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Desi Seeds and Vedic Agriculture: The Pillars of Viksit Bharat 2047

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Picture a future where every grain of food is pure, every farm flourishes without chemicals, and every farmer is free from debt-this is the vision of Viksit Bharat 2047. At the heart of this transformation lie Desi Seeds and Vedic Agriculture, India's ancient gifts to the world. For centuries, our ancestors nurtured indigenous seeds, passing them down like sacred heirlooms. These seeds weren't just the foundation of agriculture; they were a symbol of self-reliance, resilience, and harmony with nature. But today, modern industrial farming has disrupted this balance-forcing farmers to depend on expensive hybrid and genetically modified (GM) seeds, leading to soil degradation, water crisis, and economic distress.

Yet, the answers to our agricultural challenges have always been within us. As the Atharvaveda reminds us:**"माता भूमिः पुत्रोऽहं पृथिव्याः।" Mātā bhūmiḥ putro'haṃ pṛthivyāḥ.**The Earth is my mother, and I am her son.This verse is from the Atharvaveda and highlights the deep connection between humans and nature, emphasizing the duty to protect and nurture Mother Earth

By reviving Desi Seeds and embracing Vedic Farming, we can heal our land, empower our farmers, and reclaim India's status as a global leader in sustainable agriculture. The journey to Viksit Bharat 2047 starts with the wisdom of the past, guiding us towards a self-sufficient, prosperous future.

1. Seeds: The Soul of Agriculture

Imagine a world where every seed carries the legacy of generations- adapting, thriving, and nourishing

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without the need for chemicals. Our ancestors lived in perfect harmony with nature, preserving Desi Seeds that sustained civilizations for thousands of years. These seeds are more than just grains; they are a sacred bond between Mother Earth and humankind-symbols of resilience, purity, and sustainability.

However, in recent decades, this sacred balance has been disrupted. The dominance of hybrid and genetically modified (GM) seeds has led to declining soil fertility, increased chemical dependency, farmer distress, and the erosion of seed sovereignty. The very essence of India's ancient agrarian wisdom is at risk.

Yet, the solution lies within our own Vedic agricultural traditions. Our scriptures have always emphasized sustainable farming, where the land is nurtured rather than exploited.**"माता भूमिः पुत्रोऽहं पृथिव्याः।" Mātā bhūmiḥ putro'haṃ pṛthivyāḥ.**

This philosophy is at the heart of **Viksit Bharat 2047,** a vision to restore India's golden agricultural heritage through Desi Seeds and Vedic Farming. By embracing these time-tested practices, we can revive soil health, ensure food security, and position India as a global leader in sustainable agriculture.The time to act is NOW. Let's reclaim our agricultural legacy and build a self-reliant, prosperous Bharat!

2. Desi Seeds: The True Wealth of Indian Farmers

Imagine if you could grow your own food without depending on expensive market seeds every season. That's exactly what Desi Seeds offer! These are heirloom, naturally resilient seeds that have been passed down through generations.

Why are Desi Seeds important?

- Adapt to local climates and need fewer resources.
- Free from harmful GMOs and chemicals.
- Can be saved and replanted, reducing farmer dependency on corporations.

"बीजस्य शक्तिः सर्वस्य मूलम्" Bījasya śaktiḥ sarvasya mūlam. (The power of the seed is the foundation of everything.) Let's look at the difference between Desi Seeds and Hybrid/GM Seeds:

Feature	Desi Seeds	Hybrid/GM Seeds
Adaptability	Naturally strong, survive harsh weather	Need artificial protection
Nutritional Value	Higher vitamins, minerals, antioxidants	Often lower due to chemicals
Reusability	Can be stored & replanted	Must be bought every season
Cost for Farmers	Zero-cost, self-sustaining	Expensive, leads to debt

The Problem: Multinational corporations are monopolizing seed production, forcing farmers to buy expensive seeds each year.

The Solution: By reviving Desi Seeds, farmers can take back control and grow their own future.

3. Vedic Agriculture:The Ancient Science of Sustainable Farming

Our ancestors practiced agriculture that honored nature's balance, yielding abundant harvests while preserving soil health for generations. Vedic Agriculture follows this time-tested wisdom, ensuring sustainable and chemical-free farming.

