The components of crop microclimate are light, temperature, air composition and the nature of the root medium. Under open field conditions, it is not possible to control over light, temperature and air composition. The only possibility under open-field conditions is to manipulate the nature of the root medium by tillage, irrigation, fertilizer applications etc. Even here, the nature of the root medium is being modified and not controlled. A greenhouse, due to its closed boundaries, permits the control over any one or more of the components of microclimate. A greenhouse is covered with a transparent or a translucent material such as glass or plastics.

Objectives of Protected Cultivation

(i) Protection of plants from abiotic stress (physical or by non-living organism) such as temperature, excess/deficit water, hot and cold waves, and biotic factors such as pest and disease incidences, etc.
(ii) Efficient water use with minimum weed infestation.
(iii) Enhancing productivity per unit area.
(iv) Minimizing the use of pesticides in crop production.
(v) Promotion of high value, quality horticu-ltural produce.
(vi) Production of disease-free and genetic-ally better transplant

Protected Structures for Protected Cultiv-ation of Ornamentals

1. Green house
2. Shade house
3. Lath house
4. Cold frames
5. Hot beds

Greenhouse

A greenhouse can be defined as a "framed or an inflated structure with a transparent or translucent material in which crops could be grown under at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations" (Devi and Thakur 2013). The greenhouse is now better understood as a system of controlled environment agriculture (CEA), with precise control of air, temperature, water, humidity, plant nutrition, carbon dioxide and light. The inside environment (microclimate) of the greenhouse is controlled by growth factors like light, temperature, humidity and carbon dioxide concentration.

Classification of greenhouses

Greenhouse type based on shape

a) Lean to type greenhouse
b) Even span type greenhouse
c) Uneven span type greenhouse
d) Ridge and furrow type greenhouse
e) Ridge and furrow type greenhouse
f) Saw tooth type greenhouse
g) Quonset greenhouse

Net house (shade net house)

A shade net house commonly known as conservatory or fernery, is used for keeping shade loving or partial shade loving ornamental plants e.g., ferns, orchids, anth-urium, alocasia, cacti, succulents and foliage plants The material used for shading a shade house split bamboo matting, coconut leaves or coir fibers having open inter spaces to allow partial sunlight to enter Plastic nets like Seran, Netlon with varying percentage of cut out lights, like 80,60,40 are commerc-ially used to provide cover and shade.

Lath house

A valuable asset in raising seedlings, rooted cuttings, and young rhododendron plants prior to setting them out in garden. It will modify the environment in which they are growing by offering protection from hot, drying summer winds, reducing the intensity of the sunlight, lowering temperatures and by maintaining a higher humidity.

Cold frame

The cold frame is made with frame and the glass cover. Cold frames are used to protect plants from frosts heavy rains and heavy winds. These are used in winter for raising herbaceous Annuals, biennials and cut flowers and nursery of other perennial plants.

Hot beds

The main objective of hot bed is to raise seedlings earlier and protect them from weather hazards. A hot bed is one where heat is generated by decomposition of fresh manure. The heat generated is utilized for seed germination, which results in early nursery raising and protect them from weather hazards, especially during winters. First of all a trench 2 feet deep, 3 feet wide, 6 feet long is prepared. The frame generally made of wood is filled in such a way that from back side it extends up to 30-35 cm and from front side 20-25 cm above the ground.

Conditions maintained in greenhouse

A Green house maintains four distinct types of environmental parameters.

1. Carbon-Dioxide CO_2

The concentration of CO_2 in our surrounding environment is 0.03%, or 300 ppm. This CO_2 is used by plants for photosynthesis. Many farmers wonder if their winter greenhouse climate has to be supplemented with carbon dioxide (CO_2). Studies conducted in colder regions have demonstrated that increasing CO_2 levels over the typical ambient range of 350-1000 ppm frequently leads to higher yields.

Effect of CO_2 enrichment on growth and flowering of ornamentals

Crop	Concentration of CO_2 (ppm)	Effects
Begonia	700-900	Enhanced growth rate, shorter culture Time, larger flowers and abundant flowering.
Carnation	1000-1500	Better lateral branching ,higher growth Rate of young plants, higher yield and stem quality.
Chrysanthemum	700-900	Higher relative growth rate and better flower quality.
Dieffenbachia	700-900	Faster growth
Hibiscus	1000-1500	Earlier and number of leaves.
Petunia	1000-1500	Earlier flowering
Rose	1000-1500	Reduced no. of blind shoots, higher yield, longer and stronger flower stems

(S.K Bhattacharjee)

2. Temperature

Controlling the temperature is critical to the growth of greenhouse crops. Inadequate temperature management can exacerbate illness and affect the colour and quality of produce. Issues Plants are classified based on their preferred temperature. Cool seasons crops e.g., narcissus, alstroemeria. Warm season crops e.g. anthurium, gerbera.

There have been reports of low temperature damage to orchids, roses (bull heads), and chrysanthemums (pink colouring in white petals). Higher temperatures have the effect of burning and blistering leaves.

3. Light

The quantity, intensity, type, and duration of the day also known as the photoperiod of light all affect plant life. Plant vary in their requirement for light Rose and Carnation require light of high intensity 500-1000ft. candles whereas the plants like ficus, begonia, and anthurium needs light of low intensity Light intensity also effects leaf and flower colours are more intense or darker at higher light intensities.

Humidity

A general need of 65% to 80% humidity is needed for the majority of floral production. Controlled humidity allows plants to develop continuously, producing flowers with eye-catching colours and longer shelf lives after cutting. Higher humidity raises the risk of powdery mildew and downy mildew, while lower humidity can cause flowers to become desiccated and lose quality.

Climatic Factors Influencing Plant Growth

Crop	Life cycle (years)	Day (°C)	Night (°C)	Humidity (%)	Light Intensity (Lux)	CO_2 conc. (ppm)	Water requisite
Rose	6.5-7	24-28	18.5-20	65-70	60000-70000	800-1000	5-7
Gerbera	2.5-3	20-24	18-21	60-65	40000-50000	800-1000	4-6
Carnation	2-2.5	16-20	10-12	60-65	40000-50000	800-1000	4-6
Lilium	1	20-25	10-15	60-65	30000-40000	--	6-8

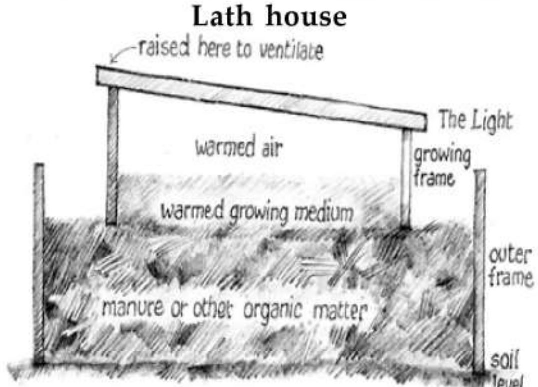
Zambre A (2011)

Green house

Shade house

Lath house

Cold frame



Hot beds

Future Strategies

- Encouragement of environmentally degradable material in floriculture.
- Development of need based polyhouse designs for different areas.
- Ensuring easy availability of U.V. stabilized plastic sheet and nets.
- Development of suitable varieties specifically for polyhouse cultivation.
- Work on eco-friendly nutrient and pest management to be taken up.

• Use of new hi-tech techniques under protected condition.

Conclusion

A controlled environment that allows for the adjustment of variables like temperature, humidity, and light based on the particular needs of the crop is known as protected culture. The overall production is increased and healthier plants are encouraged in this regulated environment. India's protected cultivation technology is still in its early stages, and all relevant agencies must work together to advance it to the level of international standards. Achieving the intended outcomes will be made easier by the combination of globalization and economic liberalization.

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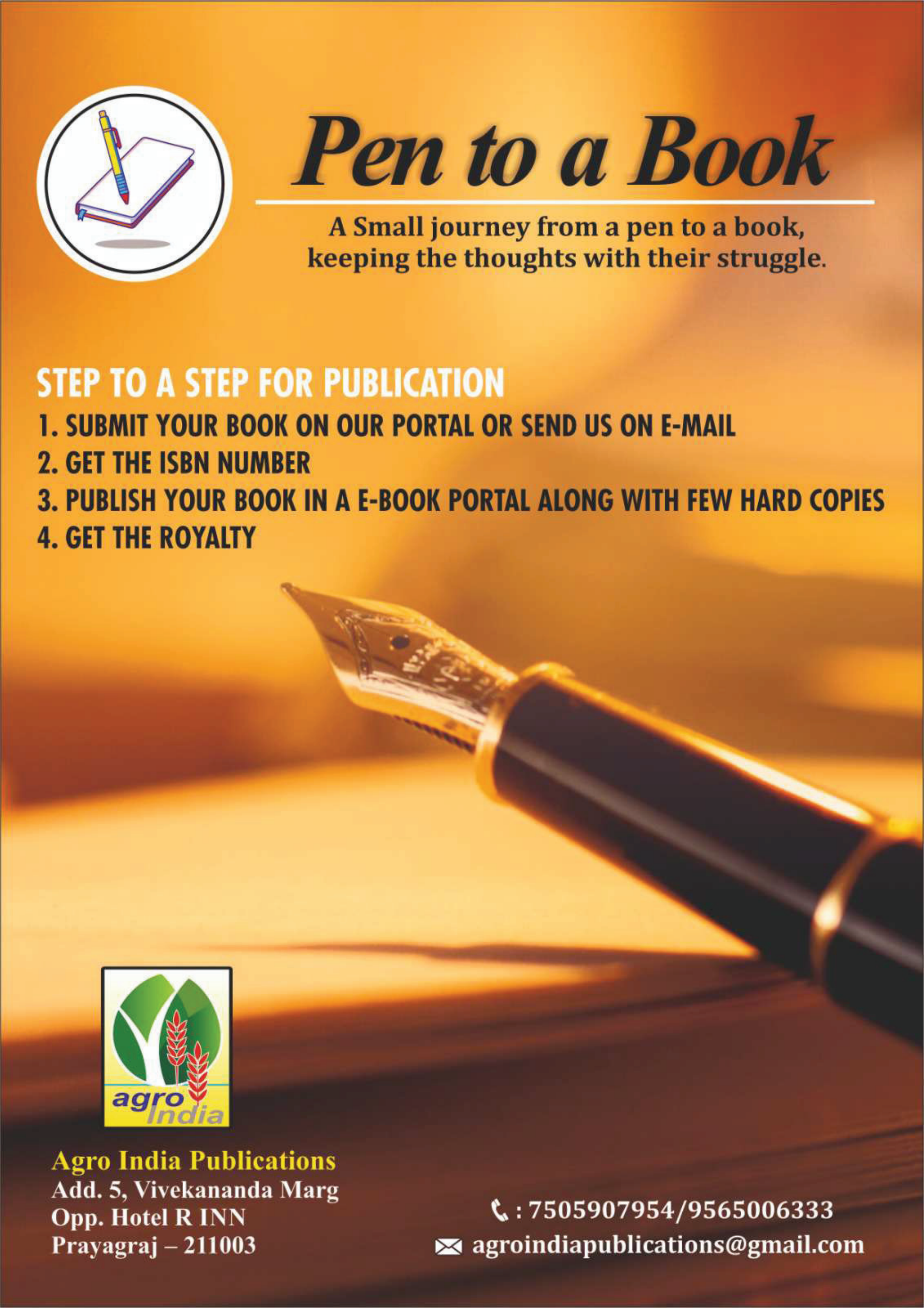
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ISSN No. 2583-3146

Application and Overview of Satellite Image Analysis for Agricultural

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Introduction

The globe over, satellite image analysis is extensively utilized for many various purposes, ncluding geographic research, the assessment and management of disasters, the identification of crops, defense applications, the identification of land cover and change, the identification of water bodies and glaciers, etc. The satellites provide both optical and Synthetic Aperture Radar (SAR) imaging. These images are utilized in accordance with the needs of the applications (Gillespie *et al*., 2007).towards climate risk mitigation.

These days, satellite imagery is widely utilized for many purposes, including object identification, defense, disaster relief, planning and development and environmental and forestry research. Nonetheless, there are still several areas where we may enhance authentication in now in use systems and employ satellite image analysis more frequently. Crop identity in agricultural applications is a critical problem. The government and farmers would both benefit greatly if we could accurately distinguish between different types of land cover and crops. Analyzing crop health using satellite imagery presents another difficulty. Crop health monitoring can help control disasters during droughts. To distinguish between distinct crops, multitemporal multisource satellite imagery taken at various phases of crop growth is needed. In a summertime diverse environment, multispectral optical vision is insufficient for crop discrimination. Synthetic Aperture Radar (SAR) imaging is appropriate for this. Every crop has a distinct look, pattern, or spectral signature on the picture; nevertheless, it can be difficult to distinguish between various species due to differences in soil characteristics, irrigation, fertilizer, pest conditions, planting dates, and intercropping (Choukri *et al*., 2024). The results of classification for crop identification are significantly improved when the visible red (R), visible green (G) and visible blue (B) bands in the short-wave infrared (SWIR) band are included.

Maximum likelihood (ML) and Support Vector Machine (SVM) outperform other classification techniques like Minimum Distance and Mahalanobis Distance. There are two main approaches for classification: Support Vector Machines (SVM) and Random Forest (RF). SVM, however, uses too many resources to be used to huge data sets. For RF, several features need to be switched on. Thus, the two approaches mentioned above are not appropriate for applications involving satellite image processing, such as accurately identifying crops across large areas.

One potent state-of-the-art technique for analyzing photos, particularly those from remote sensing, is deep learning (DL). Deep learning (DL) and ensemble-based methods have been the most widely used and effective methods for multisensor and multitemporal land cover classifications in recent years. A single satellite picture is employed in the majority of research for categorization purposes, such as land cover or object detection. Nevertheless, to accurately determine crop type, multitemporal satellite pictures are needed. Most work objectives are related to agricultural applications; these include distinguishing between land used for agriculture and non-agriculture, identifying various crops, comparing various Deep Learning classification strategies, mapping land versus crop, and suggesting the best imagery for crop identification (optical/SAR) and crop health monitoring (Shafique *et al*., 2022).

Authentic satellite image data, or data with an appropriate resolution and from an authentic agency, is the initial step in the process using the methods utilized. Satellite photos with a spatial resolution of 30 meters are appropriate for accurately identifying crops. Optical imaging may not be appropriate for crop identification in foggy or summer conditions, hence multitemporal and multisensory imagery is needed. SAR photography works well in this uneven and foggy environment. We began gathering data from two satellites, Sentinel-1A (SAR imagery with a geographical resolution of 10m) and Landsat-8 (optical imagery with a spatial resolution of 30m), while taking into account all of the aforementioned needs (Pipia *et al*., 2019).

The second, and maybe most significant, component of the process is training the data. Proper and genuine labeling of the satellite image data is necessary for training. Only a real field visit to an agricultural area may enable this labeling. We choose to employ CNN as a classifier for our work by comparing its performance with other classifiers as deep learning offers high accuracy for satellite image processing. For classifying agricultural data from multitemporal satellite images, a four-level architecture pre-processing, supervised classification, post-processing and geographic analysis is advised. Because optical imagery is tainted by clouds and shadows, pre-processing is necessary. One of the most often used techniques in satellite image processing is the creation of self-organizing Kohonen maps (SOMs), which are used to segment images and then restore missing data from time periods of satellite imagery (Mzoughi *et al.*, 2020). Two distinct Convolution Neural Network (CNN) architectures are presented for supervised classifications: 1-D CNN for spectral feature exploration and 2-D CNN for spatial feature exploration. We will compare suggested approaches with several classifiers, including RF, SVM, ML, MDM and Neural Network (NN), in this article.

Importance of study

Bump and Fourier concepts were used to demonstrate the universal expressive potential of three-layer networks as early as 1989. In 2006, Hinton put out his concept of deep learning. On May 19, 2006, a 60 km by 60 km multispectral picture panorama of the south Texas Rio Grande Valley was obtained using SPOT 5. Used several classification techniques and calculated accuracy percentages. The Joint Experiment for Crop Assessment and Monitoring (JECAM) program of the Group on Earth Observations (GEO) is actively participated in by the Space Research Institute of NAS Ukraine and SSA Ukraine (SRI, Ukraine) (Waldner *et al.*, 2016). In 2011, two JECAM test sites were constructed in Ukraine. Used Sentinel, Radar sat, and Land sat imagery in Ukraine in 2014. To improve crop discr-imination, various combinations of optical and SAR pictures, together with SAR modes and polarizations, are evaluated. In 2017, Ukraine employed a deep learning system to classify satellite photos for crop identification utilizing multitem-poral and multisensory data. Here, 1-D and 2-D CNN is the method used to identify the crop.

Sujay Dutt has worked in Hisar, Haryana State and utilizing Indian remote sensing satellite data to examine the accuracy of cotton acreage calculation. He employed the IRS satellite's LISS-I and LISS-II sensors, which have respective spatial resolutions of 72.6 and 36.25 meters, in this investigation. When compared to a 76.2m resolution image, the accuracy of a 36.25m resolution image is superior. S. Panigrahy evaluated RADARSAT Standard Beam data in order to identify the rice and potato crops in India. Five locations from the Bardhaman and Hooghli districts of West Bengal state in Eastern India were chosen for investigation inside the RADARSAT scene, each measuring 10 km by 10 km (Dutta, 1994).

