ONLINE ISSN 2583-4339
www.journalworlds.com

Agri JOURNAL WORLD

Volume 5 Issue 2 April-June 2025 Pages 107

PUBLISHED BY LEAVES AND DEW PUBLICATION

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

Published By

LEAVES AND DEW PUBLICATION
B- 132, Nanhey Park,
Uttam Nagar, New Delhi 110059

Agri JOURNAL WORLD

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

REVOLUTIONIZING FARMING: UNLEASHING THE POWER OF DIGITAL AGRICULTURE FOR A SUSTAINABLE FUTURE

Puspa Parameswari*

Division of Agronomy, ICAR-Indian Agriculture Research Institute, New Delhi-110012

**Corresponding author email:* pushpaagro95@gmail.com

ABSTRACT

Digital agriculture is reshaping modern farming by integrating advanced technologies to enhance productivity, sustainability, and resource efficiency. Techniques such as precision agriculture, drones, IoT devices, AI, robotics, blockchain, and big data are revolutionizing how farmers monitor, manage, and optimize their operations. These innovations enable real-time data-driven decision-making, reduce input waste, improve crop yields, and minimize environmental impact. Additionally, genomic technologies like CRISPR and environmental monitoring tools support the development of resilient, climate-smart farming systems. As global food demand increases, digital agriculture offers a sustainable pathway to meet this need while preserving natural resources and strengthening food system resilience.

KEYWORDS: Artificial Intelligence, Digital Agriculture, IoT, Precision Farming, Sustainable Farming

INTRODUCTION

Digital agriculture, often referred to as "smart farming" is revolutionizing the agricultural sector by harnessing the power of technology and data to improve productivity, efficiency, and sustainability. As the global demand for food continues to rise and challenges such as climate change and resource scarcity intensify, farmers and agriculturalists are turning to innovative digital techniques to optimize their operations. These technologies are not only improving yields but also contributing to more sustainable farming practices. Below, we explore some of the key techniques for digital agriculture that are shaping the future of farming.

1. PRECISION AGRICULTURE

Precision agriculture is one of the most widely adopted digital techniques. It involves the use of data analytics, GPS technology, and sensors to monitor and manage field variability in crops. By collecting data on soil conditions, weather patterns, crop health, and more, farmers can make informed decisions that increase efficiency and reduce waste.

- **GPS Guidance**: GPS technology allows farmers to track and map their fields with incredible precision, ensuring optimal use of land, water, and fertilizers.
- **Variable Rate Technology (VRT)**: VRT enables farmers to apply inputs such as water, fertilizers, and pesticides at varying rates across a field based on its specific needs, optimizing resource use and minimizing environmental impact.

2. DRONES AND AERIAL IMAGING

Drones are becoming an invaluable tool for digital agriculture, offering high-resolution aerial images that can be used to monitor crop health, assess plant growth, and detect pest and disease outbreaks. Drones are equipped with sensors and cameras that capture a range of data, including multispectral and thermal imagery, which provides farmers with detailed insights into their fields.

- **Crop Health Monitoring**: Drones can detect early signs of disease, nutrient deficiencies, or water stress, allowing farmers to intervene before problems become widespread.
- **Field Mapping**: Aerial imaging allows farmers to create precise field maps, which can be used to assess crop performance and optimize future planting strategies.

3. INTERNET OF THINGS (IOT) IN AGRICULTURE

The Internet of Things (IoT) refers to the network of interconnected devices that collect and exchange data. In agriculture, IoT devices such as soil sensors, weather stations, and automated irrigation systems are revolutionizing farming practices by providing real-time data that helps farmers monitor and manage their operations remotely.

- **Soil Sensors**: IoT-powered soil sensors provide continuous data on soil moisture, temperature, and nutrient levels which allow farmers to make timely decisions about irrigation and fertilization.
- **Smart Irrigation Systems**: Automated irrigation systems equipped with IoT sensors can deliver water precisely when and where it's needed, reducing water waste and improving crop yields.

4. ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING (ML)

AI and machine learning are playing an increasingly important role in digital agriculture by enabling farmers to analyse vast amounts of data and make predictions that optimize farming practices. Machine learning algorithms can identify patterns in data and offer insights that would be difficult for humans to detect.

- **Crop Yield Prediction**: AI-powered systems can predict crop yields based on various factors, including weather patterns, soil quality, and planting techniques, allowing farmers to plan better for harvests.

- **Pest and Disease Detection**: AI and machine learning algorithms can be trained to recognize signs of pest infestations or disease in crops, enabling early intervention and preventing widespread damage.

5. ROBOTICS AND AUTOMATION

Automation is rapidly transforming farming, with robots and autonomous machines being used for tasks such as planting, harvesting, and weeding. These innovations are improving labour efficiency, reducing costs, and minimizing the physical toll on workers.

- **Autonomous Tractors and Harvesters**: Self-driving tractors and harvesters equipped with GPS and AI can carry out field operations with minimal human intervention, improving efficiency and reducing operational costs.
- **Robotic Weeding**: Robots are being developed to automatically identify and remove weeds from fields, reducing the need for herbicides and minimizing environmental impact.

6. BLOCKCHAIN FOR SUPPLY CHAIN TRANSPARENCY

Blockchain technology is being integrated into agriculture to enhance transparency and traceability in the food supply chain. Blockchain enables secure, transparent transactions by providing an immutable ledger of all activities related to a product from farm to table.

- **Traceability**: Blockchain allows consumers to trace the origins of their food, ensuring that it was grown sustainably and ethically. This can help increase consumer trust in food products.
- **Supply Chain Efficiency**: Blockchain can streamline the supply chain by reducing fraud, lowering costs, and ensuring faster transactions between farmers, suppliers, and retailers.

7. BIG DATA AND CLOUD COMPUTING

The massive amounts of data generated by modern farming operations are a valuable resource for improving decision-making. Big data analytics and cloud computing are crucial in storing, processing, and analyzing this data to derive meaningful insights.

- **Data-Driven Decisions**: Farmers can use cloud-based platforms to access real-time data on weather, crop performance, and market conditions, enabling them to make more informed decisions about planting, irrigation, and harvesting.
- **Predictive Analytics**: Big data analytics can predict market trends, pest outbreaks, and weather events, helping farmers plan ahead and reduce risks.

8. GENOMIC TECHNOLOGIES AND CRISPR

Genomic technologies are providing farmers with the ability to breed crops that are more resistant to pests, diseases, and environmental stressors. CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is one such breakthrough technology that allows precise editing of plant DNA.

- **Improved Crop Varieties**: CRISPR technology enables the creation of crops with desirable traits, such as improved resistance to drought or pests, which can reduce the need for pesticides and increase overall productivity.
- **Sustainable Farming**: Genomic technologies can also help create crops that require fewer inputs (such as water and fertilizer), contributing to more sustainable agricultural practices.

9. SUSTAINABILITY AND ENVIRONMENTAL MONITORING

Digital agriculture also focuses on sustainability, ensuring that farming practices have a minimal impact on the environment. Technologies such as remote sensing, AI, and IoT are helping farmers monitor environmental factors and reduce their carbon footprint.

- **Carbon Footprint Monitoring**: Farmers can use IoT sensors to track carbon emissions, soil health, and water use, allowing them to adjust their practices and contribute to climate change mitigation.
- **Eco-Friendly Fertilizer and Pesticide Use**: Precision agriculture techniques enable farmers to apply fertilizers and pesticides only when necessary, reducing chemical runoff and preserving ecosystems.

CONCLUSION

Digital agriculture techniques are transforming the way we approach farming, offering innovative solutions that increase productivity, sustainability, and profitability. With the continued advancement of technologies like AI, drones, IoT, and blockchain, the future of farming is poised to be more efficient, environmentally friendly, and data-driven than ever before. As these digital techniques continue to evolve, they hold the potential to meet the growing global demand for food while minimizing the environmental impact of agricultural practices. Farmers who embrace these technologies will not only enhance their operations but also contribute to a more sustainable and resilient food system for future generations.

REFERENCES

Bongiovanni, R., and Lowenberg-DeBoer, J. (2004). Precision agriculture and sustainability. *Precision Agriculture*, 5(4), 359-387.

Kumari, K., and Kaur, R. (2020). Digital agriculture: A step towards future farming. *International Journal of Engineering Research and Technology*, 9(12), 1-6.

Liakos, K. G., Busato, P., Moshou, D., Pearson, S., and Deepak, S. (2018). Machine learning in agriculture: A review. *Computers and Electronics in Agriculture*, 147, 1-13.

Timmermann, F., and Kramer, R. (2019). Blockchain in agriculture: A critical review. *Agricultural Systems*, 173, 150-164.

Wolfert, S., Ge, L., Verdouw, C., and Bogaardt, M. J. (2017). Big Data in Smart Farming – A review. *Agricultural Systems*, 153, 69-80.

Zhang, C., and Kovacs, J. M. (2012). The application of small unmanned aerial systems for precision agriculture: A review. *Precision Agriculture*, 13(6), 693-712.

How to cite:

Puspa Parameswari (2025). Revolutionizing farming: Unleashing the power of digital agriculture for a sustainable future. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 1-5.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

BIOSENSORS IN FOOD INDUSTRY

Sunil C.[1]*, Umme Seema N[2], Jeevan H R[3], N Sudharani[4]

[1]Senior Scientist and Head, ICAR-Krishi Vigyan Kendra, Shivamogga

[2]Department of Postharvest Technology, Cashew Technology Centre, KSNUAHS, Shivamogga

[3]Department of Agronomy, Cashew Technology Centre, KSNUAHS, Shivamogga

[4]Scientist (Home science), ICAR-Krishi Vigyan Kendra, Shivamogga

Corresponding author email: ummeseema.21@gmail.com

ABSTRACT

Biosensors are advanced analytical tools that combine biological recognition elements with physical transducers to detect specific substances. In the food industry, they play a critical role in ensuring safety, quality control, and contamination monitoring. These devices offer rapid, sensitive, and cost-effective detection of pathogens, allergens, toxins, and adulterants across various food matrices. Despite challenges such as stability, calibration, and complex samples, ongoing advancements in nanotechnology, artificial intelligence, and microfabrication are enhancing their performance and reliability. As biosensors become more portable and user-friendly, their integration into food supply chains is transforming modern food safety and quality assurance practices.

KEYWORDS: Analytical Technology, Biosensors, Food Safety, Pathogen Detection, Quality Control

INTRODUCTION

The agricultural and food industry plays a critical role in the global supply chain by integrating production, processing and commercialization to meet market demands and consumer needs. However, throughout each stage of the food production chain from farm to table various threats can arise, including the risk of contamination, quality loss and the spread of diseases, as products are transported across regions and even globally. To mitigate these risks, biosensor devices are becoming increasingly important. These tools are gaining recognition for their ability to quickly, specifically and cost-effectively monitor food safety, environmental factors and clinical conditions. By using biological recognition elements such as enzymes, antibodies or nucleic acids, biosensors can detect specific substances or pathogens. The combination of these biological elements with different transducer technologies enables the rapid detection and analysis of target compounds.

COMPONENTS OF A BIOSENSOR

A biosensor consists of several key components that work together to detect specific biological or chemical substances.

Biologically Active Material: This is the core component of a biosensor responsible for detecting the target analyte. It provides the specificity of the sensor by interacting with the substance of interest.

Examples include:

- *Enzymes:* Catalyze specific biochemical reactions.
- *Antibodies:* Bind specifically to antigens.
- *Nucleic acids:* Engage in hybridization or binding to complementary sequences (e.g., DNA or RNA probes).
- *Microorganisms:* Used in biosensors for detecting environmental contaminants or pollutants

Transducer: The transducer converts the biological interaction (recognition) into a measurable signal. Depending on the type of biosensor, the transducer can operate through various signal detection methods:

- *Optical Transducers:* Measure changes in light absorption, fluorescence or reflectance (e.g., surface plasmon resonance).
- *Electrochemical Transducers:* Measure changes in electrical signals such as current, voltage or impedance (e.g., potentiometric and amperometric sensors).
- *Piezoelectric Transducers:* Detect changes in mass or mechanical properties (e.g., surface acoustic wave sensors).
- *Thermal Transducers:* Measure temperature changes resulting from biochemical reactions.

➢ **Signal Processor:** The signal processor amplifies and processes the signal generated by the transducer. It converts the raw data into a form that can be interpreted and analysed. This may involve**:**

- *Amplification:* Enhancing the detected signal for easier measurement.
- *Filtering:* Removing noise or irrelevant signals to enhance the accuracy of the measurement.
- *Data analysis:* Interpreting the processed data to quantify the presence of the target analyte.
- *Output/Display:* The final step is the output stage, where the processed data is displayed in a user-friendly format. This could be a digital readout, graphical output or an alarm system depending on the biosensor application.

WORKING PRINCIPLE:

A biosensor works by detecting a specific analyte through the interaction between a biological active material and the target molecule. The transducer plays a pivotal role in this process, as it converts the physical or chemical changes that occur during the reaction into a measurable signal. These changes can include heat output or absorption, electrical changes (such as current or voltage shifts), redox reactions, light emission or absorption or even changes in mass.

The type of transducer used depends on the nature of the reaction and the desired output. For example, optical biosensors detect changes in light properties, while electrochemical biosensors monitor electrical signals. However, the signal generated by the transducer is often weak and susceptible to noise, which can compromise accuracy. To mitigate this, a reference signal is used to establish a baseline measurement. This reference signal is obtained from a similar setup without the analyte present, helping to eliminate background interference. The difference between the sample signal and the reference signal is small and needs to be amplified for accurate detection. Once amplified, the analog signal is converted into a digital signal through an analog-to-digital converter (ADC). This allows the data to be processed by a microprocessor, which calculates the analyte concentration or presence and displays the result. The final output is presented on a display device or stored for future analysis.

CLASSIFICATION OF BIOSENSORS

Biosensors can be classified based on their transduction mechanisms and biological recognition elements.

A. Classification Based on Transduction Mechanism

1. **Electrochemical Biosensors:**
   a. Work by detecting electrical signals generated by biochemical reactions.
   b. Types include amperometric (current-based), potentiometric (voltage-based) and conductometric (resistance-based) biosensors.
   c. Commonly used for pesticide detection, heavy metal analysis and pathogen identification.
2. **Optical Biosensors:**
   a. Utilize light-based detection methods, including fluorescence and surface plasmon resonance (SPR).
   b. Used for detecting toxins, allergens and microbial contamination.
3. **Piezoelectric Biosensors:**
   a. Measure mass changes upon analyte binding using quartz crystal microbalance (QCM) or surface acoustic wave (SAW) techniques.
   b. Applied in bacterial and allergen detection.
4. **Thermal Biosensors:**
   a. Detect heat changes produced during biochemical reactions.
   b. Used for monitoring enzymatic activity in food products.

B. Classification Based on Biological Recognition Elements

1. **Enzyme-Based Biosensors:**
   a. Use enzymes as bioreceptors to catalyze reactions and generate detectable signals.
   b. Applied in detecting sugar content, alcohol levels and food freshness indicators.
2. **Immunosensors:**
   a. Use antigen-antibody interactions for high specificity detection.
   b. Effective in identifying foodborne pathogens, toxins and allergens.
3. **DNA Biosensors (Genosensors):**
   a. Detect specific DNA sequences using hybridization techniques.
   b. Useful for identifying genetically modified organisms (GMOs) and microbial contaminants.
4. **Whole-Cell Biosensors:**
   a. Use living microbial cells to detect environmental toxins and pathogens.
   b. Applied in spoilage detection and foodborne pathogen screening.
5. **Antibody-Based Biosensors**:
   These biosensors use antibodies to bind specifically to antigens (foreign molecules). The interaction between the antibody and the target analyte generates a detectable signal. Example: Immuno sensors for detecting pathogens or toxins.
6. **Nucleic Acid-Based Biosensors**:
   These biosensors use DNA or RNA molecules as recognition elements, detecting specific nucleic acid sequences through hybridization. They are often used in genetic testing or pathogen detection. Example: DNA biosensors for detecting specific gene sequences or bacterial infections.

APPLICATIONS IN THE FOOD INDUSTRY

1. *Pathogen Detection:* Biosensors detect bacteria such as *Salmonella, E. coli* and *Listeria* in meat, dairy and fresh produce.
2. *Pesticide Residue Analysis:* Electrochemical biosensors identify organophosphates and carbamates in fruits and vegetables.
3. *Toxin Detection:* Optical and immunosensors screen for mycotoxins, aflatoxins and biotoxins in cereals, nuts and seafood.
4. *Food Adulteration Monitoring:* Biosensors help in identifying adulterants such as melamine in dairy products and synthetic dyes in beverages.

5. *Quality Control:* Used in monitoring freshness indicators such as pH, volatile compounds and enzyme activity in perishable foods.
6. *Allergen Detection:* Detects common allergens like gluten, peanuts and shellfish residues in processed foods.

ADVANTAGES OF BIOSENSORS

- *Rapid Detection:* Real-time analysis reduces the need for lengthy laboratory testing.
- *High Sensitivity and Specificity:* Can detect trace levels of contaminants and adulterants.
- *Cost-Effectiveness:* Lower operational costs compared to conventional analytical methods.
- *Portability:* Handheld biosensors allow on-site testing in food production and supply chains.
- *User-Friendly Operation:* Minimal training required for field applications.

CHALLENGES AND LIMITATIONS

- *Stability Issues:* Biological components such as enzymes and antibodies may degrade over time.
- *Complex Sample Matrices:* Food samples contain multiple interfering substances that can affect sensor accuracy.
- *Calibration and Standardization:* Need for uniform regulatory guidelines to ensure consistent performance.
- *Limited Shelf Life:* Some biosensors require frequent replacement or maintenance.

CONCLUSION

Biosensors have emerged as transformative tools in the food industry, enabling real-time monitoring of safety, quality, and authenticity across the entire supply chain. Their high sensitivity, rapid response, and adaptability make them indispensable for detecting pathogens, allergens, toxins, and chemical residues. Although limitations like stability, interference from complex food matrices, and standardization remain challenges, continued innovations in materials science, nanotechnology, and AI are expanding their capabilities. As technological advancements address these barriers, biosensors are poised to become integral components of smart food systems, enhancing global food safety, supporting regulatory compliance, and promoting consumer trust in food products.

How to cite:

Sunil, C., Umme Seema, N., Jeevan, H. R., and Sudharani, N. (2025). Biosensors in food industry. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 6-10.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

BIO-PRIMING OF SEEDS: NATURE'S BOOST FOR BETTER CROPS

Janapareddy Rajesh[1]*, Cirumalla Mrudhula[2]

[1]Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India

[2]Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Tamil Nadu, India

Corresponding author email: rajeshjanapareddy2001@gmail.com

ABSTRACT

Bio-priming is an environmentally friendly method of seed treatment that combines the application of helpful microbes and hydration to improve seed germination, plant growth, and stress tolerance in crops. The process improves the vigour of the seedling, inhibits soil-borne diseases, and enhances nutrient intake without the need for chemical input. Bio-priming achieves these using microbial agents like Trichoderma, Bacillus and Pseudomonas to advance sustainable agriculture, particularly among small-scale farmers. Although there are challenges such as strain specificity and low awareness, its environmental and cost benefits make it as a future promising approach.

KEYWORDS: Bio-Priming, Plant growth promoting microbes, Seed treatment, Sustainable agriculture

INTRODUCTION

Sustainable solutions are desperately needed in modern agriculture due to factors like soil deterioration, climate change, and rising food demand. Farming was once transformed by chemical fertilizers and pesticides, but over use of these products has had detrimental effects on the environment, soil health, and pests that are resistant to them. Scientists and farmers are investigating traditional knowledge combined with contemporary research in an effort to find more environmentally friendly options. One such exciting development is bio-priming, a clever, environmentally responsible method that is subtly revolutionizing plant health and seed care.

WHAT IS BIO-PRIMING?

To put it simply, bio-priming is a seed treatment technique that entails coating seeds with advantageous microorganisms, usually fungus, plant growth-promoting rhizobacteria (PGPR), or other bioagents, then moistening them just enough to initiate early metabolic activity. By colonizing the seed surface and the rhizosphere, or emerging root zone, these bacteria aid in the growth and stress resistance of plants. The name comes from the combination of biological coating and hydration (priming).

WHY IS BIO-PRIMING NEEDED?

Numerous problems affect modern agriculture, including:

- Degradation of the soil brought on by excessive cropping and chemical inputs.
- An unpredictable climate that frequently experiences floods and droughts.
- The emergence of diseases and pests that are resistant.
- Small farmers may not always be able to afford the high prices of agrochemicals.

An affordable, environmentally friendly, and sustainable substitute is provided by bio-priming. Frequently without the use of chemicals, it improves seed germination, accelerates growth, and protects against pests and diseases.

HOW DOES BIO-PRIMING WORK?

This is a condensed explanation of the bio-priming procedure:

1. ***Seed Selection:*** Disease-free, high-quality seeds are selected. The key is uniformity.
2. ***Microbial agent selection:*** The crop and the desired advantages (such as drought tolerance, nitrogen fixation, or disease resistance) are taken into consideration when choosing beneficial bacteria like *Trichoderma*, *Bacillus*, *Pseudomonas*, *Azospirillum*, etc.
3. ***Hydration of seeds (Priming):*** To initiate early physiological processes, seeds are soaked in water for a predetermined amount of time.
4. ***Applying microbial inoculants to the surface:*** A slurry containing the chosen microorganisms is then applied to the moistened seeds. Occasionally, a binder such as gum arabic is used.
5. ***Drying and seeding:*** Before being sown, seeds are shade dried.

Once planted, these prepared seeds have stronger roots, grow more quickly, and harbour advantageous microorganisms that improve nutrient absorption and outcompete dangerous pathogens.

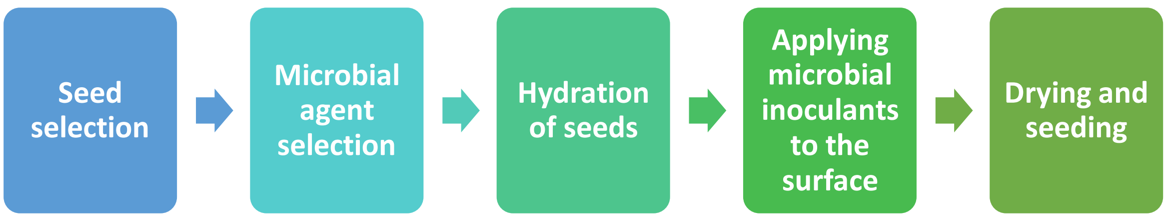


Figure 1. Steps involved in bio-priming of seeds

THE MICROBIAL CHAMPIONS OF BIO-PRIMING

Let's meet some of the microbial stars often used in bio-priming:

1. *Trichoderma spp.*
   - One potent fungus that combats soil-borne illnesses is *Trichoderma spp*.
   - Generates enzymes that break down the cell membranes of pathogens.
   - Boosts plant immunity and growth.
2. *Bacillus subtilis*
   - It is well-known for its biocontrol capabilities.
   - Generates antibiotics and causes plants to develop systemic resistance.
   - Stable endospores are formed, making them ideal for long-term preservation.
3. *Pseudomonas fluorescens*
   - Helps in suppressing root pathogens.
   - Creates siderophores that starve dangerous bacteria by binding iron.
   - Promotes the growth of roots.
4. *Azospirillum* and *Azotobacter*
   - These are free-living nitrogen-fixers.
   - Enhance plant nutrition and soil fertility.
5. *Rhizobium spp*.
   - Rhizobium binds atmospheric nitrogen and creates nodules for legumes.
   - Rhizobium bio-priming guarantees early root colonization.

BENEFITS OF BIO-PRIMING: A GREEN REVOLUTION AT THE SEED LEVEL

The following explains why bio-priming is becoming more popular globally:

1. Enhanced seedling vigour and germination

- Seeds that have been bioprimed germinate more quickly and consistently.
- Auxins and gibberellins, two growth hormones secreted by microbes, promote early growth.
- Bio-primed seeds can lead to better plant establishment and increased plant yield by increasing germination rate, increasing root length and volume, increasing the number of lateral roots (Ait Barka *et al.*, 2006; Chitra and Jijeesh, 2021).

2. Enhanced capacity to handle stress

- Heat stress, salt, and drought can all harm seedlings.

- Beneficial microorganisms enhance osmotic equilibrium and root architecture, which helps plants in withstanding stress.
- Application of *Pseudomonas geniculate* reduced the sodium uptake and increased the uptake of potassium and calcium in the roots of maize showing its role in controlling the ionic balance/homeostasis in the roots of maize under high salt stresses (Singh *et al*., 2020).

3. Natural protection against illnesses

- By combating soilborne infections, microorganisms such as *Trichoderma* and *Pseudomonas* lessen the need for fungicides.
- Bio-priming of *Pennisetum glaucum* seeds with *Pseudomonas* spp. strains helped to enhance the plant growth and resistance to the disease (Raj *et al*., 2004)

4. Improved absorption of nutrients

- Iron, phosphorus, and other nutrients are mobilized by microbes, increasing their availability to plants.

6. Economical and farmer-friendly

- Bio-priming does not require expensive equipment and is inexpensive, making it ideal for marginal and small farmers.

6. Sustainable and eco-friendly

- No chemical spills and traces.
- It is the nature assisting the mother nature.

LIMITATIONS AND CHALLENGES

Despite being a promising method, bio-priming has certain drawbacks,

- Bioagents may have a short shelf life if they are not stored properly.
- Not all microorganisms are compatible with all crops or soils due to strain-specific effects.
- For many crops, there is a lack of standardization protocols.
- In certain areas, farmer awareness and training are still lacking.

CONCLUSION

Despite its modest appearance, bio-priming has the ability to completely transform the way we produce food. Seeds are given a natural armour and a strong push toward healthy, sustainable growth by fusing cutting-edge research with traditional biological knowledge. It is a low-risk, high-reward intervention for small holding farmers, and a frontier of exciting discoveries for researchers.

REFERENCES

Ait Barka, E., Nowak, J., and Clément, C. (2006). Enhancement of chilling resistance of inoculated grapevine plantlets with a plant growth-promoting rhizobacterium, Burkholderia phytofirmans strain PsJN. *Applied and environmental microbiology*, 72(11), 7246-7252.

Chitra, P. and Jijeesh, C. M. (2021). Biopriming of seeds with plant growth promoting bacteria Pseudomonas fluorescens for better germination and seedling vigour of the East Indian sandalwood. *New Forests*, 52(5), 829-841.

Raj, S. N., Shetty, N. P., & Shetty, H. S. (2004). Seed bio-priming with Pseudomonas fluorescens isolates enhances growth of pearl millet plants and induces resistance against downy mildew. *International Journal of Pest Management*, 50(1), 41-48.