4. Key Pillars of Vedic Agriculture

Gau-Based Farming: Harnessing Panchagavya (cow urine, dung, ghee, curd, milk) as natural fertilizers.

Zero-Budget Natural Farming (ZBNF): Eliminating costly chemicals and using nature's resources.

Cosmic Farming: Aligning sowing and harvesting with planetary movements for optimal yield.

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Agroforestry: Integrating trees with crops to enrich soil fertility.
Rainwater Harvesting: Preserving water through traditional conservation techniques.

The Problem: Chemical-based farming has damaged soil and water sources.
The Solution: Switching to Vedic Agriculture to restore nature's harmony and farmer prosperity.

5. Viksit Bharat 2047: The Road to an Agricultural Revolution

"यत्र अन्नं तत्र धनं" (Where there is food, there is wealth.)

A flourishing agricultural India requires a bold and clear roadmap. Here's how we achieve a 100% sustainable farming system by 2047

Year	Goal
2025	50% increase in natural farming adoption.
2030	Ban on chemical-based farming in key regions.
2035	All Indian farmers use Desi Seeds.
2040	India becomes the world's largest organic food exporter.
2047	100% self-reliant and sustainable agriculture.

6. Challenges & Solutions

Every great transformation faces obstacles. But with the right strategies, India can overcome these challenges and become a Global Agricultural Leader

Challenge	Solution
Climate Change	Promote climate-resilient Desi Seeds.
Chemical Dependency	Popularize organic fertilizers like Jeevamrut.
Farmer Debt	Encourage Zero-Budget Natural Farming.
Water Shortage	Expand rainwater harvesting.
Soil Degradation	Use cow-based manure, crop rotation, and agroforestry.

7. Why the World Needs India's Leadership in Agriculture

As the world grapples with the challenges of climate change, soil degradation, and an overdependence on chemicals, the demand for sustainable and organic food is rising. In this global shift toward ecological balance, Bharat stands as a beacon of hope. For centuries, Indian farmers have practiced agriculture in harmony with nature, preserving biodiversity and nurturing the land with indigenous wisdom. Now, as modern farming systems struggle with sustainability, India's time-tested methods can offer a viable path forward.

India's Role in a Sustainable Future

India has the potential to become a global leader in organic and natural farming, offering solutions that are both time-tested and innovative:

The Global Organic Superpower- With its diverse agro-climatic zones and traditional seed varieties, India can lead the world in organic food production, reducing reliance on harmful chemicals.

The Knowledge Hub for Natural Farming- India's ancient agricultural practices, including Rishi Krishi and Vedic farming, have sustained civilizations for millennia. By sharing this knowledge, India can help other nations transition toward climate-resilient farming.

A $500 Billion Organic Economy by 2047- By investing in organic farming and sustainable agribusiness, India can create economic opportunities while ensuring food security and environmental protection.

This is not just about reviving ancient practices; it is about shaping the future of global agriculture. By blending our heritage with scientific advancements, Bharat can lead the world in a farming revolution that prioritizes health, sustainability, and self-reliance.

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The time to act is now-India must reclaim its rightful place as the world's agricultural torchbearer.

8. Conclusion: A Call to Reconnect with Our Roots

For centuries, Bharat's farmers nurtured the land with love, wisdom, and devotion, passing down seeds that carried the essence of life itself. But today, this sacred bond is under threat. Hybrid and genetically modified seeds have made farmers dependent on industrial systems that strip the soil of its vitality and erode our self-reliance. This is not just an agricultural crisis—it is a loss of our heritage, culture, and the deep connection we share with Mother Earth.

The path to Viksit Bharat 2047 lies in reclaiming our roots. By reviving native seeds, embracing natural farming, and fostering self-sufficiency, we can restore the balance that sustained generations before us. The G20's message of **"Vasudhaiva Kutumbakam"(The world is one family** reminds us that true prosperity comes from harmony with nature.

Now is the time to act—not just for ourselves, but for the generations to come. Let us walk the Sanatan path of sustainability, nurture our land with care, and cultivate a Bharat that stands as a beacon of self-reliance and ecological wisdom. The soil beneath our feet is not just dirt-it is the foundation of our future. Let's honor it, protect it, and let it flourish.