There are several active projects now being carried out by the National Remote Sensing Center (NRSC). Agriculture, Development Planning, ISRO Disaster Management Program, Geology and Mining, Ocean Science, Soil and LU / LC Monitoring, Technology Diffusion and Education, Urban and Infrastructure, and Water Resources are among the fields in which projects are applied.

Conclusion

Precision farming and sustainable techniques in agriculture are made possible by satellite image analysis. A bird's-eye perspective of agricultural fields is provided by satellite photos, which farmers may use to monitor crop health, growth and stress. Vegetation indices, such as the Normalized Difference Vegetation Index (NDVI), are applied in these regions to evaluate crop vitality and pinpoint areas that require maintenance. Satellite imaging used for disease detection can identify early signs of pest infestations or disease outbre-aks, allowing for more focused responses. Crop growth tracking over time allows farmers to anticipate yields and make plans appropriately.

Water shortage irrigation management is a worldwide issue. Irrigation techniques may be optimized using satellite data. Effective water usage is guided by applications of the Evapotranspiration (ET) using satellite-based estimations. The photos show soil moisture levels, which helps with irrigation scheduling and fertilizer application-appropriate nutrient management is crucial for crop health. Based on field variability, variable-rate fertilization is guided by variable-rate application of satellite data. Early identification of nutritional shortages helps to reduce yield loss. Land use decisions are informed by crop rotation and land use planning, as well as by applications of land cover categorization that help identify distinct types of land cover (urban, forest and crop).

Sustainable land usage is ensured by following crop cycles through crop rotation monitoring. Agriculture has an influence on the environment, according to environmental impact assessments. Impact assessments are aided by satellite data. Monitoring soil erosion and land deterioration is part of erosion control. The protection of biodiversity involves determining habitats and evaluating changes to the terrain. Climate-smart agriculture benefits from satellite imaging of the weather and climate resiliency. Predicting extreme occurrences and keeping an eye on weather trends are aspects of extreme weather preparation. Adapting practices to climatic changes is known as climate adaption.

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ISSN No. 2583-3146

Revolution Agriculture a Machine Learning Approach to Smart Farming

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Introduction

Precision farming, sometimes known as digital agriculture, is a new technical discipline in agriculture that uses data-centric methods to increase productivity. The data generated by various sensors in today's agricultural operations allows for a more comprehensive understanding of both the operation itself (machinery data) and the operational environment (dynamic soil, crop, and weather conditions), resulting in more accurate and efficient decision-making (Karunathilake *et al*., 2023). Based on soil acidity and alkalization, soil quality is deteriorated. These processes affect water quality and agricultural productivity. To remedy this issue and ensure that a crop will receive the proper quantity of nutrients from the soil, an accurate forecast of the soil profile must be made before planting. Since the beginning of agricultural history, crop yield output forecasting has been a persistent source of anxiety. In agriculture, several forecasting approaches have developed over time. Those that utilize forecast data are constantly looking for more timeliness, comparability, accuracy and granularity (Engen *et al*., 2021).

Food insecurity arises from agricultural destruction caused by pests and diseases, which lowers food output. Additionally, fewer people in many developing nations are knowledgeable about illnesses and pest management or control. Lackluster disease control, toxic infections and abrupt climatic shifts are some of the main causes of the decline in food output. A variety of contemporary technologies has been developed to reduce post-harvest processing, strengthen agricultural sustainability and increase yield. Polymerase chain reaction, gas chromatography and mass spectrometry methods are used for illness detection and prediction. But these methods take a lot of time and are not very economical (Singh *et al*., 2023). It encourages the identification and prediction of agricultural diseases. In areas of the world where there is food insecurity, using groundwater for agricultural production offers the potential to increase resilience. Utilizing groundwater may increase agricultural output, increase rural income and fortify farmer's resilience to water fluctuation and climatic shocks. It makes it possible to anticipate groundwater level since various types of terrain have varied groundwater levels (Rizzo *et al*., 2021).

A reservoir is a physical structure used to impound and control water, such as a lake or pond that was created naturally or intentionally. It has been employed as one of the structural methods to improve water storage, flood defense and agriculture. The choice of whether to open or close the water gate is one that the dam operator must make quickly in both flood and drought scenarios since a delayed decision might result in downstream flooding as well as harm to the dam's structural integrity (Enesi *et al*., 2023).

Lowering the risk of flooding downstream might be achieved by releasing the water before the reservoir fills. It is impossible to predict, nevertheless, if released water would be retained and put to use in the event of decreased rainfall. Low water in the reservoir will lead to disputes over its use if the dam's water is used for several purposes. According to researchers, using warning systems and forecasts might enhance decision-making and management of dams. It encourages the prediction of dam reservoir levels.

Problem definition: Over the past few decades, a number of issues have arisen in agricultural activity, particularly with regard to forecasting the acidity and alkalinity of soil profiles, crop yield, crop disease, declining groundwater levels, incorrect dam reservoir level decisions, etc. This study has sought to develop answers for the same on the basis of these. Four phases comprise the implementation of methods (Damalas and Eleftherohorinos, 2011):

Phase 1: Using a discretization technique and modified regression to predict the soil profile for crop production. Predicting the yield level by examining the unique soil features has been the focus of this phase. Given the current circumstances, extracting information from the massive volume of data is virtually a difficult task (Sahbeni *et al*., 2023). As a result, this phase has become more focused, and soil data samples have been gathered. To build training and testing sets for use with the suggested and compared classifiers, a preprocessing step was planned. For training and testing the data sets, classifiers such as Linear Regression, Simple Linear Regression, Additive Regression, and Regression by Discretization were employed. The Regression by Discretization classifier has been used and updated in this step. The outcome of this stage is altered. The least amount of prediction error was found in the regression using the discretization classifier. Compared to the other classifiers, it has the better cover coefficient and the least root relative squared error, making it possible to predict soil fertility more accurately in advance. It may be inferred that this stage will suggest the right fertilizer based on the cropping pattern and soil sample provided. While increasing the existing yield level is important, other factors should be taken into account in order to prevent soil deprivation and to expand the range of acceptable technologies available to restore problematic soils.

Phase 2: Production of Crop Yields The forecast is made using the Multilayer Perceptron and the Fuzzy C Means Algorithm and it is based on yield data that has been securely archived from that region in the past. The computers scan the data and after mining, a number of patterns derived from a wide range of characteristics forecast the outcome. Using data mining techniques to create rules for categorizing training data and executing predictions for test data, this phase oversees the forecasting of agricultural production (Al-Adhaileh and Aldhyani, 2022). The recommended approach uses Multilayer Perception architecture for prediction and the Fuzzy C means technique for clustering. As a result of this phase, the suggested FCM learning technique accurately anticipates the phenomena and makes the appropriate yield class selection. The suggested Crop Yield Production Forecasting phase has demonstrated superior performance compared to the regression models.

Phase 3: Utilizing data mining techniques like classification, data disease prediction utilizing linear discriminate analysis (LDA) helps identify or forecast crop illnesses, productivity and loss. Farmers provide information so that it may be determined what kinds of illnesses commonly affect their crops. Typically, the linkages and classification rules are applied to learn from empirical data of various datasets. This study investigates the applications of classification rules and prediction in the field of agriculture (Patil and Kumar, 2021). This paper aims to use the Linear Discriminate Analysis (LDA) technique to find classification rules for Indian banana, rice, and sugarcane. As a result of this phase, the suggested LDA technique produces predictions that are more accurate and aids in the creation of control systems that reduce yield losses. Based on the current research on bananas, it can be inferred that this stage involves applying LDA models for crop disease prediction. This makes paddy and sugarcane prediction a valuable tool for the forecasting model of the future.

Phase 4: Artificial Neural Network (ANN)-based groundwater and dam reservoir level forecasting in groundwater, one of the most precious natural resources for many developing nations. A Multilayer Perception (MLP) is utilized as a sub-approach of ANN for forecasting groundwater and dam reservoir level (Setshedi *et al.*, 2021). As a result of this phase, the suggested ANN model offers a higher degree of accuracy for predicting groundwater and dam reservoir levels and the ANN approach may be used to effectively anticipate these levels. The suggested groundwater level forecasting and dam reservoir level forecasting algorithms, in this phase, are inferred to estimate groundwater level and dam reservoir level more precisely.

Conclusion

The main goal of this endeavor is to advance agricultural technology. There are four phases to the work technique. The features of each soil layer vary and the Soil Profile aids in determining the function of the soil. Based on its chemical makeup, it separates the provided soil sample from the other soil samples. In order to analyze the yield level for different soils in different parts of India, multiple machine learning algorithms and prediction approaches have been used. One such methodology is the Soil Profile Prediction using Modified Regression by Discretization algorithm for the Crop Yield. Analyzing the data reveals that the updated regression by discretization classifier had the best cover coefficient, the least amount of root relative squared error and the least amount of error of the predicted values. Hence, in comparison to the previous classifiers, it may now be used to predict soil fertility in advance with greater accuracy. Based on soil type, farmers may choose which crops to cultivate with the aid of the crop production projection.

In order to effectively forecast agricultural diseases, a thorough investigation of several data mining classifiers on various feature sets has been conducted in conjunction with the Linear Discriminate investigation (LDA). As this study shows, the most recent machine learning algorithms, such as LDA, have a greater predictive accuracy. This will lead to a more accurate forecast and assist in the design of control systems that reduce yield losses. By holding back water during periods of high rainfall and releasing more during droughts, reservoirs may be utilized to regulate the flow of water under different weather circumstances. As a result, artificial neural networks are used to anticipate the level of groundwater and dam reservoirs, assisting in the accurate prediction of water levels. Comparisons showed that the ANN model was more accurate in predicting the levels of groundwater and dam reservoirs and that the ANN approach is an effective way to anticipate these levels.

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ISSN No. 2583-3146

Special Horticultural Practices in Flower Crops

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Introduction

In a garden there are certain operations that are to be followed judiciously for successful cultivation of flowers and ornamental plants. Flowers have good demand in the market and mostly liked by the consumers. These operations are generally known as special horticultural practices. Some special horticultural practices like pinching, disbudding, defoliation, staking, netting, de-suckering are followed for successful cultivation of flower crops. These special horticultural practices helps to build a proper structure of plant, improving growth and increase branches, quality flowers also obtained by following these practices and ultimately increase the production of flowers.

Special Horticultural Practices

1. **Stopping and pinching:** Chrysanthemum, marigold, carnation, dahlia, rose etc.
2. **Deshooting:** Rose, Dahlia, Carnation etc.
3. **Disbudding:** Chrysanthemum, carnation, dahlia, rose etc.
4. **Desuckering:** Rose, Anthurium and Chrysanthemum.
5. **Wintering:** Rose
6. **Staking:** Gladiolus, Chrysanthemum, Rose.
7. **Mulching:** Gerbera, Tuberose, Rose etc.
8. **Pruning:** Rose, Anthurium, Jasmine etc.
9. **Repotting:** Orchids
10. **Forcing:** Lily

Stopping and pinching

The operation of pinching or stopping involves the removal of the growing-point of a shoot along with a few leaves. The main purposes of pinching are to encourage branching to produce a bushy growth, increase the production of flower-buds. Pinching is done at a stage when the plants are young and between 7 and 15 cm in height, depending on their habits of growth.

Chrysanthemum

Pinching is performed both in suckers and in cuttings. It is normally done with thumb and forefinger. Pinching is most essential for small flowered chrysanthemum. First pinching is done when the plants at 4 and 7 weeks.

Rose

Pinching in rose is generally practiced to adjust flowering for a particular season. This procedure of pinching prevents flowering and encourages the plants to form new growth the base.

Important horticultural practices in different crops

Carnation

There are three ways of pinching in carnation.

1. **Single pinching:** For Early growth
2. **Pinch and a half:** For continues flowering
4. **Pinch and pull pinch:** To get large

number of flower

3. Double pinching: For delaying of flower.

- **Deeshooting**

Deshooting is practiced from time to time by removing all side shoots before they attain the size of 2.5 cm Young vegetative shoots developing from the axils of leaves of Basel and lateral shoots are removed to allow only one terminal shoots. This practice is done for getting qualitative blooms and increased stalk length.

Rose

Generally done in Hybrid Tea roses. This practice is done for getting qualitative blooms and increased stalk length.

Carnation

It is found to influence flowering in carnation. Removal of all secondary shoots from 5 week after planting and on alternate days till flowering does not affect the stem lengths but stem size and flower size is increased by 10-15 per plant

- **Disbudding**

Removal of undesirable buds, keeping the only central buds to produce quality blooms in standard types.

Carnation

To produce large specimen bloom, the flower buds per stem must be restricted to one. For this, the central or crown bud is retained and the buds or side shoots clustered around the central bud are removed.

Chrysanthemum

Disbudding method varies according to the type of chrysanthemum grown. Many of the varieties are disbudded or standard types, in which the largest terminal bud is retained and all axillary buds are removed.

Rose

The disbudding must be done regularly and also as soon as possible in order to avoid large wounds in the upper leaf axil. For most spray varieties, the center crown bud is to be removed. In hybrid Tea roses only one or at best two buds should be allowed to flower upon each shoot so as to have a large sized bloom. All other buds should be removed or disbudded.

Carnation

In standard carnations, side buds should be removed whereas in spray carnations, the terminal bud has to be removed. It is when the axillary flower buds are in pea size.

Dahlias

Dahlia will generally have three flower buds at the end of each branch. The central or "crown" bud is retained for blooming while the other two are removed at "pea" stage. If the crown bud is damaged, one side bud has to be retained in place of the central bud.

- **Desuckering**

During the vegetative growth phase, plant grows upward and new suckers continue to develop from the base of the plants, for preventing improper and vigorous growth of plant, suckers are removed from time to time. Without Desuckering, the plant will loose vigour and becomes week.

- **Wintering in rose**

Wintering is commercially practiced in Maharashtra. This may be considered as an alternative to root pruning. Flowering shrubs such as rose and jasmine can be wintered in northern and eastern India. During resting period the water supply to the plant to be wintered is stopped for a few days and the roots are exposed to the sun by removing the surface soil around the trunk. The duration of exposure varies from three to fifteen days depending upon the age, the nature and the hardiness of the plant. After this the roots are covered with the same soil enriched with farm yard manure and copiously watered.

- **Bending in rose**

Leaf is a source of food for every plant.

There should be balance between Source (Assimilation) and sink (Dissimilation). After planting, 2 to 3 eye buds will sprout on main branch. These sprouts will grow as branches and these branches in turn form buds. The mother shoot is bend on 2nd leaf or nearer to the crown region. The first bottom break or ground shoot will start coming from the base. These ground shoots form the basic framework for production and there on the ground shoots should be cut at 5th five pair of leaves and medium ground shoots should be cut at 2nd or 3rd five pair of leaves.

- **Staking**

Plants in the garden, either in pots or on ground, need support at least for a parts of, or throughout, its life. Selecting the proper stakes and fixing them aesthetically as well as purposefully is an art. The most common stakes used in India are made of either whole bamboo or split bamboo of various sizes depending upon the type of plants to be stakes.

- **Netting**

Carnation: Very important practice done in carnation. Carnation crop has the tendency to bend unless supported properly. Hence the crop needs support while growing. Good support material is metallic wire woven with nylon mesh.

- **Netting for plant support:** 4 layers
- **1st layer:** 7.5×7.5 cm.
- **2nd layer:** 10×10 cm.
- **3rd layer:** 12.5×12.5 cm.
- **4th layer:** 15×15 cm.

Gladiolus

- Especially large flowers varieties of gladiolus grown outdoor are susceptible to lodging, hence need staking.
- The stem should be tied with strings to thin but strong supports
- Earthing up of the plants, when the spike starts elongation, also provides sufficient to prevent lodging.
- The plants should be tied loosely around the stem to allow further growth of plants.

Chrysanthemum

- The lateral are staked with strong split bamboo stakes inserted in the compost with a view to given support and also see that these are spread out from each other.
- The first crown bud develops at the end of each lateral which contains maximum number of ray florets and will be give the largest bloom, though may not be the best bloom.

Conclusion

Flower Crops such as Chrysanthemum, rose, dahlia, gladiolus, carnation and gerbera are popular flower crops with high demand. Each crop has specific requirements and challenges, such as climate, soil, training, pruning, wintering, staking etc. Understanding the unique needs and characteristics of each crop is essential for successful production. By implementing these horticulture practices, flower farmers can:

- Enhance crop yields and quality
- Reduce environmental impact
- Improve profitability and competitiveness
- Meet market demands for sustainable and high-quality flowers

Overall, horticulture practices play a crucial role in ensuring the success and sustainability of flower crop production.

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ISSN No. 2583-3146

Chrysanthemum Cultivation

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Introduction

The chrysanthemum is most beautiful flower and perhaps the oldest flowering plant. As an herb is believed to have power of life. Commercially grown in different part of world. Come in a wide range of colors including white, yellow, pink, red, purple and orange. Chrysanthemums are versatile and adaptable plants, making them a favorite among gardeners and flower enthusiasts. The blooms can be single, semi double or double and come in various shapes like daisy-like, pom-pom, or spider-like, quilled, ball, spoon etc. Large flowered of chrysanthemum are classified into 13 classes and small flowered into 10 classes.