Singh, S., Singh, U.B., Trivedi, M., Sahu, P.K., Paul, S., Paul, D. and Saxena, A.K. (2020). Seed biopriming with salt-tolerant endophytic Pseudomonas geniculata-modulated biochemical responses provide ecological fitness in maize (Zea mays L.) grown in saline sodic soil. *International Journal of Environmental Research and Public Health* 17, 253.

How to cite:

Janapareddy R. and Cirumalla M. (2025). Bio-priming of seeds: Nature's boost for better crops. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 6-10.

*********XXXXX**********

JEEVAMRUT: THE NATURAL WONDER FOR SUSTAINABLE FARMING

Puspa Parameswari*

Division of Agronomy, ICAR-Indian Agriculture Research Institute, New Delhi-110012

**Corresponding author email:* pushpaagro95@gmail.com

ABSTRACT

Jeevamrut, a traditional Indian biofertilizer, is increasingly recognized for its potential in sustainable agriculture and soil health enhancement. Comprising cow dung, cow urine, jaggery, and gram flour, it is easy to prepare, cost-effective, and accessible to small and marginal farmers. Rich in beneficial microbes and essential nutrients such as nitrogen, phosphorus, and potassium, Jeevamrut enhances soil fertility, microbial activity, and crop productivity. Its natural pesticidal properties also reduce the need for chemical inputs, lowering production costs and environmental harm. By promoting biodiversity and improving plant health, Jeevamrut offers a viable, eco-friendly alternative for sustainable and resilient farming systems..

KEYWORDS: Eco-friendly, Jeevamrut, Soil health, Sustainability

INTRODUCTION

Jeevamrut is a traditional, natural farming solution originating from India, gaining recognition worldwide for its role in promoting organic farming and improving soil health. This organic mixture is widely used in agriculture to enhance soil fertility, promote plant growth, and maintain the ecological balance. The term "Jeevamrut" translates to "life nectar," highlighting its importance in rejuvenating the soil and supporting the entire ecosystem.

WHAT IS JEEVAMRUT?

Jeevamrut is a liquid organic fertilizer made from locally available, natural ingredients. It is a concoction of cow dung, cow urine, jaggery, and other organic materials, fermented to create a nutrient-rich solution for crops. This natural fertilizer acts as a vital source of nutrients for plants and enhances soil microbiology, leading to improved crop yields and healthier soil over time.

KEY INGREDIENTS OF JEEVAMRUT

The core ingredients of Jeevamrut are carefully chosen to create a balanced, nutrient-rich mixture:

1. *Cow Dung:* Cow dung is rich in beneficial microbes that promote healthy soil. It helps in improving soil structure, enhancing microbial activity, and providing essential nutrients to plants.
2. *Cow Urine:* Cow urine is considered a potent natural pesticide and is rich in nitrogen, phosphorus, and potassium, the primary nutrients plants need for growth. It also contains trace minerals that enhance soil health.
3. *Jaggery:* Jaggery acts as a food source for the microbes in the mixture. It accelerates the fermentation process and adds essential trace elements and sugars that the microbes feed on, helping them thrive.
4. *Water:* Clean, non-chlorinated water is used as a base to dissolve and mix the ingredients.
5. *Gram Flour or Pulses (Optional):* Sometimes, gram flour or pulses are added to further enhance microbial activity and provide additional nutrients.

BENEFITS OF JEEVAMRUT IN FARMING

Jeevamrut offers numerous benefits for organic farming practices, making it a valuable tool for sustainable agriculture:

1. **Improves Soil Health:** The mixture promotes microbial activity in the soil, which is essential for breaking down organic matter and releasing nutrients to plants. The rich microbial life improves soil texture, increases water retention, and reduces soil erosion.
2. **Enhances Crop Yield**: By supplying essential nutrients like nitrogen, phosphorus, and potassium in a natural form, Jeevamrut boosts plant growth and increases crop yields. The nutrients in Jeevamrut are easily absorbed by the plants, leading to healthier, more robust crops.
3. **Natural Pest Control**: The cow urine in Jeevamrut has pesticidal properties that help in controlling pests naturally, reducing the need for harmful chemical pesticides. It also strengthens plants' immune systems, making them more resistant to diseases.
4. **Cost-Effective**: Since Jeevamrut is made from locally available ingredients, it is a cost-effective alternative to chemical fertilizers. It reduces dependency on external chemical inputs and supports farmers in maintaining an economically viable farming practice.
5. **Promotes Sustainability**: By using organic methods, Jeevamrut promotes environmentally friendly farming practices. It supports biodiversity and reduces the ecological footprint of agriculture by avoiding chemical inputs that can degrade soil and water quality.
6. **Supports Soil Fertility**: Unlike synthetic fertilizers that can degrade soil health over time, Jeevamrut rejuvenates the soil by enhancing microbial activity and nutrient cycling. It helps in restoring and maintaining long-term soil fertility.

HOW TO PREPARE JEEVAMRUT?

Making Jeevamrut is relatively simple and requires minimal effort. Here's a step-by-step guide:

Ingredients:

- 10 kg fresh cow dung
- 2 liters cow urine
- 1 kg jaggery (or sugar)
- 1 kg flour (optional, to improve microbial activity)
- 200 liters of water

Fig 1: Preparation of Jeevamrut

METHOD OF PREPARATION OF JEEVAMRUT:

1. **Mix Cow Dung and Cow Urine**: In a large container, mix the fresh cow dung with the cow urine. Stir thoroughly to create a homogeneous mixture.
2. **Add Jaggery**: Dissolve the jaggery (or sugar) in a small amount of water and add it to the cow dung and urine mixture. This helps in providing food for the microbes.

3. **Add Flour (Optional)**: If you're using flour or pulses, add them to the mixture. This step is optional but can enhance microbial activity.
4. **Dilute with Water**: Add the 200 liters of water to the mixture, ensuring that it is well-diluted but still maintains the essential nutrients.
5. **Ferment the Mixture**: Allow the mixture to ferment for 48 hours. Keep it in a shaded, warm area to facilitate the fermentation process. Stir it twice a day to ensure proper fermentation.
6. **Apply to Crops**: Once the fermentation is complete, Jeevamrut is ready for use. It can be applied directly to the soil or sprayed on crops using a watering can or sprayer.

APPLICATION OF JEEVAMRUT

Jeevamrut can be applied in various ways depending on the needs of the crops and the specific farming practices:

1. **Soil Application:** Jeevamrut can be directly applied to the soil, enhancing soil health and boosting nutrient availability. It can be applied before or after planting.
2. **Foliar Spray**: Jeevamrut can be diluted further and sprayed on plant leaves, where it is absorbed through the stomata to provide nutrients.
3. **Compost**: Jeevamrut can be added to compost piles to speed up decomposition and enrich the compost with beneficial microorganisms.

CONCLUSION

Jeevamrut is a powerful tool in sustainable farming practices. It promotes soil health, enhances crop growth, reduces the need for synthetic fertilizers and pesticides, and helps in maintaining ecological balance. As organic and eco-friendly farming methods continue to gain popularity, Jeevamrut stands out as an accessible and effective solution for farmers worldwide, especially in regions looking to transition to more natural, sustainable agricultural practices. By utilizing Jeevamrut, farmers can foster healthier crops, better soil, and a more sustainable future for agriculture.

REFERENCES

National Centre for Organic Farming. (2025). *Jeevamrut: Natural farming for soil health and fertility*. Ministry of Agriculture and Farmers Welfare, Government of India. Retrieved from https://ncof.dac.gov.in/

Indian Council of Agricultural Research. (2024). *Promoting organic farming: Techniques and practices for sustainable agriculture*. ICAR. Retrieved from https://www.icar.org.in/

Gopal, B. (2018). *Organic farming for sustainable agriculture*. Springer. https://doi.org/10.1007/978-3-319-97674-4

Organic Farming Research Foundation. (2023). *Introduction to natural farming: Jeevamrut and its benefits*. Retrieved from https://ofrf.org/

Singh, M., and Sharma, R. (2020). Jeevamrut: The organic solution to modern agricultural challenges. *Journal of Organic Agriculture*, 5(2), 123-130. Retrieved from https://www.journaloforganicagriculture.com.

How to cite:

Puspa Parameswari (2025). Jeevamrut: The Natural Wonder for Sustainable Farming. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 16-20.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

BIODEGRADABLE SEED COATINGS: A GREENER SOLUTION

Cirumalla Mrudhula[1]*, Janapareddy Rajesh[2]

[1]Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Tamil Nadu, India

[2]Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India

Corresponding author email: cmrudhula2736@gmail.com

ABSTRACT

Biodegradable seed coatings represent an eco-friendly and sustainable approach to enhancing seed performance while minimizing environmental impact. Derived from natural materials such as starches, proteins, clays, and plant oils, these coatings support germination, deliver nutrients, and offer pest protection without leaving harmful residues. Their ability to decompose naturally improves soil health and reduces dependency on synthetic fertilizers and pesticides. As agriculture faces increasing environmental pressures, these coatings offer a promising alternative for both conventional and organic systems. While challenges such as cost and durability persist compared to synthetic counterparts, ongoing innovations are improving accessibility and performance, enabling the cultivation of healthier, more resilient crops.

KEYWORDS: Biodegradable seed coatings, Organic farming compatibility, Sustainable agriculture, Seed protection

INTRODUCTION

Seed coatings are protective layers composed of various materials including minerals, fertilizers, fungicides, insecticides, polymers, and occasionally biological agents. These coatings are applied to seeds to enhance germination, facilitate nutrient uptake, and provide protection against pests and diseases, particularly during the initial stages of plant growth. Both conventional and organic farmers utilize seed coatings to improve crop yields while reducing reliance on chemical inputs. Seed coatings are typically categorized into two broad types: synthetic and biodegradable. Synthetic coatings, although effective, contribute to soil and environmental pollution due to their persistence in the soil. In contrast, biodegradable seed coatings decompose into non-toxic byproducts such as water, carbon dioxide, and organic matter after fulfilling their purpose, offering a more environmentally sustainable solution.

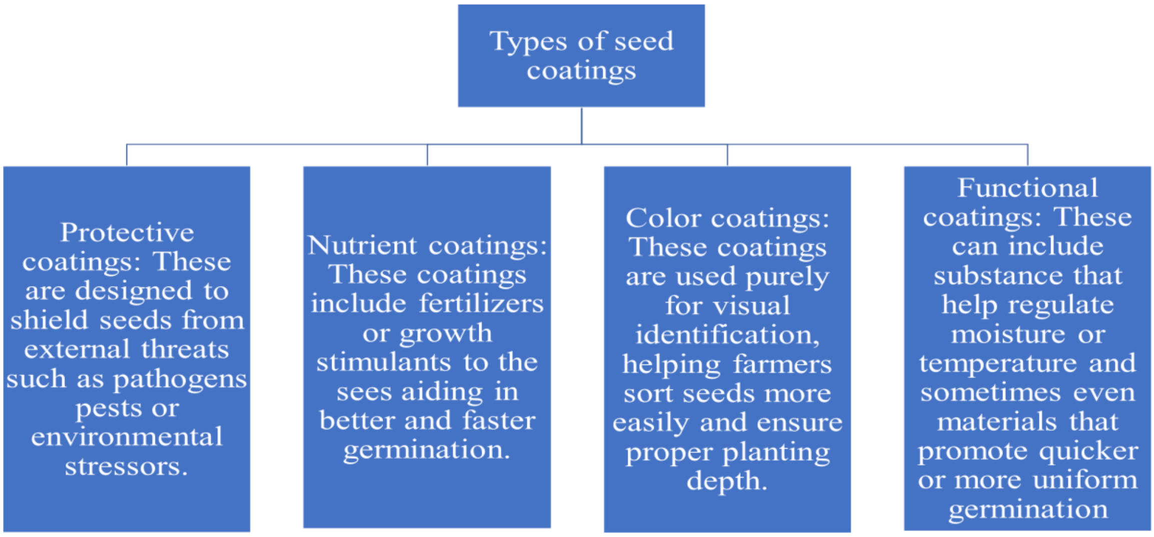


Figure 1: Classifications of seed coatings based on functional role

BIODEGRADABLE SEED COATINGS

Biodegradable seed coatings are produced using natural, eco-friendly materials designed to enhance crop yield and seed performance while reducing environmental impact. These coatings protect and nourish seeds during the early stages of growth and decompose over time, leaving no toxic residues. Unlike petroleum-based synthetic coatings that can degrade soil quality and contaminate groundwater, biodegradable alternatives promote healthier ecosystems by supporting soil microbial communities and nutrient cycling (Sohail et al., 2022).

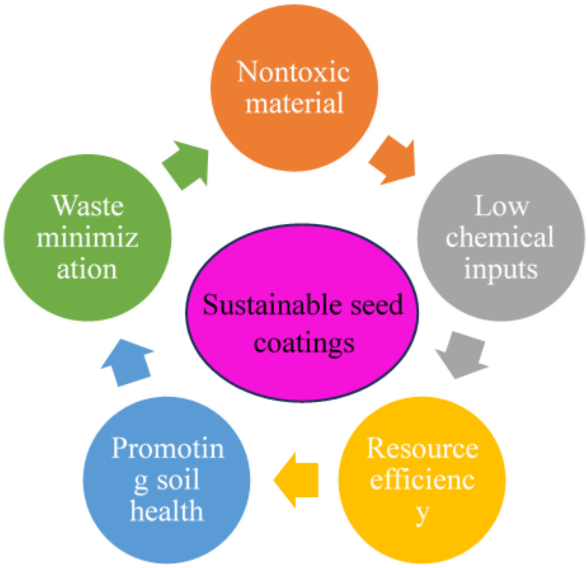


Figure 2: Benefits of sustainable seed coating

TYPES OF BIODEGRADABLE SEED COATINGS AND THEIR MECHANISMS

Biodegradable seed coatings are formulated from diverse natural sources that serve multiple functions—supporting germination, delivering nutrients, and defending against pests and pathogens. The primary types of biodegradable coatings include:

- **Polysaccharide-based coatings:** Derived from natural carbohydrates like starch, cellulose, guar gum, and alginate, these coatings improve moisture retention around the seed, especially in arid conditions, thereby enhancing germination rates.
- **Protein-based coatings:** Produced from casein, soy protein, or chitosan (from crustacean shells), these materials offer protection against soil-borne diseases and fungal infections. They also promote effective contact between the seed and soil, which is essential for optimal germination.
- **Clay-based coatings:** These form a hard, protective shell around the seed, offering resistance to mechanical damage, pest attack, and moisture loss. Though their degradation is slower, they do not leave harmful residues.
- **Organic oil and resin-based coatings:** Derived from natural sources such as neem oil, pine resin, or soybean oil, these coatings retain moisture and deter pests. Neem oil, in particular, offers natural fungicidal and insecticidal properties. A hydrophobic barrier created by these coatings also minimizes water loss during germination.

KEY BENEFITS AND ADVANTAGES OF BIODEGRADABLE SEED COATINGS

As sustainable agriculture gains global momentum, biodegradable seed coatings emerge as an innovative and eco-conscious solution. Their advantages include:

- **Improved Soil Health:** Many biodegradable coatings promote beneficial microbial activity, enhance nutrient cycling, and support long-term soil fertility. Materials containing plant-based ingredients or microorganisms create a biologically active rhizosphere that enhances crop resilience.
- **Reduced Chemical Input:** By incorporating natural nutrients and pest-repelling substances, these coatings diminish the need for synthetic fertilizers and pesticides, making them safer for pollinators and contributing to ecological balance.
- **Enhanced Germination and Early Growth:** Coatings protect seeds from abiotic stressors such as drought or temperature fluctuations and biotic threats like pathogens and pests, ensuring stronger seedling establishment.

- **Nutrient Delivery:** As the coating materials decompose, they release essential nutrients gradually, fostering healthy early-stage growth. Coatings embedded with beneficial microbes further stimulate root development.
- **Organic Farming Compatibility:** These coatings align with organic farming principles by utilizing non-toxic, natural materials. Many are made from certified organic inputs, making them suitable for certified organic operations.
- **Long-term Economic Benefits:** Despite higher upfront costs, biodegradable coatings can reduce reliance on costly agrochemicals and increase yields, offering financial savings over time.
- **Climate Resilience:** By supporting water retention and temperature regulation, biodegradable coatings help crops adapt to variable climatic conditions, improving food security in vulnerable regions.

CONCLUSION

Biodegradable seed coatings represent a significant advancement in sustainable agricultural practices, offering multifaceted benefits including improved germination, enhanced plant health, and reduced ecological impact. Their alignment with organic farming principles and ability to break down into non-toxic substances make them an ideal alternative to conventional synthetic coatings. As environmental concerns such as soil degradation and plastic pollution escalate, biodegradable coatings offer an effective means to protect seeds while fostering soil health and biodiversity. Though current limitations include production cost and performance variability, ongoing research and innovation continue to improve their practicality. With growing global interest in eco-friendly farming solutions, biodegradable seed coatings are poised to play a pivotal role in promoting agricultural sustainability and food system resilience.

REFERENCES

Rocha, I., Ma, Y., Souza-Alonso, P., Vosátka, M., Freitas, H. and Oliveira, R.S. (2019). Seed coating: a tool for delivering beneficial microbes to agricultural crops. *Frontiers in plant science*, 10, 1357.

Sohail, M., Pirzada, T., Opperman, C.H. and Khan, S.A. (2022). Recent advances in seed coating technologies: transitioning toward sustainable agriculture. *Green Chemistry*, 24(16):.6052-6085.

Vercelheze, A.E.S., Marim, B.M., Oliveira, A.L. and Mali, S. (2019). Development of biodegradable coatings for maize seeds and their application for *Azospirillum brasilense* immobilization. *Applied Microbiology and Biotechnology*, 103:2193-2203.357.

How to cite:

Cirumalla M. and Janapareddy R. (2025). Biodegradable seed coatings: A greener solution. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 21-25.

*********XXXXX**********

JACKFRUIT: WASTE TO WEALTH

Mahantesh P S[1]*, Shruti P Gondi[2]

[1]ICAR-KVK, Chitradurga, KSNUAHS, Shivamogga

[2]College of Horticulture, Hiriyur, KSNUAHS, Shivamogga

Corresponding author email: mahanteshps@uahs.edu.in

ABSTRACT

Jackfruit a nutritionally rich tropical fruit, generates significant waste in the form of peel, seeds, and fibrous core. These by-products, often discarded, pose environmental challenges but offer considerable potential for value addition. Rich in fibre, starch, antioxidants, and bioactive compounds, jackfruit waste is suitable for diverse applications in food, pharmaceutical, cosmetic, animal feed, and biofuel sectors. Its conversion into biodegradable packaging, bioethanol, and functional foods can reduce ecological burdens while promoting economic growth. Proper utilization of jackfruit waste aligns with sustainable development goals, offering a promising pathway for environmental conservation and circular bioeconomy advancement.

KEYWORDS: Bio-based applications, Jackfruit waste utilization, Value-added products, Sustainable agriculture

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus*), native to South and Southeast Asia, is among the largest tree-borne fruits and widely cultivated in tropical regions. It is renowned for its nutritional richness and culinary adaptability. Despite its economic and dietary importance, a substantial portion of the fruit—comprising its peel, seeds, and core—is often discarded, contributing to environmental degradation and resource inefficiency.

Global attention towards jackfruit is growing due to its potential in addressing food security, particularly as a plant-based meat substitute. The edible pulp is widely utilized in fresh and processed forms including chips, jams, and canned products. However, approximately 50–60% of the fruit's total weight remains underutilized. These non-edible components are rich in bioactive compounds and nutrients, making them suitable for diverse industrial applications.

The jackfruit peel, constituting a major portion of the waste, is rich in dietary fibre, antioxidants, and polyphenols, and shows promise in applications such as animal feed, biodegradable packaging, and natural dyes. Jackfruit seeds, with high starch and protein content, can be processed into flour and functional food ingredients. The fibrous core and rind are also valuable for biofuel production. Additionally, bioactive compounds in jackfruit waste exhibit medicinal properties, presenting opportunities for pharmaceutical and nutraceutical development. Strategic utilization of these components can contribute significantly to sustainable development and circular economy models.

COMPOSITION AND NUTRITIONAL VALUE OF JACKFRUIT

Jackfruit waste primarily includes peel, seeds, and fibrous core, each with distinct nutritional profiles:

Peel: Rich in dietary fibre, antioxidants, and polyphenols; beneficial for gut health and suitable for bio-based product development.

Seeds: Contain substantial amounts of starch, protein, and essential minerals; viable for food, pharmaceutical, and industrial applications.

Core and Rind: Predominantly fibrous and phytochemical-rich, suitable for biochar, bioethanol, and functional food production.

Nutritional Composition (per 100g dry weight):

- Carbohydrates: 60–70%
- Protein: 6–8%
- Fat: 0.4–1%
- Starch: 35–40%
- Dietary Fibre: 3–5%
- Minerals: Potassium, Magnesium, Calcium

Other Key Nutritional Components:

- Moisture: 50–80% (dependent on ripeness)
- Crude Fibre: 10–20%
- Ash: 2–5%
- Vitamins: Vitamin A (β-carotene), B1, B2, B3, B6
- Minerals:
- Potassium: 300–400 mg
- Calcium: 20–37 mg
- Magnesium: 27 mg
- Phosphorus: 38 mg
- Iron: 0.5 mg

3. APPLICATIONS OF JACKFRUIT WASTE

3.1 Food Industry Applications

1. *Jackfruit Seed Flour*: Jackfruit seeds, which make up approximately 10–15% of the fruit's weight, are rich in carbohydrates, proteins, and dietary fibre. They can be processed into flour for use in baked goods, pasta, and other products, enhancing nutritional value while reducing reliance on wheat or maize-based flours.
2. *Snacks and Confectionery*: Boiled or roasted jackfruit seeds serve as high-protein, antioxidant-rich snacks. These seeds are also incorporated into confectionery items like chocolates and energy bars, providing a nutritious and sustainable alternative.
3. *Fermented Products:* The fermentable sugars in jackfruit peel and core allow their use in producing vinegar, probiotic beverages, and alcoholic drinks such as wine, offering innovative avenues in fermented food products.

3.2 Animal Feed

Due to their high fibre and protein content, jackfruit peel and seeds can be converted into livestock feed. Dried peel is suitable for inclusion in feed formulations for cattle, poultry, and goats, offering an economical and sustainable alternative to conventional feed ingredients.

3.3 Bioplastics and Packaging Materials

Jackfruit peel, rich in lignin and cellulose, is a valuable raw material for bioplastic production. Biopolymers extracted from jackfruit starch and fibre can replace petroleum-based plastics in sustainable packaging, contributing to waste reduction and environmental conservation.

3.4 Pharmaceutical and Cosmetic Applications

1. *Antioxidant and Antimicrobial Properties:* Jackfruit waste contains flavonoids, tannins, and phenolic compounds with significant antioxidant and antimicrobial activity. These bioactives have potential for use in pharmaceutical formulations targeting oxidative stress and infections.
2. *Skincare and Haircare*: Extracts from jackfruit waste are incorporated into personal care products due to their moisturizing, anti-aging, and protective properties. Their rich antioxidant profile makes them suitable for creams, lotions, and haircare formulations.

3.5 Biofuel and Biogas Production

High carbohydrate and lignocellulosic content make jackfruit waste ideal for bioenergy production. Anaerobic digestion of peels and seeds generates biogas for use in cooking and electricity. Similarly, bioethanol can be extracted, supporting renewable energy initiatives and reducing fossil fuel dependence.

3.6 Composting and Organic Fertilizer

Jackfruit residues are rich in organic matter and nutrients, making them ideal for composting. Compost derived from peels, seeds, and cores enhances soil fertility and microbial health, providing an eco-friendly alternative to chemical fertilizers.

3.7 Enzyme Production

Jackfruit waste serves as a cost-effective substrate for producing industrial enzymes like cellulase and amylase. These enzymes have applications in starch hydrolysis, textile processing, and industrial waste management, further expanding the value chain of jackfruit by-products.

CONCLUSION

Jackfruit waste presents a promising opportunity for sustainable resource utilization. Although often discarded, components such as seeds, peels, and fibrous core are rich in nutrients and bioactive compounds. These by-products can be effectively harnessed in food, pharmaceutical, cosmetic, energy, and agricultural sectors. Utilizing jackfruit waste not only mitigates environmental impact but also adds economic value through product diversification. Strategic integration of jackfruit by-products into industrial applications supports a circular economy, enhances sustainability, and contributes to waste-to-wealth transformation in tropical agriculture.

How to cite:

Mahantesh P S and Shruti P G. (2025). Jackfruit: Waste to wealth. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 26-29.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

ASSESSMENT OF AFFORESTATION AND DEFORESTATION DYNAMICS THROUGH NDVI IMAGERY ANALYSIS

Sayantan Mandal[1]*, Sritama Choudhury[2], Shreetama Giri[3], Sayan Kumar Naskar[3]

[1]Department of Soil Science, IARI-Kolkata hub, CRIJAF, Barrackpore, West Bengal, India

[2]Department of Agronomy, Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, Kolkata, West Bengal, India

[3]Department of Agronomy, School of Agriculture and Allied Sciences, The Neotia University, Sarisha, South 24 Parganas, West Bengal, India

**Corresponding author email*: sayantanmandal456@gmail.com

ABSTRACT

The Normalized Difference Vegetation Index (NDVI) derived from satellite imagery is a powerful tool for monitoring vegetation dynamics over time. NDVI utilizes red and near-infrared (NIR) reflectance to assess vegetation health and density. In this study, LANDSAT data from different time periods were processed and analyzed using GIS techniques to assess spatial vegetation trends. NDVI rasters were reclassified into vegetation and non-vegetation classes and compared across timeframes to evaluate changes. The results indicate a general decline in vegetation density over the years, despite localized afforestation efforts. This methodology demonstrates the utility of NDVI analysis in environmental monitoring and sustainable land-use planning.

KEYWORDS: Afforestation, ArcGIS, Deforestation, LANDSAT, NDVI

INTRODUCTION

Vegetation dynamics are critical for maintaining ecosystem functions, influencing climate patterns, and sustaining biodiversity. Understanding spatial and temporal variations in vegetation cover is essential for informed environmental monitoring and resource management. Remote sensing, particularly through satellite imagery, provides a reliable means to observe and quantify vegetation changes over broad spatial and temporal scales (Htitiou et al., 2020).

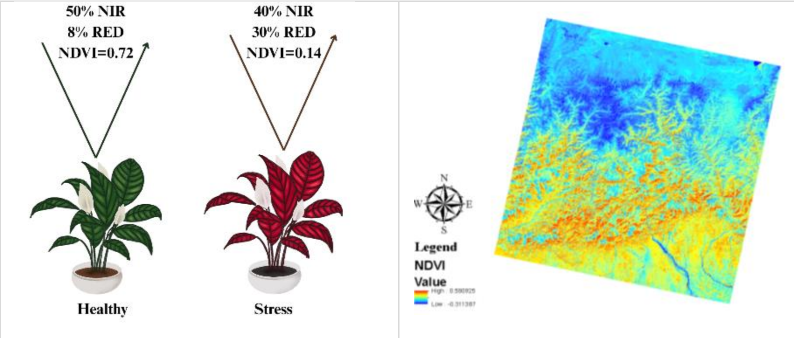
The NDVI is a widely used vegetation index calculated from satellite data that quantifies the greenness and photosynthetic activity of vegetation (Bhandari et al., 2012). It also helps distinguish between healthy vegetation and background features like soil, dead plant material, and surface roughness (Li et al., 2016).