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The Evolution of Insecticide Doses in Agriculture: A Paradigm Shift in Pest Management

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Agriculture has undergone a remarkable transformation over the centuries, and one of the most critical aspects of this evolution is pest management. Farmers have relied on various methods to control insect infestations, ranging from traditional practices to the use of chemical insecticides. Over the years, insecticide doses have changed significantly due to advancements in scientific research, environmental concerns, resistance development, and the emergence of more efficient formulations. This article explores the historical context, factors influencing dose modifications, and the implications of changing insecticide doses in modern agriculture.

Historical Perspective on Insecticide Usage: The application of insecticides in agriculture dates back to ancient civilizations. The Chinese used arsenic compounds, while the Greeks and Romans relied on plant extracts and sulfur to manage pests. The 19th century witnessed the introduction of synthetic insecticides such as Paris Green and lead arsenate. However, the widespread adoption of chemical insecticides began in the mid-20th century with the discovery of organochlorines like DDT. These chemicals were initially applied in high doses to achieve immediate pest control, but their adverse environmental and health impacts led to gradual modifications in their usage.

Factors Influencing Changes in Insecticide Doses

Several factors have contributed to the shift in insecticide dosage in modern agriculture:

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1. Development of Resistance

Insecticide resistance occurs when pests develop the ability to withstand chemical treatments, leading to reduced efficacy. High doses of insecticides were initially used to eliminate pests completely, but over time, many insect populations adapted to these chemicals. This prompted researchers and agricultural experts to adjust doses, incorporate rotation strategies, and introduce integrated pest management (IPM) approaches.

2. Environmental and Health Concerns

The extensive use of high-dose insecticides has had detrimental effects on ecosystems, water sources, and human health. Residues in soil and water bodies caused bioaccumulation in the food chain, leading to stricter regulations on permissible doses. Modern insecticide formulations are now designed to be effective at lower concentrations, reducing their environmental footprint.

3. Precision Agriculture and Technological Advancements

The advent of precision agriculture has revolutionized pest management strategies. Farmers now use sensor-based technology, drones, and GPS mapping to apply precise doses of insecticides only where needed. This targeted application reduces overall chemical use, ensuring efficiency while minimizing wastage.

4. Regulatory Policies and Guidelines

Global regulatory bodies such as the Environmental Protection Agency (EPA) and the Food and Agriculture Organization (FAO) have established strict guidelines on insecticide application. Maximum Residue Limits (MRLs) and Acceptable Daily Intake (ADI) values determine how much of an insecticide can be safely used. These regulations have led to a shift towards lower doses and safer formulations.

5. Biopesticides and Eco-friendly Alternatives

The development of biopesticides and microbial-based insecticides has significantly influenced dosage modifications. These natural alternatives require lower doses to be effective and are often used in combination with conventional insecticides to enhance pest control while reducing chemical dependency.

Modern Approaches to Insecticide Dosing

1. Reduced Application Rates

New-generation insecticides are designed to be effective at lower application rates. Compounds such as neonicotinoids and insect growth regulators (IGRs) are potent at minute concentrations, reducing the need for high-dose applications.

2. Microencapsulation and Controlled Release Formulations

Innovative formulations such as microencapsulation allow for the slow and controlled release of insecticides, maintaining efficacy over extended periods. This reduces the frequency and quantity of applications required.

3. Targeted Application Techniques

Technologies like electrostatic spraying, UAV-based precision application, and soil injection techniques have allowed farmers to apply insecticides only in affected areas, rather than blanket spraying entire fields.

4. Integrated Pest Management (IPM)

IPM combines multiple pest control strategies, including biological control, crop rotation, and resistant crop varieties, reducing reliance on chemical insecticides and thereby minimizing required doses.

Challenges and Future Perspectives

Despite these advancements, challenges remain in implementing optimized insecticide dosing:

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- **Farmer Awareness and Adoption**: Many farmers still rely on traditional high-dose applications due to a lack of awareness or access to modern technologies.
- **Cost Implications**: Precision agriculture and advanced insecticide formulations can be costly, limiting their adoption in small-scale farming.
- **Regulatory Compliance**: Strict regulations often make it challenging for new formulations to be approved quickly, delaying their commercial availability.

The future of insecticide dosing lies in continued research into biological alternatives, advancements in application technologies, and global collaboration to promote sustainable pest management.