- **Scientific Name:** *Dendranthema Grandiflora.*
- **Family:** Asteraceae
- **Growth Habit:** Perennials in most climates (Chrysanthemum morifolium): they can also be grown as annuals in colder areas.
- **Propagation:** Suckers, Division, Cuttings and Seed (Annual chrysanthemum can be propagated through seed).
- **Uses:** Cut flower, loose flower, pot plant, herbaceous border, bedding and edges

• **Varieties**

Standard types: Bonfire Orange, Bonfire Yellow.

Spray types: Apsara, birbal sahani, jayanti, jublee, Reagan Yellow, Reagan White, Nanako, etc.

• **No pinch-No stake:** Sharad singar, Hemant singar, Arun singar, haldighati.

• **SenRin Tsukuri:** method of growing thousand blooms practiced in Japan.

• **Cascade:** Form of taining followed in japan to give the effect of waterfall in booming stage.

Climate

Tropical and subtropical climatic conditions are ideal. However, the best temperature for growing chrysanthemum is 20-28ºC for day and 15-20ºC for night. CO_2 600 - 900 ppm required. Chrysanthemum is a qualitative short day plant, planting should be done such that flowering coincides with short day conditions.

Soil

Well drained red loamy soil with pH of 6 to 7. Chrysanthemum is sensitive to water logging. Good drainage facility should be available.

Growing media

The growing media consists of soil, compost and coco peat in the ratio of 1:1:2. The beds are formed with 1m width, 0.3m height and at convenient length. The soil pH must be 6.5 with 1 to 1.5 EC (Electrical Conductivity).

Propagation and planting

Commercial propagation is through terminal cuttings (5-7 cm long) or suckers. Planting during June - July at 30 x 30 cm and 30 x 45 cm spacing on one side of ridges (1,11,000 plants/ha).

Irrigation

Irrigation is done twice a week in the first month and subsequently at weekly intervals.

Manuring

Recommended dose: 25t FYM and 125: 120: 25 kg NPK/ha.

Basal application: half of N + entire P and K; top dressing - half of N applied 30 days after planting. Micronutrients- Foliar spray of $ZnSO_4$ 0.25% + $MgSO_4$ 0.5% should be applied.

NPK @ 20:20:10 g/m2 is applied through fertigation at weekly intervals.

Pinching

Done 4 and 6 weeks after planting to induce lateral branches.

Desuckering

Remove the side suckers periodically its essential for good number of flowers.

Disbudding

In spray varieties, only the large apical bud is removed and the lateral buds are retained. In standard varieties, the lateral buds are removed and only apical buds are allowed to develop.

Biofertilizers

Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100kg of FYM and applied.

Growth regulators

Spray GA3 @ 50 ppm on 30, 45 and 60 days after planting.

Plant protection

Pests

Thrips, aphids and leaf eating caterpillars: Spray Acetamiprid @ 0.3 g/l or Indoxacarb @ 1 ml/l

Diseases

Root rot: Soil drenching with Copper oxychloride 2.5 g/lit or Trifloxystrobin + Tebuconazole @ 0.75 g/litre or Difenoconazole @ 0.5ml/l

Leaf spot: Foliar application of Mancozeb

@ 2.5g/l or Azoxystrobin @ 1g/l

Chrysanthemum mosaic disease

Cuttings should be obtained from virus – free indexed stocks. Removal and destruction of infected plants, destruction of the weed host.

Leaf spot

To control the leaf spot, spray Mancozeb @ 2 g/lit.

Duration

The duration is 6 - 8 months for plant crop and 4 months for ratoon crops.

Harvest

Harvesting of the flowers starts from 3rd month onwards at 4 days intervals. Harvesting is done at 3/4 to full open stage for nearby markets and 1/2 open stage for distant markets

Yield

An average yield of 7-15 t/ha loose flower, **Sprays** 1,00,000/ha and cut flowers 26.6 to 41.4 lakh/ha.

Conclusion

Success in chrysanthemum cultivation is largely determined by the growers ability to control these variables ensuring the plants health and optimal flowering. With appropriate technique like pinching, staking and pest control high quality blooms can be consistently achieved.

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ISSN No. 2583-3146

Impacts Canopy Architecture on Pest and Disease Development in Fruit Trees

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Introduction

In fruit production systems, tree canopy structures are manipulated to optimize radiation interception by leaves which enhance their physiological activity and results in higher yield. Relationships between the canopy structure and the tree physiology have been widely investigated and modeled, but much more less attention has been paid to effects on pest and diseases development, especially in fruit trees. Plant canopies are highly structured environments set by the size, shape, orientation and density of plant organs. Such complex structures can act at least at two levels. First, pathogens and insect herbivores, predators and hymenopterous parasitoids are not evenly distributed within plant canopies and their movements depend on the level of connectedness between plant organs. Second, architecture directly sets the heterogeneity of microclimatic conditions which in turn influences the performance of pests (Pincebourde *et al*., 2007). Manipulating plant canopy architecture is likely to influence these aspects of insect ecology The architecture of crop plants is influenced by endogenous factors (hormone signals, trophic competition between organs) as well as by exogenous factors (light distribution, soil water, nutrients of organs, temperature, wind). For perennial plants, the crop density and the pruning type are defined at planting time, while significant changes in growth and architecture can be generated during the vegetative season by cultural practices. Some of these practices act on exogenous factors which have a positive effect on primary growth and ramification.

Plant architecture and its interactions with pest and pathogen

Crop structure, planting density, pruning and training system can generate various spatial canopy structures or the spatial distribution of organs at plant level, with consequences for epidemics. In grapevine, the row structure of the crop was suspected to have an effect on the dispersal of the wind-dispersed, xerophilic spores of powdery mildew (Erysiphenecator). The velocity of disease spread decreased along the row with an enhanced effect in highly vigorous plots (with a high visual density of leaves), whereas vigour was conducive to disease spread between rows (Calonnec *et al.* 2009). In apple orchards, the development of apple scab, caused by Venturia inaequalis, depended on the training system (Simon *et al.* 2006). The effect of the training system might be caused either by inoculum removal during the thinning cut of fruiting spurs,

or by a decrease in leaf wetness duration due to increased light penetration. On grapevine, free positioned top vines experienced a higher level of powdery mildew on bunches than on vertical shoot positioned vines (Zahavi *et al*. 2001). Similarly, vines with the highest level of disease on clusters were those that have a significantly lower proportion of clusters well exposed to sunlight (Austin and Wilcox 2011). Additionally, clusters that were well exposed to sunlight were also well exposed to spray deposit. Thus, canopy management practices designed to optimize the sunlight exposure of grape clusters for fruit quality purpose should also significantly contribute to the management of the disease. In fact, different types of management (e.g., cover-crop, weed control, irrigation, and fertilization) showed significant positive correlations between the disease incidence and shoot vigour (Valdes-Gomez *et al*. 2008). Light could have indirectly decreased pathogen infection on berries through modifications of plant physiology, such as a decrease in pH and K concentration and an increase in polyphenol and anthocyanin concentration (Zahavi and Reuveni 2012). Indeed, berries picked in the field from two vine training systems were inoculated and incubated in controlled conditions and those that had been collected under the system which received 50% less radiation intensity had higher disease incidence. Manipulating plant canopy architecture is likely to influence aspects of insect ecology and disease epidemiology. Indeed, the hypothesis that there should be canopy configurations minimizing pathogen and insect herbivore population development has been evoked (Simon *et al*. 2006, 2007); however it has never been tested properly. Using concept-ual and methodological advances of model-assisted design of ideotypes, the complex interactions between architectural traits and several pest ecological and epidemiological processes can be studied which will facilitate in exploiting full advantage of the rapid advances in high-throughput (Andrivon *et al*., 2013). This will pave the way to envisage about designing plant canopy ideotypes within cropping system ideotypes, as one component of the cropping system, rather than as the product of this system.

Conclusion

Research on canopy architecture in fruit trees, has focussed mainly on improving and/or regulating fruit yield and fruit quality. Though the relationships between tree structure and pest infestations or pathogen infections have long been recognized, but such inter-relations are seldom established on a scientific basis. Among the plant traits, the influence of tree architecture on herbivorous insects and diseases is probably the least studied. While architecture has a strong genetic component, it can also be manipulated through different horticultural approaches. The architecture of plant canopies interacts with environmental factors to create a diverse range of microclimates. Plant canopy architecture and microclimate can be affected by both training system and cultivar. Pruning fruit trees exert a negative impact on build-up of pests and disease by altering microclimate and architecture of the canopy particularly better aeration, decreased shoot and canopy density thereby improving pesticide penetration and deposition. The main reason for this is that an unpruned tree provides more shaded leaves within the tree crown owing to higher foliage density. Besides, modification in tree architectural features altered changes in tree physiology inducing resistance or otherwise changing tissue susceptibility which inturn generates favourable or unfavourable conditions for development of host populations. Management of plant architecture could provide an innovative alternative for low pesticide pest management systems and provide an eco-friendly approach to control pest development under the expected changing climate. Hence, in addition to genetic resistance, the use of a plant architecture which produces a less favourable microenvironment for fungal infection could significantly reduce disease.

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ISSN No. 2583-3146

Protected Cultivation of Horticultural Crops

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Introduction

Horticultural crops under protected structures are a relatively new form of agriculture in which the crops are grown under structures like green house, poly house and tunnels to reduce the impact of weather factor, pests and diseases. It has picked up in the recent past especially in areas with unfavourable climatic conditions for farming such as the Northern part of India where there is high heat and humidity and areas with heavy rainfall can be a big disadvantage in crop growing. Protected cultivation provides a suitable growing environment that enables the production of high value crops all-round the year; this includes vegetables such as tomato, capsicum, cucumber, fruits and flowers. Not only it raises the yield and quality of produced crops, but also it allows the off-season production, so that it raises availability and profitability of crops in the market for farmers. Modern methods in production include system planting with controlled application of water and other inputs are used to enhance resource efficiency. In addition, it decreases the use of chemicals during the agricultural practices, hence encouraging the use of green agriculture. This article therefore concludes that protected cultivation is a tool that is important in the creation of increased demand for food and improved livelihoods for farmers; increased generation of employment which ensures sustainable horticultural practices.

Importance of protected cultivation

1. Climate Resilience

Another advantage of protected farming can be said to be that it can address issues related to climate change. Due to climatic factors, the growth of crops is greatly affected by extreme temperatures, heavy rainfall, or any form of unpredictable weather. Protected structures can provide favourable conditions for plant growth, so that it can grow throughout the year. This is especially helpful in areas like northern India, where the rainy season poses a real threat to the proper growth of delicate crops like tomato, cucumber and capsicum.

2. Improved crop quality and yield

Protected structures for growing horticultural crops help in obtaining high quality produce. Since it limits the attacks of pests and diseases, healthier plants and high-quality fruits and vegetables are obtained. For example, there is evidence that crops grown in polyhouses produce much more than crops grown in open fields because they are usually better managed and have less environmental stress. Some crops that can be grown out of season include strawberries, melons and grafted fruit plants which are of high quality and fetch high prices in the market.

3. Efficient resource use

Protected cultivation also leads to optimal use of inputs such as water, fertilizers and pesticides. Under this system, water resources are easily controlled as the environment is enclosed hence reducing evaporation and runoff. Moreover, when used in greenhouses, drip irrigation ensures that water reaches the roots of the plants, reducing water wastage. This efficiency is most important where water scarcity is felt; thus, protected farming is sustainable in the future.

4. Economic Viability

The results show that protected cultivation can be more profitable than unprotected cultivation when the right capital investments are made. The possibilities of producing high-value crops out of season are likely to increase income. Also, total crop failure due to some adverse weather conditions assures the farmer of what to expect financially. Other measures that help to generate revenue and provide protected farming with economic stability include government programs and subsidies.

A view of different types of protected structures

Types of Protected Structures

1. Greenhouses

Greenhouses are enclosed structures made of transparent materials such as glass or transparent plastic that enable sunlight to enter the structure while at the same time retaining heat. They can be built in various sizes and forms, from small home greenhouses to large commercial greenhouses. The light transmittance, insulating capacity and rigidity of the product depend on the choice of the covering material. Some of the features of greenhouses are; they can be equipped with ventilation, heating and coolers to provide a favourable environment for plant growth.

2. Polyhouse

Polyhouses are one of the sub-categories of greenhouses and have polyethylene film as the covering material. They are comparatively cheaper and more common to build than standard greenhouses and are mostly used in vegetable and flower production. Polyhouses can be designed on small size walk-through tunnels or larger structures depending on the specific crop to be grown in the structure. Polyhouse facilities have been widely effective for growing crops such as tomato, capsicum and cucumber during the rainy season in northern India.

3. Shade Nets

Shade nets have been widely used to protect crops from bright light and heat. They are most beneficial in areas that receive too much sunlight which affects a wide variety of crops grown. This is why shade nets help control temperature and humidity and make the climatic conditions more favourable for growth. They can also be combined with other protected structures to improve crop production.

Selection of suitable crops for protected production system

The kind of crops to be grown in protected manner is very important so as to get maximum yield and return on investment. This may be because high value vegetables and fruits are essential products and are usually expensive too. Some of the crops commonly grown in protected environment are as follows

1. Tomato

Tomato is one of the most important and widely grown protected horticultural crops. Some varieties like Naveen and Sartaj have been found to be well suited for polyhouse and the fruits obtained are of better quality. Cultivation in open field leads to diseases like blight and blossom end rot but since tomato are grown in controlled environment, the chances of disease attack are reduced.

2. Capsicum

These are capsicum also known as bell-pepper and they need protection from adverse conditions in terms of temperature and humidity. Some varieties like Bharat and Indra have shown good results especially in polyhouses giving good, colourful, and saleable fruits. This is an advantage as capsicum can be grown even outside the season and this can improve the profitability of the business.

3. Cucumber

Cucumber are of two types, one which requires pollination for the production of fruit and the other is known as parthenocarpy cucumber which do not require pollination for the production of fruit and such cucumber are suitable for protected cultivation. This helps in reducing the effect of pests as well as diseases, which are almost certain to affect your crops in the open environment.

4. Strawberries

Strawberries are also one of the crops that are of high value for protected structures or shade houses. The temperature and humidity mean enable people to produce fresh and tasty strawberries in the period which is not conducive to their growth to meet the demands of consumers. Another advantage of grafted strawberry plants is that they can be grown in polyhouses throughout the year.

Management Practices in Protected Cultivation

Successful protected cultivation requires careful management of various factors including temperature, humidity, irrigation and pest control. Here are some essential management practices

1. Temperature control

Temperature is very important in plant growth and development for horticultural crops. To reduce the chances of high temperatures within the greenhouse and poly house they must be provided with some sort of ventilation system to control the temperature during sunny weather. This can also work in the same way with shade nets, especially where the use of foam is impossible due to heat build-up. In cold weather, the environment may need to be heated so that the crops can grow well.

2. Humidity management

Like temperature, humidity levels must be assessed with consistency to avoid the development of fungal diseases. It is recommended to control the humidity level for which proper air circulation and introducing air conditioners such as dehumidifiers are necessary. In addition, there are ways to control humidity, for example preventing water accumulation and increasing the air quality inside the structure.

3. Irrigation practices

Of all the methods of irrigation that can be used in protected cultivation, drip irrigation appears to be the most effective. It irrigates water directly to the root zone, so there is very little water wastage or excess water on the plant, which helps reduce fungal diseases caused by overhead watering. It is therefore important to monitor the soil moisture level so as to meet the moisture requirement of the plant while avoiding water accumulation.

4. Pest and disease management

Generally, it is important for farmers practicing protected cultivation to always practice pest and disease control. The first tip is that regular checking should be done for signs of pests and diseases, as well as integrated pest management (IPM) should be put into practice. This may include the use of biocontrol agents, pheromone traps, and organic pesticides to reduce the use of chemicals.

Challenges in Protected Cultivation

While protected cultivation offers many benefits, it also presents several challenges that farmers must address

1. High initial investment

Greenhouse and polyhouse construction involves quite a large initial cost in its development and implementation. Some of them include this factor which can limit the progress of small-scale farmers who may lack the capital to start the process. However, this challenge can be solved by supplementing protected farming through government assistance and subsidies.

2. Technical knowledge and skills

This means that it is necessary to have a complete understanding of that growth platform and its management to achieve the best results in protected cultivation. Farmers may also need skill development in other areas such as selection of crops for cultivation, control of pests and water use in farming, etc. In this regard, extension services and training programs have the potential to prepare farmers accordingly.

3. Maintenance and operational costs

However, one must also keep in mind that apart from the initial investment, subsequent maintenance and operational costs are relatively expensive. This includes costs associated with heat, lighting and fumigation. These are among the many costs that farmers need to balance properly or else their operation may not be economically feasible.

4. Risk of disease transmission

Protected structures if not managed well can accelerate the spread of diseases. To prevent the spread of diseases, high quality seeds and planting material should be used in the farm field. The following measures should be adopted on a regular basis to prevent the incidence of diseases and cleaning should be done on a regular basis.

Prospects of Protected Cultivation

The future of protected cultivation appears to be bright with the added bonus of advancement of technology and increased awareness about the related protective techniques. Technological developments that include climate control, hydroponics and the use of smart ACs for vertical farming are expected to bring major changes in greenhouses. They can also improve efficiency and labour cost and maturity yield of crops.