NDVI

The NDVI is a widely used remote sensing index designed to measure and monitor plant growth, vegetation cover, and biomass production. It is derived from satellite or airborne sensor data by utilising the unique reflectance characteristics of vegetation in the red and near-infrared (NIR) regions of the electromagnetic spectrum. Healthy, dense vegetation strongly absorbs visible red light for photosynthesis and reflects a large portion of NIR light, while sparse or stressed vegetation reflects more red light and less NIR. The NDVI is calculated using the following formula:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

Where 'NIR' refers to the reflectance in the near-infrared band, and 'RED' refers to the reflectance in the red band. NDVI values typically range between -1 and +1. Higher NDVI values (closer to +1) are associated with vigorous and dense vegetation, moderate values indicate sparse vegetation, and lower or negative values often correspond to barren surfaces, water bodies, or built-up areas (Blanco et al., 2020).



a) b)

Figure1. a) Difference in reflectance and NDVI between healthy and stressed plants b) NDVI raster

METHODOLOGY

To monitor vegetation changes over time, NDVI must be generated for both periods using Landsat imagery. First, download relevant data from the USGS Earth Explorer and load it into ArcGIS. Use the Raster Calculator under Spatial Analyst Tools > Map Algebra to compute NDVI. For example, to compare vegetation between 1990 and 2024, you would need to use:

Landsat 4–5 for data from 1990, using Band 4 (NIR) and Band 3 (Red),

Landsat 8–9 for data from 2025, using Band 5 (NIR) and Band 4 (Red).

Since each Landsat generation has its sensor system, the correct band combination must be applied during NDVI calculation to ensure accurate and comparable results across different years.

Table 1. List of different LANDSATS for different periods

Landsat Mission	Time Period Available	Bands Used for NDVI
Landsat 1–3	1972 – 1983	Band 2 (Red), Band 4 (NIR)
Landsat 4–5	1982 – 2012 (L5 longest)	Band 3 (Red), Band 4 (NIR)
Landsat 7	1999 – Present (gap-filled after 2003)	Band 3 (Red), Band 4 (NIR)
Landsat 8	2013 – Present	Band 4 (Red), Band 5 (NIR)
Landsat 9	2021 – Present	Band 4 (Red), Band 5 (NIR)

First, classify the NDVI raster into two categories: ‘vegetation’ and ‘no vegetation’. Use the Reclassify tool to assign the value +1 for vegetation and -1 for no vegetation. Then, go to the Conversion Tools and use the Raster to Polygon tool to convert the classified raster into polygons with only two grid codes: +1 and -1. Next, use the Dissolve tool from the Geoprocessing toolbox to merge polygons based on their grid codes. Open the attribute table of the dissolved polygons and create two new fields: one to calculate the area of each class, and another to label the grid codes as 'vegetation' and 'no vegetation'. After that, use the Intersect tool (under Geoprocessing) to overlay the two polygon layers from different time periods. This will create one intersected polygon layer that contains data from both years. In the attribute table of this new layer, create a field and calculate values using this format: "[Class of past year] + ' to ' + [Class of present year]"

This step defines the type of vegetation change (e.g., “vegetation to no vegetation”). Finally, create another field to calculate the total area under each change type. Based on this information, update the classes in the intersected polygon to reflect the vegetation change categories.

Table 2. New classes according to the vegetation change trends.

Vegetation changing type	New class of intersected polygons
No vegetation to No vegetation	No vegetation (unchanged)
No vegetation to vegetation	Afforestation
Vegetation to No vegetation	Deforestation
Vegetation to vegetation	Vegetation (unchanged)

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

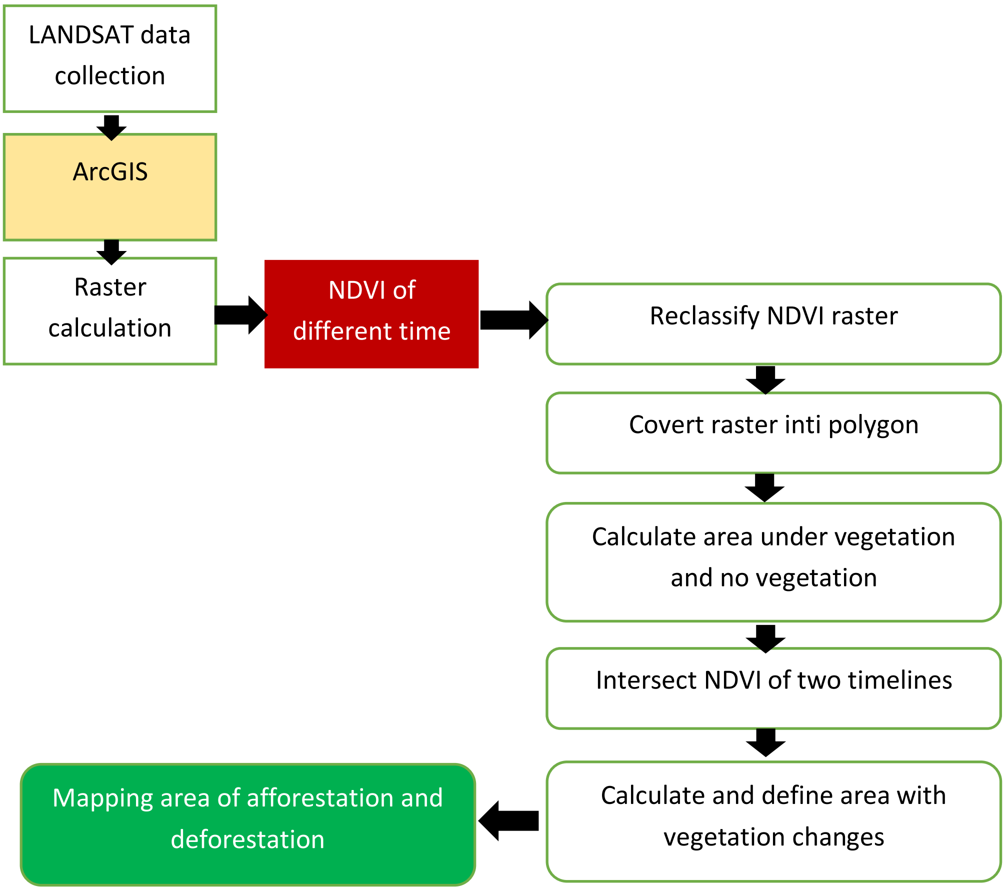
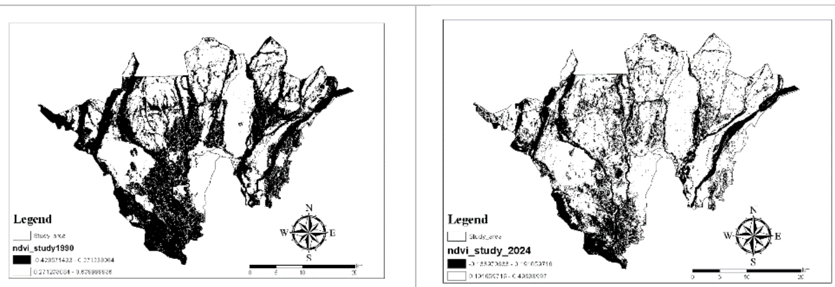


Figure 2. Flowchart of complete methodology for monitoring vegetation change trends

RESULTS

We have gained a change of vegetation at three blocks of Jalpaiguri district of West Bengal, calculating the NDVI of 1990 and 2025 using LANDSAT 5 and LANDSAT 8, respectively. Surprisingly big area with afforestation though, has been indicated still difference between NDVI of these two terminal time has shown us that the density of the vegetation has been reduced gradually.



a) b)

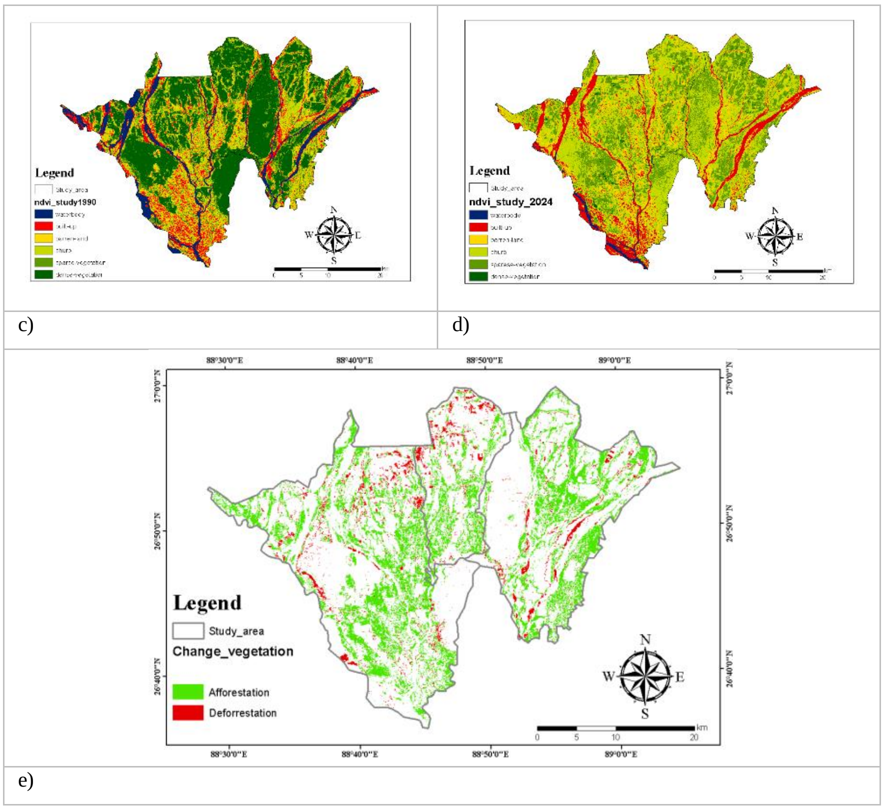


Figure 3. Reclassified NDVI of a) 1990. b) 2024. NDVI raster of c) 1990 and d) 2025 e) Afforestation and deforestation area mapping of the study area

CONCLUSION

Urban expansion and agricultural development continue to reduce vegetation cover and density. Monitoring these changes using NDVI-based analysis provides critical insights for managing afforestation and deforestation dynamics. This study highlights the effectiveness of satellite imagery and GIS in assessing vegetation loss, planning reforestation initiatives, and promoting sustainable land use. Such tools are vital for timely decision-making and improved environmental conservation strategies.

REFERENCES

Blanco, V., Blaya-Ros, P. J., Castillo, C., Soto-Vallés, F., Torres-Sánchez, R., & Domingo, R. (2020). Potential of UAS-Based Remote Sensing for Estimating Tree Water Status and Yield in Sweet Cherry Trees. *Remote Sensing*, *12*(15), 2359. https://doi.org/10.3390/rs12152359

Htitiou, A., Boudhar, A., Lebrini, Y., & Benabdelouahab, T. (2020). Deep Learning-Based Reconstruction Of Spatiotemporally Fused Satellite Images For Smart Agriculture Applications In a Heterogeneous Agricultural Region. *International Archives of the Photogrammetry, Remote*

Sensing and Spatial Information Sciences, *XLIV-4/W3-2020*, 249–254. https://doi.org/10.5194/isprs-archives-xliv-4-w3-2020-249-2020

GIS & RS Solution. (2023). [Video]. You Tube. Retrieved April 25, 2025, from https://youtu.be/JLUhzjS3v0U?si=9y9TglHg5jI_bwE5

How to cite:

Mandal S., Choudhury S., Giri S., and Naskar, S. K. (2025). Assessment of Afforestation and Deforestation Dynamics through NDVI Imagery Analysis. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 30-35.

*********XXXXX**********

HONEY CARAMELIZATION: A DEEP DIVE

Sunil C.[1]*, Umme Seema N[2], and Jeevan H R[3]

[1]Senior Scientist and Head, ICAR-Krishi Vigyan Kendra, Shivamogga

[2]Department of Postharvest Technology, Cashew Technology Centre, KSNUAHS, Shivamogga

[3]Department of Agronomy, Cashew Technology Centre, KSNUAHS, Shivamogga

Corresponding author email: csuniluas@gmail.com

ABSTRACT

Honey caramelization is a complex thermal process that transforms the physical and chemical properties of honey, enhancing its flavour, colour and aroma. Unlike Maillard browning, caramelization involves the pyrolysis of sugars without amino acids, occurring at temperatures typically above 110°C. Factors such as pH, moisture content and sugar profile influence the rate and extent of caramelization. Additionally, the botanical origin of honey can impact its thermal behaviour due to variations in composition. Understanding honey caramelization is crucial in culinary arts, food technology and nutrition, where controlled heating is employed to achieve desired sensory qualities without compromising its nutritional integrity.

KEYWORDS: Culinary Applications, Food Chemistry, Honey Caramelization, Sugar Pyrolysis

INTRODUCTION

Honey is a natural substance produced by bees from the nectar of flowers, and is a complex mixture of sugars, water and other trace elements such as minerals, enzymes and vitamins. The composition of honey can vary depending on the flowers the nectar was gathered from, which results in different types of honey with unique flavours, colours and textures. The two primary sugars found in honey are fructose and glucose, but it also contains sucrose, maltose and other disaccharides in smaller quantities.

Honey has been used by humans for thousands of years, not only as a sweetener but also in medicinal and cosmetic applications. It is a staple in both traditional and culinary applications due to its rich flavour character, which ranges from light and sweet to dark and strong. Caramelization is an innovative procedure that uses heat to change the properties of honey and improve its flavour.

Caramelization is a well-known process in food science and culinary applications, where sugars undergo thermal decomposition, resulting in complex flavour and colour transformations. It is a process that occurs when sugars are heated to a high temperature, leading to a breakdown of their molecular structure. When the sugars in honey (primarily glucose and fructose) are exposed to heat, they begin to decompose, forming a range of new compounds that give caramel its distinct colour, flavour and aroma. This transformation is known as the Maillard reaction, a non-enzymatic browning process that occurs in foods when exposed to heat, and is a key element in the development of a caramelized flavour.

CHEMISTRY OF HONEY CARAMELIZATION

Glucose and fructose, the two primary sugars in honey, each have unique thermal properties. For example, glucose caramelizes at a slightly lower temperature than fructose, but both sugars start to break down around 320°F (160°C), which is the standard temperature for caramelization. This temperature can vary slightly depending on the exact ratio of sugars in the honey, but 320°F is generally considered the point where noticeable changes in colour and flavor begin.

1. **Glucose and Fructose**:

   Glucose: A monosaccharide (single sugar unit) and highly reactive when heated. During caramelization, it tends to break down into smaller molecules that contribute to the formation of various caramel compounds. The breakdown of glucose also produces a slight nutty flavour.

   Fructose: Monosaccharide, fructose tends to caramelize at a lower temperature than glucose, producing a more intense caramel flavour. When honey contains a higher proportion of fructose (as in clover honey), the caramelization process will be slightly faster.

2. **Water Content**:

   Honey contains approximately 17-20% water, which affects how it caramelizes. As water evaporates from the honey during heating, the concentration of sugars increases, which accelerates the caramelization process. The more water, the longer it will take for caramelization to occur, as it will be diluted until the water evaporates.

3. **Other Components**:

   Honey contains small amounts of organic acids, minerals and enzymes, which also influence the caramelization process. For example, the presence of minerals like calcium, iron and potassium can slightly affect the way sugars react to heat, contributing to the final flavor profile of the caramelized honey.

STAGES OF CARAMELIZATION IN HONEY

Caramelization happens in distinct stages, with each phase contributing to changes in the appearance, flavour and texture of the honey.

- **Initial Heating (Below 250°F / 120°C)**:

  The water content of honey starts to evaporate as it is heated gradually. Over time, the honey will gradually darken and become more viscous. During this stage, there are no significant flavour changes, but the honey starts to lose its light, floral notes and gain a deeper, richer colour.

- **Browning (250°F - 320°F / 120°C - 160°C)**:
  This is where the caramelization process begins. As the temperature increases, the sugars start to break down. The glucose and fructose start forming new compounds, and the colour shifts from light amber to a darker brown. The honey begins to develop a more intense and caramel-like flavour. This stage is the key to achieving the signature deep, nutty flavours associated with caramelized honey.
- **Full Caramelization (320°F / 160°C and above)**:
  As the temperature reaches and exceeds 320°F (160°C), the honey reaches its maximum caramelized state. The sugars have fully broken down, and a rich, complex caramel flavour emerges. At this point, the honey is quite dark and may take on slightly bitter undertones if overheated. The viscosity of the honey may also decrease, becoming more fluid.
- **Burning Point**:
  If the honey is heated too long or the temperature goes too high (above 350°F / 175°C), the sugar in the honey will begin to burn, leading to a bitter taste and potentially undesirable effects. This is why precise temperature control is essential during caramelization.

FACTORS INFLUENCING HONEY CARAMELIZATION

Several factors affect how honey caramelizes:

- **Temperature**
  - ✓ Lower temperatures (110-130°C) result in mild caramelization with subtle flavours.
  - ✓ Higher temperatures (140-150°C) lead to deeper caramelization but also risk burning.
- **Moisture Content**
  The initial water content in honey affects how it caramelizes; higher moisture levels require longer heating times to achieve caramelization.
- **Heating Method**
  Slow, controlled heating in a double boiler ensures even caramelization, while direct heating can cause uneven browning or burning.
- **Type of Honey**
  Darker honey (e.g., buckwheat honey) contains more minerals and antioxidants, influencing the flavour and final colour of caramelized honey.
- **pH and Acidity**
  Natural acidity of honey can affect caramelization reactions, leading to distinct taste variations compared to neutral sugars.

APPLICATIONS OF CARAMELIZED HONEY

Caramelized honey enhances the depth and richness of various culinary and commercial products. Some popular uses include:

Culinary Applications

- **Baking:** Adds depth to cakes, cookies, and pastries
- **Sauces & Glazes:** Enhances savoury and sweet dishes
- **Desserts:** Used in ice creams and custards
- **Beverages:** Provides complexity to coffee, teas, and cocktails
- **Candy Making:** Forms the base for caramel candies and chewy sweets
- **Meat Marinades:** Enhances barbecue sauces and glazes for meats
- **Salad Dressings:** Adds a rich, sweet note to vinaigrettes
- **Breakfast Items:** Drizzled over pancakes, waffles, and oatmeal

Industrial and Commercial Uses

- **Confectionery:** Used in caramel-based candies and chocolates
- **Dairy Industry:** Added to flavoured yogurts and dairy-based products
- **Alcoholic Beverages:** Incorporated into honey wines and flavoured liquors
- **Nutritional Products:** Enriched in functional foods and herbal syrups
- **Cosmetics & Skincare:** Included in face masks, scrubs, and lip balms for its humectant properties
- **Pharmaceuticals:** Utilized in cough syrups and medicinal lozenges
- **Food Preservation:** Acts as a natural preservative due to its antimicrobial properties
- **Artisanal Food Products:** Used in gourmet food products such as speciality sauces and infused oils

CONCLUSION

Honey caramelization is a fascinating process that transforms natural sugars into complex flavour and aroma. By understanding the chemistry, controlling the heating process and choosing the right honey variety, one can harness the unique benefits of caramelized honey for both culinary and industrial applications. Whether used in baked goods, sauces, or confectionery, caramelized honey offers a distinctive sweetness that enhances a wide range of products.

REFERENCES

Chou, W. M., Liao, H. C., Yang, Y. C. and Peng, C. C., (2020). Evaluation of honey quality with stored time and temperatures. *Journal of Food Nutrition Research* 8: 591-599.

Nagai, T., (2017). Chemical properties of commercially available honey species and the functional properties of caramelization and maillard reaction products derived from these honey species. *Journal Food Science Technology* 55(2): 586–97.

How to cite:

Sunil, C., Umme Seema, N., and Jeevan, H. R. (2025). Honey Caramelization: A Deep Dive. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 36-40.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

SEED SCIENCE IN THE 21ST CENTURY: FROM GENOMES TO SMART SYSTEMS

Janapareddy Rajesh[1]*, Cirumalla Mrudhula[2], Noru Rajasekhar Reddy[3]

[1]Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India

[2]Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Tamil Nadu, India

[3]Department of Genetics and Plant Breeding, Kerala Agricultural University, Kerala, India

Corresponding author email: rajeshjanapareddy2001@gmail.com

ABSTRACT

Seed science in the 21st century has evolved into a multidisciplinary frontier encompassing biotechnology, nanotechnology, AI, and omics-based approaches. Gene-editing tools like CRISPR, advanced priming methods, and hologenomics are redefining seed improvement strategies. Smart coatings, nanocarriers, and intelligent packaging enhance seed viability and delivery efficiency. AI-driven trait prediction and speed breeding are revolutionizing crop cycles and performance. Integration of cryopreservation and artificial seeds ensures long-term conservation and uniform propagation. These technologies collectively engineer seed systems that are resilient, productive, and responsive to environmental stimuli. This review outlines key innovations shaping seed science for climate-resilient and sustainable agriculture.

KEYWORDS: Artificial Seeds, CRISPR, Multi-Omics, Seed Enhancement Technologies, Seed Priming

INTRODUCTION

The 21st century has witnessed a paradigm shift in seed science, integrating genomics, digital technologies, and sustainable practices to reshape modern agriculture. Seeds, the starting point of the food chain, are being transformed into intelligent biological systems capable of enhanced performance, resilience, and predictability. Innovations such as precision gene editing, nanotechnology-enabled seed coatings, and artificial seeds have accelerated breeding cycles and increased stress tolerance. Meanwhile, the use of artificial intelligence, hologenomics, and multi-omics platforms enables more accurate trait prediction and better understanding of seed physiology. With global climate variability, rising food demands, and increasing pressure on land and water resources, seed science is becoming a cornerstone of sustainable agriculture and food security. This article explores how advances in seed priming, storage, microbiome engineering, and digital systems are converging to develop next-generation seeds that are not only productive but also adaptive and ecologically harmonious, ensuring global agricultural resilience and long-term sustainability.

1. SEED HOLOGENOMICS: PLANT-MICROBE INTERACTIONS

Seed hologenomics views seeds as holobionts—an integrated unit of plant and microbial genomes. Microorganisms associated with seeds play vital roles in germination, nutrient acquisition, and stress adaptation. Advancements in metagenomics, such as 16S rRNA and ITS sequencing, enable the profiling of seed-associated microbiota. Recent research supports the use of microbial inoculants (e.g., *Trichoderma*, *Pseudomonas*) through bio-priming or coating to enhance seedling vigor and root colonization (Reed, 2008). These microbial consortia can induce systemic resistance and modulate hormonal signaling, supporting robust early growth. By engineering seed microbiomes, scientists aim to develop tailored microbial environments that improve plant resilience, even under abiotic stress conditions such as drought or salinity. This bio-symbiotic approach fosters sustainable agriculture by reducing the dependency on synthetic fertilizers and agrochemicals, positioning seed hologenomics as a vital pillar in seed enhancement. Furthermore, microbial-assisted seeds represent a next-generation strategy for achieving ecological intensification and soil health restoration in degraded agro-ecosystems.

2. SEED COATING AND PELLETING TECHNOLOGIES

Seed coating involves applying external materials onto the seed surface to improve physical handling, germination efficiency, and protection. Modern coatings employ biodegradable polymers, hydrogels, and smart polymers that release active compounds such as nutrients, growth stimulants, or pesticides in response to environmental cues. In pelleting, small or irregular seeds are reshaped with inert fillers and binding agents to standardize size and weight for mechanical sowing. Materials such as clay, bio-based adhesives, and polymer blends are used to facilitate uniform field distribution. Advanced coatings may integrate beneficial microbes, biostimulants, or micronutrients, enhancing early seedling development and disease resistance. Research has shown improved field emergence and crop establishment in coated seeds, especially under stress-prone conditions (Watson et al., 2018). These innovations reduce input costs and enhance seedling uniformity, critical for precision agriculture. As smart agriculture progresses, intelligent coatings that sense temperature or moisture levels will further automate and optimize seed-soil interactions in diverse agro-climatic conditions.

3. SEED PRIMING TECHNIQUES

Seed priming is a physiological pre-sowing treatment that initiates metabolic activity in seeds without actual germination. Techniques like hydro-priming (water soaking) and osmo-priming (PEG solutions) condition seeds for faster and uniform emergence. Hormonal priming uses gibberellic acid, brassinosteroids, or salicylic acid to modulate growth signaling pathways, while bio-priming introduces beneficial microbes for stress mitigation and plant defense activation. Emerging priming technologies include nano-priming (using ZnO, AgNPs), which enhances water uptake and germination, and electro-priming or magneto-priming, which use electric and magnetic fields to stimulate cellular activity. Chemo-priming and halo-priming apply salts or chemicals like nitrate and ascorbate to induce adaptive stress tolerance. These techniques increase germination speed, improve seedling vigor, and enhance stress resilience under drought, salinity, or low temperature. Multi-priming approaches combine physical, chemical, and biological methods to create synergistic effects on seed performance. Priming is now a vital component in seed technology, especially for climate-resilient and organic farming systems.

4. CRISPR AND PRECISION GENE EDITING

CRISPR-Cas9 and its derivatives such as base and prime editing are revolutionizing seed genetics by enabling precise, heritable modifications without introducing foreign DNA. Applications include gene knockout for trait elimination, and gene insertion or substitution for desired trait enhancement. Multiplex editing allows simultaneous editing of multiple genes, accelerating the breeding of complex traits. In wheat and rice, CRISPR has enabled resistance to diseases and improved yield traits (Zhang et al., 2016). Unlike traditional breeding, CRISPR is faster, cost-effective, and transgene-free, making it publicly acceptable and regulatory-friendly. The technology's integration with speed breeding and genomic selection further reduces breeding cycles. Novel delivery methods like nanocarriers and ribonucleoprotein complexes are improving gene-editing efficiency in recalcitrant species. CRISPR's scalability is driving its adoption in seed companies and public breeding programs for crops such as maize, sorghum, and millet, marking a transformative shift in seed biotechnology toward customized and adaptive seed solutions.