Conclusion

The evolution of insecticide doses in agriculture reflects a dynamic interplay between scientific advancements, environmental considerations, and regulatory frameworks. While high-dose applications were once the norm, modern agricultural practices emphasize precision, sustainability, and reduced chemical usage. The adoption of lower-dose, more effective insecticides, coupled with integrated pest management and technological innovations, ensures that pest control remains efficient without compromising environmental and human health. As agriculture continues to evolve, the refinement of insecticide dosing strategies will play a pivotal role in fostering sustainable and productive farming systems worldwide.

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Use of Artificial Intelligence in Agriculture

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"Indian farmers face many types of challenges during the agricultural lifecycle, like adverse weather changes, starvation, improper water supplies and inadequate choices regarding productivity. Artificial intelligence has played a significant role in making successful decisions in agricultural activities and implementing them effectively. The term artificial intelligence describes a machine's capacity to carry out intellectual duties including analysis, understanding, learning, problem-solving, and decision-making. Artificial intelligence is beneficial in various agricultural sectors to enhance production and efficiency."

Artificial intelligence (AI) technologies are helping overcome traditional barriers in every industry. In agriculture, its involvement helps farmers improve their agricultural efficiency while minimizing negative environmental impact. Agri businesses have embraced it whole heartedly to improve overall outcomes. As a result of this technology, the methods of food production are undergoing transformation.

Application of AI in Agriculture

Land information and monitoring with UAVs (Unmanned Aerial Vehicles)

Unmanned Aerial Vehicles (UAVs) are autonomous remote sensing devices used to capture images and collect data from specific locations, offering a cost-effective solution for large-scale environmental monitoring. Drone technology is rapidly gaining popularity among farmers. It offers new ways to

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enhance crop yields through in-depth analysis, long-distance pesticide spraying, and highly efficient crop analysis.

Monitoring Soil Health and Seed Sowing

Soil health can be monitored using sensors, cameras and infrared rays that scan the soil for its nutrient properties. Artificial intelligence also helps determine how different seeds respond to various types of soil. Additionally, it indicates the impact of weather changes on the soil and assesses the likelihood of disease and pest outbreaks.

Irrigation and Fertilizer Management

During agricultural surveys, a map of the field can be created to identify areas where crops require water, fertilizers and pesticides.

Weed Management

Using artificial intelligence, data is collected to inspect areas affected by weed infestation. This allows farmers to spray chemicals only where weeds are present. This method reduces the harm and cost associated with pesticides and herbicides.

Advice on Preventing Pest Attacks

A computer-aided system can effectively diagnose diseases and implement control measures. Image processing can also be used to identify pests and detect nutrient deficiencies.

Precision Farming

Precision farming is a type of agriculture that requires a high level of accuracy and control. It involves advanced technologies such as global positioning systems, geospatial mapping, remote sensing, integrated electronic communication, variable rate technology, optimal planting, harvesting times, water resource management, plant and soil nutrient management and pest and disease control. These technologies collectively enable precision in farming practices.

Agricultural Product Monitoring and Storage Control

In agricultural storage, drying and grading of harvested crops are also very important aspects.

Greenhouse Automation

There are numerous factors that influence plant growth and crop ripening in greenhouses. It is nearly impossible for humans to analyse all these factors and predict how plants will develop. Artificial intelligence makes it possible to analyse these growth factors and provides highly accurate assessments of plant growth.

Driverless Tractors

Driverless tractors perform all agricultural tasks independently and with precision. This includes monitoring obstacles and determining where agricultural inputs should be applied. Technologies such as GPS systems, radar and sensors are already being used in agriculture to open up new opportunities.

Weather Forecasting

Meteorologists use various types of sensors, satellites, and computer models to predict future weather patterns. Artificial intelligence techniques are applied by considering past predictions and actual

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outcomes. Therefore, AI is capable of efficiently forecasting to reduce the risk of crop loss and improve productivity.

Artificial intelligence can be suitable and efficient in the agricultural sector. It optimizes the efficiency of resource use. It also addresses the problem of resource and labour shortages to a significant extent. Adopting AI in agriculture is highly beneficial, as it helps farmers make informed decisions. To feed the growing global population, implementing artificial intelligence in agriculture is essential to bring about a revolution in the field.