1. Automation and smart farming

Efficiency in resource use as well as management practices can be enhanced when protected farming adopts automation and smart farming techniques. Real-time information about the growth of crops can be obtained from sensors and data analytics. This can lead to higher efficiency and lower cost of operations among industries.

2. Sustainable practices

With the growing concern for environmental friendly production practices, protected farming has the potential to meet the need for sustainable agriculture. Hence, sustainable food production is achieved due to conservation of resources, limited use of pesticides, and the ability to cultivate the crop in urban areas.

3. Research and development

Ongoing studies and innovations in protected structure technology will further improve the production and quality of crops. Strategies include the search for disease tolerant stocks and breeding programs of horticultural crops to enhance the ability of crops to withstand changes in climate, which will be important for future structural transformation in the horticultural industry.

Conclusion

Thus, protected cultivation of horticultural crops offers the possibility of coping with the challenges posed by climate change and increasing demand for food. Since in controlled environment farming, the farmer is able to produce crops of better quality and heavier yields than in open soil farming. Hence protected cultivation is advisable even if the above challenges persist in the long run. Every disadvantage of protected cultivation has an advantage as well for the farmer. If protected cultivation gets the support of the government, research institutes and adoption of new technologies, protected cultivation becomes important for improving food security and farmers' income. Thus, protected cultivation technique is considered to be the key to the future of horticultural production and profitability in view of increasing physical and climatic risks.

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ISSN No. 2583-3146

GMO Production: Potential Impacts and Sustainable Use

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Introduction

Genetic engineering is a scientific approach that allows for the modification of an organism's genetic material through gene splicing and the insertion of DNA fragments from one organism to another in order to introduce new traits or modify existing ones (Gatew & Mengistu, 2019; Hug, 2008). A genetically modified organism, or GMO, is one in which the genetic material has been artificially transformed by genetic engineering. Boyer and Cohen successfully developed the first GMO by introducing a specific gene into bacteria in 1973, raising tremendous expectations for its possible application (Marmiroli, 2005).While conventional plant breeding has been successful in developing new kinds and breeds, the practice is inherently inefficient in sexual compatibility, gene linkage and the period for obtaining the harvest (Ghimire *et al.*, 2023).

GMOs have the ability to boost crop yields, improve nutrition, improve food quality, reduce environmental impact, maximize resource utilization, provide medical applications, and protect biodiversity. However, thorough research, risk assessment, and regulation are required to assure their safe and responsible use (HILL, 2005). For example, the use of genetic engineering techniques has demonstrated the possibility of using genetically modified microorganisms as soil inoculants, but there is a risk that they will have unintended environmental consequences and play more important ecological roles than their wild counterparts (Prakash *et al.,* 2011).

Genetically modified microorganisms

GMMs are important in several industries, including agriculture, bioremediation, and food production. GMMs in agriculture contribute to sustainable agricultural techniques by improving nutrient availability, disease control, and stress tolerance, hence reducing the requirement for chemical inputs in the soil. GMMs are a viable method for cleaning polluted areas in bioremediation. They can breakdown oil spills, heavy metals and other toxins, helping to restore the ecosystem. GMMs are used in the synthesis of enzymes, flavors, and additives. GMMs are employed in food processing and fermentation processes to efficiently produce bioactive chemicals, vitamins, and other useful components.

Furthermore, GMMs help to reduce food waste by facilitating the conversion of food wastes into valuable goods. While engineered microorganisms can improve food quality and minimize waste, safety assessments are required to determine potential dangers to human health and the environment. Researchers can modify the rhizosphere system to improve plant health and performance by understanding how the plant genotype, soil microbial population, and surrounding environment interact. This engineering approach entails encouraging the growth of beneficial microbes and providing a favorable environment for their activities (Nadarajah and Kumar, 2019). As a result, plants can benefit more from microbial interactions in the soil, which leads to increased growth, nutrient uptake, and stress tolerance. Manipulating the rhizosphere system can improve plant health and promote sustainable agriculture practices (Pérez-Izquierdo *et al*. 2019). For example, the CRISPR/Cas9 system has been used to target damaging phytopathogens such as *Alternaria solani, Colletotrichum sansevieriae, Fusarium proliferatum, Phytophthora* spp., and *Sclerotinia sclerotium* (Nakamura *et al*., 2019; Prabhukarthikeyan *et al*., 2020). By inhibiting specific genes that produce mycotoxins, such as fumonisin in *Fusarium*, the method decreases crop damage and enhances food safety (Ferrara *et al*., 2019). Furthermore, beneficial bacteria such as *Trichoderma atroviride* have been genetic-ally engineered to improve their potential to suppress soil pathogens (Fang & Chen, 2018). Through gene editing, microorgani-sms such as Trichoderma can become more effective biocontrol, lowering the need for hazardous chemical pesticides. These examples indicate GMM's (Nadarajah & Abdul Rahman, 2023) enormous promise for sustainable agriculture, delivering ecologically friendly solutions, and contrib-uting to global food security.

GMMs are widely used in the synthesis of medical and food substances as a result of significant advances in biochemistry and molecular biology. GMMs provide environmentally safe, animal-friendly, and cost-effective ways to produce a variety of chemicals. Insulin, trypsin, chymosin, vitamins, amino acids, functional proteins, and food enzymes are all now manufactured utilizing GMMs instead of animal-based methods. GMMs have numerous advantages over animal-based production. For example, when comparing GMM-based production to traditional farming of plant-based compounds such as steviol glycosides (Philippe *et al*., 2014) and vanillin (Brochado *et al*., 2010), GMMs provide environmental benefits. GMMs have been used successfully to produce riboflavin (Schwechheimer *et al*., 2016) as well as other vitamins, amino acids, functional proteins, oligosaccharides, tastes, and sweeteners (Adrio and Demain, 2010). Overall, GMM used for food production use less land, produce less waste and provide a consistent and low cost supply to fulfill rising consumer demand.

Genetically modified plants

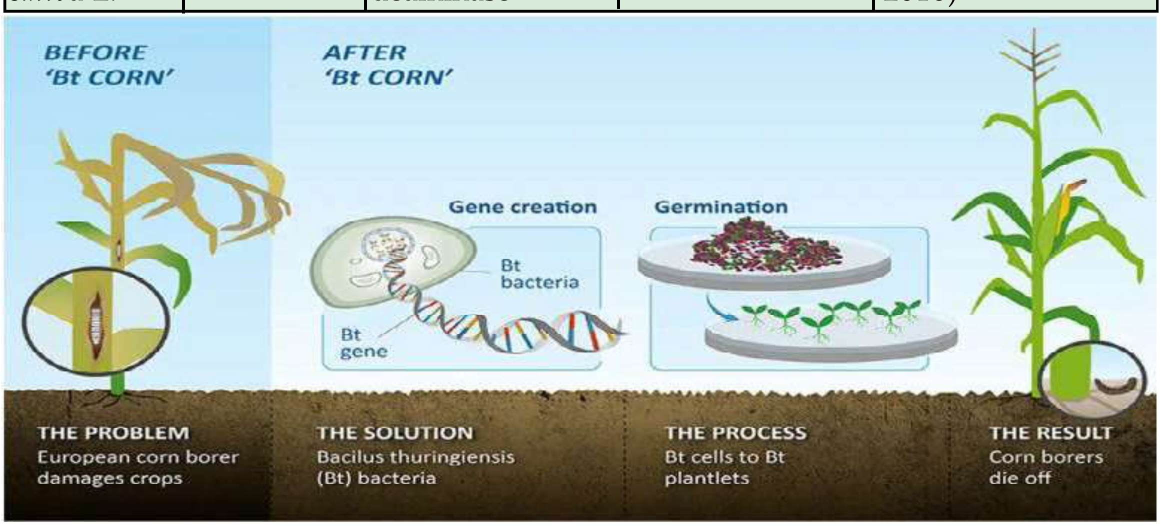
They have numerous benefits in various fields of agriculture and human health. One such advantage is biofortification, which aims to alleviate micronutrient deficiencies that impact a large proportion of the global population (Szenkovics *et al*., 2021). "Golden Rice," a genetically engineered Oryza sativa, is an example where genes responsible for beta-carotene production were introduced, leading in higher quantities of vitamin A (Singh *et al*., 2023). Regular rice lacks beta-carotene, which is crucial because vitamin A deficiency is a common health issue in many under developed nations. Genetic alteration can improve phytochemicals and biological activity in plants. Cucumis melo (melon) was altered using bacterial genes, resulting in higher amounts of phenolic compounds and better antibacterial activity (Matsuda *et al*., 2000). Genetic engineering in plants has also opened up new avenues for vaccine development.

Transgenic tomatoes expressing genes producing Rabies Capsid proteins, HBsAG, and HIVgag provide edible vaccinations for disease prevention at a low cost and ease of distribution.

Genetically engineered crops help to preserve the environment by producing toxic proteins such as CRYIAc from Bacillus thuringiensis (Bt), minimizing the need for chemical pesticides and herbicides (Peng *et al.*, 2018).This method is used by rapeseed, among other crops, to efficiently control pests such as hairy bugs, diamond back moths, and cotton bollworms. Another possible application is to increase biofuel capacity, where genetically altered Miscanthus sinensis with lower lignin concentration allows for increased biofuel output (Yoo *et al.*, 2018). Furthermore, genetically modified Ipomoea batatas (Sweet Potato) has greater stress tolerance due to increased lignin levels, making it suited for production in harsh conditions (Lee *et al.*, 2021). However, appropriate and ethical methods are essential for ensuring the safe and effective use of genetically modified organisms in our goal of a better and more sustainable future.

Genetically Modified Plants for the improvement of Biotic and Abiotic Stress Resistance in Crops

GMP	Plant part	Introduced gene	Biotic & abiotic Resistance	References
Medicago sativa	Leaves & petiole	CRY3A (Bt Toxin)	Insect resistance	(Tohidfar *et al.*,2013)
Oryza sativa L.	Seed	ITR1 gene	Insect resistance	(Alfonso-Rubi *et al.*, 2003)
Glycine max L.	Somatic embryo	Viral coat protein	Soyabean dwarf virus resistance	(Tougou *et al.*, 2006)
Glycine max L.	Leaves	CRY1A gene	Insect resistance	(Macrae *et al.*,2016)
Solanumme longena L.	Leaves	CYSTATIN gene	Inhibition of root-knot nematode in transgenic plant	(Papolu *et al.*, 2016)
Camelina sativa L.	Floral parts	ACDS:ACC deaminase	Salinity tolerance	(Heydarian *et al.*, 2016)



Conclusion

In agriculture, GMOs contribute to increased crop yields, improved nutritional quality and reduced environmental impact through decreased use of pesticides and fertilizers. GMOs also play a role in producing essential substances for food, pharmaceuticals and industrial applications more efficiently and sustainably. Genetic alterations can have unforeseen consequences, changing gene expression and potentially triggering gene inactivation or interference. As we move forward, we must create a balance between scientific breakthroughs and environmental protection, enabling a future in which GMOs contribute positively to global concerns while adhering to principles of sustainability and ethical considerations. Adopting this technology with diligence, teamwork, and a dedication to maintaining our ecosystems' delicate balance will be critical to create a more sustainable and resilient world for future generations.

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ISSN No. 2583-3146

Establishment of a Kitchen Garden

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Introduction

Kitchen gardening has been an integral part of households for centuries, offering a source of fresh produce and culinary herbs right at the doorstep. With increasing awareness about healthy eating, food safety and environmental sustainability, the concept of kitchen gardening is gaining renewed popularity. The COVID-19 pandemic further highlighted the need for self-reliance and the ability to produce fresh, nutritious food at home.Establishing a kitchen garden involves careful planning, site selection, soil preparation and the use of proper management practices to ensure a steady supply of vegetables and herbs. It requires minimal investment and space, making it accessible to a wide range of people, whether in urban or rural areas.

Importance of Kitchen Gardens

1. Nutritional Benefits: Kitchen gardens provide direct access to a variety of fresh and nutrient-rich vegetables and herbs. Home-grown produce is often more nutritious because it can be harvested at peak ripeness, unlike store-bought produce, which may be picked early to withstand transportation and storage.

2. Food Security: By producing a portion of their food, families can reduce their dependence on external sources. This is particularly beneficial in times of economic instability or when supply chains are disrupted.

3. Environmental Impact: Growing food at home reduces the carbon footprint associated with transporting food over long distances. Kitchen gardens also promote biodiversity and can support beneficial insects, birds, and soil organisms.

4. Economic Savings: While the initial setup of a kitchen garden may require some investment, it significantly reduces the cost of purchasing vegetables and herbs in the long run. This is especially true for high-value crops such as organic vegetables and culinary herbs.

5. Health and Well-being: Gardening is a form of physical exercise that can improve fitness, reduce stress and enhance mental well-being. It encourages a healthy lifestyle by increasing the consumption of fresh, organic produce.

6. Educational Value: Kitchen gardens serve as a practical educational tool for children and adults alike. They offer firsthand experience in understanding plant biology, ecology, and sustainable agricultural practices.

Steps to Establish a Kitchen Garden

1. Planning

- **Identify the Purpose:** Determine what you want to grow based on your family's dietary preferences and nutritional needs.
- **Layout Design:** Plan the layout considering the size of the area, crop selection and ease of access. Raised beds, containers, or vertical gardens can be used in small spaces.

2. Site Selection

- Choose a location that receives at least 6-8 hours of sunlight daily.
- Ensure that the site has good drainage to prevent waterlogging.
- Proximity to the kitchen is ideal for easy access to fresh produce.

3. Soil Preparation

- Test the soil for pH and nutrient levels. Most vegetables prefer a slightly acidic to neutral pH (6.0 to 7.0).
- Enrich the soil with organic matter such as compost, well-rotted manure, or vermi-compost to improve fertility, structure, and water-holding capacity.

4. Selection of Crops

The selection of crops depends on several factors, including climate, soil type, available space and personal preference. Here are some guidelines for choosing suitable crops for a kitchen garden

Vegetables

- **Leafy Greens:** Spinach, lettuce, kale and Swiss chard are easy to grow and can be harvested multiple times.
- **Root Vegetables:** Carrots, beets, radishes, and potatoes are ideal for loose, well-drained soil.
- **Fruiting Vegetables:** Tomatoes, bell peppers, cucumbers and eggplants require full sun and a longer growing season.
- **Legumes:** Beans and peas improve soil fertility by fixing nitrogen. They are suitable for small spaces and can be trained to grow vertically.

Herbs

- Basil, parsley, cilantro, mint and thyme are popular kitchen garden herbs. They require minimal space and can be grown in containers.
- Perennial herbs like rosemary and sage are drought-tolerant and can be grown in garden borders.

Fruits

- **Small Fruit Plants:** Strawberries, raspber-ries and blueberries are suitable for small gardens and containers.
- **Fruit Trees:** Dwarf or semi-dwarf varieties of fruit trees such as citrus, apples, and peaches can be grown in large containers or small plots.

Seasonal Considerations

• Select crops based on the local climate and growing season. Cool-season crops like broccoli, cabbage and peas are best planted in early spring or fall, while warm-season crops like tomatoes and peppers thrive in late spring and summer.

5. Planting

• Seedlings vs. Direct Sowing: Depending on the crop, you can either start with seedlings or sow seeds directly into the soil.

• Follow the recommended spacing guidelines to avoid overcrowding and competition for resources.

• Practice crop rotation to maintain soil health and prevent the build-up of pests and diseases.

6. Irrigation

• Regular watering is crucial, especially during the early stages of growth. Drip irrigation or soaker hoses are effective methods that conserve water and ensure uniform moisture distribution.

• Avoid overhead watering, which can promote fungal diseases.

7. Fertilization

• Apply organic fertilizers like compost or vermicompost at regular intervals. This not only provides nutrients but also improves soil structure and microbial activity.

• Avoid over-fertilizing, as it can lead to nutrient imbalances and negatively impact plant health.

8. Pest and Disease Management

• Use integrated pest management (IPM) techniques, such as introducing beneficial insects, using organic pesticides, and practicing crop rotation and companion planting.

• Regularly inspect plants for signs of pests or diseases and take corrective actions promptly.

9. Harvesting

• Harvest crops at the appropriate stage of maturity to ensure maximum flavour and nutritional value. Regular harvesting also encourages continued production in many vegetables.

10. Maintenance

• Keep the garden free from weeds, as they compete with crops for nutrients and water.

• Mulching helps retain soil moisture, suppress weeds and regulate soil temperature.

Conclusion

Establishing a kitchen garden is a practical and rewarding endeavour that offers multiple benefits, from providing fresh, nutritious produce to promoting environmental sustainability and personal well-being. By following the outlined steps and employing good management practices, anyone can create a productive kitchen garden, regardless of the size of their available space. As more people embrace this form of gardening, it can contribute significantly to food security and a healthier lifestyle.