5. PANGENOMICS AND SUPER-PANGENOMES

Conventional reference genomes represent a limited view of a species' genetic diversity. Pangenomics overcomes this by compiling core and accessory genes across multiple genotypes, revealing a broader spectrum of alleles associated with stress tolerance, productivity, and adaptation. Super-pangenomes further include genes from wild relatives, enhancing gene discovery across interrelated species. For example, the African rice pangenome revealed unique alleles for heat and drought tolerance not present in conventional cultivars. These resources facilitate genomic-assisted breeding by identifying novel trait-linked markers. Computational platforms such as PanTools and VG-Flow enable the analysis of pangenomic data. Pangenomics also supports seed system development by identifying genotypes suitable for specific ecologies or marginal environments. This approach allows breeders to mine natural variation efficiently, accelerating the deployment of climate-smart cultivars. As climate variability escalates, pangenomics and super-pangenomes will play a critical role in safeguarding agricultural biodiversity and delivering high-performing seeds across diverse agro-ecological regions.

6. MULTI-OMICS INTEGRATION IN SEED BIOLOGY

Modern seed science embraces a systems biology approach through integration of genomics, transcriptomics, proteomics, metabolomics, and epigenomics. Each omics layer provides unique insights—genomics reveals gene structure, transcriptomics identifies gene expression profiles, while metabolomics and proteomics offer downstream phenotypic data. Tools like OmicsBox and Galaxy facilitate the simultaneous analysis of these datasets, leading to predictive models for traits like dormancy, vigor, and desiccation tolerance. Epigenomic data inform how DNA methylation and histone modifications regulate seed responses to environmental stress. This integrative approach enables identification of key regulatory networks and molecular markers for use in marker-assisted or genomic selection. In crops like soybean and chickpea, omics-driven discoveries have led to improved seed longevity and germination under stress. Multi-omics is also central to understanding seed microbiome interactions. As data acquisition and computational capacities improve, multi-omics will be indispensable in designing smart seeds tailored for both high performance and resilience across environments.

7. AI AND MACHINE LEARNING IN SEED TRAIT PREDICTION

Artificial intelligence (AI) and machine learning (ML) are revolutionizing trait prediction and seed selection by processing complex datasets from genomics, weather, and field phenotyping. Supervised learning models like support vector machines (SVMs), random forests, and neural networks are trained to predict traits such as germination rate, stress resistance, and yield. Deep learning techniques, including convolutional neural networks (CNNs), are used for image-based seed phenotyping. AI tools such as DeepVariant assist in variant calling for genome editing, while Breeding Insight helps breeders prioritize lines based on predictive modeling. Integration with IoT sensors and satellite data enhances real-time decision-making. AI is especially useful in screening thousands of genotypes, accelerating varietal selection in breeding programs. This predictive capacity reduces trial-and-error and enhances precision in seed technology. With increasing data availability and algorithm sophistication, AI will be instrumental in designing custom-tailored seeds for specific climates, geographies, and market needs.

8. SPEED BREEDING IN CONTROLLED ENVIRONMENTS

Speed breeding leverages extended photoperiods, temperature control, and LED lighting in growth chambers to accelerate plant life cycles. Crops such as wheat, barley, and chickpea can achieve up to six generations per year under optimized conditions (Watson et al., 2018). This rapid generation turnover is particularly valuable when combined with genomic selection and CRISPR editing to compress breeding timelines from decades to a few years. Speed breeding also facilitates quicker trait fixation and early-stage testing under controlled stress simulations. Facilities now use fully automated phenotyping systems, light recipes tailored to crop type, and precision irrigation to optimize growth. The technique's success depends on integrating phenological modeling and predictive analytics to synchronize flowering and seed set. Its role in seed technology is indispensable for fast-tracking high-performing cultivars, especially in addressing climate-induced threats to crop productivity. Speed breeding is expected to be a mainstay in global crop improvement pipelines.

9. NANOTECHNOLOGY-ENHANCED SEED DELIVERY SYSTEMS

Nanotechnology introduces precision and efficiency in seed delivery through nano-encapsulation and nano-carriers. These systems provide controlled release of nutrients, growth regulators, and biocontrol agents, ensuring their targeted availability at critical growth stages. Nanoparticles like nano-silver and nano-clay are used in coatings to provide antimicrobial action and improve water retention around the seed. Nanogels and nano-emulsions are moisture-sensitive and enable smart, slow-release mechanisms that enhance germination and early seedling vigor. Additionally, nanoencapsulation allows thermal or pH-sensitive release of bioactives, protecting them from degradation. Such delivery systems enhance resource-use efficiency, reduce environmental contamination, and are particularly useful in resource-poor or marginal areas. Research indicates significant improvement in germination uniformity and seedling robustness when nanocarriers are employed. Moreover, nanotechnology facilitates the integration of sensors into seeds for real-time physiological monitoring, opening new frontiers for digital agriculture. These smart delivery systems are redefining seed enhancement, with a focus on precision, sustainability, and scalability.

10. ARTIFICIAL SEEDS AND SOMATIC EMBRYOGENESIS

Artificial seeds, generated through somatic embryogenesis, simulate the structural and physiological properties of natural seeds, enabling their use in propagation, storage, and planting. These synthetic units are produced from totipotent somatic cells and encapsulated in a gel matrix, often supplemented with nutrients or growth hormones. Artificial seeds are invaluable for the mass production of elite genotypes, particularly in horticultural and forestry crops where conventional propagation is slow or inefficient. This technique also supports biodiversity conservation by enabling ex situ preservation of rare or endangered species. The technology allows uniform planting material, facilitating mechanized sowing and reducing genetic variability in field performance. Research has shown that encapsulation-dehydration methods preserve somatic embryos with high post-thaw viability. Artificial seed systems can be enhanced with microbial inoculants or nanocarriers, combining tissue culture and seed enhancement technologies. Their potential in seedling uniformity, genetic conservation, and resource efficiency makes them a promising component of next-generation seed systems.

11. ADVANCED SEED STORAGE AND LONGEVITY TECHNOLOGIES

Seed storage is fundamental to genetic conservation, breeding, and seed system reliability. Traditional storage focuses on moisture control and temperature regulation to prevent deterioration. However, recent advancements offer more precise and longer-term solutions. Cryopreservation at -196°C using liquid nitrogen halts all cellular processes, enabling the indefinite storage of orthodox and recalcitrant seeds. Techniques like vitrification and encapsulation-dehydration improve survival rates post-thaw (Reed, 2008). Smart packaging materials embedded with sensors allow real-time monitoring of humidity, gas exchange, and temperature within seed containers. These sensors alert users to adverse conditions, enabling timely interventions to maintain seed quality. Moreover, active packaging with antimicrobial agents prevents fungal growth and insect damage. Such innovations ensure seed viability, vigor, and genetic stability across long storage durations, which is essential for national gene banks and seed banks. These technologies contribute significantly to global efforts toward food and genetic security in the face of climate uncertainty.

CONCLUSION

Seed science in the 21st century is at the intersection of biological innovation, data science, and engineering. Technologies like CRISPR, AI-based trait prediction, and multi-omics integration allow the precise design of seeds with enhanced traits. Nanotechnology, bio-priming, speed breeding, and smart packaging further contribute to improving seed performance and longevity. These innovations enable the development of resilient, adaptive, and sustainable seed systems tailored for diverse agro-ecological zones. The incorporation of microbial symbiosis and artificial seed technology also supports conservation and uniform crop establishment. Collectively, these advances are positioning seed science as a cornerstone of climate-resilient agriculture and food security.

REFERENCES

Reed, B. M. (Ed.). (2008). *Plant cryopreservation: A practical guide* (p. 513). New York: Springer.

Watson, A., Ghosh, S., Williams, M. J., Cuddy, W. S., Simmonds, J., Rey, M. D., Asyraf Md Hatta, M., Hinchliffe, A., Steed, A., Reynolds, D. and Hickey, L. T. (2018). Speed breeding is a powerful tool to accelerate crop research and breeding. *Nature Plants*, 4(1), 23–29.

Zhang, Y., Liang, Z., Zong, Y., Wang, Y., Liu, J., Chen, K., Qiu, J.L. and Gao, C. (2016). Efficient and transgene-free genome editing in wheat through transient expression of CRISPR/Cas9 DNA or RNA. *Nature Communications*, 7(1), 12617.

How to cite:

Janapareddy R., Cirumalla M., and Reddy N. R. (2025). Seed Science in the 21st Century: From Genomes to Smart Systems. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 41-47.

*********XXXXX**********

Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

NEW GENERATION VETERINARY VACCINES

Sabarinath Thankappan*, Priyanka Mahadappa, Gnanavel Venkatesan

ICAR-Indian Veterinary Research Institute, Bengaluru campus, Karnataka, India

**Corresponding author email:* drsabari143ivri@gmail.com

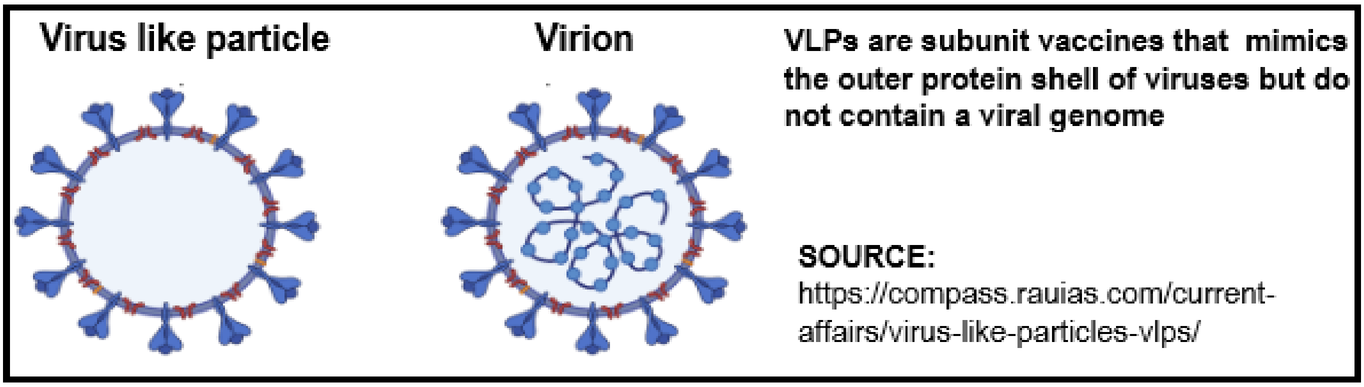
ABSTRACT

New generation vaccines such as Virus-like particles (VLPs), bacterial ghosts, Outer membrane vesicles (OMVs), and SRP technology have opened new vistas in vaccine development to curb infectious diseases in livestock. Unlike conventional vaccines, such as killed bacterial vaccines, bacterial ghosts are excellent alternatives because their antigenic components remain undenatured. VLPs act as modular vaccine platforms for several viral diseases since VLPs confer dense repeating protein arrays and conformational epitopes homogeneous to those of native viruses.

KEYWORDS: Artificial Seeds, CRISPR, Multi-Omics, Seed Enhancement Technologies, Seed Priming

VIRUS-LIKE PARTICLES (VLPs)

VLPs are subunit vaccines that closely imitate the outer protein shell of viruses. VLPs do not contain a viral genome and hence are non-infectious. VLPs possess the exact size and shape of native viruses. VLPs present the immune system with multiple viral epitopes in the precise conformation.



VLPs can activate helper T cells, can give rise to long-lived memory cells and induce a strong antibody response. VLPs stimulate dendritic cell activation and are efficiently taken up and processed by dendritic cells, and presentation of antigens is done using both MHC class I and class II molecules, which helps to prime both CD4+ and CD8+ T cells. This ability to target dendritic cells makes VLPs highly effective immunogens, which helps to circumvent the requirement of using adjuvants and hence VLPs can act as self-adjuvanting vaccines. Because of their immunogenicity, VLPs are needed in smaller doses when compared with conventional subunit vaccines and this reduces vaccine costs.

VLPs are currently produced using different expression systems such as *E. coli*, yeasts, mammalian cells or insect cells. Among the various production systems, the most promising is the one involving the use of insect cells to grow baculoviruses, which helps to co-express multiple viral proteins that are then allowed to self-assemble into VLPs.

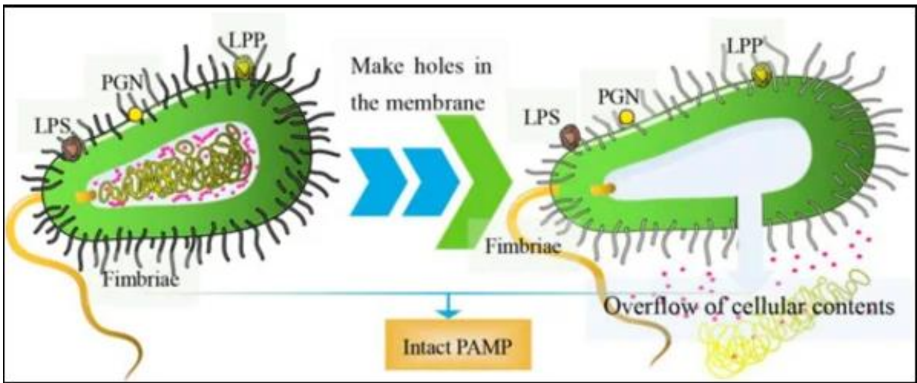
VLP-based vaccines have been produced against various veterinary virus pathogens such as caliciviruses, nodaviruses, and birnaviruses, all of which can form VLPs with just a single capsid protein. Nowadays, VLP-based vaccines have been developed against parvovirus, circovirus and Newcastle disease virus. Other noteworthy VLP-based veterinary vaccines include those against Avian Influenza and FMD virus.

Two VLP-based vaccines currently available for human use are hepatitis B VLPs and human papilloma VLPs. The hepatitis B VLPs utilise adjuvant system-4 to induce a Th1 response. This hepatitis B vaccine was the first human vaccine to use VLPs and is also credited as the first anticancer vaccine to utilise VLPs since hepatitis B can cause liver cancer.

BACTERIAL GHOSTS

Bacterial “ghosts” emanate from gram-negative bacteria and are basically empty cell envelopes. Bacterial “ghosts” have no cytoplasm and no chromosomal or plasmid DNA. Bacterial “ghosts” from *E. coli* are constructed using controlled expression of the cloned bacteriophage φX174 lysis gene *E.* Gene *E* codes for a 91 amino acid protein, and this protein fuses the inner and outer membranes of gram-negative bacteria to form a transmembrane pore through which bacterial cytoplasm escapes.

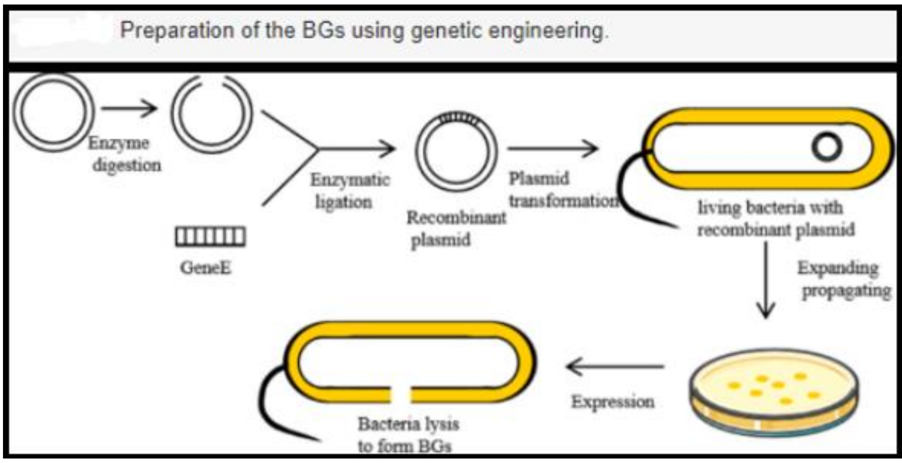
Protein E-specific lysis tunnel spans the inner (IM) and outer membrane (OM), which is located at membrane adhesion sites within the host cell. The bacterial ghosts contain no genetic information, since any remaining DNA is destroyed by the expression of cloned staphylococcal nuclease A in *E. coli*.



φX174 lysis gene *E* product fuses the inner & outer membranes of gram-negative bacteria & cause overflow of cellular contents

SOURCE: https://www.mdpi.com/1999-4923/13/11/1892

Because of their structure, they have intrinsic adjuvant activity and can induce both adaptive and innate immune responses.



Preparation of Bacterial Ghosts using genetic engineering

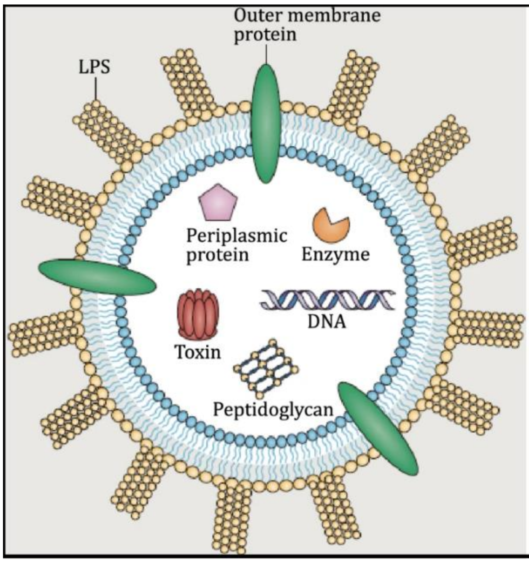
SOURCE: https://www.mdpi.com/1999-4923/13/11/1892

Bacterial ghost technology has been used against *Actinobacillus pleuropneumoniae.* When *Actinobacillus pleuropneumoniae* bacterial ghost was administered orally in pigs, it generated sterile immunity and cross-protection between serotypes. When given intramuscularly, it was protective, but did not induce sterile immunity. Bacterial Ghosts have also been generated successfully against *Pasteurella multocida* and *Mannheimia haemolytica*.

OUTER MEMBRANE VESICLES (OMVS)

Bacterial outer membrane vesicles are miniature membrane vesicles with huge vaccine potential. OMVs are globular particles having a diameter of 20-300 nm released by gram-negative bacteria. OMVs are generated by the budding out of the bacterial outer membrane and contain many bacterial outer membrane components. OMVs can induce strong immune responses as they are highly immunogenic. Bacteria can be engineered to increase vesicle production, reduce LPS toxicity and increase expression of protective antigens.

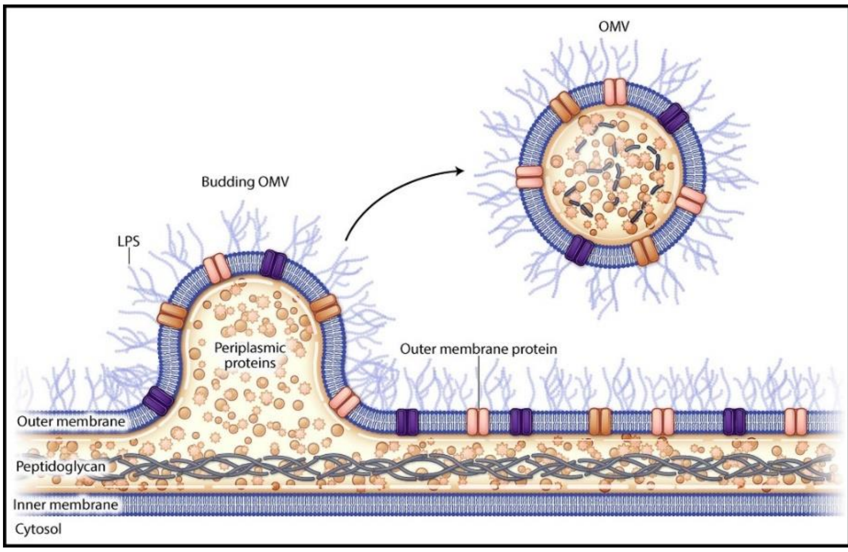
OMVs are readily phagocytosed by Antigen Processing Cells (APCs) and carry many Pathogen-Associated Molecular Patterns (PAMPs) including LPS, lipoproteins and peptidoglycans. OMVs induce a potent cell-mediated immune response (type 1 effector response). OMVs can be readily obtained in large quantities from culture supernatants. The main limitation of OMVs is their strain specificity.



Schematic diagram of bacterial outer membrane vesicle

SOURCE: https://link.springer.com/article/10.1007/s41048-019-00095-6/figures/1

An anti-Neisseria based OMV vaccine is commercially available for humans. Heterologous proteins of other species may be incorporated into OMVs. For example, *Leishmania* antigens have been incorporated into *E. coli* OMVs.

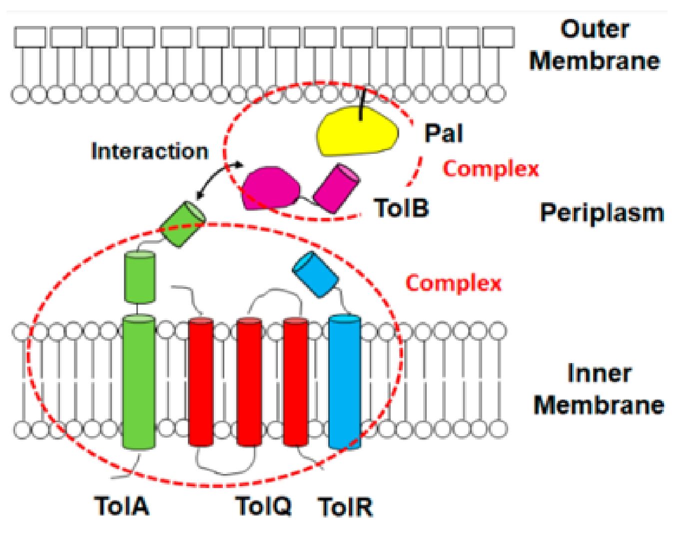


Outer membrane vesiculation occuring in a Gram-negative bacterial cell wall

SOURCE: https://www.frontiersin.org/files/Articles/1029146/fmicb-13-1029146-HTML-r1/image_m/fmicb-13-1029146-g001.jpg

GENETIC ENGINEERING IN INCREASING THE PRODUCTION OF OMVS

Tol-Pal system functioning affects the OMV production. TolR, TolQ and TolA proteins form an inner membrane complex. The C-terminal domain of the periplasmic TolB protein is associated with the outer membrane-associated Pal protein, while the N-terminal domain of TolB interacts with the C-terminal domain present on the TolA protein. The *tolB* mutant shows increased OMV release in several bacteria such as *S. typhimurium*, *E. coli*, and *H. pylori*.

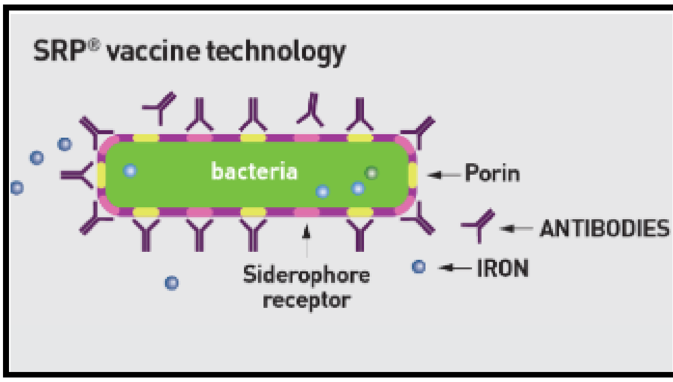


Structural representation of the Tol/Pal Protein complexes

SOURCE: https://www.mdpi.com/2076-393X/10/3/422

SRP VACCINE TECHNOLOGY

Iron is an essential growth factor for many pathogenic bacteria. Bacteria take up iron from their environment by the use of iron-binding proteins called Siderophores. Siderophores such as Enterobactin (Enterochelin) have such a high affinity for ferric iron that they can take it from the host's iron-binding proteins. Bacteria have a siderophore receptor (Porins) on their outer membrane that facilitates the transfer of this iron into the cell. Antibodies directed specifically against these siderophores or their cell surface receptors (porins) will effectively block bacterial iron acquisition and thus inhibit bacterial growth.



Siderophore receptors and porins (SRP) vaccine technology

SOURCE: https://vetovax.vetoquinol.ca/

If bacteria are cultured in a low-iron environment, they express increased quantities of their iron acquisition proteins. These can be harvested, and the siderophore receptors and porins (SRP) can be purified, and these purified proteins can be used in vaccines.

VETERINARY VACCINES BASED ON SRP VACCINE TECHNOLOGY

E. Coli bacterial extract, made with SRP technology, is the only USDA-licensed vaccine approved to reduce *E. coli* O157 prevalence in cattle. This vaccine is effective for vaccination of healthy cattle, ≥ 5 months of age, against *E. coli* O157.

Salmonellosis is responsible for acute diarrhoea in calves and multisystemic illness in adult cattle. Salmonellae are transmitted to humans through meat/milk products. Therefore, it is important to control Salmonella-mediated disease in addition to the shedding of these organisms in cattle. SRP vaccine licensed by USDA reduces shedding of serotype Newport in dairy cattle and is available in USA/Canada for vaccination of cattle at ≥ six months of age.

SRP vaccination of cattle at ≥ 22 months against mastitis caused by *Klebsiella pneumoniae* has been shown to reduce mastitis prevalence in the vaccinated herd. SRP vaccination of layer/broiler breeder chickens is an innovative option for Fowl Cholera as it protects poultry against mortality and improves livability in flocks affected by fowl cholera.

VETERINARY VACCINES BASED ON SRP VACCINE TECHNOLOGY

SOURCES: https://vaxxinova.us.com/cattle/e-coli-o157/
https://vaxxinova.us.com/cattle/salmonella-srp/
https://vaxxinova.us.com/cattle/vaxxon-srp-klebsiella/
https://vaxxinova.us.com/poultry/vaxxon-srp-pasteurella/

CONCLUSION

Novel vaccine technologies, such as SRP vaccine technology, hold promise against several egregious diseases in livestock and poultry. Nowadays, refinement in Outer Membrane Vesicles, such as the knock-out of *msbB* and *lpxL1* genes, has significantly decreased the level of LPS endotoxin in OMVs, which has led to the generation of OMVs with low toxicity and high safety.