Future Strategy

- Awareness programs and demonstrations should be organized on the applications of artificial intelligence and its use in agricultural activities.
- Capacity building programs should be organized to provide farmers with knowledge and skills.
- There is a need to develop farmer organizations at the grassroots level based on artificial intelligence adoption and dissemination.
- It is essential to identify and develop master trainers at the village level for the horizontal spread of related technologies.
- A follow-up mechanism should be included after the introduction of artificial intelligence technologies at the farmer level.
- Knowledge and skills related to the use of platforms at the scientific, extension, and farmer levels should be updated.
- Subsidies should be provided for the purchase of AI technologies to increase access for farmers.
- To better serve rural farmers, the development of necessary infrastructure should reduce fluctuations in the network and irregular power supply.

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Integrated Nutrient Management in Fruit Crops

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Importance of fruits in our life-

Consuming fruits on a daily basis can help manage diabetes mellitus, delay the onset of chronic diseases, change metabolic processes, improve physiological processing and system performance, and diminish the negative effects of hazards on the human body. Due to the fact that they include vital vitamins, minerals, and fiber, fruits are a natural food source that is beneficial to our health. Fruits are rich in vitamins, minerals, and other nutrients, including potassium and vitamins C and folate. A healthy source of dietary fiber that might aid in digestion and ward against constipation is fruit. Additionally, fiber can lower the risk of colon cancer. Consuming a diet high in fruits can help lower the risk of major illnesses like type 2 diabetes, heart disease, stroke, and some types of cancer. Generally speaking, fruits are low in calories, especially when weighed against other foods. Fruits are naturally sweet and flavorful, and they come in a wide variety. have a significant position in our agricultural diversification and are essential to the security of our food supply and nutrition. extremely beneficial for enhancing the quality of our food. People should be fed a lot of nutritious, protecting food.

Today's need –Eco-friendly Technologies (Sustainable fruit production).

Chemical pesticides and fertilizers have been used excessively and carelessly throughout the year in intensive agriculture.

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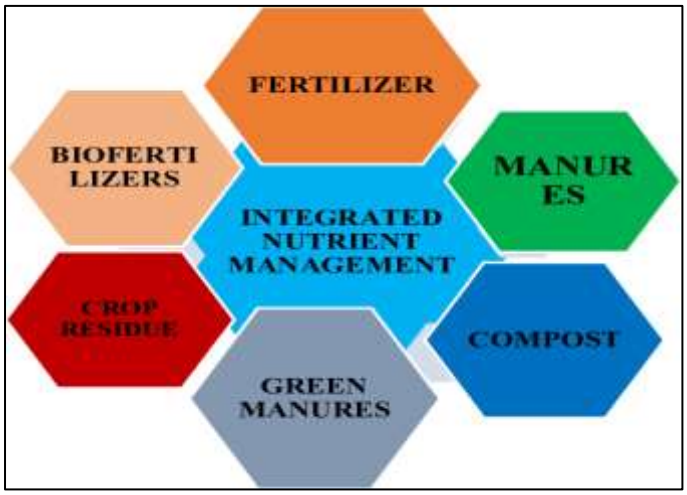
Because of this, the soil has grown toxic and environmental issues have arisen. It's past time we gave advanced environmentally friendly technologies like integrated pest and disease management, organic farming, and integrated nutrient management more attention. In a time when efficiency and sustainability are more important than ever, fruit crop production is being revolutionized by precise nutrient management. This creative method minimizes environmental effect while maximizing fruit crop health and productivity by fusing state-of-the-art technology with agricultural knowledge.



Let's examine the ways in which precise nutrient management is revolutionizing fruit cultivation and the reasons it holds great promise for the agricultural industry's future. PNM, or precision nutrition management, is a cutting-edge method for maximizing fruit crop nutrient supply. It guarantees that at the proper time and location, plants get the precise quantity of vital nutrients they require. This novel strategy tackles the drawbacks of traditional nutrient management techniques, which frequently lead to overfertilization, nutritional imbalances, environmental damage, and monetary losses. By precisely managing fertilizer dosages to satisfy the specific requirements of each plant, it improves plant health, maximizes yields, reduces environmental impact, and increases farm profitability. This approach uses technology like data analytics, remote sensing, and soil sensors to assess plant needs and soil nutrient levels in real time, allowing for accurate fertilizer delivery modifications.