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ISSN No. 2583-3146

New Plant Breeding Technique "Periclinal Chimera", Invincible over Mericlinal, Sectorial and Traditional Breeding

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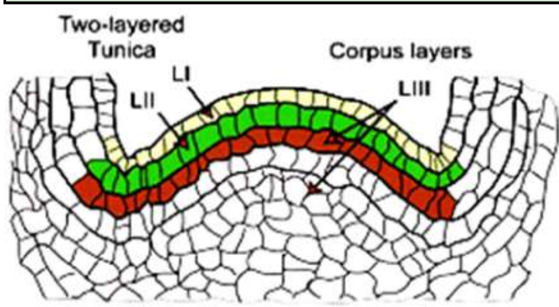
Introduction

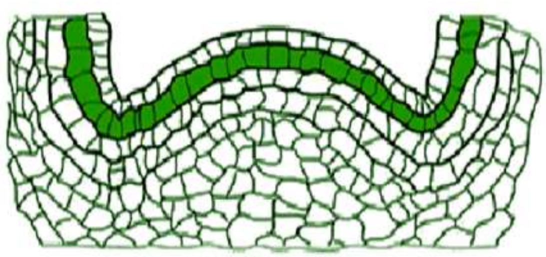
Chimera term refers two or more different genotype in a single plant. Most chimeras usually originate from mutations either from spontaneous or induced in one of the cells of the shoot apex. It typically originates from a bud, whether apical or lateral meristem. However, it is usually composed of three layers: the outer layer known as LI, the second inner layer referred to as LII, and the innermost layer, LIII, which contributes to the central tissues.



A dicot shoot meristem tissue

Observe Chimera in apple fruit

Chimera is classified into three types

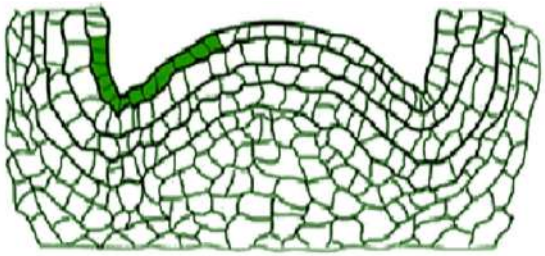


Periclinal

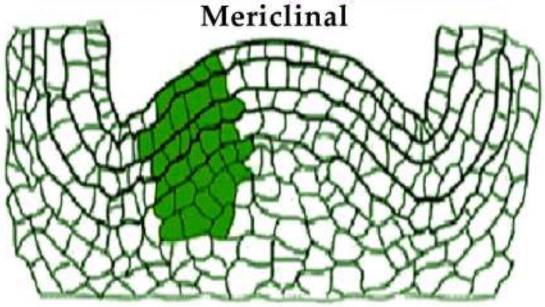
Periclinal: Periclinal refers to the outer layer epidermis is genetically distinct from the inner tissues as a whole.

Mericlinal: Mericlinal chimera possess a small portion of one layer, typically the outer layer, that is genetically distinct from the rest of the inner tissues.

Sectorial: Sectorial chimera refers



Mericlinal



Sectorial

occupying entire sectors extending on the longitudinal part of the whole plan

Why periclinal chimeraprefers in plant breeding over Mericlinal, Sectorial chimera and Conventional breeding?

Periclinal chimera: The mutated tissues occupy layers of cells that completely surround an inner core of non mutated tissue. It is stable chimera. In this chimera, a tissue with one genotype occur comparati-vely as a thin layer around genetically non-mutated tissue.

Example: many red colored fruit cultivars in apple, the red pigment is located only in the epidermal layers whereas the cells of the inner tissue have alleles for green or yellow colour.

Advantages of Periclinal chimera over conventional breeding

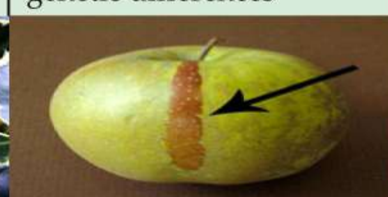
1) Rapid synthesis of periclinal chimeras, which can occur in just a few months, unlike the several years required to develop a new variety using conventional methods.

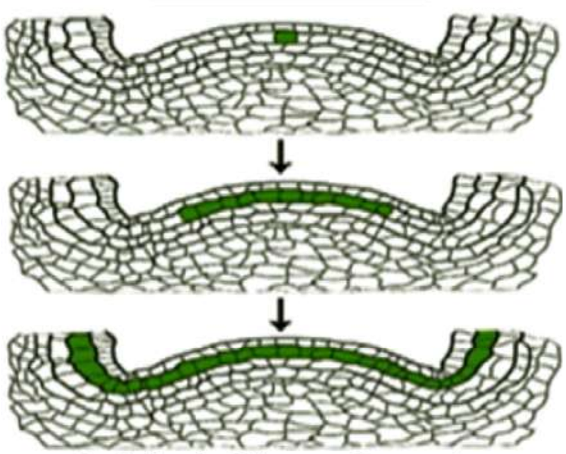
2) Periclinal chimeras can confer disease resistance from either of their two parents, resulting in a resistant type within a relatively short time.

3) The properties of periclinal chimeras have enabled the replacement of traditional methods, along with the ease of synthesis through simple modifications of grafting techniques.

4) The vigor of a hybrid obtained when using two varieties of high combining ability to synthesize a new periclinal chimera (Nassar *et al*).

Comparision Periclinal chimera with Mericlinal chimera and sartorial chimera

Periclinal chimera	Mericlinal chimera	Sectorial chimera
Genetic variance occurs in outer layer	Genetic variance occurs in a specific sector or branch of plant	Genetic variance occurs in distinct sectors or wedges within a plant
Inner layer remain genetically uniform	Some branches exhbit genetic differences	These sectors can be visible as strips
		
Variegated leaves with diffe-rence colour on the edges and centre	section of the skin has beco-me mutated to form red pigment (anthocyanin)	A plant with striped leaves, on half of each layer in the meristem contains mutated cells.



Periclinal Chimera Formation

Formation of Periclinal chimera

- In this chimera, one entire layer in the meristem LII contains the mutation. (Layer II: Part of leaf Mesophyll)
- A mutation occurs in a single cell within a layer,
through anticlinal cell divisions, at last entire
layer becomes genetically distinct from the other two layers.
- This is a relatively stable form of chimera if propagated through stem or grafting.
- However, it is not stable if propagated by other methods, such as, root cuttings.

Conclusions

The conclusion drawn from these examples is that the vigor of root formation in periclinal chimeras relies on the combining ability of the two genotypes used in the graft. Additionally, gene movement occurs across both layers in contact within the chimera. Furthermore, vigor is increased when the chimera is created by grafting two polyploid forms.

The transference of DNA from the epidermis to internal tissues resulted in a significant plant breeding phenomenon the transmission of disease resistance from the paternal genotype to the periclinal chimera plant, leading to the development of a new resistant cultivar. This finding was supported by the work of Nassar and collaborators. In this study, resistance to nematodes was transferred from the resistant genotype M. fortalizensis using the periclinal chimera technique. The resulting periclinal chimera gained resistance from M. fortalizensis, with its tissue forming the sub-epidermis and internal layers. Apparently, resistance was due to interaction of DNA of the chimera components since they move within all plant tissues.

Periclinal chimeras will attract the interest of crop breeders because they require a relatively short time for synthesis and vegetative reproduction, whereas traditional methods for improving varieties typically take decades. Additionally, they have made it possible to realize breeders' aspirations of sustaining hybrid vigor achieved through combining ability.

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ISSN No. 2583-3146

Mulching: A Practical Approach to Enhance Productivity of Flower Crops

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Introduction

Floriculture has been identified as a viable economic sector in India and around the world due to a shift in farmer focus towards high-value floriculture and the use of flowers in social events as well as industrial applications. In the current context of acute water scarcity and unpredictable weather circumstances, effective and economical resource utilization is critical, which can be accomplished through the use of improved techniques such as mulching. This article delves on mulching and its effects and discusses the opportunities they provide for problem solving in floriculture.Mulching is the process of spreading various covering materials, both organic and inorganic, on the surface of soil to reduce moisture loss and weed population. The term "mulch" is derived from the German word "molsch," which means "soft to decay," and is said to have originally referred to the use of leaves and straw as mulch by gardeners. Mulches have been demonstrated to be beneficial for increasing soil water retention and availability by decreasing evaporation losses and reducing the negative impacts of water stress on soil and plants.

Types of Mulches

A. Organic Mulches

Organic mulches are made from plant and animal components such as straw, hay, peanut hulls, leaf mould, compost, sawdust, wood chips, shavings and animal manures. Organic mulches decompose and biodegrade quickly; hence they are not durable. These mulches must be replaced by farmers at predetermined intervals. The use of organic mulches lowers the pH of the soil (increases the acidic level of the soil).

1. Dry leaves: When leaves are used as mulch, they supply nutrients to the soil. The thickness of the dry leaves mulching is around 3-4 inches.

2. Compost: Compost is a beneficial mulch and soil conditioner that may be easily produced at home by composting various waste items such as leaves, straw, grass and plant residues, etc.

3. Straw: The use of straw mulch provides excellent insulation, water penetration, and weed control. The thickness of straw mulching is around 6 to 8 inches.

4. Mushroom compost: Mushroom compost is commercially available as spent mushroom compost/spent mushroom substrate. It is relatively affordable and also improves soil fertility because of its high nutrient content. The soil's ability to retain water is improved by this kind of compost.

Pine needles used in Planting of Marigold

Spent mushroom compost used in planting of chrysanthemum

Straw and dry oak leaves used in planting of chrysanthemum

B. Inorganic Mulches

Rocks or gravel, plastic sheeting, landscape fabric, and rubber mulch are the most popular types of inorganic mulch. Inorganic mulches do not degrade or breakdown slowly over time. The black plastic film prevents sunlight from entering the soil. As a result, weed growth is completely halted because photosynthesis does not occur in the absence of sunshine. Most ultraviolet (UV), visible and infrared (IR) wavelengths of incoming sun light are absorbed by black mulch and re-radiated as thermal radiation or long wavelength infrared radiation. Sunlight can pass through transparent mulch. It absorbs minimal solar light but transmits 85% to 95% of it. In addition to having a significant impact on the microclimate around a crop, mulch colour has been found to have an impact on insect behavior.

Different plastic mulches used in marigold and chrysanthemum production

Table 1. Mulching treatments in different flower crops

	Mulch used	Outcomes	Crop	Reference
1.	Black polythene mulch	Results in higher moisture content, helps in weed suppression, higher net returns and also improve vegetative and floral parameters	Gerbera, Rose and Marigold	Samrah *et al.*, 2014, Sardar *et al.*, 2016 & Shinde *et al.*, 2022
2.	Silver Black polythene mulch	Superior effect on vegetative growth, flower yield, water saving and profitable	Marigold	Sikarwar *et al.*, 2021 and Yadav *et al.*, 2023,
2.	Sugarcane trash mulch	Enhanced vigorous growth, improve flower quality and results in highest net returns	Chrysanthemum and Rose	Vamaja, 2021 and Soujanya, 2022
3.	Water hyacinth mulch	enhanced growth and yield	Tuberose	Barman *et al.*, 2015
4.	Yellow polythene mulch	Helpful in weed suppression	Calendula	Ahmed *et al.*, 2022
5.	Rice straw mulch	encourages flower production both qualitatively and quantitatively	Freesia	Younis *et al.*, 2012

Advantages of Mulching

• Mulches warm the soil by trapping sun radiations, promoting early plant growth. Mulched crops mature 14 to 21 days earlier than non-mulched crops.

• The usage of mulches greatly reduces nutrient leaching. Mulches are impermeable to water and thus help to preserve moisture content for a longer period of time.

•Maintain soil comp activity, which results in a loose and friable soil.

•By reducing soil borne diseases, crop quality and yield are improved.

• Mulches can prevent the growth of weeds and pests.

Conclusion

Mulching is no less than a boon for flower crops because they create favourable conditions for them by regulating soil temperature. In conclusion, mulching with organic and inorganic materials increases the nutrient availability in the soil, maintain soil moisture and also help in the weed suppression. Farmers can use mulches to increase the production and yield of flower crops.

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ISSN No. 2583-3146

Various Types of Sprayers Used in Contemporary Farming

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Introduction

A sprayer is a tool used in agriculture that is intended to spray liquids such as herbicides, insecticides and water. Applying chemicals is one of the most crucial farming practices for increasing production. There are currently several varieties for sprayers and weed eaters available, including self-propelled, tractor mounted, animal drawn and manually driven models. Spray nozzles, liquid tanks, sprayer pumps, pressure regulators, valves, fluid plumbing and spray guns are some of the parts of agricultural sprayers. There are several sizes, designs and performance parameters available for these agricultural sprayers. Many sprayers are available, each with a specific purpose in mind, such as weed control, vegetable gardening, plant growth, fruit and animal requirements. Pesticides are crucial to the agricultural sector's ability to maintain crop health and, by extension, the stability of farmers' profits. For a range of farming jobs throughout the crop production cycle, this equipment is perfect. These incredible farming implements are available in a range of shapes and sizes, from enormous trailed or mounted sprayers to sophisticated atomizers, and they start with hand-held and manual sprayers.

In modern agriculture, sprayers are crucial equipment for applying fertilizer, herbicides and pesticides. Creating ecologically safe and sustainable pest management solutions has drawn more attention in recent years. In the agriculture sector, one such device that has attracted a lot of interest is remote-controlled boom sprayers that run on solar power. This kind of sprayer minimizes chemical exposure to humans by using solar panels to power its electrical components, which can be operated remotely and cut down on the demand for fossil fuels.

Hydraulic knapsack sprayer: With a 15-liter tank capacity, this manually controlled sprayer maintains steady pressure with the aid of a hand lever. Spot treatment is the main application for this sprayer.

Pneumatic or compressed system knapsack: Pumping is not required while using this sprayer to apply spray. A tank is pressurized once the liquid has reached two thirds of its capacity. It is sprayed sparingly on weeds in jute and paddy fields.

Motorized pneumatic: Because it is a smaller volume sprayer, it works well for concentrated spray liquid applications. When air is forced through the nozzle tube and delivery hose's spraying jet, spray liquid is ejected. Spray liquid is atomized into tiny droplets by air blast. Air serves as a carrier; the higher the air pressure, the greater the atomization. These sprayers have blower applications as well. Herbicides, insecticides and fungicides are examples of CPP (The crop Protection Products) that are significantly lost to wind using mist blowers.

Foot sprayer/pedal pump sprayers: This foot-operated sprayer is frequently utilized for CPP application. It has delivery tubes that are 1-2 long and can be equipped with lance or 2–6 nozzle booms. The vast area coverage and high spray volume of this sprayer are its advantages.

Animal operated spraying

An apparatus for drawing fractions with a bullock is invented and constructed. Under laboratory and field conditions, the sprayer's performance was assessed for several parameters at a pressure of 3.5 kg/cm2. Under laboratory and field circumstances, the average booming discharge was 2.47 l/min and 2.53 l/min, respectively. At 400 mm height, the spray dispersion pattern was the same for every nozzle. At 400 mm height, the central nozzles' spray pattern widens. The machine needed an average of 0.486 horsepower to run. With a standard field capacity of 0.704 ha/h, the sprayer outperformed the backpack sprayer by nearly seven times. Just 1.44 man-hours were needed for the sprayer to cover a 1 hectare area. The sprayer is made up of an operator's chair, a chemical tank, a gear pump and a boom with numerous Controlled Droplet Applicator (CDA) atomizer nozzles. The framework supporting the sprayer is fastened to the back axle. It was discovered that the dynamical wheel load, assuming an even load distribution, was 1575 N with a net draw of 820 N. The net pull makes the task of spraying steep terrain easier and will readily use the energy required, developed sprayed with solar power using an animal draw. Tractor operated or mounted sprayer a broad spray boom placed on a tractor was created for more effectiveness. With the stresses on the boom structure in mind, a 15-meter tractor-mounted spray boom was designed. To assess its performance, it underwent tests both in the field and in the lab. The created spray boom was tested against an existing 9-meter spray boom made by a local company. Additionally, an economic assessment was conducted on both spray booms. According to statistical analysis, there was no discernible difference in the spray uniformity throughout all test trials within a field. The current 9-meter spray boom was shown to be less cost-effective than a 15-meter spray boom. It is designed and assessed a tractor-mounted air-assisted cotton sprayer in the field. Tractor-mounted, air-assisted, and conventional sprayers sprayed dye solution on the crop at a variety of advance speeds (0.5, 2.5, and 4.0 km/h). The following factors were examined: droplet density, uniformity coefficient, droplet size (NMD and VMD), percentage of surfaces covered by droplet spots per square centimetre, and bioefficiency. The air assisted sprayer achieved a superior uniformity coefficient of 1.69 at a forward speed of 4.0 km/h than the conventional sprayer, which achieved a uniformity coefficient of 2.04. Droplet depositing on the underside of the leaves by the tractor-mounted air-assisted sprayer ranged from 14 to 94 drops/cm^2 at various plant sections. The area covered by droplet on the underside of the top, middle, and bottom leaves at a forward speed of 4.0 km/h was 1.11, 0.93, and 0.44 % for the air assisted sprayer, whereas no droplets were deposited by the conventional sprayer.

Solar operated sprayer

Because they are environmentally beneficial, renewable energy sources are the best options for producing electrical energy. Solar energy is the most abundant renewable energy source available because it is pollution-free, limitless and free of cost. Solar panels, which are composed of photovoltaic cells, are typically used to capture solar energy. Roughly 80% of all solar systems are connected to form a freestanding unit. It was determined that, despite their lower yields, backpack sprayers are a popular choice among small and marginal farmers for pest control due to their low cost and ease of use. A solar-powered sprayer with a higher output (0.3 ha/h) and less physiological energy consumption and pain was attempted to be developed. For a longer operational life, an electronic control was integrated to prevent the battery from deep drain and overcharging. After two hours of exposure to sunlight, the system may be completely powered by solar energy and run nonstop for six hours. This guarantees a swath of high-quality spray with consistent droplet size. Solar Operated Sprayer was designed and evaluated. An anti-clogging filter was also put before the nozzle in the nozzle head for trouble-free operation and extended nozzle service life.