REFERENCES

Chen, H., Ji, H., Kong, X., Lei, P., Yang, Q., Wu, W., Jin, L., & Sun, D. (2021). Bacterial Ghosts-Based Vaccine and Drug Delivery Systems. *Pharmaceutics*, *13*(11), 1892. https://doi.org/10.3390/pharmaceutics13111892

Dairy Cow Vaccine Line | Vetovax. (2018). Vetoquinol.ca. https://vetovax.vetoquinol.ca/

Hirakawa, H., Suzue, K., & Tomita, H. (2022). Roles of the Tol/Pal System in Bacterial Pathogenesis and Its Application to Antibacterial Therapy. *Vaccines*, *10*(3), 422. https://doi.org/10.3390/vaccines10030422

Lieberman, L. A. (2022). Outer membrane vesicles: A bacterial-derived vaccination system. *Frontiers in Microbiology*, *13*. https://doi.org/10.3389/fmicb.2022.1029146

Qing, G., Gong, N., Chen, X., Chen, J., Zhang, H., Wang, Y., Wang, R., Zhang, S., Zhang, Z., Zhao, X., Luo, Y., & Liang, X.-J. (2019). Natural and engineered bacterial outer membrane vesicles. *Biophysics Reports*, *5*(4), 184–198. https://doi.org/10.1007/s41048-019-00095-6

Virus-like particles (VLPs) - Rau's IAS. (2024, June 5). Compass by Rau's IAS. https://compass.rauias.com/current-affairs/virus-like-particles-vlps/

How to cite:

Thankappan S., Mahadappa P., and Gnanavel V. (2025). New generation veterinary vaccines. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 48-54.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

BREEDING STRATEGIES OF BASMATI RICE (*Oryza Sativa* L.) FOR MULTIPLE DISEASE RESISTANCE

Supratim Sadhu*, Rahul Nandi

Faculty of Agriculture, JIS University, Agarpara, Kolkata, West Bengal-700109, India

**Corresponding author email:* supratim.sadhu@jisuniversity.ac.in

ABSTRACT

Dwarfism (sd-1) from Pusa-1121 was combined with Khalsa-7's scent and disease resistance into a Type-3 basmati background. Plants devoid of common rice illnesses were chosen by screening the dwarf segregants of the cross (Khalsa 7 × Pusa 1121) with Type-3 under artificially produced epiphytotic conditions. All India Coordinated Research Project (AICRP) trials were utilized to demonstrate yield and physical requirements of quality traits that are acceptable in world trade. Although breeders have been using biotechnology tools to increase their breeding capacity, many programs are still having trouble integrating them and balancing the distribution of resources between traditional and new technologies.

KEYWORDS: Backcrossing, Basmati rice, BLB, Marker-assisted breeding, Resistance

INTRODUCTION

The entire traditional basmati growing area under India's Geographical Indication (GI) has been designated as an Agri-Export Zone for Basmati rice by the Indian government in order to promote production of the commodity and improve the socioeconomic conditions of the local farmers due to the high demand for basmati rice on the domestic and international markets at premium prices. Traditional basmati rice cultivars are resilient, photosensitive, and vulnerable to all local rice diseases (Singh *et al.*, 2000). Due to their thin stems and height, these types also fall under high input agriculture, which lowers yield and degrades quality. Thus, extra attention must be paid to the development of dwarf, short-duration, photo-insensitive, and disease-resistant kinds of basmati rice. In light of this, the review involves various breeding strategies for multiple diseases resistance.

MAJOR DISEASES AFFECTED BASMATI RICE

Various diseases affected Basmati rice include:

1. Bacterial leaf blight
2. Rice blast
3. Rice tungro disease

4. Sheath blight

BREEDING APPROACHES FOR MULTIPLE DISEASE RESISTANCE

1. MOLECULAR MARKER-ASSISTED BREEDING

From one varietal background to another, a large number of genes for resistance to disease and insects are frequently transferred. Transferring most genes takes time and requires dominant or recessive behaviour. Occasionally, the screening processes are costly, time-consuming, and space-intensive. Transferring these genes from one varietal background to another can save time and money if they can be identified by close association with molecular markers. Rice blast, which is caused by the fungus *Pyricularia oryzae*, and bacterial blight, which is caused by *Xanthomonas oryzae pv. oryzae* are two of the most dangerous and pervasive diseases in rice cultivation. International Rice Research Institute (IRRI) is working together to use molecular marker technologies to develop long-term resistance to certain illnesses.

The backcrossing of a gene or QTL from exotic cultivars or wild relatives into an elite cultivar or breeding line was accelerated using molecular markers. Backcrossing to elite cultivars of rice has revealed the presence of favoured genes or alleles from wild species (Moncada, 2001). Likewise, this method could detect genes from foreign cultivars that provide a better phenotype, even if the parent may not have a worse phenotype for this characteristic. This strategy seems to be promising in the rice industry as some cultivars are widely cultivated due to their adaptability, consistent performance, and good grain quality.

2. GENETIC ENGINEERING

The simplicity, ease of use, and versatility of the CRISPR-Cas9 system have made it the preferred approach for genome editing. By using DNA's complementary base pairing mechanism, this technique directs site-specific Cas9 endonuclease to the intended location. Following template screening, the guide RNA (gRNA) identifies the precise complementary target sequence and instructs Cas9 to create a double strand break (DSB) at the target location. It is necessary for Cas9 to introduce a double strand break (DSB) 3-bp upstream of the protospacer-associated motif (PAM), which is a triplet of nucleotides (NGG) at the 3′ end of the target site. According to (Barrangou *et al.*, 2007), these DSBs are fixed by either template-guided precise homology directed repair (HDR) or imprecise non-homologous end joining (NHEJ). As of right now, this method has shown effectiveness in enhancing agronomic traits and engineering resistance against a variety of diseases.

3. POLYMERASE CHAIN REACTION

Blast resistance was found in the genotype Vallabh Basmati-21 using PCR products employing random amplified polymorphic DNA (RAPD) and sequence characterized amplified regions (SCAR) markers.

The genealogy with historic types of basmati rice was evaluated for the Basmati type, disease-resistant, and promising selections.

4. CONVENTIONAL BREEDING

Disease-resistant Basmati rice cultivars are created using traditional breeding techniques such as recurrent selection, backcrossing, and pedigree selection. By means of repeated crosses and selections, these techniques aim to introduce resistance genes from donor plants into Basmati rice. The use of marker-assisted selection (MAS) to lessen linkage drag and promote the transmission of resistance genes is also growing.

A. Pedigree method

Pedigree choice is the method most frequently used to breed for disease resistance. Using this method, the individual plant life from the F_2 generation is selected for resistance by crossing parents (one with the resistance trait and some with specific agronomic qualities). These options are permitted to provide seed for the next generation. With each new technology, the selection process is repeated, and until homozygosity is achieved, a higher proportion of resistant plant life is obtained. The majority population choice technique bulks early separating generations typically F_2 to F_5 collectively without giving them a choice. In subsequent generations, when the majority of plant life is homozygous, male or female plants are selected for resistance, and their offspring are assessed for resistance using the pedigree technique.

B. Backcrossing

Another popular method for interrogating or replacing the desired gene from donor parent to the recipient parent in rice breeding is backcrossing. The primary purpose of the backcrossing procedure is to reduce the amount of donor genetic material in the offspring. Recurrent selection is another well-established breeding technique for disease management in rice, in addition to backcross breeding (Fujimaki, 1979). In addition to offering the chance to create a wide variety of genetic diversity in breeding lines, it permits shorter breeding cycles and more focused monitoring of genetic improvements. Recurrent selection is used to create many blast-resistant cultivars, including the upland variety CG-91.

5. TRANSGENICS

A highly effective strategy for increasing the gene pool of commercial cultivars is the genetic transformation approach, which can transfer particular genes from chosen sources to cultivated species. For *R* genes in rice, the transgenic method has proven to be highly effective in avoiding time-consuming and laborious backcrossing. Given its tiny genome, enriched genetic map, and accessibility to the complete genome sequence, rice is arguably the monocot most suitable for genetic transformation (Kathuria *et al.*, 2007).

In plants, antimicrobial peptide genes have also been demonstrated to act as resistance genes. In multiple studies, transgenic plants that carry genes for antimicrobial traits have a markedly increased resistance to bacterial and fungal infections. The main problems with transgenic techniques for disease resistance breeding include transgene silencing, instability, and rearrangements, which are frequently seen in transgenic plants; as a result, thorough evaluations are required because these are deemed to be extremely undesirable. The ultimate goal of transgenic techniques is to locate and modify plant genes that increase disease resistance without materially compromising production.

ACHIEVEMENTS

1. Using genes like *Pi1*, *Pi2*, and *Pi54*, rice lines resistant to blast disease are developed.
2. Multiple disease resistance genes in peak Basmati cultivars are efficiently pyramided.
3. Basmati varieties with better yield stability under disease pressure.
4. Increased potential for exports and farmer income as a result of consistent quality and yield.
5. Utilizing genomic selection and QTL mapping, disease resistance characteristics are found and monitored.
6. India's leadership in Basmati rice breeding is recognized through global collaborations (e.g., IRRI).
7. Decreased reliance on fungicides and insecticides as a result of inherent resistance

FUTURE PROSPECTS

1. Pan-genomics and transcriptomics are used to find new genes.
2. Combining phenomics with artificial intelligence for high-throughput screening.
3. Breeding techniques that adapt to the climate.
4. To guarantee adoption, farmers participate in breeding.
5. Machine learning models are used to forecast disease outbreaks and direct breeding decisions.
6. To guarantee local acceptability and adaptability, farmers should be involved in variety selection.
7. Persistent application of various resistance genes (e.g., *Xa*, *Pi*, *qSBR*) in conjunction using marker-assisted selection (MAS).

CONCLUSION

Through the integration of conventional breeding, molecular tools, and biotechnological approaches, breeding tactics for producing Basmati rice (*Oryza sativa* L.) with various disease resistance have evolved dramatically over the past few decades. While maintaining the distinctive quality characteristics of

Basmati rice, researchers have made significant strides in improving resistance against important rice diseases like bacterial blight, blast, and sheath blight through the use of marker-assisted selection, gene pyramiding, and genomic selection. The formation of novel pathogen races and the intricate inheritance of resistance traits are two obstacles that still exist in spite of these advancements. Prospects for the future include using state-of-the-art technologies such as pan-genomics, high-throughput phenotyping, and CRISPR/Cas9 to create long-lasting, broad-spectrum disease-resistant Basmati cultivars. Maintaining sustainable rice production and food security will need ongoing co-operation between breeders, pathologists, and biotechnologists.

REFERENCES

Barrangou, R., Fremaux, C., Deveau, H., Richards, M., Boyaval, P., Moineau, S. and Horvath, P. (2007). CRISPR provides acquired resistance against viruses in prokaryotes. *Science*, 315(5819):1709-1712.

Fujimaki, H. (1979). Recurrent selection by using genetic male sterility for rice improvement. JARQ (Tsukuba), **13**(3):153-156.

Kathuria, H., Giri, J., Tyagi, H., and Tyagi, A. K. (2007). Advances in transgenic rice biotechnology. *Critical reviews in plant sciences*, **26**(2):65-103.

Moncada, P., Martinez, C. P., Borrero, J., Châtel, M., Gauch Jr, H., Guimaraes, E., and McCouch, S. R. (2001). Quantitative trait loci for yield and yield components in an *Oryza sativa* X *Oryza rufipogon* BC2F2 population evaluated in an upland environment. *Theoretical and applied genetics*, 102:41-52.

Singh, R. K., Singh, U. S., and Khush, G. S. (2000). Aromatic rice. International Rice Research Institute. Oxford and IBH Publishing Co Pvt Ltd, New Delhi.

How to cite:

Sadhu S. and Nandi R. (2025). Breeding Strategies of Basmati Rice (*Oryza sativa* L.) for Multiple Disease Resistance. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 55-59.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

MANAGEMENT OF RESPIRATORY DISEASES IN CHICKENS

Asok Kumar Mariappan*, Megha Sharma, Rahul Singh

Avian Diseases Section, Division of Pathology, ICAR-IVRI, Izatnagar,

Bareilly Uttar Pradesh- 243122, India

**Corresponding author email:* drasokvet@gmail.com

ABSTRACT

Respiratory diseases in chickens significantly impact poultry health and productivity, resulting in high mortality and considerable economic losses. These conditions are triggered by a variety of infectious agents, including viruses, bacteria, and fungi, as well as by environmental stressors. This article discusses the most prevalent respiratory diseases in poultry—such as Infectious Bronchitis, Newcastle Disease, Avian Influenza, Mycoplasmosis, and Infectious Coryza—highlighting their causes, clinical signs, diagnostic methods, and control measures. Emphasis is placed on integrated disease management approaches, including vaccination, biosecurity, environmental regulation, and nutritional support, aiming to mitigate disease spread and improve flock resilience and productivity in poultry farms.

KEYWORDS: Biosecurity, Disease management, Poultry health, Respiratory diseases, Vaccination

INTRODUCTION

Respiratory diseases in chickens are a major concern in poultry farming due to their high morbidity and mortality rates, resulting in substantial economic losses. These diseases are caused by a range of pathogens, including viruses, bacteria, and fungi, as well as environmental stressors such as poor ventilation and overcrowding. Effective disease management requires a combination of preventive strategies, early detection, timely treatment, and robust biosecurity practices. This article presents an overview of the most common respiratory diseases affecting chickens, outlining their etiology, clinical manifestations, diagnostic techniques, treatment protocols, and prevention strategies, supported by scientific literature.

COMMON RESPIRATORY DISEASES IN CHICKENS

1. Infectious Bronchitis (IB)

Cause: Infectious Bronchitis is caused by the Infectious Bronchitis Virus (IBV), a coronavirus that primarily targets the respiratory tract but can also affect the kidneys and reproductive system (Jackwood and de Wit, 2020).

Clinical Signs:

- Sneezing, coughing, nasal discharge
- Watery eyes, swollen sinuses
- Reduced egg production, poor eggshell quality in layers
- High mortality in young chicks (Cavanagh & Gelb, 2008)

Diagnosis:

- PCR (Polymerase Chain Reaction)
- Serological tests such as ELISA
- Virus isolation

Treatment & Prevention:

- No specific antiviral treatment; supportive care includes antibiotics to prevent secondary bacterial infections
- Vaccination with live and inactivated vaccines
- Implementation of strict biosecurity protocols (Jackwood & de Wit, 2020)

2. Newcastle Disease (ND)

Cause: Newcastle Disease is caused by the Newcastle Disease Virus (NDV), an avian paramyxovirus (APMV-1), known for its high contagion and outbreak potential (Miller & Koch, 2020).

Clinical Signs:

- Respiratory distress: gasping, coughing
- Neurological symptoms: neck twisting, paralysis
- Greenish diarrhea
- Sudden mortality in severe cases (Alexander, 2000)

Diagnosis:

- Hemagglutination inhibition (HI) test
- RT-PCR for viral RNA
- Postmortem: hemorrhages in trachea and intestines

Treatment & Prevention:

- No cure; affected birds are culled
- Vaccination using LaSota strain and inactivated vaccines
- Quarantine and restriction of bird movement (Miller & Koch, 2020)

3. Avian Influenza (AI)

Cause: Avian Influenza is caused by the Influenza A virus, with strains classified as either highly pathogenic (HPAI) or low pathogenic (LPAI) (Swayne, 2020).

Clinical Signs:

- Facial swelling, comb cyanosis
- Severe respiratory difficulty
- Sudden death in HPAI cases
- Decline in egg production

Diagnosis:

- Virus isolation
- RT-PCR
- Serological tests (AGID, ELISA)

Treatment & Prevention:

- No treatment; affected flocks are culled
- Vigilant biosecurity and national surveillance
- Vaccination in endemic regions (Swayne, 2020)

4. Mycoplasmosis (Chronic Respiratory Disease - CRD)

Cause: Caused by *Mycoplasma gallisepticum* (MG), a common respiratory pathogen in poultry (Ley, 2008).

Clinical Signs:

- Chronic coughing, nasal discharge
- Swollen sinuses
- Decreased growth and egg production

Diagnosis:

- ELISA serological tests
- PCR diagnostics
- Culture and organism isolation

Treatment & Prevention:

- Antibiotic therapy (tylosin, tetracyclines, enrofloxacin)
- Vaccination (live and inactivated)
- All-in/all-out management systems to prevent spread (Ley, 2008)

5. Infectious Coryza

Cause: Caused by *Avibacterium paragallinarum* (formerly *Haemophilus paragallinarum*) (Blackall, 2020).

Clinical Signs:

- Facial swelling, foul-smelling nasal discharge
- Conjunctivitis
- Poor feed intake

Diagnosis:

- Bacterial culture from nasal exudate
- PCR assays

Treatment & Prevention:

- Antibiotics such as erythromycin and sulfonamides
- Vaccination with inactivated bacterins
- Improved ventilation and hygiene (Blackall, 2020)

GENERAL MANAGEMENT STRATEGIES FOR RESPIRATORY DISEASES

1. Biosecurity Measures

- **Farm Isolation**: Limit visitor access and isolate new flocks
- **Sanitation**: Regular disinfection of housing, tools, and clothing
- **Pest Control**: Rodents and wild birds should be excluded to prevent disease transmission (FAO, 2021)

2. Vaccination Programs

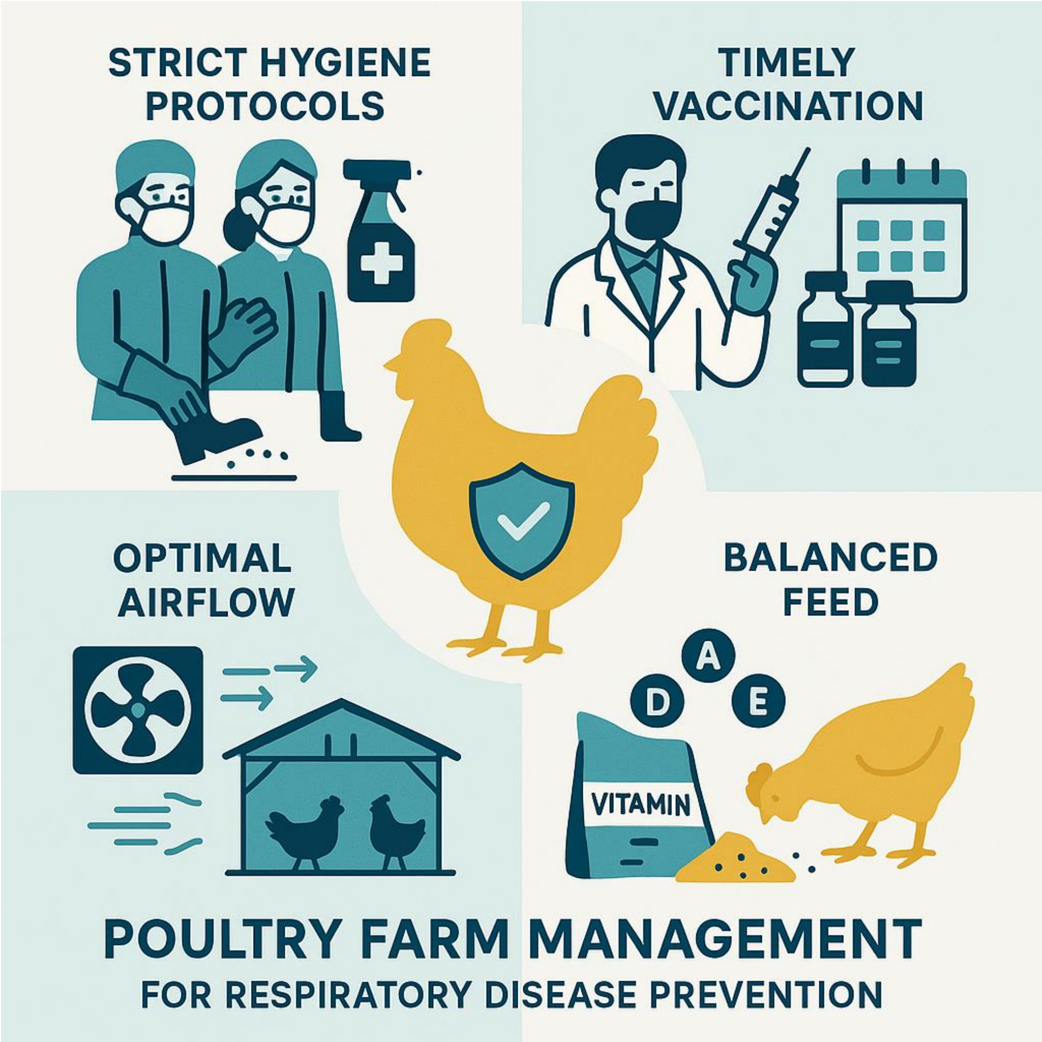
- **Live Vaccines**: Offer fast-acting immunity for diseases like IB and ND
- **Inactivated Vaccines**: Preferred for layers and breeders for long-term protection (OIE, 2022)

3. Environmental Management

- **Ventilation**: Adequate airflow reduces ammonia and respiratory stress
- **Litter Quality**: Dry, clean bedding reduces bacterial and fungal proliferation (Dunlop et al., 2016)

4. Nutritional Support

- **Vitamin Supplementation**: Vitamins A, C, and E enhance immunity
- **Probiotics**: Improve gut health and resistance to infections (Dhama et al., 2018)



CONCLUSION

Respiratory diseases remain a critical challenge in poultry production, significantly affecting health, welfare, and farm economics. Effective management relies on comprehensive strategies, including routine vaccination, strict biosecurity, improved housing conditions, and nutritional supplementation. Prompt identification and control measures are essential to prevent the rapid spread of infections. Continuous research and innovation in vaccines, diagnostic tools, and antibiotic alternatives are vital to sustaining poultry health and productivity.

REFERENCES

Alexander, D. J. (2000). Newcastle disease and other avian paramyxoviruses. *Revue Scientifique et Technique*, 19(2), 443-462.

Blackall, P. J. (2020). Infectious coryza: Overview and vaccine development. *Avian Pathology*, 49(3), 227-235.

Cavanagh, D., and Gelb, J. (2008). Infectious bronchitis virus: Trends in vaccine development. *Avian Diseases*, 52(1), 1-8.

Dhama, K., et al. (2018). Probiotics in poultry production: Mechanisms of action and applications. *Journal of Animal Science*, 96(6), 1-15.

Dunlop, M. W., et al. (2016). Ammonia and respiratory disease in poultry. Poultry Science, 95(5), 1013-1018.

FAO. (2021). *Biosecurity guidelines for poultry production*. Food and Agriculture Organization.

Jackwood, M. W., & de Wit, S. (2020). *Infectious bronchitis virus variants and vaccination strategies*. Avian Diseases, 64(2), 1-10.

Ley, D. H. (2008). *Mycoplasma gallisepticum infection in poultry*. Avian Diseases, 52(3), 367-374.

Miller, P. J., & Koch, G. (2020). *Newcastle disease virus: Evolution and vaccination*. Viruses, 12(5), 500.

OIE. (2022). *Manual of diagnostic tests and vaccines for terrestrial animals*. World Organisation for Animal Health.

Swayne, D. E. (2020). *Avian influenza: Control strategies and vaccination*. Avian Diseases, 64(2), 1-10.

How to cite:

Mariappan A.K., Sharma M, and Singh R. (2025). Management of respiratory diseases in chickens. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 60-65.

*********XXXXX**********

Agri JOURNAL WORLD

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

CONTRIBUTIONS OF IVRI IN VETERINARY VACCINE DEVELOPMENT AND DISEASE ERADICATION IN INDIA

Sabarinath Thankappan*, Priyanka Mahadappa, Gnanavel Venkatesan

ICAR-Indian Veterinary Research Institute, Bengaluru campus, Karnataka, India

*Corresponding author email: drsabari143ivri@gmail.com

ABSTRACT

Indian Veterinary Research Institute (IVRI) has made immense contributions to veterinary vaccine development in India. IVRI has made indigenous vaccines at an affordable cost, which are highly efficacious under field conditions and has reduced the disease incidence in India. Further, the veterinary indigenous vaccines developed by IVRI have also substantially reduced the import burden of overseas vaccines and have contributed immensely to the national exchequer. Moreover, IVRI has played a pivotal role in the eradication of nefarious diseases such as Rinderpest and Contagious Bovine Pleuropneumonia (CBPP).

KEYWORDS: Disease eradication, Livestock health management,Veterinary vaccines

CONTRIBUTION OF IVRI IN VETERINARY VACCINE PRODUCTION IN INDIA

1. IMPROVED BOVINE BRUCELLOSIS VACCINE

The deletion of the perosamine synthetase gene (per gene) from the conventional Brucella vaccine, S19 led to the development of *Brucella abortus* S19 Δper vaccine by IVRI scientists. This improved vaccine is highly stable, possesses DIVA capability and provides protection levels similar to S19. By deleting the perosamine synthetase gene, which is integral for LPS biosynthesis and replaced this gene with a kanamycin marker in the S19 backbone, the improved version of the bovine brucellosis vaccine was created.

2. LUMPY SKIN DISEASE (LSD) VACCINE

LSD Vaccine (Lumpi-provac Ind) provides absolute protection against virulent LSDV challenge. LSDV virus formulated in the vaccine was first isolated from LSD infected cattle from Ranchi in 2019. The vero cell line-based LSDV virus attenuated by 50 passages was used as a vaccine. A single dose of the LSD vaccine comprises of $10^{3.5}$ $TCID_{50}$ of live-attenuated LSD virus (LSDV/2019/India/Ranchi).

3. CLASSICAL SWINE FEVER VACCINE

An indigenous live attenuated CSF Cell Culture Vaccine has been developed using an Indian field isolate. The most remarkable feature of this vaccine is its very high titre ($1x10^{9.5}$ $TCID_{50}$/ml). Due to its high titre, a large multitude of vaccine doses (approximately 6 million) can be comfortably produced from only one 75 cm^2 tissue culture flask. The annual requirement of India (22 million doses) can be prepared in just four 75cm^2 tissue culture flasks. This is the most frugal CSF cell culture vaccine available at less than Rs 2/- per dose.

4. INFECTIOUS BURSAL DISEASE SUBVIRAL PARTICLE-BASED VACCINE

SVP-Gumboro Vac is a subviral particle-based IBD vaccine. This recombinant vaccine intended for use against IBD consists of IBDV major capsid protein VP2 expressed in yeast. This sub-viral particle-based vaccine protects day-old broiler chicks in the presence of maternal antibodies. Moreover, this vaccine does not cause immunosuppression, as has been demonstrated by an intact histological architecture of the Bursa of Fabricius in immunized birds.

5. INDIGENOUS PPR VACCINE

PPR vaccine (PPRV/Sungri/96 strain), a Vero cell-based live-attenuated vaccine, was developed at ICAR-IVRI in 2002 and has a shelf-life of 1 year at 4°C in the freeze-dried form. The recommended dose of PPR vaccine is 1.0 ml (containing $10^{2.5}$ $TCID_{50}$ per animal inoculated by subcutaneous route at the mid-neck region. This vaccine technology has been transferred to Hester Biosciences Ltd, Indian Immunologicals Ltd., and Brilliant Bio Pharma Pvt. Ltd and Biomed Pvt. Ltd. Two hundred million doses of PPR vaccine have been produced by the companies after acquiring this technology from ICAR-IVRI.

6. LIVE ATTENUATED VERO CELL-ADAPTED GOATPOX VACCINE

A live attenuated goatpox vaccine, indigenously developed by IVRI, is presently used in the goat population for the immunization against goatpox virus, an egregious viral pathogen of caprines. This vaccine has huge commercial potential for control and possible eradication of goatpox in the endemic regions, which include not only India but countries in Central Asia, the Middle East, Northern and Central Africa. Extensive use of this vaccine will notably reduce the disease incidence, contributing to the augmented small ruminant productivity.