Challenges of Traditional Nutrient Management

1. **Nutrient Deficiencies and Excesses:** Where nutrients are applied uniformly, both nutrient excess and nutritional deficit may occur. While nitrogen excesses can cause nutrient runoff and pollution of the environment, nutrient deficiencies can impact crop development and output.
2. **Environmental Pollution:** The loss of nutrients from soil to water bodies due to overfertilization can cause eutrophication and toxic algal blooms. Human health is at danger in addition to the harm this does to aquatic ecosystems.
3. **Economic Inefficiency:** Reduced returns on investment and higher input costs can result from fertilizer application that ignores the unique requirements of various field zones.

Technological Innovations in Precision Nutrient Management

To overcome these challenges, precision nutrient management integrates several advanced technologies to integrate several advanced technologies.

1. Remote Sensing: Remote sensing offers detailed information on crop health, soil moisture, and nutritional status through the use of satellite and drone data. By identifying spatial heterogeneity

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within fields, this technique makes it easier to provide fertilizers precisely where they are needed.

2. Variable Rate Technology (VRT): With VRT, fertilizer may be applied at different rates according to real-time data. This focused strategy makes sure that the right amount of nutrients is applied to every part of the field, increasing productivity and decreasing waste.

3. Fertigation: The timing and quantity of nutrients can be precisely controlled by fertilization and irrigation systems. During crucial developmental stages, this technique ensures that plants will have access to essential nutrients by enhancing and decreasing absorption.

4. Slow/Controlled Release Fertilizers: These fertilizers release nutrients gradually over a period of time, ensuring a consistent supply of essential elements and mitigating the possibility of nutrient runoff. This controlled release improves nutrient utilization efficiency and supports long-term crop growth.

5. Organic Amendments: Organic materials like manure and compost improve the fertility and structure of the soil. They improve water-holding capacity and nutrient retention, which leads to a more sustainable and balanced nutrient supply.

FUE (Fertilizer Use Efficiency) by INM

Fertilizer Use Efficiency (FUE) is a critical factor in sustainable agriculture, influencing both environmental health and economic viability. Enhancing FUE involves optimizing the uptake of applied nutrients by crops, thereby improving yields and minimizing negative environmental impacts.

Environmental Implications of Inefficient Fertilizer Use:

- **Nutrient Runoff and Water Pollution:** Excessive application of fertilizers can lead to nutrient runoff into water bodies, causing eutrophication and degrading aquatic ecosystems.
- **Greenhouse Gas Emissions:** Overuse of nitrogen fertilizers contributes to the release of nitrous oxide, a potent greenhouse gas, exacerbating climate change.

Economic Implications:

- **Increased Production Costs:** Applying more fertilizer than necessary elevates production costs without corresponding yield benefits, reducing overall farm profitability.
- **Resource Waste:** Inefficient fertilizer use leads to significant nutrient losses, with studies indicating that a substantial portion of applied nitrogen is not utilized by crops, representing wasted resources.

Strategies to Enhance FUE:

- **Precision Agriculture:** Employing technologies that allow for precise application of fertilizers based on soil and crop needs can improve FUE and reduce environmental impacts.
- **Use of Biofertilizers:** Incorporating biofertilizers, which utilize living microorganisms to enhance nutrient availability, can improve soil fertility and crop yields while being environmentally friendly.
- **Adoption of 4R Nutrient Stewardship:** Implementing the right source, right rate, right time, and right place principles for fertilizer application can significantly enhance FUE and mitigate environmental risks.

By adopting these strategies, farmers can achieve higher crop productivity, reduce costs, and minimize the environmental footprint of agricultural practices, contributing to the sustainability of the agricultural sector.