Drone mounted sprayer

When human participation is not an option, this sprayer comes in very handy for chemically spraying crops, such as rice fields, orchard crops and crops grown in areas with uneven terrain. In addition to lowering environmental pollution and pesticide application costs, this method significantly improves the biological efficacy of pesticide treatment for small farming communities. The developed and field-tested drone mounted sprayer is primarily composed of six BLDC motors installed on a hexacopter frame to lift a payload of five kilograms, LiPo (Lithium polymer) batteries, a pesticide tank, a pump, and ~147 ~ ~ 148 ~. The 8000 mAh capacity of two LiPo batteries with six cells were utilized to provide the propulsion system with the required current. The insecticide solution was stored in a conical-square-shaped fluid tank with a capacity of five litters. Four nozzles were utilized to atomize the spray liquid into fine spray droplets after it had been pressurized using a 12 V DC motor and pump. The aerosol liquid tank, sprayer motor, spray and supporting legs (landing gears) were mounted on an appropriate aluminum supporting structure to ensure a safe takeoff and landing. HD FPV camera is also provided at the front downward side of the drone sprayer unit to view the live spraying operation. The entire drone mounted sprayer operation is controlled with the aid of a transmitter at ground level.After being tested in groundnut and paddy crops, the created drone mounted sprayer's average field capacity was determined to be 1.15 ha/h and 1.08 ha/h, respectively, at a forward speed of 3.6 km/h and a spray height of 1 meter. It has been calculated that the cost of operating a drone-mounted sprayer for paddy and groundnut crops is 345 and 367 Rs/ha, respectively. As the operating pressure and spray height increased, so did the spray uniformity.

Conclusions

Sprayers are a major tool in modern agriculture, used to administer fertilizer, herbicides and insecticides to crops. With changes in farming practices and technological advancements, the types of sprayers used in agriculture have changed over time. The boom sprayer is one of the most often utilized types of sprayers in contemporary agriculture. Boom sprayers administer pesticides or other chemicals to crops by mounting a number of nozzles on a horizontal boom. These sprayers can swiftly and effectively cover a huge area and they are usually placed on tractors. Growing interest has been shown in the application of solar-powered sprayers in contemporary agriculture in recent years. Solar panels are used to power the pump and various other parts of solar-powered sprayers, like the solar boom sprayer. Compared to conventional sprayers, this technology offers a number of benefits, such as lower fuel usage and carbon emissions. Because solar-powered sprayers don't need to be operated by a tractor or other vehicle, they also provide more mobility and freedom. This can be especially helpful in isolated places or those with limited access to energy. Furthermore, compared to conventional sprayers, solar-powered sprayers are usually quieter, which can lessen noise pollution and cause less disturbance to nearby residents and wildlife. Although solar-powered sprayers have a number of advantages over conventional sprayers, each farming situation should be considered individually when determining the efficacy and cost-effectiveness of solar-powered sprayers. Farmers may find them to be a more attractive alternative in the future if efficiency and cost improvements continue to drive technological advancements in this field. In general, the kind of sprayer utilized in contemporary agriculture is determined by several elements, such as the crop type being sprayed, the area to be treated's size, and the chemical type being employed. The choice of sprayer depends on several factors, and advances in technology have made these sprayers more efficient and environmentally friendly.

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ISSN No. 2583-3146

Initiatives for Engaging Youth in Agriculture Sector

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Introduction

Engaging youth in agriculture is crucial for the sustainability and modernization of the agricultural sector. With the global population increasing and the average age of farmers rising, it is imperative to attract young people to agriculture to ensure food security and rural development. Various initiatives have been introduced worldwide to encourage youth participation in this vital industry. One significant initiative is the provision of education and training programs. Agricultural schools, universities and vocational training centers offer courses tailored to young people, emphasizing modern agricultural techniques, entrepreneurship, and sustainable practices. These programs aim to equip the youth with the necessary skills and knowledge to innovate and improve agricultural productivity. Another effective approach is the use of technology and digital platforms. Mobile apps, online forums, and social media are leveraged to disseminate information, provide agricultural advice, and connect young farmers with markets. Technology-driven solutions such as precision farming, drone usage, and smart irrigation systems make agriculture more appealing and manageable for tech-savvy youth. Financial support and incentives are also crucial in engaging youth in agriculture. Governments and non-governmental organizations (NGOs) provide grants, low-interest loans, and subsidies to young farmers. These financial aids help mitigate the high startup costs associated with farming, making it a more accessible career choice for young individuals. Mentorship and networking opportunities play a significant role as well. Programs that pair young farmers with experienced mentors can provide valuable guidance and support. Additionally, agricultural fairs, conferences, and youth farming organizations create platform.

Need to focus on Youth

Youth is period from adolescence to middle age. Age constitute the determining characteristics in the definition of youth by various agencies. The National Youth Policy initially (2003) defined the youth as in the age group 13-35. However, National Youth Policy, 2014 modified it and defined "youth' as persons in the age group of 15-29 years (Verma *et al*., 2017). As per India's Census, 2011, Youth in India constitutes one-fifth (19.1%) of India's total population. India is expected to have 34.33 per cent share of youth in total population by 2020 outh being enthusiastic, vibrant, innovative and dynamic in nature is the most important section of the population. They show strong passion, motivation and will power which also make them the most valuable human resource for fostering economic, cultural and political development of a nation. A country's ability and potential for growth is determined by the size of its youth population. The energy and passion of the youth if utilized properly, can bring huge positive change to the society and progress to the nation. Youth are the creative digital innovators in their communities and participate as active citizens, eager to positively contribute to sustainable development (Verma *et al*., 2017). This section of the population need to be harnessed, motivated, skilled and streamlined properly to bring rapid progress for a country. Young people are three times more likely to be unemployed than adults and more than 75 million youth. Worldwide are looking for work (ILO, 2014). Due to their limited access to assets (in particular land), markets, finance and education and skills training, youth are often unemployed or work informally often in unpaid, very low-skilled, insecure and sometimes hazardous jobs (IFAD, 2012). The agricultural sector offers huge potential for job creation.

Conceptual Framework

Stakeholders

(Parents, Teachers and media) intervention

• Participation of the youth in the agri-/food business enterprise.

• Perception, Interest and attitude of the agri-/food business sector.

• Skills, funds and technology access in the agri -/food business sector.

Expectations of youth from an occupation

Fixed income: Jobs in corporate sectors are giving fixed income to youth but in farming monthly income is not fixed, there is a continuous fluctuation in income and it depends on so many extraneous factors like rainfall, weather, pest and insect attacks and policies of government (Be, 2015). Compensation: High compensation from a job is expected like overtime wages, bonus pay, merit pay, insurances and standard vacation policy and pension plan but in farming no such compensation is given. Youths in farming, often complain that agriculture is not attractive enough in terms of compensation and conditions of service compared to what other professions like law, medicine or banking offer (Neelam, 2017).

Job security: Jobs in service sector gives assurance that an employee has about the continuity of gainful employment for his/her work. But continuous economic losses from farming force the farmers to quit farming and go for some other occupation.

Job satisfaction: Money is one of the aspect of doing job but not the most important, the most important aspect in job is the job satisfaction. Whether or not a person enjoys the job. Many farmers have low self-esteem and they do not like farming they are just doing as they have no other option available (Srivastava, 2012).

Work and working conditions: The work should not be too much laborious and everyone wants to work in air conditioned offices well furnished with clean and calm environment. But, the work of farmers is often strenuous, working hours are frequently long and they rarely have days off during the planting, growing and harvesting seasons. Sometimes are exposed to contaminants such as pesticides.

Factors influencing youth to move away from farming

Economic factors

Low income: Ranghnathan (2016) found that about 53.37 per cent of farm households earn income lesser than poverty line income. Bihar, Uttaranchal, Uttar Pradesh, Puducherry and Jharkhand had more than 60 per cent farm households earning less than poverty line while Telangana, Sikkim, Gujarat, Lakshadweep, Jammu and Kashmir, Haryana, D and N Haveli, Meghalaya, Punjab, Kerala, Chandigarh and Delhi had less than 40 per cent farm households earning below poverty line. According to NSSO's (2013) Situation Assessment Survey of agricultural households, the average monthly income of a farm household in was just Rs. 6,426 per month in 2013 out of which the share of cultivation and livestock know was just Rs.3,844 - implying 40 per cent of incomes earned by agricultural households were due to non-farm sources.

Low minimum support price: Low MSP rates are fixed by the government and MSP is not set for all the available crops which are the biggest problem among farmers in India.

Small landholdings: Youngsters are not able to get enough land to cultivate. All children get a share in their father's property that leads to division of landholdings. Cultivation on such a small area is not economically feasible (Ram *et al*., 1999). A farm household needs to have at least 1 hectare of land to make ends meet every month. But given that over 65 per cent of households have less than one hectare of land, this means that two out of three farm households are simply not able to make ends meet (Kedia, 2018).The average size of the holding has been estimated as 1.15 hectare (Census, 2011). The average size of holdings has shown a steady declining trend over 2.3 hectares in 1970-71.

Social factors

Low social status: Farming has low occupational status. Farmers don't get much respect as compared to people from another profession. Farming stands at lowest ladder as the profession in the society. Girls do not want to marry a farmer, marrying a farmer means physically hard life.

Psychological factors

Lack of interest and non-farming aspirations: Only four per cent of young people were interested and considering a career in farming and food supply. The youth are not interested to continue as farmers due to the falling profitability and incomes in agriculture (Yadav, 2018). Aspirations play an important role in influencing how young people make life choices. Many studies from different parts of the globe both from developing and developed nations point to this fact. Only a meaner proportion of 2.4 per cent of the youths wanted to be farmers (Talfere and Woldehanna, 2012). The survey showed that just 1.2 per cent aspired to be a farmer. While 18 per cent of the boys wanted to join the army or the police, 12 per cent wanted to be engineers. Young girls preferred teaching (25%) or working as a doctor or a nurse (18%). About 13 per cent of the boys and 9 per cent of the girls surveyed also said that 'any government job' is preferable (Bera, 2018).

Physical factors

Inadequate and expensive irrigation facility: Research study shown that agricultural workers of U.P., during the reasons behind not getting the better amount of the cultivation, were facing various problems of inadequate irrigation facility (58.17%) (Singh, 2015). Lack of efficient irrigation systems (46%), often refers to the need for drip irrigation systems, which remain unaffordable among farmers (Guilini *et al*., 2017). Irrigation facilities are inadequate, as revealed by the fact that only 52.6 per cent of the land was irrigated in 2003–04, which result in farmers still being dependent on rainfall, specifically the monsoon season.

Middle men: Middle men and retailers take the major share of profit. The farmer actually gets a lot less than the selling price. A study by Ali *et al*. (2012) revealed that farmers obtained only about 53 per cent of the price of rice, 31 per cent being the share of middlemen. In the case of vegetables and fruits, the share of farmers was even less- 39 per cent in the latter.

Subsidies: Government has implemented agricultural debt, wiever and debt relief scheme. Most of the subsides welfare schemes announced by the central and state government do not reach upto the farmers in reality. On the contrary, only big land holders are benefited by these schemes (Anonymous, 2014).

Risk and uncertainties in farming: Uncertainty and risk go hand in hand with farming Agricultural production is directly dependent on nature including, (droughts, floods, frosts, storms, cyclones etc.), and long-term climate (such as climatic change including greater variability due to changes in the greenhouse effect) and the ever-changing incidence of pests and disease (Ullah *et al*., 2016).

Initiatives by Government for retaining youth in farming

Skill training for rural youth (STRY): Under sub-mission on agricultural extension (SMAE) of National Mission on Agriculture Extension and Technology (NMAET). Aimed at imparting skill-based training to rural youth on agri-based vocational areas in compliance with National Policy on Skill Development and Entrepreneurship-2015 in agriculture and allied areas to promote employment in rural areas.

Attracting and retaining youth in agriculture (ARYA): ICAR has initiated a programme on "Attracting and retaining youth in agriculture". Aimed to attract and empower the youth in rural areas to take up various agriculture, allied and service sector enterprises for sustainable income and gainful employment in selected districts and to enable the farm youth to establish network groups to take up resource and capital intensive activities like processing, value addition and marketing (Anonymous, 2016c).

National rural livelihood mission (NRLM): NRLM aims at creation of opportunities for both wage employment and skill development for the rural youth, who lack skills in many areas of agricultural production and processing. National Skill Development Mission and the National Skill Qualification Framework are, thus, aggressively pushing the agenda of skill development to build the capacity of rural youth so that they are meaningfully employed in rural areas itself (Ministry Rural Dev, 2011).

Agriclinics and agribusiness centres: Agriclinicsare envisaged to provide expert advice and services to farmers on technology, cropping practices, protection from pests and diseases, market trends, prices of various crops in the markets and also clinical services for animal health which would enhance productivity of crops/ animals and increased income to farmers. Agribusiness Centres are envisaged to provide farm equipments on hire, sale of inputs and other services for crop production (Bairwa *et al.*, 2014 and Chandra, 2003).

Dairy farming: Dairy farming is considered as village industry in India. Increasing population and growing consumption of milk and milk products like Dahi, cream, Paneer indicate that there is a great potentiality for dairying in India. India's milk demand is likely to increase to 170 million tonnes by 2020 from the present 105 million tones (Bairwa *et al.*, 2014). Individuals with less risk taking nature but high obsession for agripreneuership may opt for setting up a small dairy farm that can generate him/ her income from the day one (Srivastava, 1989 and Bairwa *et al.*, 2014). Fishery and fish processing:

Fish and fish processing sector is an emerging tool to agriculture. Fish and shrimp have good export potential but there is an immense lack of cold storage and modern processing facilities.

Goat farming: Is the act of rearing goat in a farm for the purpose of producing milk and meat (Anonymous, 2013).

Strong market systems: Efficient market information can be shown to have positive benefits for farmers and traders. Up-to-date information on prices and other market factors enables farmers to negotiate with traders and also facilitates spatial distribution of products from rural areas to town and between markets.

Role of various agencies/institution retaining youth in agriculture

Role of state agriculture universities

Training to youth: Most of the agricultural extension programmes which we implemented since independence in India traditionally targeted the head of families for training and technology transfer. In extension studies too, we consider the head of family, mostly male as the respondent, though in every diffusion-adoption study we found the early adopters to be younger. Youth are more techno-savvy and they could access information and knowledge promoted through the new ICTs which uses computer, internet and mobiles. Young farmers often have greater capacity for innovation, imagination, initiative and entrepreneurship than older adults and these characteristics should be effectively harnessed by extension services to provide better livelihood opportunities for youth in agriculture.

Role of Government: At present, only a few crops get a minimum support price (MSP) guarantee from the government. This has created a vicious cycle. Farmers are growing the same crops every season to sustain their livelihoods. It is time to break this cycle and think beyond this stunted vision. The government must assure MSP for other crops as well. This will encourage the youth to take up farming without bothering about the market risks (Palanismy, 2017). Agriculture subsidies need to be well targeted. The criteria of disbursement of agricultural subsidies should be based on farmers' operational landholding for ensuring maximum coverage of small and marginal farmers (Anand, 2016).

Role of educational institutions: Experience has shown that students with rural background are more comfortable in assimilating knowledge and efficient in practical performance in Agriculture Universities. The admission policy needs to encourage the graduates who are willing to work on the field (Aulak, 2018).

Agriculture as a subject in the school curricula: Primary and high school education could include modules on farming, from growing to marketing crops. This could help young people see agriculture as a potential career (Anonymous, 2017).

Role of media: Success stories of the innovative young farmers/ agri-preneurs including those youth who have successfully launched agri-ventures/ agri-entrepreneurship in different parts of the country may be highlighted through radio, TV and newspapers to motivate other young farmers. The community radio too can play vital role in encouraging and making young farmers aware about the possibilities in agricultural sector.

Conclusion

India is losing more than 2,000 farmers every single day and that since 1991; the overall number of farmers has dropped by 15 million. Involvement of youth is epic necessary for agricultural development while at present youth involvement is below the mark despite of having agricultural education degree (Chander, 2018). Generally, youth are willing to adopt new ideas and technologies and, therefore, government, SAUs and extension services should target youth to transform agriculture. The youth could be the ideal catalyst to change the poor image of persons involved in agriculture, especially in the rural communities given their greater possibility to adapt new ideas, concept and technology which are all important to changing the way agriculture is practiced and perceived. By encouraging and supporting youth participation in agriculture improving their capacities and increasing their involvement will also help in changing the negative perception about farmers as "uneducated and unskilled, physical labourers engaged in a glamour less vocation with extremely low economic returns" There is urgent need to enhance the agricultural graduates' participation in agricultural production. Important identified constraints are hard work, no assurance of profit, lack of incentives in farming, lack of access to farm implements and inputs, lack of insurance facility in agriculture and inadequate credit facilities. All these problems need attention to encourage the youth's participation in agriculture.