7. LIVE ATTENUATED VERO CELL-ADAPTED SHEEPPOX VACCINE (SPPV)

The exotic RF vaccine strain available presently for preventive vaccination in the Indian sheep population has been replaced by the indigenous sheeppox virus strain [SPPV Srin 38/00] developed by IVRI. This vaccine has been adapted to grow in the Vero cell line.

8. LIVE ATTENUATED VERO CELL-ADAPTED BUFFALO POX VACCINE

A live-attenuated vero cell adapted Buffalopox vaccine has been developed using an indigenous Vij96 strain isolate by 50 passages in Vero cell lines for the control of buffalopox. This vaccine is highly efficacious in the control of buffalo pox infection in endemic areas of India. The indigenous Vij96 strain-based buffalo pox vaccine has been assessed both in-house and at field conditions.

9. INACTIVATED VERO CELL-BASED JAPANESE ENCEPHALITIS VACCINE

The indigenous inactivated vero cell culture-adapted Japanese encephalitis vaccine derived from an Indian JEV isolate (JEV/SW/IVRI/395A/2014) is expected to protect the pigs from the JEV prevalent region in India.

10. LIVE ATTENUATED DUCK PLAGUE VACCINE

A live attenuated cell culture-based duck plague vaccine has been formulated by attenuating an Indian DPV isolate (DPvac/IVRI-19) in Chicken embryo fibroblast

cell culture. The titre of the duck plague vaccine virus is $10^{7.5}$ $TCID_{50}$/ml, and approximately 1.5 lakh doses can be produced utilizing one 75 cm^2 culture flask, which is compliant for industrial-scale mass production as it is cheap and economical.

CONTRIBUTION OF IVRI IN RINDERPEST ERADICATION

The Imperial Bacteriological Laboratory (IBL) was shifted from Pune to Mukteswar in 1893 with Rinderpest as the primary target for its research efforts. Anti-RP serum was developed in 1899 at IVRI, Mukteswar, and this serum was utilized for passive immunization against Rinderpest. J.T. Edward (Director at IBL, Mukteswar) developed the Goat attenuated Rinderpest vaccine by serial passages (600 times) in goats in 1927, and this vaccine provided long-lasting immunity against rinderpest in cattle & buffaloes without any side effects. This Goat Tissue-adapted Virus (GTV) caprinized vaccine conferred life-long immunity to Rinderpest. The GTV vaccine developed by J.T. Edward at IVRI, Mukteswar, was the first vaccine for Rinderpest for the whole world. In 1967, IVRI started the production & supply of Tissue Culture Rinderpest (TCRP) vaccine. The Unveiling of the commemorative “Global Rinderpest Eradication Memorial” at IVRI, Mukteswar, took place in 2012.

CONTRIBUTION OF IVRI IN CBPP ERADICATION IN INDIA

T1/44, a Tanzanian strain which was egg-passaged 44 times, was sufficiently attenuated to protect cattle without post-vaccinal severe reactions was extensively employed to eradicate CBPP in India. To obtain provisional freedom from CBPP decreed by the WOAH, a program was undertaken in 2001 by DAHD in collaboration with IVRI & Department of Veterinary and Animal Husbandry, Government of Assam. Cattle sera and tissue samples were tested for both the antibodies and the bacterial pathogen, which was done together by Mycoplasma Laboratory, IVRI, Izatnagar and by the CBPP laboratory, Khanapara. India was declared provisionally free from the CBPP in October 2003, as no CBPP cases were detected during this investigation. As per OIE resolution number 17, the WOAH declared India free from CBPP infection on 26 May 2007.

CONCLUSION

The significant contributions of IVRI to veterinary vaccine development and disease eradication have made intensive livestock and poultry production possible in India. The combined PPR-Goatpox vaccine in caprines and PPR-Sheeppox vaccine in ovines launched by IVRI is expected to increase the profitability of small ruminant husbandry. Further, IVRI is expected to play a pivotal role in the eradication of nefarious diseases such as Peste des Petits Ruminants (PPR) in line with the ambitious PPR Global Eradication Programme launched by the FAO by 2030.

REFERENCES

IVRI technologies. Vaccines developed by ICAR-IVRI. Retrieved from https://www.ivri.nic.in/Technologies/Vaccines.aspx

Yadav, M. P. (2011). Laboratory Contributions for Rinderpest Eradication in India

---

How to cite:

Thankappan S., Mahadappa P., and Gnanavel V. (2025). Contributions of IVRI in veterinary vaccine development and disease eradication in India. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 66-69.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

BLENDING FOR BETTER HEALTH: CREATING NUTRITIONALLY BALANCED EDIBLE OILS

Prathap V*

ICAR-Indian Institute of Oil Palm Research, Pedavegi-534450, Eluru District, Andhra Pradesh, India

**Corresponding author email:* prathubiochem07@gmail.com

ABSTRACT

Most vegetable oils, nutritionally valuable, but not ideal in their original forms due to imbalanced fatty acid compositions. Considering this limitation, a new approach was explored that involved the blending of palm oil with sunflower and groundnut oils to achieve a healthier fat profile. The goal was to create blends that align with the World Health Organization's (WHO) recommended ratio of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA), which is 1:1.3:1. The resulting oil blends not only matched this target but also brought together antioxidant-rich palm oil with the heart-healthy traits of sunflower and groundnut oil. This blending strategy offers a promising solution for both everyday cooking and nutritional interventions aimed at promoting public health.

KEYWORDS: Cardiovascular nutrition, Edible oil blending, Fatty acid balance

INTRODUCTION: A NEW WAY OF THINKING ABOUT OILS

In Indian households, oil is not merely just a cooking medium, it's central to taste, tradition, and nourishment. Yet behind the scenes, scientists and health experts have long been grappling with a fundamental challenge: no single oil offers the perfect nutritional balance. Vegetable oils like sunflower, groundnut, and palm oil each have their own benefits. Sunflower oil is high in polyunsaturated fats, groundnut oil is rich in monounsaturated fats, and palm oil brings oxidative stability and natural antioxidants to the table. However, none of them meet the ideal fatty acid ratio recommended for long-term cardiovascular and metabolic health. So, what if we could create an oil that offers the best of all worlds? That question led to an innovative yet simple idea: blending oils to achieve balance.

UNDERSTANDING THE IDEAL OIL

According to WHO (2008), a healthy oil should contain a fatty acid ratio of SFA: MUFA: PUFA = 1:1.3:1. Additionally, the balance between omega-6 (linoleic acid) and omega-3 (linolenic acid) fatty acids is crucial to prevent lifestyle disorders such as cardiovascular disease, obesity, and diabetes. No single oil naturally adheres to all these nutritional criteria. Palm oil, although often debated for its saturated fat content, primarily contains palmitic acid, which is less cholesterol-raising compared to lauric or myristic acids. It also offers a high level of carotenoids (500–700 ppm) and tocotrienols, which provide antioxidant benefits and support cardiovascular and liver health. Its semi-solid nature also makes it suitable for baked and fried goods. Sunflower oil, favoured for its light taste and long shelf life, contains about 60% polyunsaturated fats, making it excellent for heart health. Groundnut oil, widely used in Indian cooking, contributes a rich amount of monounsaturated fats (around 46%) and offers oxidative stability during frying.

Table 1. Nutritional profile of palm, sunflower and ground oils

Oil	Carotene (mg/kg)	Tocopherol (mg/kg)	SFA (%)	MUFA (%)	PUFA (%)	Cost as of 2023 (Rs)
Palm oil	500-700	11.5-37	49.3	37	9.3	95
Groundnut oil	0-8	149-191	16.9	46.2	32	196
Sunflower oil	0-8	41-72	10.3	19.5	65.7	115

CRAFTING THE RIGHT BLENDS

The journey of formulation began with experimental blending of palm oil with sunflower and groundnut oils in various ratios to match WHO guidelines. Two combinations stood out:

- A 60:40 blend of palm oil and sunflower oil resulted in a fatty acid ratio of 1:1.39:1.03 (SFA: MUFA: PUFA), with 23.32% palmitic, 42.91% oleic, and 26.88% linoleic acid, very close to the ideal profile (Prathap *et al.*, 2025).
- A 50:50 blend of palm oil and groundnut oil offered a profile of 31.08% saturated, 43.86% monounsaturated, and 22.36% polyunsaturated fats, resulting in a ratio of 1:1.6:1.01, again aligning well with WHO's recommendation (Prathap *et al.*, 2025).

These blends weren't just nutritionally sound, they also held up under cooking conditions, making them practical for household and commercial use.

BROADER HEALTH AND ECONOMIC RELEVANCE

Such scientifically developed oil blends can play a key role in dietary interventions. The presence of beta-carotene in palm oil makes these blends potentially useful for public health programs, especially those aimed at preventing vitamin A deficiency in children. In terms of cost, palm oil remains one of the most affordable edible oils, making the blend an economically viable option as well. Moreover, these blends can be incorporated into a variety of processed foods from frying oils and margarine to bakery shortenings and ready-to-eat snacks, bringing better health outcomes without sacrificing flavour or texture.

CONCLUSION

This exploration into oil blending reveals a practical, science-backed solution to a longstanding nutritional challenge. By combining palm oil with sunflower and groundnut oils, a balanced fatty acid profile close to the WHO's ideal ratio was achieved. Among all tested combinations, the 60:40 blend of palm and sunflower oil emerged as the most nutritionally balanced, cost-effective, and cooking-friendly option. This oil blend not only supports heart health and antioxidant defence, but also holds potential for addressing micronutrient deficiencies in vulnerable populations. It serves as a reminder that thoughtful food innovation, sometimes as simple as blending two oils, can lead to powerful solutions for healthier lives.

REFERENCES

Prathap, V., Yadav, P., Manorama, K., Ravichandran, G., Suresh, K., & Mathur, R. K. (2025). Optimizing fatty acid composition and nutritional profile of palm oil-based blends for improved functional properties. *Journal of Food Measurement and Characterization*, **19**(4):2861–2878.

World Health Organization (2008). Expert consultation on fats and fatty acids in human nutrition: Interim summary of conclusions and dietary recommendations on total fat & fatty acids (WHO Technical Report Series, pp. 8–9).

How to cite:

Prathap, V. (2025). Blending for better health: Creating nutritionally balanced edible oils. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 70-72.

*********XXXXX**********

Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON DIFFERENT CROP GROWTH STAGES OF OKRA (*Abelmoschus esculentus* L.)

Chandrakanta Yadav[1]*, Rohit Sharma[2], Sonali Rajput[1]

[1]Department of Seed Science and Technology, Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand, India

[2]Department of Seed Science and Technology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahilyanagar, Maharashtra, India

*Corresponding author email: yadavchandrakanta2001@gmail.com

ABSTRACT

This study evaluates the impact of organic and inorganic fertilizers on the growth and yield of okra (Abelmoschus esculentus L.) across different developmental stages. Organic fertilizers enhance soil structure, microbial activity, and long-term fertility, while inorganic fertilizers offer immediate nutrient availability, boosting early growth and yield. Results highlight that although inorganic inputs improve short-term performance, overuse can degrade soil quality. Organic sources support sustainability but act slowly. Integrated nutrient management, combining both types, was most effective—improving seedling vigor, flowering, dry matter production, and overall yield. A balanced fertilization approach is essential for optimizing productivity and maintaining soil health in okra cultivation.

KEYWORDS: Integrated nutrient management, Okra growth stages, Organic and inorganic fertilizers, Sustainable vegetable production

INTRODUCTION

Okra (*Abelmoschus esculentus* L.), a widely cultivated vegetable in tropical and subtropical regions, plays a significant role in human nutrition due to its high content of vitamins, minerals, and dietary fibre. As a fast-growing crop with a short maturity period, okra requires adequate and balanced nutrient supply throughout its growth stages-from germination to flowering and pod development-for optimal yield and quality. Fertilizers, both organic and inorganic, are critical in ensuring this nutrient availability. Organic fertilizers, such as compost, manure, and biofertilizers, improve soil structure and enhance microbial activity, leading to long-term soil fertility and sustainable crop production. In contrast, inorganic fertilizers, including urea, NPK blends, and other chemical formulations, provide readily available nutrients that can promote rapid plant growth and high yields, though often with environmental concerns over time. The use of either fertilizer type, or a combination thereof, can have varying effects on the physiological and morphological development of okra at different growth stages (Ayodele *et al.*, 2008).

Understanding the comparative impacts of organic and inorganic fertilizers on okra growth is essential for developing effective nutrient management practices that not only boost productivity but also maintain soil health. This study aims to evaluate how different fertilizer treatments influence okra growth parameters such as germination rate, plant height, leaf number, flowering time, and fruit yield-across various developmental stages. The findings can guide farmers, agronomists, and policymakers in choosing appropriate fertilization strategies for sustainable okra production (Karim *et al.*, 2024).

EFFECT OF ORGANIC AND INORGANIC FERTILIZERS APPLICATION ON DIFFERENT CROP GROWTH STAGES

SEEDLING STAGE

The seedling growth stage of okra is highly sensitive and sets the foundation for the plant's overall development and productivity. At this early stage, adequate nutrient availability is essential for strong root formation, early shoot growth, and healthy leaf emergence. Organic fertilizers, such as well-decomposed compost or vermicompost, improve soil structure, enhance moisture retention, and stimulate microbial activity, which collectively create a favourable environment for seedling establishment. However, the slow nutrient release from organic sources may not always meet the immediate demands of fast-growing seedlings. Inorganic fertilizers, particularly those rich in phosphorus and nitrogen, provide quick nutrient access, promoting faster germination, root elongation, and early leaf growth. While inorganic fertilizers may boost seedling vigour in the short term, meanwhile excessive use can lead to nutrient imbalances or salt stress. A balanced approach that combines both organic and inorganic fertilizers can enhance seedling growth effectively, offering immediate nutrient supply while supporting soil health and resilience (Sharma and Behera, 2010).

FLOWERING STAGE

The flowering stage of okra is a vital reproductive phase that directly influences fruit set and overall yield. During this period, the plant requires a balanced supply of nutrients particularly phosphorus and potassium to support flower initiation, development, and retention. Organic fertilizers, such as composted manure or poultry litter, enrich the soil with micronutrients and organic matter, improving soil structure and biological activity, which can enhance flower quality and longevity over time. However, their nutrient release is gradual and may not fully satisfy the high, immediate nutrient demand during peak flowering. Inorganic fertilizers, especially those with appropriate phosphorus and potassium concentrations, provide quick nutrient availability, encouraging abundant flowering and reducing flower drop. Yet, over-reliance on chemical inputs can lead to nutrient leaching and reduced soil fertility. Combining organic and inorganic fertilizers during the flowering stage can offer a synergistic effect-ensuring immediate nutrient uptake while improving soil health-thereby promoting better flower formation and setting the stage for higher fruit yields (Yadav & Lourduraj, 2006).

YIELD RESPONSE

In okra production, inorganic fertilizers typically lead to higher yields in the short term due to their rapid nutrient availability. For example, applying NPK at 100–120 kg/ha has been shown to significantly enhance flowering, fruit set and overall fruit size. In contrast, organic fertilizers such as well-decomposed poultry manure or compost release nutrients more slowly through gradual mineralization, resulting in moderate short-term yields. However, with long-term application, organic fertilizers improve soil structure, water retention, and fertility, which ultimately support sustained or increasing yields over time. Studies indicate that okra grown with 10–15 tons/ha of poultry manure, especially when combined with good practices like mulching and irrigation, can achieve yields comparable to those with chemical fertilizers, while also improving fruit taste and nutritional quality. Therefore, while inorganic fertilizers offer immediate productivity advantages, organic fertilizers provide more sustainable benefits in terms of soil health and crop quality (Silwal *et al.*, 2023).

DRY MATTER PRODUCTION

The application of organic, inorganic, and integrated fertilizers significantly influences dry matter production in okra cultivation, each with distinct effects. Organic fertilizers like poultry manure improve soil structure and microbial activity, releasing nutrients slowly and supporting steady dry matter accumulation; for example, okra plants treated with 10–15 tons/ha of poultry manure have shown notable increases in biomass over time. Inorganic fertilizers such as NPK (100–120 kg/ha) and urea, on the other hand, supply immediate nutrients, promoting rapid early vegetative growth and leading to higher initial dry matter production, with studies reporting increased leaf area and plant biomass during the early growth stages. However, reliance on inorganic inputs alone may lead to soil degradation and reduced long-term productivity. Integrated fertilizer use, which combines 60 kg/ha of NPK with 7.5 tons/ha of poultry manure, has been found to enhance nutrient uptake, sustain photosynthetic activity, and result in significantly higher total dry matter yields than either source used independently. This integrated approach not only boosts immediate plant growth but also supports long-term soil fertility and sustainable production (Ayoola & Makinde, 2008)

CONCLUSION

The application of organic and inorganic fertilizers plays a pivotal role in influencing the growth, development, and yield of okra across various growth stages. Organic fertilizers contribute significantly to improving soil structure, enhancing microbial activity, and promoting sustainable agricultural practices, although they release nutrients slowly. In contrast, inorganic fertilizers offer immediate nutrient availability, resulting in rapid vegetative growth, earlier flowering, and higher short-term yields. However, long-term reliance on chemical inputs can lead to soil degradation and environmental concerns. The evidence from various studies clearly indicates that an integrated nutrient management approach-combining both organic and inorganic fertilizers-strikes the optimal balance. It not only enhances seedling vigour, flowering success, and dry matter accumulation but also sustains soil fertility and ensures continued productivity. Therefore, adopting a balanced fertilization strategy is essential for achieving both high yields and sustainable okra production in the long run.

REFERENCES

Ayodele, J. T., and Omotoso, S. O. (2008). Nutrient management for sustainable okra (*Abelmoschus esculentus L.* Moench) production in a tropical derived savanna zone of Nigeria. *Journal of Sustainable Agriculture*, **32**(3):567–577.

Ayoola, O. T., and Makinde, E. A. (2008). Performance of okra (Abelmoschus esculentus L.) under varying levels of poultry manure and NPK fertilizer. *American-Eurasian Journal of Agricultural and Environmental Sciences*, 3(1):29–36.

Karim, M. R., Sattar, M. A., Rouf, A., Hossain, S., and Hoque, M. M. (2024). Effect of Different Organic and Inorganic Fertilizers on the Growth and Yield of Okra. *IUBAT Review—A Multidisciplinary Academic Journal*, **7**(2):85–99.

Olaniyi, J. O., and Akanbi, W. B. (2008). Effects of organic, organomineral and inorganic fertilizers on the growth, fruit yield and quality of okra (*Abelmoschus esculentus L.*) in southwest Nigeria. *Research Journal of Agronomy*, **2**(4):135–140.

Sharma, S. K., and Behera, S. K. (2010). Effect of integrated nutrient management on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench). *Indian Journal of Agricultural Sciences*, 80(11):925–928.

Silwal, S., Acharya, S., Sangpang, D. R., Chalaune, N., Mandal, J. L., Pathak, R., and Poudel, P. R. (2023). Effect of Different Combinations of Nitrogen, Phosphorus, and Potassium on Growth and Yield of Okra (Abelmoschus esculentus L.) under Rupandehi Condition. *Journal of Institute of Agriculture and Animal Science*, 37:1–8.

How to cite:

Yadav C., Sharma, R., and Rajput S. (2025). Effects of organic and inorganic fertilizers on different crop growth stages of okra (*Abelmoschus esculentus* L.). Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 73-77.

*********XXXXX**********

FLOWERS AS FOOD AND MEDICINE: TRADITION MEETS NUTRACEUTICAL SCIENCE

Rayapu Sai Theja[1]*, Janapareddy Rajesh[2]

[1]Department of Floriculture and Landscaping, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

[2]Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India

*Corresponding author email: rayapusais.s@gmail.com

ABSTRACT

Nutraceuticals—foods or components offering medical and health benefits—are gaining prominence in disease prevention and wellness. Edible flowers are emerging as rich sources of nutraceutical compounds such as carotenoids, flavonoids, anthocyanins, phenolic acids, vitamins, and essential oils. These bioactives offer antioxidant, anti-inflammatory, antimicrobial, anticancer, and neuroprotective effects. Flowers like marigold, rose, chrysanthemum, and Viola have long-standing medicinal and culinary uses. As health awareness rises, India's nutraceutical market is projected to reach USD 28 billion by 2025. Driven by sustainability, innovation, and shifting regulations, edible flowers hold strong potential in the global nutraceutical industry as natural, functional ingredients for personalized nutrition.

KEYWORDS: Edible flowers, Health, Nutraceuticals, Phytochemicals

INTRODUCTION

Nutraceutical is any substance that may be considered as a food or a part of the food and provides medical or health benefits, encompassing prevention and treatment of diseases. Floral chemicals responsible for these are carotenoids, flavonoids, anthocyanins, simple phenolic acids and also vitamins and essential oils (Mlcek and Rop, 2011**).** The mineral content of flowers is significant both in terms of macronutrients (phosphorus, potassium, calcium and magnesium) and micronutrients (iron, manganese, copper and zinc). Flowers belonging to the genus *Chrysanthemum*, *Dianthus* and *Viola* are rich in these substances, especially in terms of potassium (Rop *et al.*, 2012). Flowers like Marigold, Chrysanthemum, Portulaca, Daylilies, Rose, Bougainvillea, Viola and some tree flowers have been reported to possess medicinal properties for diseases/disorders such as hypoglycemic, antimicrobial, anti-Alzheimer, the prevention of liver injury, analgesic, anti-obesity, visual health, neuroprotective, anti-bacterial and diuretic properties**.**

In the modern era, edible flowers are gaining more attention due to their extra-ordinary nutraceutical potential. Flowers are good source of nutritional and phytochemical compounds. The most representative phytochemical compounds found in flowers are phenolic acids, carotenoids, flavonoids, including anthocyanins which are well known for health benefits. Flowers possess strong medicinal properties, viz., antidiabetic, anti-cancer, anti-anxiety, anti-inflammatory, antimicrobial, hepatoprotective, neuroprotective etc.

HISTORY

The Greek Physician Hippocrates, often known as father of medicine said "Let food be your medicine and medicine be your food". The philosophy behind is Focus on Prevention. In ancient Rome, for example, flowers of various species of roses (*Rosa spp.*) were used when cooking various kinds of puree. In medieval France, the flowers of calendula (*Calendula officinalis*) were used when preparing various salads. The term "Nutraceutical" was coined by combining the terms "Nutrition" and "Pharmaceutical" in 1989 by Dr. Stephen DeFelice, Chairman of the Foundation for Innovation in Medicine. Nutraceutical is any substance that may be considered a food or part of a food and provides medical or health benefits, encompassing, prevention, and treatment of diseases.

NUTRACEUTICALS MARKET STATUS IN INDIA

India's nutraceuticals market is getting ready to be a global leader at USD 4-5 billion. It is expected to grow approximately USD 28 billion by 2025. The dietary supplements market in India is valued at USD 394.44 million in 2020 and reports say that it will reach USD 10, 198.7 million by 2026 which is a 22% growth rate year by year.

FLORAL COMPONENTS HAVING NUTRACEUTICAL ACTIVITY

The nutraceutical activity is due to the presence of carotenoids, flavonoids, anthocyanins, simple phenolic acids, vitamins and essential oils. The anthocyanins are particularly important since highly pigmented flowers have a high antioxidant activity compared to cultivars of the same species characterized by less pigmented flowers. The phenolic acids and flavonoids are the most common phenolic compounds with nutraceutical activity.

Marigold: Carotenoids (lutein esters) from marigolds are effective in preventing free radical generation, age-related muscular degeneration, cataracts, cancer and coronary heart diseases. Dried marigold petals and concentrates are used as feed to improve the pigmentation of the poultry skin and the eggs of yolk sac.

Nasturtium: It is a good source of vitamin C, silanol and oxalic acid. It contains Glucosinolates which have antibiotic and anti-tumor effects.

Chrysanthemum: Chrysanthemum shows marked antimicrobial, anti-inflammatory and anti-cancerous effects due to the presence of triterpenes Arni diol, Fara diol and Heliantriol

Carnation: Terpene caryophyllene is found in Carnation responsible for its anti-inflammatory properties. Flowers are considered to be antispasmodic, cardiotonic, diaphoretic and nerve tonic.

Bougainvillea: *Bougainvillea spectabilis* contains quinones, flavonoids, phenols, sterols, glycosides, tannins, furanoids and small amounts of sugars. The alcoholic extract of the leaf has been used for the management of diabetes. The aqueous extract and decoction of this plant have been used as fertility control among tribal people in many countries. It possesses anticancer, antidiabetic, antihepatotoxic, anti-inflammatory, antimicrobial, and antiulcer properties.

Portulaca: *Portulaca grandiflora* contains alkaloids, glycosides, mucilage, tannins and triterpenoids. It is used in the treatment of hepatitis, swelling and pain in the pharynx. The fresh juice of the leaves and stems is applied externally as a lotion to snake and insect bites, burns, scalds and eczema.

HEALTH BENEFITS OF EDIBLE FLOWERS

- **Anti-cancer -** Marigold, Bauhinia, Hibiscus, etc.
- **Anti-obesity** - Hibiscus, Tropaeolum, Viola, etc.
- **Anti-Inflammatory** - Rosa, Chrysanthemum, Hibiscus, Viola, Hibiscus, Day lily, etc.
- **Neuroprotective effect** - Hibiscus, Marigold, Honeysuckle, etc.
- **Antimicrobial activity** - Calendula, Nasturtium, Rose, Hibiscus, etc.

FUTURE PROSPECTS OF FLORAL NUTRACEUTICALS

Rising Health Awareness: As consumers become more health-conscious, demand for nutraceuticals foods and supplements with health benefits beyond basic nutrition-will increase. Flowers with medicinal properties or those used in herbal supplements might see growth in popularity.

Sustainability: There will be a stronger focus on sustainable and eco-friendly practices in both the production of nutraceuticals and flowers. This includes organic farming and environmentally responsible sourcing.

Technological Advancements: Innovations in agricultural technology and biotechnology could enhance the efficiency of growing and processing flowers and nutraceuticals, leading to better yields and higher-quality products

Global Trade: As markets expand, international trade in nutraceuticals and flowers will likely grow. Countries with favorable climates for growing medicinal plants or those with advanced biotech capabilities could become key players.

Regulatory Changes: Increased regulation and scrutiny of health claims will affect how nutraceuticals are marketed and traded. Compliance with international standards will be crucial.

Consumer Preferences: There will be a growing interest in personalized nutrition and natural remedies, driving demand for specialized nutraceuticals and flowers with specific health benefits. Overall, the trade of nutraceuticals and flowers will be dynamic, driven by technological, environmental, and market forces.

CONCLUSION

Edible flowers are valuable reservoirs of nutraceutical metabolites such as carotenoids, flavonoids, anthocyanins, phenolic acids, vitamins, and volatile oils that exhibit varied health advantages including anti-inflammatory, antioxidant, anti-cancer, antimicrobial, and neuroprotective action. Flowers such as marigold, chrysanthemum, Portulaca, Bougainvillea, and Viola exhibited remarkable medicinal potentials. India's nutraceutical industry is aggressively expanding due to increasing awareness on health. The historical utilization and scientific documentation in favour substantiate their prospect. Future opportunities are fuelled by sustainable practices, technology, international trade growth, regulatory changes, and individualized nutrition trends. Overall, edible flowers have tremendous potential in supporting health and disease prevention through natural and functional nutrition options.