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Why is Organic Matter Important

Healthy soil is fundamental to the food system, as it supports the growth of nutritious crops that sustain human populations. However, maintaining healthy soil requires deliberate care and effort from farmers, as farming inherently disrupts natural soil processes, including nutrient cycling—the process by which nutrients are released and absorbed. Plants derive nutrients from two primary natural sources: organic matter and minerals. Organic matter consists of decomposing plant or animal materials that enrich the soil. This material not only supplies nutrients and creates habitats for soil organisms but also improves soil structure by binding particles into aggregates and enhancing water retention. Though typically comprising only 2–10% of soil content, organic matter plays a disproportionately vital role in soil health. Soil is a dynamic, living ecosystem filled with microorganisms and larger organisms that perform essential functions. These include decomposing organic matter and minerals into plant-available nutrients. Different organisms feed on various organic substrates, and their activity is closely linked to the availability of organic matter. The interactions among organic matter, water, and soil are critical to maintaining soil fertility, which is necessary for sustainable agricultural production. If soil is overexploited for crop production without replenishing its organic matter and nutrients or maintaining its structure, nutrient cycles become disrupted. This leads to a decline in soil fertility, destabilizing the balance of the agro-ecosystem. Sustainable practices are, therefore, essential to preserving soil health and ensuring long-term agricultural productivity.

Benefits of Bio-fertilizers in INM

- Biofertilizers are eco-friendly and do not have any ill effect on soil health and environment.
- It has easy application methods and less expensive leads to high benefit cost ratio.
- It has stimulated plant growth and reduce the incidence of certain diseases due to excretion of various growth hormones.
- Biofertilizers are very useful for dry land and rain fed farming.

Azotobacter

Azotobacter is a beneficial free-living aerobic nitrogen-fixing bacterium known for its significant contributions to agriculture. Key benefits include:

- **Nitrogen Fixation**: Azotobacter enhances soil fertility by converting atmospheric nitrogen into a form usable by plants.
- **Seed Germination and Root Growth**: It improves seed germination and promotes robust root proliferation.
- **Disease Resistance**: Azotobacter reduces crop damage by providing some resistance to plant diseases.
- **Yield Improvement**: Studies have recorded yield increases with Azotobacter inoculation:
    - Cereals: 15–30%
    - Vegetables: 2–45%
    - Cash Crops: 10–20%

These features make Azotobacter an essential component of sustainable agriculture practices, promoting both crop health and productivity.

Rhizobium

Rhizobia are specialized bacteria that form a vital symbiotic relationship with leguminous plants, significantly contributing to nitrogen fixation. Key characteristics include:

- **Root Invasion**: Rhizobia invade legume roots through root hairs, initiating the formation of nodules.
- **Nodule Formation**: They create effective pink-colored nodules on roots, an indicator of active nitrogen fixation.

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- **Symbiotic Nitrogen Fixation**: Rhizobia live symbiotically inside the nodules, converting atmospheric nitrogen into forms accessible to plants.
- **Host Specificity**: Most rhizobia are host-specific, forming symbiosis with particular legume species.
- **Global Contribution**: Approximately 175 million metric tons of nitrogen are fixed annually through biological nitrogen fixation involving legume-Rhizobium symbiosis.

This relationship plays a critical role in sustainable agriculture, reducing the need for synthetic nitrogen fertilizers while enhancing soil fertility.

Constraints in adoption of INM

- Insufficient availability of organic manure.
- Rapid Composting Technology is still unknown to most farmers.
- Lack of facilities to collect and market agricultural wastes.
- For growing green manure crops Seeds are not available.
- Lack of farmers' knowledge.
- Farmers who have domesticated animals, do not have facilities to collect, store and market their animal waste.
- Low awareness about using biofertilizers.
- Chemical fertilizers are easily available and easy to use.
- Scarcity of labours.

Conclusion

It is concluded that INM can result in agronomically feasible, economically viable and environmentally sound sustainable crop production system. Fruit crops give good response to the integrated nutrient management using INM, higher growth, early fruiting and improved yield and fruit quality can be achieved. INM reduce adverse effects on soil, water pollution and air pollution. Therefore, there is an urgent need to make aware fruit orchardists to minimize use of chemicals slowly and slowly by the increasing use of organic manures, bio fertilizers and bio-pesticides for improving the soil health, reduction of environmental pollution, lowering the production costs and producing the quality fruits.