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ISSN No. 2583-3146

Significance of Smart Farming for Improving Agricultural Management

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Introduction

Smart agriculture is a technology that relies on implementing AI and IoT in cyber-physical farm management. Its significance lies in its ability to optimize resource usage, boost agricultural productivity, reduce cultivation costs and mitigate environmental impact. In the current agricultural landscape, where population growth strains food production and climate change poses challenges, smart farming offers solutions for both present and future generations to meet their food demands. The Internet of Things (IoT) technology facilitates the interconnection of various remote sensors, such as robots, ground sensors, and drones. This technology allows devices to be linked using the internet, enabling them to operate automatically. Precision agriculture aims to improve spatial management practices to increase crop production while minimizing the misuse of fertilizers and pesticides. Real-time monitoring enables farmers to manage water, soil nutrients, and crop health quantitatively. Modern smart tools like AI algorithms can analyse vast amounts of data to provide actionable insights at the right time. It enables predictive maintenance, pest detection, and yield optimization while minimizing water wastage and optimizing energy consumption. Smart farming fosters sustainability by reducing chemical usage and indirectly boosting soil biota, thus promoting sustainability in farming practices. It enhances precision farming practices, enabling farmers to tailor their approaches to specific crops and environments. It not only improves yields but also reduces costs and the environmental footprint.

Components of Smart Farming and Their Applications in Agriculture

Smart farming integrates various components and technologies to optimize agricultural processes and enhance productivity.

I. Internet of Things (IoT)

The Internet of Things (IoT) is a sophisticated and promising technology that offers innovative and practical solutions across multiple sectors, including smart cities, smart homes, traffic control, health-care and smart agriculture. IoT technology has undergone significant development in agricultural management within the farming sector.

Application of IoT in agriculture: IoT devices such as sensors and actuators are deployed or installed throughout the farm to collect real-time data on soil moisture, temperature, humidity, and crop health.

This data enables accurate decision-making regarding farm resource timing and efficient utilization.

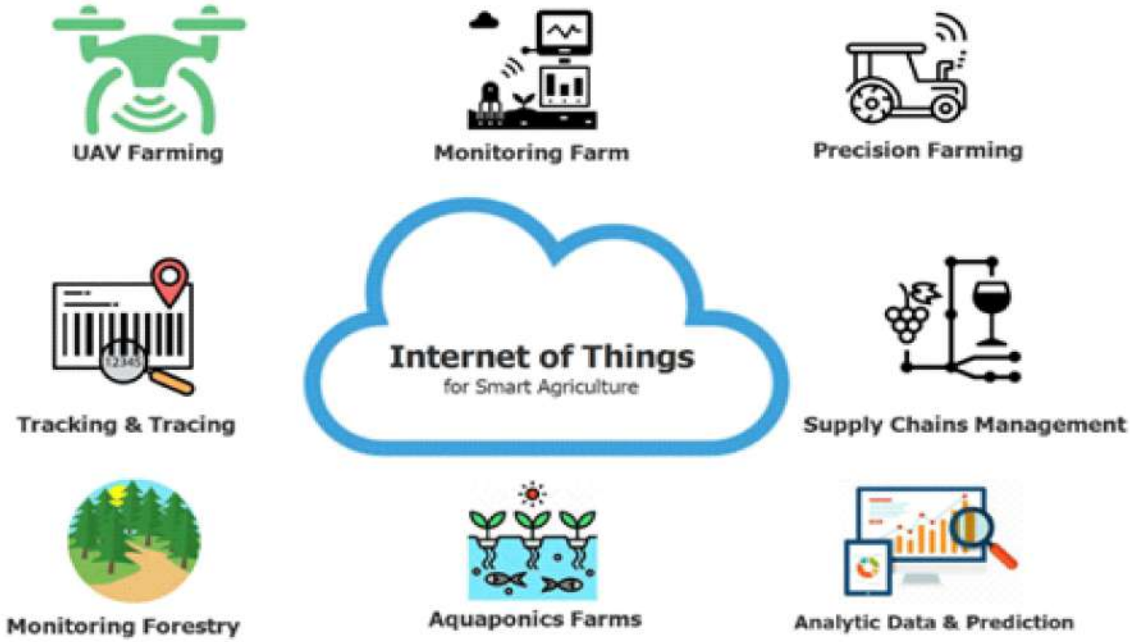


Fig. 1 An Illustration of IoT applications for smart agriculture

II. Data Analytics

Data analytics transforms raw data into actionable insights, employing various tools, technologies, and processes to uncover trends and address issues through data utilization. It has evolved into an indispensable asset across diverse industries, including agriculture.

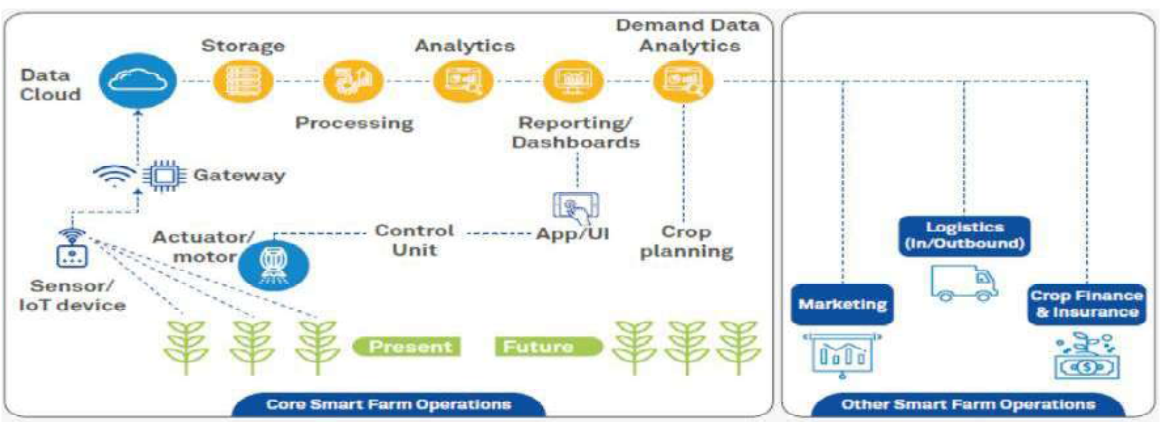


Fig. 2 Smart Farm Operating Model with Data Analytics

Application of Data Analytics in agriculture: Advanced data analytics techniques are applied to analyse data collected by farm IoT devices, encompassing information on soil moisture, temperature, relative humidity, and crop conditions.

III. Remote Sensing

Remote sensing involves the utilization of satellite imagery to capture photos of a field over time, enabling growers to analyse conditions based on the data and take actions that positively influence crop yield.

Application of remote sensing in agriculture: It provides invaluable insights into crop health, environmental conditions, and land management. Through satellite imagery, drones, and other remote sensing tools, high-resolution data is collected on various agricultural aspects, including crop growth, soil moisture levels, pest infestations, and nutrient deficiencies. This technology empowers farmers and crop growers to make informed decisions regarding agricultural practices such as timely irrigation scheduling, fertilization, pest control, and harvesting timing.

Fig. 3 Remote Sensing Enables Smarter Farming Decisions

IV. Automation and Robotics

Industrial automation and robotics use computers, control systems and information technology to handle industrial processes and machinery, replacing manual labor and improving efficiency, speed, quality, and performance.

Application of Automation and Robotics in Agriculture: Automation and robotics are revolutionizing agriculture by streamlining labor-intensive tasks and increasing efficiency. In crop cultivation, robots are utilized for planting, weeding, and harvesting, reducing the necessity for manual labor while enhancing accuracy and speed.

Fig. 4 Application of Automation and Robotics in Agriculture

Benefits of smart farming in the current scenario

i. Increased Efficiency: Smart farming technologies enable farmers to monitor crops, soil conditions, and livestock in real time.

ii. Resource Conservation: Smart farming has the ability to conserve precious resources like water, energy, and fertilizers.

iii. Optimized Crop Management: Smart farming enables farmers to monitor crop health and growth patterns with unprecedented accuracy.

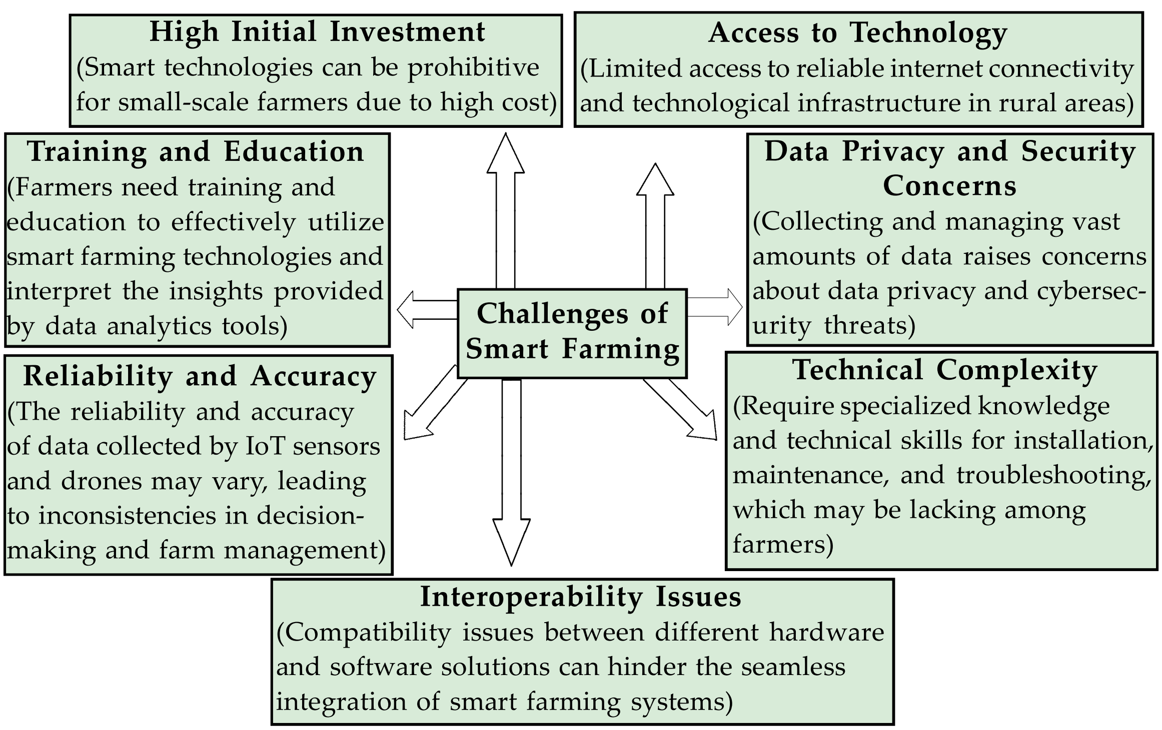
iv. Data-Driven Decision Making: Data-driven decision-making enhances productivity and reduces risks associated with uncertainty in farming operations.

v. Environmental Sustainability: By reducing chemical inputs and optimizing resource utilization, smart farming helps mitigate soil degradation, water pollution, and greenhouse gas emissions associated with conventional farming methods.

vi. Enhanced Food Safety and Quality: With consumers becoming increasingly concerned about food safety and quality, smart farming offers solutions to ensure the integrity of agricultural products.

vii. Empowerment of Farmers: Smart farming gives farmers access to information, knowledge, and tools needed to succeed in a rapidly evolving agricultural landscape.

Challenges of Smart Farming



Future Line of Work to Adopt Smart Farming in Agriculture

Conclusion

The emergence of smart farming signifies a transformative shift in agricultural practices, bearing profound implications for the future of agriculture. By seamlessly integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and robotics, smart farming has emerged as a potent tool to optimize agricultural operations, boost productivity and tackle the myriad challenges traditional farming methods encounter. The significance of smart farming transcends mere technological innovation; it heralds a paradigm shift towards a more sustainable, efficient, and resilient agricultural sector. As we continue to leverage the potential of smart farming technologies and integrate them into mainstream agricultural practices, we can unlock new opportunities for heightened productivity, increased profitability, and enhanced environmental stewardship, ensuring a brighter and more sustainable future for farming.

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ISSN No. 2583-3146

Effect of Temperature on Growth and Development of Vegetable Crops: A Comprehensive Review

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Introduction

Temperature is one of the most critical climatic factors influencing the growth, development and productivity of vegetable crops (Babu *et al.*, 2024). Although temperature does not directly provide energy, it controls the rate of numerous biochemical reactions essential for plant processes such as seed germination, growth, flowering, pollination and fruit set (Bhattacharya. 2022). Understanding the physiological and morphological responses of crops to temperature is vital for improving crop resilience in the face of rising global temperatures (Aslam *et al.*, 2022).

Physiological and Biochemical Effects of Temperature

Temperature influences a variety of physiological processes in vegetable crops, including photosynthesis, respiration and water relations (Nemeskéri and Helyes., 2019). High temperatures can disrupt these processes, leading to oxidative stress and damage to cellular structures, which ultimately affects plant growth and productivity (Dolkar *et al.*, 2019a). Additionally, temperature variations impact the biochemical composition of vegetables. For example, high temperatu-res increase glucosinolate concentrations in rocket salad, although these increases do not always translate to higher nutritional benefits due to enzyme inhibition at extreme temperatures (Jasper *et al.*, 2020).

The reproductive stages of vegetable crops are particularly vulnerable to heat stress. High temperatures can impair pollen viability, stigma receptivity and seed filling, leading to reduced yields (Chaudhary *et al.*, 2022). Therefore, reproductive failures under heat stress represent a significant challenge for crop production, especially in regions with rising temperatures.

Morphological and Yield Effects of Temperature

Temperature fluctuations also influence the morphology and yield of vegetable crops. Increased temperatures can accelerate the growth rate and leaf area of leafy vegetables like lettuce and pak choy, but this may be accompanied by a reduction in their mineral content (Kong *et al.*, 2023). In controlled environments, temperature management can help reduce the occurrence of issues such as tipburn in lettuce (Kumazaki, 2022). Excessive heat, however, can cause morphological damage such as leaf tip burn and fruit abortion, common issues in many vegetable crops that can lead to substantial economic losses (Aleem *et al.*, 2020). Thus, maintaining optimal temperature conditions is critical for achieving maximum yield and quality.

Adaptation and Mitigation Strategies

Given the adverse effects of temperature on vegetable crops, various strategies have been developed to mitigate these impacts. One key approach is the development of heat-resilient vegetable cultivars through breeding and biotechnol-ogical methods. Genomics-assisted breedi-ng, gene editing and speed breeding are being employed to create temperature-resilient varieties more efficiently (Saeed *et al*., 2023). Additionally, agronomic practices such as mulching and raised bed cultivation help conserve soil moisture and reduce the impact of excessive heat (Bukharov *et al*., 2023). Physiological traits, such as canopy temperature depression and chlorophyll fluorescence, are being studied to develop heat-tolerant varieties. Molecular approac-hes are also being explored to provide insights into the mechanisms of thermo tolerance. Together, these strategies form the foundation for enhancing the resilience of vegetable crops to temperature stress.

Temperature and Seed Germination

Seed germination is highly sensitive to temperature. Warm-season vegetables, for instance, require minimum soil temperatures of 17°C and an optimum range of 24-30°C for germination. Excessively high temperatures, however, can impair seed germination by damaging membrane integrity and increasing the leakage of electrolytes and macromolecules (Dolkar *et al*., 2019b).

In contrast, cool-season crops such as onions, peas, and carrots can germinate at lower temperatures, with a minimum requirement of 2-5°C (Donald and War land., 2020). However, rapid germination at high temperatures can expose seedlings to fungal infections, reducing their overall viability.

Temperature Effects on Root Performance

Soil temperature plays a vital role in root growth and water absorption. Cooler soils decrease water uptake due to increased water viscosity, reduced cell permeability and lower soil pH (Lambers *et al*., 2019). Furthermore, lower temperatures reduce the activity of soil microorganisms, which in turn diminishes nutrient uptake and hampers root growth (Das *et al*., 2022). The reduction in root growth can negatively impact photosynthesis, as fewer carbohydrates are available for transloca-tion to the shoots (Wang and Ruan. 2015).

Photosynthesis, Respiration and Temperature

Photosynthesis and respiration rates in vegetable crops are directly influenced by temperature (Yamori *et al*., 2022). While a slight increase in temperature can enhance photosynthesis, temperatures that exceed the plant's optimal range often result in higher respiration rates, leading to reduced growth and lower yields (Dusenge *et al*., 2019). Conversely, suboptimal temperatures can slow both photosynthesis and respiration, resulting in decreased carbohydrate accumulation and stunted plant development (De Bang *et al*., 2021). The temperature at night also plays a crucial role in determining the rate of carbohydrate loss through respiration, which in turn affects crop yields and quality (Xu *et al*., 2021).

Effect of Temperature on Development of Economic Plant Parts

Temperature influences the formation and development of economically valuable parts of vegetable crops (Saqib *et al*., 2022). For example, potatoes require a temperature range of 18-24°C for tuber formation, but extreme temperatures can inhibit tuberization and lead to poor yield (Dahal *et al*., 2019). Similarly, high temperatures can affect the bulb formation in onions and garlic, while carrots show optimal root development at temperatures between 15-21°C (Atif *et al*., 2020).