REFERENCES

Mlcek J and Rop O. 2011. Fresh edible flowers of ornamental plants-A new source of nutraceutical foods. *Trends in Food Science & Technology*. **22**(10):561-569

Rop O, Mlcek J, Jurikova T, Neugebauerova J and Vabkova J. 2012. Edible flowers-a new promising source of mineral elements in human nutrition. *Molecules*. **17**(6):6672-6683

How to cite:

Rayapu S.T. and Janapareddy R. (2025). Flowers as food and medicine: tradition meets nutraceutical science. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 78-81.

*********XXXXX**********

SOIL MOISTURE CONSTRAINTS IN RAINFED AGRICULTURE: MITIGATION STRATEGIES FOR SUSTAINABLE CROP PRODUCTION UNDER THE CHANGING CLIMATE

Rajagopal Vadivel*, K. Sammi Reddy

ICAR-National Institute of Abiotic Stress Management, Malegaon Khurd, Maharastra, India

**Corresponding author email:* rgpssac@gmail.com

ABSTRACT

Soil moisture stress in rainfed agriculture poses a major threat to crop productivity and sustainability, especially under climate change. Erratic rainfall, dry spells, and rising temperatures worsen moisture loss, reduce infiltration, deplete nutrients, and harm microbial activity. These factors lead to declining yields and soil health. Effective mitigation strategies include mulching, conservation tillage, cover cropping, rainwater harvesting, and micro-irrigation. Soil amendments like compost and biochar improve moisture retention, while agroforestry stabilises ecosystems. Weather-based crop planning and drought-resilient crops enhance adaptability. Sustaining productivity requires integrated water management, climate-smart practices, farmer training, and policy support for long-term resilience and food security.

KEYWORDS: Climate change, Moisture, Rainfed, Resilience, Sustainability

INTRODUCTION

Rainfed agriculture plays a crucial role in global food security, particularly in regions with limited access to irrigation. Some estimates suggest that rainfed agriculture occupies about 67% of the net sown area, supporting 40% of the population. Rainfed regions contribute around 40% of the total food grain production in India. These areas are particularly significant for certain crops, producing: 95% of coarse cereals, 91% of pulses, 80% of oilseeds, 65% of cotton and 53% of rice (CRIDA 2011, Rao, 2019)

Rainfed agriculture in India is spread across diverse climatic and agroecological zones, each with distinct rainfall patterns and soil characteristics. In arid and semi-arid regions such as Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, and Tamil Nadu, rainfall is less than 750 mm annually, making soil moisture retention crucial for crops like millets, pulses, oilseeds, and cotton. Dry sub-humid regions, including Madhya Pradesh, Chhattisgarh, Jharkhand, Odisha, and parts of Uttar Pradesh, receive 750-1200 mm annual rainfall, supporting crops like rice, maize, pulses, oilseeds, and wheat. Humid and per-humid regions, found in northeastern states, West Bengal, and Kerala, receive more than 1200 mm of rainfall, favouring the cultivation of rice, tea, rubber, and spices. In hilly and mountainous regions such as the Western Ghats, Eastern Ghats, and the Himalayas, highly variable rainfall patterns influence the production of horticultural crops, maize, and pulses.

THE SOIL WATER CONSTRAINS OF THE RAINED AREAS UNDER THE CHANGING CLIMATE

Soil available moisture content is significantly influenced by changing climatic conditions, which directly affect plant growth and drought resilience. Rising temperatures increase evaporation from the soil surface and enhance plant transpiration, leading to faster depletion of soil moisture. Changes in rainfall patterns, such as irregular precipitation or extreme weather events, also impact soil moisture retention. Heavy rainfall can cause surface runoff, preventing adequate infiltration, while prolonged dry spells reduce groundwater recharge and soil moisture storage. The effect of climate change on soil moisture availability varies with soil texture. Sandy soils, with their low water-holding capacity, lose moisture quickly through leaching, making them highly vulnerable to drought. Clayey soils, although capable of retaining more water, tend to develop cracks under dry conditions, leading to water loss. Loamy soils, which offer a balance between water retention and drainage, are generally more resilient to climatic variations. In contrast, shallow and gravelly soils, often found in hilly or degraded lands, have limited moisture storage capacity, making them particularly sensitive to changing climate patterns.

CLIMATE SMART MANAGEMENT STRATEGIES FOR SUSTAINABLE CROP PRODUCTION

SOIL MOISTURE CONSERVATION TECHNIQUES

Soil moisture conservation is vital for sustaining crop productivity in rainfed agriculture, where water availability is limited and erratic. Effective techniques include in situ conservation, rainwater harvesting, and soil amendments. In-situ methods like mulching, conservation tillage, contour farming, and cover cropping help reduce evaporation, improve water infiltration, and enhance soil moisture. Mulching retains moisture and suppresses weeds, while conservation tillage preserves soil structure and boosts infiltration. Contour farming reduces runoff and erosion, and cover crops improve soil health and moisture retention. Rainwater harvesting techniques—such as farm ponds, percolation tanks, and check dams—capture excess runoff, recharge groundwater, and provide supplementary irrigation during dry periods, improving moisture availability and crop yields. Soil amendments, including organic matter, clay, zeolites, and super absorbent polymers (SAPs), enhance soil structure and water-holding capacity. Organic matter boosts microbial activity and moisture retention, while SAPs like hydrogel help plants access water during dry spells. Integrating these strategies is crucial to building resilience in rainfed systems. Together, they improve soil moisture, mitigate drought stress, and support sustainable crop production amid climate variability.

EFFICIENT WATER MANAGEMENT TECHNIQUES

Efficient water management is vital for sustaining food grain production in rainfed agriculture, where erratic rainfall and dry spells limit productivity. Key strategies include rainwater harvesting, micro-irrigation, and crop selection, all of which enhance soil moisture, improve water use efficiency, and boost crop resilience.

Rainwater harvesting methods—such as farm ponds, percolation tanks, and check dams—capture runoff and improve soil infiltration. In semi-arid India, farm ponds increased soil moisture by 20–30% and crop yields by 25%.

Micro-irrigation systems like drip and sprinkler irrigation deliver water directly to plant roots, minimising evaporation losses. Drip irrigation has reduced water use by 50% and improved wheat yields by 30–40%. Sprinkler systems support shallow-rooted crops like pulses, while deficit irrigation improves efficiency in crops like rice and maize.

Crop selection plays a key role in managing water scarcity. Drought-tolerant and deep-rooted crops like millets, sorghum, pigeon pea, and chickpea thrive under low-moisture conditions and enhance soil health. Studies show drought-resistant millet varieties yield 30–50% more than traditional types.

Integrating these methods can boost water use efficiency by 40–50% and crop yields by 25–50%, supporting climate-resilient, sustainable food grain production in rainfed regions.

APPLICATION OF ORGANIC MANURES

Enhancing soil organic matter (SOM) through compost and manure application significantly boosts water retention and crop resilience in rainfed agriculture. Organic amendments like farmyard manure (FYM), compost, and green manure improve soil structure, porosity, and aggregation, which enhance water infiltration and reduce evaporation. SOM acts like a sponge, holding 10–20 times its weight in water (Hudson, 1994), ensuring a steady supply of moisture during dry periods.

Studies show FYM application increases soil moisture by 10–30% and reduces evaporation losses by 15–25% (Blanco-Canqui and Lal, 2009). Improved soil porosity allows water to penetrate deeper, promoting root growth and access to subsoil moisture, which enhances drought tolerance and yield stability (Ghosh et al., 2020).

Recommended FYM doses vary: 10–15 t/ha for sandy soils, 7–10 t/ha for loamy, and 5–7 t/ha for clay. In Central India, 10 t/ha of FYM improved wheat yields by 30% and soil moisture by 25% (Sharma et al., 2017). Compost at 12 t/ha increased sorghum moisture storage by 20–35% (Patil et al., 2019), confirming its value in moisture-limited systems.

AGROFORESTRY SYSTEMS

Agroforestry, the integration of trees with crops and livestock, enhances soil moisture, reduces erosion, and improves biodiversity, making it ideal for rainfed agriculture. Deep-rooted trees access subsoil moisture, reduce evapotranspiration, and increase organic matter, improving resilience to drought (Mahmud et al., 2024). Systems like agri-silviculture (e.g., Acacia, Neem, Khejri with crops) in Rajasthan and agri-horticulture (mango, pomegranate with cereals) in Maharashtra demonstrate success under moisture stress (Singh et al., 2020). Silvi-pastoral systems with fodder trees like Hardwickia binata are effective in arid zones.

Agroforestry improves soil moisture by 15–30% and increases yields by 25% in low-rainfall years (Yadav et al., 2019). Trees create favourable microclimates, enhance water retention, and support nitrogen fixation. Beyond agronomic benefits, agroforestry diversifies income and sequesters carbon, aiding climate change adaptation. Promoting agroforestry offers a nature-positive solution for sustainable food production in rainfed systems.

BIOCHAR APPLICATION

Biochar, a carbon-rich material from pyrolysed biomass, enhances soil fertility and moisture retention, making it ideal for rainfed agriculture (Lehmann and Joseph, 2024). Its porous structure improves soil aeration, aggregation, and water-holding capacity, aiding crops under drought. Biochar increases soil moisture by 10–30% and reduces evaporation losses by 20–25% (Abel et al., 2013; Mukherjee and Lal, 2013). Application rates vary by soil type: 5–15 t/ha for sandy, 3–10 t/ha for loamy, and 2–5 t/ha for clay soils. It promotes microbial activity and root growth, enhancing drought resilience. Combined with compost or manure, biochar supports sustainable dryland farming.

CONCLUSION

Rainfed agriculture faces major challenges due to low and erratic soil moisture, intensified by climate change. This limits crop growth, nutrient availability, and soil health. To address these issues, integrated soil and water management is essential. In-situ moisture conservation methods like mulching, conservation tillage, and cover cropping reduce evaporation and improve infiltration. Rainwater harvesting through farm ponds and check dams boosts water availability, while micro-irrigation systems optimise water use during critical crop stages. Soil amendments such as biochar, compost, and manure enhance soil structure and moisture retention. Agroforestry systems offer long-term resilience by improving microclimates, organic matter, and soil moisture. By integrating these strategies, rainfed agriculture can become more resilient and productive, ensuring food grain production even under moisture-limited conditions.

REFERENCES

Abel, S., Peters, A., Trinks, S., Schonsky, H., Facklam, M., and Wessolek, G. (2013). Impact of biochar and hydrochar on water retention and water repellency of sandy soil. *Geoderma*, 202, 183-191.

Lehmann, J., and Joseph, S. (Eds.). (2024). Biochar for environmental management: science, technology and implementation. Taylor and Francis.

Mahmud, A. A., Raj, A., and Jhariya, M. K. (2021). Agroforestry systems in the tropics: A critical review. *Agricultural and Biological Research*, 37(1), 83-87.

Mukherjee, A., and Lal, R. (2013). Biochar impacts on soil physical properties and greenhouse gas emissions. *Agronomy*, 3(2), 313-339.

Pandey, D. N. (2007). Multifunctional agroforestry systems in India. *Current Science*, 92(4), 455-463.

Raj, R., Kumar, P., and Singh, R. (2018). Silvi-pastoral systems for sustainable land management in dry regions of India. *Agroforestry Systems*, 92(5), 1091-1103.

Rao, K. P. C., Ndegwa, W. G., and Kizito, K. (2019). Enhancing rainfed farming resilience through weather-based crop advisories in semi-arid India. *Climatic Change*, 157(3), 447-463.

Sharma, A., Mishra, V., and Gupta, R. (2017). Effect of tree-crop interactions on soil properties and water use efficiency in rainfed agroforestry systems. *Journal of Soil and Water Conservation*, 76(4), 324-330.

Singh, B., Chauhan, R., and Yadav, S. (2020). Agroforestry for sustainable agriculture in water-scarce regions of India. *Indian Journal of Agroforestry*, 22(1), 45-56.

Yadav, S., Kumar, A., and Patil, D. (2019). Role of agroforestry in enhancing soil moisture retention and crop productivity under semi-arid conditions. *Environmental Management*, 64(3), 345-356

How to cite:

Vadivel R. and Reddy K. S. (2025). Soil moisture constraints in rainfed agriculture: mitigation strategies for sustainable crop production under the changing climate. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 82-86.

*********XXXXX**********

WATERSHED WONDERS: INTEGRATED WATER MANAGEMENT FOR SOIL PROTECTION IN INDIA

Arup Mondal*

Bidhan Chandra Krishi Viswavidyalaya, Nadia - 741252, West Bengal, India

**Corresponding author email:* arup.096@gmail.com

ABSTRACT

India's agrarian foundation rests upon its soil and water resources, both of which are increasingly threatened by overexploitation and climate variability. Integrated Water Management (IWM), particularly through watershed development programs, offers a holistic and sustainable response. This article examines how IWM - through rainwater harvesting, soil conservation, afforestation, and community involvement—has revitalized degraded lands and enhanced agricultural productivity. Drawing from successful interventions across drought-prone regions, the analysis demonstrates significant gains in water availability, crop yields, and rural livelihoods. The paper underscores the urgency of mainstreaming IWM to secure India's ecological and socio-economic future.

KEYWORDS: Groundwater Recharge, Integrated Water Management, Soil Conservation, Sustainable Agriculture, Watershed Development

INTRODUCTION

Soil, often referred to as the "silent partner" in agriculture, is central to food security and rural economies. Yet, this vital resource is under severe stress in India due to land degradation, unscientific farming, deforestation, and poor water management. According to NBSS & LUP (2016), nearly 30% of India's land is degraded. Simultaneously, groundwater depletion is accelerating in several states due to over-irrigation and lack of recharge structures, particularly in agriculturally intensive regions like Punjab, Maharashtra, and Tamil Nadu.

Traditional water management systems are ill-equipped to cope with increased pressure from a growing population and erratic climatic patterns. In this context, Integrated Water Management (IWM) has gained prominence as a comprehensive strategy to conserve both soil and water. Based on the watershed approach, IWM integrates ecological, technical, and social interventions for sustainable development. This article explores the mechanisms and impacts of IWM through watershed development initiatives, with case studies and empirical data demonstrating their success.

UNDERSTANDING INTEGRATED WATER MANAGEMENT

Integrated Water Management is a systems-based approach that promotes the coordinated development and management of land, water, and other natural resources. The objective is to optimize their use for economic and social welfare while maintaining ecosystem sustainability.

KEY PRINCIPLES

- ✓ Coordinated surface and groundwater management
- ✓ Participatory planning involving local stakeholders
- ✓ Sustainable and equitable use of natural resources
- ✓ Integration of long-term ecological goals with local needs

THE ROLE OF SOIL CONSERVATION

Healthy soil is critical to the agricultural and hydrological cycle. It enhances water retention, reduces runoff, supports biodiversity, and stores nutrients essential for plant growth. However, when degraded, soil loses its ability to sustain crops, increasing dependency on external inputs and reducing resilience to climate extremes.

BENEFITS OF SOIL CONSERVATION

- ✓ Improved infiltration and reduced erosion
- ✓ Enhanced nutrient retention
- ✓ Better drought tolerance
- ✓ Increased microbial and carbon activity

Neglecting soil health leads to loss of fertility, lower yields, and long-term unsustainability of agricultural systems.

WATERSHED DEVELOPMENT: CONCEPT AND RELEVANCE

A watershed refers to a topographically defined area where all water drains to a common outlet. Watershed development leverages this natural unit for implementing soil and water conservation through both structural and participatory interventions.

OBJECTIVES

- ✓ Improve water availability through recharge
- ✓ Reduce surface runoff and erosion
- ✓ Restore soil fertility and reduce degradation
- ✓ Enhance rural livelihoods through sustainable agriculture

KEY NATIONAL PROGRAMS:

Program	Launch Year	Objective
IWMP (now WDC-PMKSY)	2009	Restore productivity in rainfed areas
MGNREGA	2006	Develop water conservation structures
RKVY	2007	Improve agri-infrastructure and soil health

CORE COMPONENTS OF INTEGRATED WATERSHED MANAGEMENT

a. *Water Harvesting Structures:* Check dams, percolation tanks, and farm ponds facilitate rainwater capture and groundwater recharge.

b. *Soil Conservation Techniques:* Contour bunding, mulching, vegetative barriers, and cover cropping reduce erosion and improve fertility.

c. *Afforestation and Agroforestry:* Tree planting stabilizes soil, enhances organic matter, and diversifies land use systems.

d. *Cropping and Livelihood Support:* Promotion of drought-tolerant crops and micro-irrigation systems increases water-use efficiency and income.

CASE STUDIES FROM ACROSS INDIA

a. *Hiware Bazar, Maharashtra*

Once drought-prone and barren, the village transformed through water budgeting, afforestation, and check dams. Groundwater levels rose dramatically from 70m to 6m, supporting year-round agriculture.

b. *Sujalam Sufalam Yojana, Gujarat*

With 13,000+ structures built in just four months, the initiative improved water availability and facilitated crop diversification.

c. *Jal Shakti Abhiyan*

A nationwide initiative promoting watershed trenching, rainwater harvesting, and decentralized planning.

These examples demonstrate that community-led watershed projects can produce transformative results.

DATA-DRIVEN IMPACT ASSESSMENT

Indicator	Pre-IWM	Post-IWM (Avg)	% Improvement
Soil Erosion (tons/ha/year)	12.5	4.2	66%
Groundwater Depth (m)	18	8	55%
Rainwater Runoff (%)	55	20	63%
Crop Productivity (kg/ha)	1600	2600	62.5%
Annual Household Income (₹)	₹40,000	₹85,000	112%

These statistics clearly demonstrate the ecological and economic gains from integrated watershed management.

IMPACTS ON SOIL CONSERVATION

Watershed programs contribute significantly to restoring soil health by improving organic content, enhancing porosity, and reducing erosion. They also promote vegetative cover that reduces surface runoff.

LONG-TERM BENEFITS

- ✓ Carbon sequestration through increased biomass
- ✓ Enhanced microbial activity and nutrient cycling
- ✓ Improved cropping intensity and resilience
- ✓ Over time, these interventions restore land productivity and support biodiversity.

COMMUNITY PARTICIPATION AND POLICY CONVERGENCE

Local participation is critical for the success of watershed projects. Villagers contribute labor through shramdaan, assist in maintenance, and engage in participatory planning.

POLICY MECHANISMS

Formation of Watershed Committees

Integration of MGNREGA, NABARD's WDF, and state schemes

Use of soil health cards and digital tools for monitoring

Such convergence ensures accountability, efficiency, and sustainability of watershed efforts.

CHALLENGES AND LIMITATIONS

Despite its benefits, IWM faces several challenges:

- ✓ Fragmented landholdings hinder unified planning
- ✓ Delays in fund disbursal reduce momentum
- ✓ Technical skill gaps at the village level

- ✓ Climate variability introduces unpredictability
- ✓ Encroachment and urbanization affect recharge zones

Addressing these bottlenecks requires targeted policy and institutional reforms.

WAY FORWARD: STRATEGIC RECOMMENDATIONS

- ✓ *Capacity Building:* Train local youth as watershed managers and field staff
- ✓ *Technological Integration:* Employ drones, GIS, and mobile apps for planning and monitoring
- ✓ *Community Empowerment:* Strengthen gram sabhas and promote inclusive governance
- ✓ *Financial Incentives:* Provide subsidies for micro-irrigation, agroforestry, and composting
- ✓ *Research & Innovation:* Encourage soil and water research tailored to regional needs

Scaling successful models requires multi-stakeholder coordination and long-term investment.

CONCLUSION

Soil is not merely a medium for crops—it is a living, dynamic ecosystem essential for sustaining life. Integrated Water Management, rooted in watershed development, presents a powerful model to halt and reverse land degradation. By harvesting rain where it falls and empowering communities where they live, India is witnessing the emergence of "watershed wonders." These interventions offer replicable blueprints for climate resilience, food security, and rural prosperity. For a sustainable future, India must invest in expanding and institutionalizing these integrated approaches to preserve its soil legacy.

How to cite:

Mondal A. (2025). Watershed wonders: Integrated water management for soil protection in India. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 87-91.

*********XXXXX**********

Agri JOURNAL WORLD

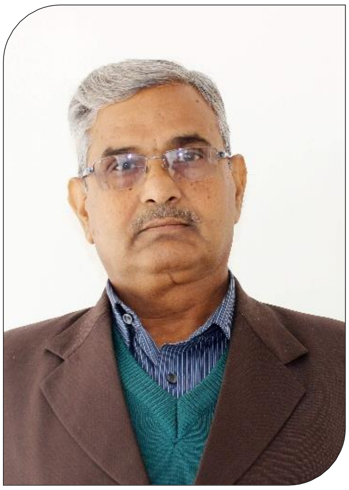
www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

REDISCOVERING NUTRITIONAL WEALTH: UNDERUTILISED HORTICULTURAL CROPS AND THEIR COMPARATIVE NUTRITIONAL VALUE

Amar Singh*

ICAR-Indian Agriculture Research Institute, New Delhi – 110012 India

Corresponding author email: amarenv@gmail.com



ABSTRACT

Underutilised horticultural crops offer immense potential for enhancing nutrition, promoting biodiversity, and supporting sustainable agriculture, especially in marginal environments. This article explores six such crops—Cape Blueberry, Cape Gooseberry, Bael, Jamun, Karonda, and Kachnar—highlighting their nutritional richness, adaptability to adverse conditions, and unique bioactive compounds. These crops often surpass commercial counterparts in specific nutrients such as vitamin C, polyphenols, and proteins, yet remain neglected due to poor market integration and limited awareness. By drawing comparative nutritional insights, the article emphasises the need for renewed focus on these crops to diversify food systems, address micronutrient deficiencies, and strengthen rural livelihoods.

KEYWORDS: Climate-resilient horticulture, Indigenous fruits, Nutritional diversity, Underutilised crops,

INTRODUCTION

Horticultural production worldwide has long focused on a narrow spectrum of commercially profitable crops, often neglecting a vast diversity of indigenous and underutilised plant species. These lesser-known horticultural crops typically grow in marginal environments, exhibit high resilience to climatic variability, and require minimal agricultural inputs. Despite their adaptability and rich nutritional composition, they remain underexploited due to inadequate research, limited market integration, and low consumer awareness. Many of these crops—such as wild berries, edible flowers, and hardy fruiting trees—are excellent sources of vitamins, antioxidants, fiber, and essential minerals, often surpassing conventional produce in specific nutritional attributes. Their inclusion in mainstream agriculture could enhance dietary diversity, support ecological sustainability, and improve the livelihoods of smallholder and tribal farming communities. This article aims to highlight the nutritional value and ecological relevance of select underutilised horticultural crops by comparing them with common fruits, thereby demonstrating their potential contribution to sustainable food and nutrition security.

CAPE BLUEBERRY

Cape Blueberry, scientifically known as *Vaccinium capense*, is an indigenous shrub of the Cape Floristic Region of South Africa. It bears small, deep blue to almost black berries similar in appearance to the well-known North American blueberries, but has not attained similar commercial success. This wild blueberry species thrives naturally in acidic, sandy soils and mountainous forests with minimal human intervention. The berries, though smaller in size, are nutritional powerhouses. They contain significant amounts of anthocyanins — bioactive pigments responsible for their rich colour and antioxidant strength. On average, 100 grams of Cape Blueberries supply about 45 kilocalories, with 9–12 grams of carbohydrates, around 2 grams of dietary fiber, and approximately 10–15 milligrams of vitamin C. Studies indicate that their anthocyanin concentration ranges from 200 to 400 milligrams per 100 grams, making them comparable or superior to some cultivated blueberry varieties. Despite this, Cape Blueberry remains largely untapped due to a lack of domestication, limited awareness, and the absence of organised supply chains.

CAPE GOOSEBERRY

Known locally as Rasbhari in India, Cape Gooseberry (*Physalis peruviana*) is a versatile fruit crop that is both hardy and productive under diverse climatic conditions. Native to the Andean region but widely naturalised in India, it grows easily on marginal soils and withstands erratic rainfall. The bright yellow-orange berries, enclosed in a papery husk, are rich in vitamins, antioxidants, and bioactive compounds. Per 100 grams, the fruit provides about 53 kilocalories, 11–14 grams of carbohydrates, nearly 2 grams of protein, and a vitamin C content ranging between 20 to 30 milligrams. It is also a fair source of provitamin A and polyphenols, which help protect cells from oxidative damage. Compared to conventional berries like strawberries and blueberries, Cape Gooseberry stands out with its higher vitamin C and provitamin A content, yet it remains underutilised outside local fresh fruit markets and small-scale processing units.

BAEL

Bael (*Aegle marmelos*), an indigenous tree of India, holds a revered place in traditional Ayurveda due to its medicinal properties. It flourishes in dry and semi-arid regions with poor soils and negligible irrigation. The round or oval fruits have a hard woody shell enclosing aromatic, sweet, and fibrous pulp.

This pulp, eaten fresh or made into sherbet, is rich in carbohydrates, mucilage, and tannins, which are soothing to the digestive tract. One hundred grams of bael pulp provides about 88 kilocalories, 31 grams of carbohydrates, nearly 2 grams of protein, and 8 to 10 milligrams of vitamin C. The pulp is especially beneficial for treating digestive disorders and dehydration during the summer. Despite its immense health benefits and adaptability to harsh climates, bael is seldom cultivated on a commercial scale and remains confined to homestead gardens and local markets.

JAMUN

Jamun (*Syzygium cumini*), commonly called black plum or Indian blackberry, is another underutilised fruit with high nutritional and medicinal relevance in India's subtropical belts. The deep purple, juicy fruits are seasonal delights during the summer and monsoon months. They are particularly valued for their richness in iron, polyphenols, and anthocyanins, which contribute to their dark hue and antioxidant capacity. A typical serving of 100 grams yields about 60 kilocalories, 14 grams of carbohydrates, around 0.7 grams of protein, and about 18–20 milligrams of vitamin C. Jamun is widely used in traditional medicine for managing blood sugar levels, yet it has not found a place in organized orchards and large-scale fruit supply chains, limiting its economic potential.

KARONDA

Karonda (*Carissa carandas*) is a drought-hardy shrub producing small, sour fruits that are traditionally used for pickles, chutneys, and preserves. It is well suited to semi-arid and rainfed conditions and often grows wild on wastelands and field boundaries. The berries are nutritious, offering roughly 42 kilocalories, 10–12 grams of carbohydrates, 2 to 3 grams of protein, and about 16–18 milligrams of vitamin C per 100 grams of fresh fruit. It is also a moderate source of iron and calcium. Despite its culinary utility and adaptability to degraded soils, karonda is neglected in scientific research and large-scale cultivation programs.