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Mobile Phone Use in Smart Agriculture

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Indian farmers currently need to adopt innovative and sophisticated techniques to increase agricultural production in order to ensure the country's food security. The previous procedures are no longer appropriate now because The results of farming are heavily influenced by local environmental factors and management techniques. New farming techniques have been created, among other technologies, in the last few decades. like precision farming. The most significant electronic gadget in agriculture nowadays is a mobile phone. where farmers themselves receive solutions to their farming issues and advance knowledge about utilising mobile phone apps to support farming practices. Mobile phone with its current trends and most applicable in the field of agriculture to assess the weather and climate (cloud computing), information for crop selection and timely agricultural practices, soil description, agriculture market information related to price of crops, current demand of commodities, and various useful government schemes, crop disease news sensor control, GPS, GIS, data mining, language processing, and other techniques. Farmers can use smartphone-based help apps to increase their profits and farming production if they have already adopted aid from other information technologies.

Mobile phones play a big role in agriculture

Here, we give a description of the survey's mobile phone applications. Farming, farm management, information systems, and extension services were the four main categories into which the applications fell.

1. **Information on resources:** To identify and present data on fertilisers, insecticides, herbicides, and seed quality.

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2. **Farm input calculation**: A smart phone can quickly and accurately determine the amount of farm input. Applying fertiliser correctly in order to get the best results is a crucial farming activity. With the aid of smartphone applications, farmers may determine the right fertiliser treatments for their fields by examining the colour of the crop leaves.
3. **Disease identification and control**: Plantix, a smartphone application that uses sensors, is focused on disease detection in farms.
4. **Current agriculture use**: Providing up-to-date information about agriculture, including market prices for crops, agricultural input subsidies, and cautions about the use of chemicals with significant hazardous residues, both locally and globally.
5. **Estimating the water needs of crops**: In order to increase productivity, farmers must also decide when and how much water their crops will require. The amount of water needed depends on a number of factors, including the type of crop, the season, the climate, and the key phases of the crop. Crop evapotranspiration is how plants lose water. To compensate for water loss, crop water requirements are examined. Farmers were able to calculate the Leaf Area Index (LAI), a crucial metric in estimating crop water needs, with the aid of smartphone software called Pocket LAI.
6. **Applications of information systems**: Today, a wide variety of applications offer information, which is essential for good decision-making in all industrial sectors, including agriculture. It is well known that knowledge can aid farmers in boosting agricultural productivity. Farmers can choose the types and quantities of crops to plant, as well as the markets in which to sell their wares, to maximise their profits by using up-to-date information on prices and market demands.
7. **keep a calendar for crops and livestock**
8. **Data on the weather**
9. **Pest and insect alert**
10. **supplying advice on crop cultivation in an organic manner.**
11. **submission of pollution and activity reports**
12. **providing a field map and calculating the overall field area**
13. **Governmental programmes**

Summary of mobile phone-based sensors in agricultural context.

Sensors	Year	Application Name	Features
cameras	2012	BaiKHao	Pictures of rice leaf are taken to analyze chlorophyll contents
Cameras	2013	MapIT	Images of object/area of interest are captured for geographic information collecting purpose
Cameras	2013	PocketLAI	Images of leaf canopy are acquired to estimate leaf area index [LAI], which is turn gives crop water requirements
Cameras	2011	mKRISHI	Images and videos can be sent along with a farmers query to an expert to seek advice
GPS	2013	Magri	GPS location are used to generate location –aware pest/disease alerts to farmers
GPS	2013	SIFSS	Soil characteristics and information such as pH, soil carbon, N, P and K, are deliverd based on users GPS location in Scotland
GPS	2013	iDee	Users can view location – based river conditions in the river Dee catchment based on their GPS positions
GPS	2013	Safe Driving	GPS coordinates of tractor rollover accidents are reported
Microphone	2011	mKRISHI	Audio queries can be recorded and sent to expert

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Accelerometer	2013	Safe Driving	Accelerometer is used to obtain a roll angle and pitch angle of the tractor in order to detect a rollover event
Gyroscope	2013	Safe Driving	Gyroscope is used to obtain a roll angle and pitch angle of the tractor in order to detect a rollover event

Conclusion: -

Without the need for external sensors, a mobile phone can be highly useful in the agricultural sector. Numerous mobile phone-based agricultural applications have been discovered that fall within our perview. Rural farmers who previously had little access to current agricultural information (such as market, weather, and crop disease news) for smart agriculture practices are now able to take advantage of new opportunities thanks to affordable cell phones loaded with a variety of agriculture crops.

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