Challenges and Future Directions

Despite advancements in understanding the role of temperature in vegetable crop growth and development, challenges remain (Ahmed *et al.*, 2024). The complexity of plant responses to temperature stress, coupled with the variability in climate conditions, necessitates continued research into breeding, physiological and agronomic solutions (Langensiepen *et al.*, 2020). Future efforts should focus on integrating molecular, physiological and breeding approaches to develop comprehensive solutions that ensure the sustainability of vegetable crop production in the face of climate change.

Conclusion

Temperature is a key environmental factor affecting the growth, development, and productivity of vegetable crops. While temperature extremes can lead to physiological disruptions, morphological changes, and yield losses, the development of temperature-resilient varieties and the adoption of agronomic practices offer promising avenues for mitigating these challenges. As climate change continues to alter temperature regimes worldwide, ongoing research into plant thermotolerance and climate adaptation strategies will be essential for securing the future of vegetable production.While the focus is often on high temperatures due to global warming, low temperatures also pose significant challenges, particularly in regions prone to cold spells. The development of cold-tolerant varieties and the implementation of protective agronomic practices are equally important. Continued research and innovation in breeding and agronomy are essential to enhance the resilience of vegetable crops to both high and low temperature stresses, ensuring sustainable productivity in the face of climate change.

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ISSN No. 2583-3146

Impact Analysis of Indian Mustard Variety DRMR 1165-40 Under Cluster Frontline Demonstrations (CFLDs)

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Introduction

Rapeseed and mustard oil is used primarily for edible purposes and is the principle cooking oil in the mustard growing area of the country. Known for its great taste and subtle flavor, this vegetable oil is the world's second leading source of protein meal. Besides seeds, it is used as condiments. The meal cake left after oil extraction forms important cattle feed and may also be used as organic manure. *Brassicas* are rich source of vitamins, minerals and contains many medicinal properties. They provide high amounts of vitamin C, soluble fiber and contain multiple nutrients with potent anti-cancer properties. Oil is used in Northern India for cooking and frying purposes. It is also used in preparation of hair oil and medicines. It has industrial importance in soap making and in mixtures with mineral oils for lubrication and grease for various machines. Tender leaves of young plants are used as green vegetable and are good source of sulphur and other minerals in diet. Botanically, the genus *Brassica* comprises six species (*B. nigra, B. oleracea, B. campestirs, B. carinata, B. juncea* and *B. napus*). Among them first three species are elementary and diploid with 2n=16, 18 and 20chromosomes and other three are tetraploids with chromosomes numbers 2n=34, 36 and 38. All these crops are grown under wide range of agro-climatic conditions. Indian mustard [*Brassica juncea* (L.) Czern & Coss], which is cultivated under the genus Brassica is cultivated all over India and it is throughout the world belongs to family Cruciferae (*Brassicaceae*). It has 38 to 42 % oil and 24% protein.

Methedology

1. About CFLDs on Indian Mustard (*Brassica juncea* L. Czern & Coss): Cluster Front Line Demonstrations (CFLDs) on Indian Mustard conducted in Eleven villages namely; Raipur Shumali, Khajoori, Dhanora Mafi, Dhanora Mandi, Nagla Mafi, Rehmapur Mafi, BaldanaAsgar Ali, Fatehpur Chitra, Nanai, Gajraula Basti & Salempur Gonsai of Districts Amroha of Uttar Pradesh in eastern region during Rabi-2022-23 funded by ATARI, Kanpur, Zone-III. Total 60 CFLDs were conducted in 60acre areas. The CFLDs techniques was used as "*Improved varieties* vs. *Commercial cultivars (local check*)".

Table-1: Details of the CFLDs on Rabi Indian Mustard (*Brassica juncea* L. Czern & Coss) during-2022-23.

S.No.	Details	Quantity to be used
1.	Total number of CFLDs conducted	60 CFLDs
2.	Total area covered (1 acre for 1 CFLDs)	60 acre (60 farmers)
3.	Hybrids/varieties used to conduct FLDs on Indian mustard	DRMR 1165-40

2. Selection of the farmers: Total 60 marginal farmers were selected on the basis of their socio-economic conditions and also on the basis of their own choice for conducted Cluster Front Line Demonstrations (CFLDs) on Indian Mustard (*Brassica juncea* L. Czern & Coss) during Rabi-2022-23 in Eastern Uttar Pradesh region for maximize the production and double your income as per the suggestions of our Hon'ble Prime Minister Shri Narendra Modi Ji. The details are given as below intable-2.

Table-2:Summary of the CFLDs Conducted During 2022-23.

S. No	Name of the centre/ institute	Krishi Vigyan Kendra, Gajraula, Amroha
1.	Total no. of the CFLDs sanctioned in the workshop	60
2.	Total no. of the CFLDs actually conducted	60
3.	Name of Crop	Indian Mustard
4.	Types of CFLDs with numbers	Full packaged: 60
5.	Name of demonstrated varieties	DRMR 1165-40
6.	Situation: Rainfed/ irrigated and Normal sown / late sown	Irrigated Normal sown
7.	Total no. and name of the villages covered	Raipur Shumali, Khajoori, Dhanora Mafi, Dhanora Mandi, Nagla Mafi, Rehmapur Mafi, Baldana Asgar Ali, Fatehpur Chitra, Nanai, Gajraula Basti & Salempur Gonsai
8.	Total no. and name of the district(s) covered	(01) Amroha.
9.	Cropping systems prevailing in the demonstration area	(i) Paddy, Mustard, Urd (ii) Maize, Mustard, Moong
10.	Date of sowing (range)	03-10-2022 to 02-11-2022
11.	Date of harvesting (range)	24-01-2023 to 06-04-2023
12.	Specify pests and disease situations	Low Aphid
13.	Farmer's opinion about the improved technology (Feedbacks)	Satisfied with variety and technology
14.	Visitors/ Monitoring team (No. date and place with remarks)	Monitoring team monitored CFLDs on 12.01.2023 to 27.01.2023 and was satisfied with CFLDs.
15.	Remarks of the Scientists involved in the demonstration	Very Good and Team was satisfied with all the CFLDs.
16.	**Details of the demonstrated improved technology and farmers practice/ indigenous Technical**	
	Components of demonstrated technology	**Prevailing farmers practices against demonstrated technology**
	Full package	Farmers are being adopted conventional method to grow the crop like seed of

17.	Any other observation	old variety, broadcasting method of seed sowing and fertilizer application, no thinning and not plant protection masseurs adopted. Farmers were happy with new variety seed and fully satisfied with new technologies for cultivation of frontline demonstrations

3. Features of hybrids & seed distribution programme: The high yielding varieties/ hybrids namely; DRMR 1165-40 was used for distribution of seed under CFLDs on Indian Mustard (*Brassica juncea* L. Czern & Coss) during Rabi-2022-23in Eastern Uttar Pradesh region. The average yield of these varieties/hybrids are 18-22 q/ha. and mature in medium duration.

Table 3: Organized & participated in the field day under Cluster Front Line Demonstration (CFLDs) on Mustard during Rabi 2023 sponsored by Krishi Vigyan Kendra, Gajraula, Amora, Uttar Pradesh, Sardar Vallabhbhai Patel University of Agriculture & Technology, Kanpur-208002, U.P., India.

Date	Name of activity (Field day)	Name of Villages	Block & District	No. of Farmers participated
30/01/2023	CFLD on Mustard	Khajoori	Joya, Amroha	36
24/01/2023	CFLD on Mustard	Khajoori	Joya, Amroha	35
11/01/2023	CFLD on Mustard	Dhanori Mafi	Joya, Amroha	25
21/10/2022	CFLD on Sesame	ChotiKhajoori	Joya, Amroha	25
12/10/2022	CFLD on Sesame	Dhanori Mafi	Joya, Amroha	25

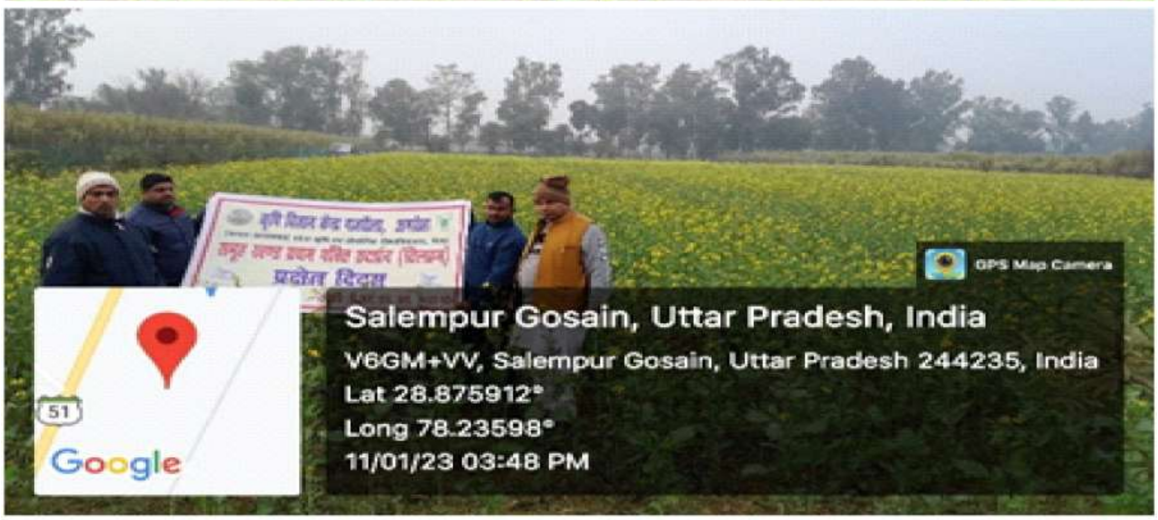
Table 4: Performance of CFLD.

Yield of local Check q./ha	Increase in yield (%)	Economics of demonstration (Rs./ha.)				Economics of check (Rs./ha.)			
		Gross Cost	Gross Return	Net return	C.B. RATIO	Gross Cost	Gross Return	Net return	C.B. RATIO
10	11	12	13	14	15	16	17	18	19
10.25	39.02	25750	92455	66705	3.59	24250	56375	32125	2.32

Table 5: Conducted Training on Mustard varieties & production technology and seed distribution programme under CFLDs on Mustard during Rabi, 2022-23.

ISSN No. 2583-3146

Field visit & monitoring the performance of CFLD on Mustard at Village Khajoori & Dhanauri Mafi on 11/01/2023.



Conclusion

Most of the Marginal/Micro land holding Farmers with or without resources keep their land fallow in Rabi and cultivate wheat, gram, linseed and lentil in Rabi. Here we found Indian Mustard a promise crop to increase Cropping intensity in Western region of Uttar Pradesh. With majority of Scheduled Castes population / marginal farmers living in villages under studied area were economically isolated. Those were below poverty line and their livelihood dependent solely on agriculture and livestock rearing the NFSM Plan seems to be boon for uplifting their status.

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ISSN No. 2583-3146

Production of Hydrogen Cyanide (HCN) by Soil Bacteria and its role in Plant Growth Promotion

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Introduction

Microbes play an important role in the acquisition and transfer of nutrients in soil. Therefore, the utilization of soil microbes to activate minerals and enhance nutrient uptake in plants has attracted increasing attention in sustainable agriculture (Fayez and Mahmoud, 2006). HCN a volatile, secondary metabolite produced naturally by number of soil bacteria mainly is known tobe a broad-spectrum antimicrobial compound and have a role in biological control of pathogens especially limiting the fungal growth and root disease (Rezzonico *et al*. 2007; Ahmad *et al*. 2008). Recently the main contribution of biogenic HCN is suggested in the sequestration of iron through production of siderophore (SD) and consequentially in direct increase of phosphate availability through phosphate solubilization (PS activity) resulting in increased plant growth. The role of HCN producing bacteria in mobilization of nutrient elements from rocks in natural environments by formation of complexes with transitional metals and phosphorous is suggested (Rijavec and Lapanje, 2016).

Recently, Sagar *et al.*, (2018) conducted a study with soil bacteria on production of HCN, SD and PS and results are summarized in following table

Production of HCN, SD and PS in Soil Bacteria

Isolates	No.	No. of positive isolates (%)		
		HCN	SD	PS
Heterotrophs	149	41 (27)	44 (29)	29 (19)
Coliform	107	03 (02)	35 (32)	43 (40)
Pseudomonas sp.	132	81 (61)	111 (84)	72 (54)
Rhizobium sp.	132	27 (20)	76 (57)	65 (49)
Azotobacter sp.	130	28 (21)	99 (76)	34 (26)
Total	650	180 (27)	365 (56)	243 (37)

of 650 soil bacteria screened, production of HCN, SD and PS was detected in 180 (27%), 365 (56%) and 243 (37%) organisms, respectively. Production of SD and PS was detected significantly higher in coli forms and *Rhizobium* spp. when compared to HCN. In *Pseudomonas* spp. and *Azotobacter* spp. production of SD was significantly higher number of organism as compared to HCN.

Phosphorus (P) is one of the major essential macronutrients for plants. In India, it is estimated that there are almost 260 million tons of phosphate rock deposits and this material should provide a cheap source of phosphate fertilizer for crop production (FAI 2002). Although in soil P is available abundantly its bioavailability in soil remains low due to the chemical transformations of P into insoluble forms (Rodríguez and Fraga1999) and thus a major constraint to the plant growth and crop production (Chiquito-Contreras et al. 2012). Bacteria with PS activity through HCN production have been considered as one of the possible alternatives for mediating inorganic phosphate solubilization and increasing its availability to the plants (Sagar *et al.* 2018).

Iron (Fe) is an essential plant micronutrient and microbial siderophores enhance Fe uptake by plants (Dimkpa *et al.* 2009) and thus plays an important role in plant growth promotion. Although large portion of Fe is present in soil it acts as a limiting factor for plant growth because its existence in the form of highly insoluble ferric hydroxide. Bacteria secrete sideroph-ores to solubilize Fe from their surrounding environments by forming a complex ferric-siderophore and provide it to the plants for growth promotion (Andrews *et al*. 2003). Production of HCN in bacteria induced by iron under influence of quorum sensing in rhizosphere has been suggested by several investigators (Pessi and Haas, 2000).

Recent finding by Sagar and co-workers (2018) that the main contribution of HCN is in the sequestration of metals and indirectly increasing the availability of phosphate, thus consequently increasing nutrients availability has introduced a paradigm shift in understanding the role of biogenic cyanide in plant growth promotion activity.

HCN a volatile, secondary metabolite produced naturally by number of soil bacteria is known to have a role in biological control of phytopathogens. As soils are becoming deficient in nutrients at increasing rate, utilization of HCN producing soil bacteria will assume greater important role in sustainable agriculture in the future.

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ABOUT THE SOCIETY

Father of Nation Mahatma Gandhi's concept of rural development meant self-reliance, and least dependence on outsiders. India is an agrarian country and about 65% of our population lives in rural areas. But unfortunately, most of us do not have any idea about the extent of poverty and the real conditions of rural India.

With the purpose of serving the agricultural fraternity and farming community the Society for Advancement in Agriculture, Horticulture and Allied Sectors (SAAHAS) was founded in 2020 (under Society Registration Act, 1860). Among multifarious ways of serving farming community we are involved in training of the farmers by organising technology dissemination programmes in villages, guiding them to adopt good agricultural practices involving planned crop management. It helps in reducing farm base losses and motivating them to become farmer level entrepreneur rather than a simple producer. It involves initiating skill based knowledge to the student of agriculture, horticulture and allied sectors to encourage them to serve the farmers in the best possible ways.

SAAHAS calls us to look into the genuine problems of farmers and address those issues for their betterment in the arena of Agriculture, horticulture and allied sectors. Besides agriculture, horticultural crop production has been given a major focus by Govt. of India in future crop diversification, improving livelihood through doubling farmers' income, economic opportunities through export and job opportunities. While good beginning is made, much is to be achieved in different areas in agro-horticulture sector.

Apart from that, SAAHAS helps developing the culture to involve more number of women in farming, processing of crops and value addition thereof for higher returns in terms of total income. SAAHAS eagerly involves with the farmers and agriculture entrepreneur to motivate them for introducing hi-tech farming, which includes growing of high value horticultural crops in hydroponics, aeroponics, polyhouse, net house and greenhouse. The society has geared up its activities to take up the challenges of biotic and abiotic stresses, emerging needs of quality seeds and planting material and reducing cost of production.

There are several government and non-government organisations intended of farmer's welfare; still there is dire need for more involvement and attachment with the farmers. Our society's noble initiative can ensure diminishing of the persistent gap between agro-technocrats, scientists with the needy farmers. We not only ensure that the farmers choose right variety of right crop, better nutrient management through diagnosis recommended system and pest diagnosis but we also help them to sale their produce at premium rates. There is a major issue of chemical residues in food, soil and ecology which is also a big concern of the century. The Society also aims to motivate the farmers either for minimal use of chemical inputs or total adoption of organic farming. Consultancy, training, awareness programs, national and international seminars and symposia and technical services are the prime activities of the SAAHAS.

Society for advancement in Agriculture, Horticulture and Allied Sectors publishes peer reviewed scientific journal, 'Journal of Applied Agriculture and Life Sciences (JAALS)', biannually since January 2020 focusing on articles, research papers and short communications of both basic and applied aspect of original research in all branches of Agriculture, horticulture and other allied sciences. To apprise the scientists and all those who are working in the field of Agriculture, horticulture and allied sectors about recent scientific advancement is the aim of the Journal.