KACHNAR

Unlike typical fruit crops, Kachnar (*Bauhinia variegata*) is known for its edible flower buds rather than fruits. These tender buds are a traditional delicacy in various parts of India, cooked as vegetables or added to curries. Kachnar trees thrive in dry, rocky soils with minimal inputs and add to the agro-biodiversity of rural landscapes. Nutritionally, fresh Kachnar buds offer about 40 kilocalories, 4 to 5 grams of carbohydrates, and a relatively high protein content of 3 to 4 grams per 100 grams. The buds are also rich in fiber, calcium, and phosphorus, making them a valuable addition to rural diets that often lack protein variety.

COMPARATIVE NUTRITIONAL SUMMARY

A comparative look at the nutritional profiles of these underutilised crops reveals their remarkable contribution to dietary diversity. For instance, Cape Blueberry rivals the commercial blueberry in antioxidant strength; Cape Gooseberry surpasses strawberries in vitamin C and provitamin A; Bael provides higher carbohydrates than most tropical fruits; Jamun is a natural source of iron and polyphenols; Karonda matches strawberries in vitamin C while adding iron and calcium; and Kachnar buds supply more protein than many leafy vegetables. Such comparative advantages highlight the potential of these crops in addressing micronutrient deficiencies and enriching local food baskets.

Table 1: Comparative analysis of nutritional quality different underutilized fruits

Crop	Energy (kcal)	Carbohydrates (g)	Protein (g)	Vitamin C (mg)	Unique Nutritional Feature
Cape Blueberry	45	9–12	0.6	10–15	High anthocyanins (200–400 mg)
Cape Gooseberry	53	11–14	1.9	20–30	Provitamin A, polyphenols
Bael	88	31	1.8	8–10	Mucilage, tannins
Jamun	60	14	0.7	18–20	Iron, polyphenols
Karonda	42	10–12	2–3	16–18	Iron, calcium
Kachnar Buds	40	4–5	3–4	Low	High protein, minerals

CONCLUSION

The comparative nutritional profiles of underutilised horticultural crops reveal their untapped potential in combating malnutrition and promoting agrobiodiversity. Their resilience and ability to thrive on marginal lands underscore their relevance in climate-resilient agriculture. However, their inclusion in mainstream horticulture necessitates targeted research, market development, and consumer education. Efforts must be made to improve agronomic practices, processing technologies, and policy support to ensure wider adoption. By integrating these crops into local and global food systems, we can create more sustainable and nutrition-sensitive agricultural landscapes that benefit both producers and consumers across diverse socio-economic settings.

REFERENCES

Bhag Mal, Padulosi, S., and Ravi Kumar, B. (2010). Biodiversity of Underutilised Horticultural Crops. Bioversity International.

National Horticultural Board (2022). *Horticultural Statistics at a Glance*. Ministry of Agriculture and Farmers Welfare, Government of India.

Shukla, G., and Singh, S. (2020). Underutilised Fruits: A Rich Source of Phytochemicals and Nutraceuticals. *Journal of Food Biochemistry*, 44(11).

Singh, B. P., and Prasad, R. N. (2015). Nutritional Composition of Underutilised Fruits. *Journal of Food Science and Technology*, 52(6), 3301–3313.

How to cite:

Singh A. (2025). Rediscovering nutritional wealth: underutilised horticultural crops and their comparative nutritional value. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 92-96.

*********XXXXX**********

INTRODUCTION TO VETERINARY VACCINES: WORLDWIDE SCENARIO

Sabarinath Thankappan*, Priyanka Mahadappa, Gnanavel Venkatesan

ICAR-Indian Veterinary Research Institute, Bengaluru campus, Karnataka, India

**Corresponding author email:* drsabari143ivri@gmail.com

ABSTRACT

The history of veterinary vaccines can be divided into four distinct stages. The first stage was the discovery of variolation against smallpox and its eventual evolution into vaccination. The second stage was pioneered by the discoveries by Louis Pasteur and his colleagues, which paved the way for the early production of several successful vaccines against primarily bacterial diseases. The third stage, epitomised by the canine distemper vaccine development, was a process of advancement in these vaccines and resulted from a growing awareness about viruses and their behaviour. Eventually, the fourth stage is characterised by the experienced and suave use of vaccines, which led to the eradication of two major diseases, Smallpox and Rinderpest, and the near eradication of diseases such as Poliomyelitis.

KEYWORDS: Disease eradication, Livestock health management,Veterinary vaccines

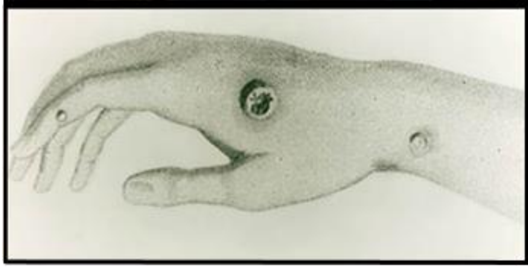
HISTORY OF SMALLPOX VACCINATION

VARIOLATION

In medieval Asia, medical practitioners started using the variolation technique, which is the intentional infection with smallpox. Dried smallpox scabs were deliberately blown into the nostrils of individuals who developed a mild version of smallpox. Upon recuperation, the individuals were immune to smallpox. Variolation was never a reliable and harmless procedure. There is a considerable risk of the patient dying from the procedure. Around 1-2% of the individuals variolated died due to the procedure. This is negligible when compared to 30% who succumbed when they developed smallpox naturally. Moreover, the mild form of the disease which the patient developed has the potential to spread, resulting in an epidemic. By 1700, India, Africa and the Ottoman Empire had adopted variolation to safeguard against smallpox. In contrast to Asians and Africans who were inoculated by blowing dried smallpox scabs into the nostrils, the Americans and Europeans were inclined to immunise through a puncture in the skin.

Variolation by inhalation practised in China

SOURCE:
https://www.labroots.com/trending/microbiology/4928/variolation-vaccination



Variolation done through puncture of the skin

SOURCE:
https://www.nlm.nih.gov/exhibition/smallpox/sp_variolation.html#:~:text=In%20Asia%2C%20practitioners%20developed%20the,individual%20was%20immune%20to%20smallpox.

THE ADVENT OF COWPOX VACCINATION FOR SMALLPOX BY EDWARD JENNER

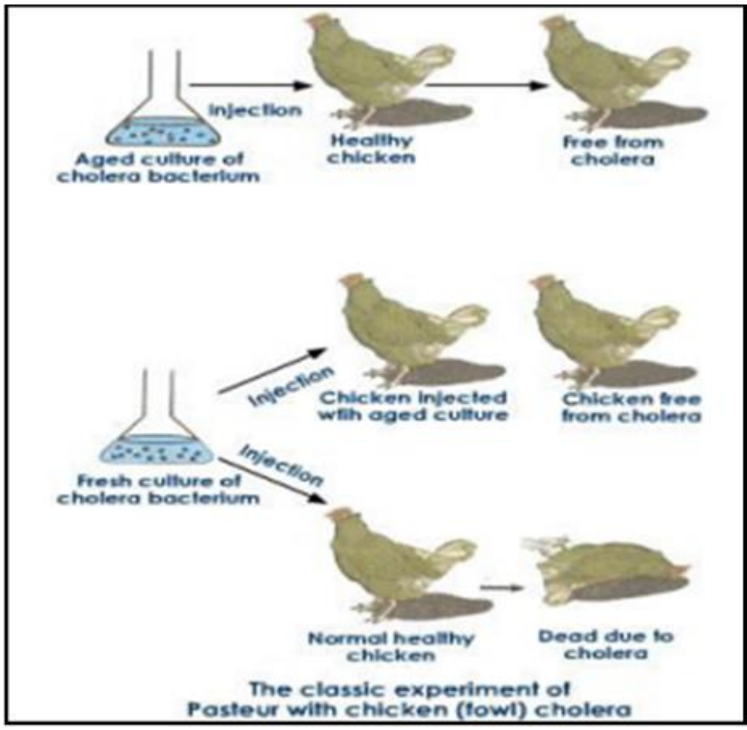
Edward Jenner, an English physician, observed in 1796 that milkmaids who had acquired cowpox were naturally protected from smallpox. Jenner presumed that prior exposure to cowpox could be utilised to safeguard against smallpox. To test his hypothesis, Dr. Jenner took samples from a cowpox sore on the hands of a milkmaid and inoculated them into the arm of James Phipps, an 8-year-old boy. After several months, Jenner exposed Phipps several times to variola virus, but Phipps never developed smallpox. Jenner declared in his dissertation, "On the Origin of the Vaccine Inoculation", that the elimination of smallpox, the most dreadful bane of the human species, must be the final result emanating from this practice.

Edward Jenner performing his first smallpox vaccination on James Phipps on 14th May, 1796

SOURCE:
https://museumandarchives.redcross.org.uk/objects/46915

CLASSICAL ATTENUATION EXPERIMENT BY LOUIS PASTEUR WITH FOWL CHOLERA PATHOGEN

In 1879, Pasteur, planning for a holiday, instructed his assistant, Charles Chamberland, to inoculate the chickens with fresh bacterial (*Pasteurella multocida)* culture. Chamberland forgot and went on a holiday himself. Pasteur, returning a month later from holiday, found the flask of bacteria that had prepared before he had left, and decided to use it for inoculating the hen rather than discarding it. In one month, the microbes had become attenuated/ weakened, due to the aging process and exposure to oxygen. When Pasteur inoculated the aged bacterial culture into healthy chickens, they not only survived but developed robust immunity against the disease. Later, when Pasteur injected the freshly recovered hens with fresh bacterial culture that would normally have killed other chickens; the chicken in this experiment no longer developed any signs of infection. It became clear to Pasteur that the weakened bacteria had caused the chickens to become immune to the disease. Thus, the first laboratory-produced vaccine revolutionised the field of immunology.

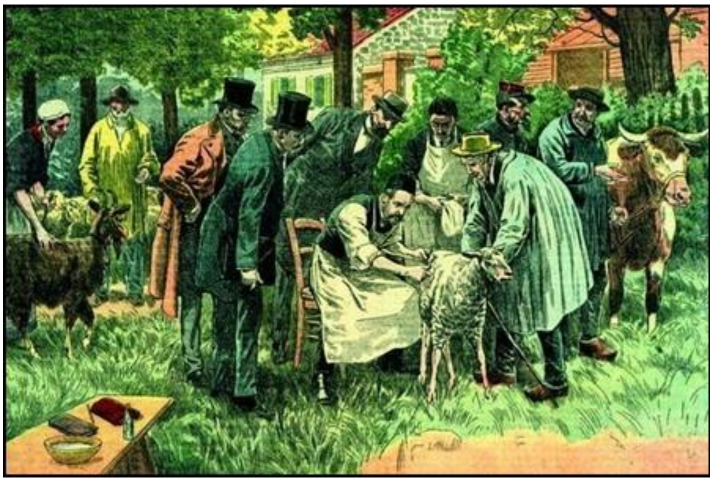


Classical attenuation experiment by Louis Pasteur with Fowl Cholera Pathogen

SOURCE: https://schillerinstitut.dk/si/wp-content/uploads/2019/10/Pasteur-Article-Part-2.pdf

ATTENUATED ANTHRAX VACCINE PRODUCTION BY LOUIS PASTEUR

After his success in attenuating Fowl Cholera pathogen, Louis Pasteur concentrated his efforts on attenuating *B. anthracis* so it could no longer cause disease. Pasteur grew the organism at an unusually high temperature of 108° F ("high-fever" temperature), where he could prevent the formation of spores and produce attenuated bacteria by infusing oxygen into the bacterial culture. This attenuation was then transmitted to successive generations of bacteria cultivated at normal body temperature, and in early 1881, a vaccine was produced. On May 5, 1881, Pasteur put on a public demonstration of his anthrax vaccine at Pouilly-le-Fort, a small village near Paris, using two groups of animals. The vaccinated group comprising 24 sheep, 1 goat, and 6 cattle received two doses of the vaccine at a 15-day interval while the unvaccinated group received nothing., All the animals were challenged with a potent anthrax culture at 30 days after the 1st vaccine dose. All the vaccinated animals survived, while all the unvaccinated animals were dead or dying. The publicity given to this experiment made Pasteur famous and introduced the public to the potential of vaccines in combating infectious disease.



Public demonstration of Louis Pasteur's Anthrax vaccine at Pouilly-le-Fort

SOURCE: https://link.springer.com/chapter/10.1007/978-1-4419-1108-7_4

ATTENUATED RABIES VACCINE PRODUCTION BY LOUIS PASTEUR

Pasteur's method of attenuation was rabies transmission from rabbit to rabbit (attenuation by lapinization) by intracranial inoculation for 15 passages until the shortest incubation period and the greatest degree of virulence have been attained. This lapinization technique, developed by Louis Pasteur, refers to viruses that have been adapted to develop in rabbits through serial transfers. This lapinized vaccine, developed by Louis Pasteur, became the blueprint for future veterinary vaccines such as the lapinized Classical Swine Fever vaccine.

Pasteur collected the spinal cord from deceased rabbits and kept it in tubes until the rabies virus virulence disappeared by the 15th day. Dogs were made immune to rabies by first inoculating with stale rabbit spinal cord specimens and later with fresh and virulent specimens.

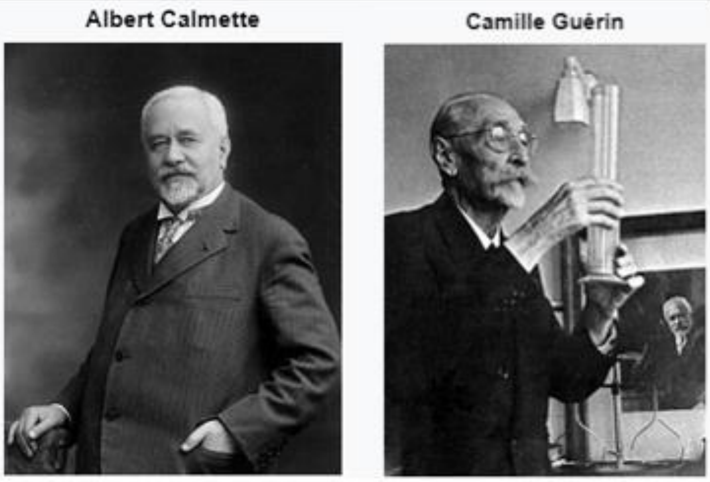
After successfully protecting dogs from the disease, on July 6, 1885, Louis Pasteur injected the first of 14 daily doses of desiccated spinal cord suspensions from rabid rabbits by injecting increasingly virulent virus preparations until the fully active virus was injected into 9-year-old Joseph Meister, who had been severely bitten by rabid feral dogs. Pasteur became an international hero since Joseph Meister never developed any symptoms of rabies.

Louis Pasteur's method of rabies virus attenuation employing lapinization

SOURCE: https://www.britannica.com/biography/Louis-Pasteur/Vaccine-development

BACILLUS CALMETTE-GUÉRIN (BCG) VACCINE FOR PROTECTION AGAINST TUBERCULOSIS

BCG is an attenuated live vaccine prepared from *Mycobacterium bovis,* which is used to prevent tuberculosis. The vaccine was developed by Albert Calmette (French Immunologist) and Camille Guérin (French Veterinarian/Bacteriologist) and was first administered to human beings in 1921. BCG is the only vaccine against tuberculosis and an integral part of the routine newborn immunisation schedule. BCG vaccine also ensures safety against non-tuberculous mycobacterial infections like Buruli ulcer and leprosy



BCG Vaccine developed by Albert Calmette and Camille Guerin

SOURCE:

https://en.wikipedia.org/wiki/Albert_Calmette

https://en.wikipedia.org/wiki/Camille_Gu%C3%A9rin

CONCLUSION

The eradication of smallpox in humans using cowpox vaccination by Edward Jenner, and protection of humanity against tuberculosis using BCG vaccine, which is an attenuated live vaccine prepared from *Mycobacterium bovis* demonstrate the intricate linkage between human and veterinary medicine. In fact, the eradication of smallpox in humans became the blueprint for the eradication of Rinderpest and

Contagious Bovine Pleuropneumonia (CBPP) in cattle, thereby underlining the fact that human and veterinary medicine can synergistically address public health challenges.

REFERENCES

Albert Calmette. (2020, April 18). Wikipedia. https://en.wikipedia.org/wiki/Albert_Calmette

Dr Edward Jenner carrying out his first smallpox vaccination on James Phipps, 14 May 1796. (n.d.). British Red Cross Collection Online. https://museumandarchives.redcross.org.uk/objects/46915

Evans, K. (2017). *From variolation to vaccination*. LabRoots. https://www.labroots.com/trending/microbiology/4928/variolation-vaccination

Ham, D., & Ham, R. (n.d.). *What is Life? The Passionate Dedication of Louis Pasteur Part II*. Retrieved May 7, 2025, from https://schillerinstitut.dk/si/wp-content/uploads/2019/10/Pasteur-Article-Part-2.pdf

National Library of Medicine. (2013, July 30). *Smallpox: Variolation*. Nih.gov; U.S. National Library of Medicine. https://www.nlm.nih.gov/exhibition/smallpox/sp_variolation.html

Peter. (2009). Anthrax. *Springer EBooks*, 57–71. https://doi.org/10.1007/978-1-4419-1108-7_4

Ullmann, A. (2018). Louis Pasteur - Vaccine development. In *Encyclopædia Britannica*. https://www.britannica.com/biography/Louis-Pasteur/Vaccine-development

Wikipedia Contributors. (2025, February 22). *Camille Guérin*. Wikipedia; Wikimedia Foundation. https://en.wikipedia.org/wiki/Camille_Gu%C3%A9rin

How to cite:

Thankappan S., Mahadappa P., and Gnanavel V. (2025). Introduction to veterinary vaccines: worldwide scenario. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 97-102.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOL. 5 ISSUE 2 APRIL-JUNE, 2025

HARNESSING DRONE TECHNOLOGY FOR ASSESSMENT AND MONITORING OF ON-FARM SOIL FERTILITY FOR SUSTAINABLE FOOD GRAIN PRODUCTION

Rajagopal Vadivel*, K. Sammi Reddy

ICAR-National Institute of Abiotic Stress Management, Malegaon Khurd, Maharastra, India

*Corresponding author email: rgpssac@gmail.com

ABSTRACT

The assessment of soil fertility is vital for sustainable food production. Traditional soil testing methods are laborious and limited in spatial accuracy. Drone technology offers a transformative solution by enabling high-resolution, real-time monitoring through multispectral, hyperspectral, LiDAR, thermal, and RGB sensors. This paper discusses how drones assess nutrient distribution, moisture, organic matter, and pH variability. The integration of GIS, AI models, and machine learning enhances soil mapping and nutrient prediction. Despite challenges like high costs and regulatory hurdles, drones hold great promise for advancing precision agriculture and sustainable soil management.

KEYWORDS: Drone-based soil assessment, Precision agriculture, Site-specific nutrient management, Sustainable food production

INTRODUCTION

Soil fertility is a fundamental determinant of sustainable food grain production, as it governs the soil's capacity to supply essential nutrients for optimal crop growth and yield. It is influenced by a complex interplay of physical, chemical, and biological properties, including nutrient availability, organic matter content, microbial activity, and moisture retention. Conventional soil fertility assessment methods—based on manual sampling and laboratory analysis—are time-consuming, labour-intensive, and often incapable of capturing spatial heterogeneity within fields. This limitation hinders timely and precise nutrient management, particularly for smallholder farmers with limited access to technical resources. The inability of traditional methods to reflect intra-field variability leads to inefficient fertilizer application, which can result in nutrient imbalances, reduced crop productivity, and environmental degradation through leaching and runoff.

The advent of drone technology offers a transformative alternative, enabling rapid, high-resolution, and non-invasive soil assessments. Drones equipped with advanced sensors such as multispectral, hyperspectral, LiDAR, and thermal cameras can accurately detect spatial variations in nutrient content, moisture levels, organic matter, and soil texture. These insights facilitate the development of real-time soil fertility maps, supporting site-specific nutrient management (SSNM) and the application of variable rate technology (VRT). The integration of drone-generated data with Geographic Information Systems (GIS), Internet of Things (IoT) devices, and artificial intelligence (AI) analytics enhances decision-making and predictive modelling. This results in more efficient resource use, reduced input costs, and minimized environmental impact. Ultimately, drone-based soil monitoring strengthens the resilience and sustainability of agricultural systems by promoting biodiversity, conserving soil health, and improving long-term productivity.

DATA PROCESSING AND INTERPRETATION

The vast amount of data collected by drones requires advanced processing and interpretation using specialized software and analytical tools. Geographic Information Systems (GIS), AI-based soil fertility models, and machine learning algorithms play a pivotal role in analyzing drone-generated data. GIS facilitates the visualization of spatial variability in soil fertility, while AI and machine learning enable predictive modelling of nutrient availability, soil degradation trends, and optimal fertilizer application strategies. A key application of this processed data is the creation of high-resolution soil fertility maps that capture variations in nutrient distribution, organic matter, pH levels, and soil moisture across agricultural fields. By integrating drone imagery with historical soil records, farmers can apply fertilizers more precisely based on specific field conditions, thereby improving nutrient use efficiency and minimizing environmental impact.

To ensure accuracy and reliability, drone-based soil assessments must be validated against ground-based data collected through conventional sampling and laboratory testing. This calibration, often referred to as ground truthing, enhances the precision of drone sensor readings and strengthens the predictive capability of AI models. Despite these advancements, drone-based assessments face certain limitations. Environmental factors such as cloud cover, sensor sensitivity, and differences in soil reflectance can affect data quality. Moreover, the effectiveness of these technologies depends on continuous improvements in sensor calibration, machine learning algorithms, and real-time data analytics. Addressing these challenges is essential to fully harness the potential of drone technology in soil fertility assessment and precision agriculture.

APPLICATION OF DRONE-BASED SOIL MONITORING IN SUSTAINABLE FOOD GRAIN PRODUCTION

The integration of drone technology in soil monitoring has several practical applications in ensuring sustainable food grain production. One of the primary benefits is the optimization of fertilizer application through site-specific nutrient management, reducing excessive use of chemical fertilizers and ensuring balanced soil nutrition. By enabling real-time monitoring of soil health, drones help prevent nutrient depletion and soil degradation, contributing to long-term soil sustainability. Additionally, drones can monitor erosion trends and soil degradation in croplands, allowing for timely intervention through conservation practices. Another crucial application is in water use efficiency, where drones assess soil moisture variability, enabling farmers to implement more precise irrigation schedules and reduce water wastage. Furthermore, drones help detect nutrient deficiencies at different crop growth stages, allowing farmers to adjust nutrient inputs and improve overall crop productivity.

ROLE OF DRONE TECHNOLOGY IN SOIL FERTILITY MANAGEMENT

Drone technology plays a pivotal role in modern soil fertility management by delivering high-resolution, real-time data that supports precise nutrient application and improved soil health. One of its primary advantages is the rapid assessment of soil nutrient status, enabling early detection of deficiencies in essential elements such as nitrogen (N), phosphorus (P), and potassium (K). Using multispectral and hyperspectral imagery, drones generate detailed soil fertility maps, facilitating targeted nutrient management and reducing input costs and environmental impact. Additionally, drones enhance precision agriculture by enabling variable rate technology (VRT), which ensures fertilizers are applied only where needed, optimizing crop yields and preventing soil degradation.

Beyond nutrient management, drones significantly improve irrigation efficiency and soil conservation practices. Equipped with thermal and multispectral sensors, they monitor soil moisture variations, allowing farmers to optimize irrigation schedules—especially critical in drought-prone areas. Integration with smart irrigation systems ensures precise water delivery, reducing both overwatering and drought stress. LiDAR-equipped drones detect early signs of soil erosion and compaction by capturing high-resolution topographic data, guiding the implementation of conservation techniques like contour farming and no-till methods. Furthermore, drones with near-infrared (NIR) sensors can assess soil organic carbon, supporting the evaluation of organic amendments such as compost and biochar. This enables farmers to track changes in soil organic matter and microbial activity over time, helping develop long-term, sustainable soil fertility strategies

ASSESSING SOIL FERTILITY USING DRONES

Drone technology enables precise assessment of various soil parameters critical for maintaining soil fertility and productivity. Organic carbon and soil organic matter (SOM) can be effectively analyzed using Normalized Difference Vegetation Index (NDVI) and Near-Infrared (NIR) reflectance sensors, providing insights into soil health and biological activity. Essential macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) are mapped using spectral indices, allowing farmers to identify nutrient deficiencies and optimize fertilizer application. Additionally, drones equipped with remote sensing algorithms can assess soil pH, electrical conductivity (EC), and salinity levels, which are crucial for preventing soil degradation and ensuring optimal crop growth. Soil moisture content, another key factor in soil fertility, is effectively monitored using thermal and multispectral sensors, helping farmers manage irrigation more efficiently. To ensure accuracy, drone-based assessments are often integrated with traditional soil sampling methods for validation, improving the reliability of nutrient management strategies.

CHALLENGES AND FUTURE PROSPECTS OF DRONE APPLICATION IN SOIL FERTILITY ASSESSMENT

Despite its advantages, drone technology in soil fertility assessment faces several challenges. High initial costs of drones and specialized sensors remain a significant barrier, especially for smallholder farmers. Moreover, operating drones, processing data, and interpreting results require technical expertise, limiting adoption in regions with low technological infrastructure. Regulatory restrictions, including airspace regulations and licensing, also pose hurdles. Furthermore, weather conditions such as wind and cloud cover can affect drone performance and data accuracy.

Looking ahead, the prospects for drone-based soil fertility assessment are highly promising. Integration with AI, IoT, and cloud computing can improve data precision and predictive modelling. Advances in sensor technology, such as real-time nutrient detection and enhanced hyperspectral imaging, will further refine soil analysis. Additionally, promoting cooperative farming models and providing government subsidies can increase scalability and affordability. These innovations are expected to make drone-based assessments more accessible and effective for farmers worldwide, supporting sustainable agricultural practices.

CONCLUSION

Drone technology represents a transformative advancement in soil fertility assessment, offering rapid, high-resolution, and real-time data essential for precision agriculture. By integrating advanced sensors with AI, GIS, and IoT, drones enable accurate monitoring of soil nutrients, moisture, pH, and organic matter, supporting site-specific nutrient management and sustainable farming. Despite challenges such as high costs and regulatory constraints, continued innovation and supportive policies can enhance accessibility and scalability. Ultimately, drone-based soil monitoring promotes efficient resource use, improved crop yields, and long-term soil health, playing a crucial role in ensuring food security and environmental sustainability in modern agriculture.

How to cite:

Vadivel R. and Reddy K. S. (2025). Harnessing drone technology for assessment and monitoring of on-farm soil fertility for sustainable food grain production. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 5 (2): 103-107.

*********XXXXX**********