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MANUFACTURING DRONES for India's AGRICULTURAL TRANSFORMATION

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AGRICULTURE UPDATES

Unjha Cumin and Fennel Receive GI Tag, Boosting Gujarat's Global Spice Identity

Unjha Cumin (Jeera) and Unjha Fennel (Variyali), two of North Gujarat's most renowned spice products, have been granted Geographical Indication (GI) tags by the Geographical Indications Registry of India. The registration certificates were issued on 28 March 2026 in the name of the Unjha Agriculture Produce Market Committee (APMC), under Class 30 for spices. The achievement is the result of a collaborative effort involving the Unjha APMC, the Gujarat Government's Department of Horticulture and Farmers' Welfare, Sardarkrushinagar Dantiwada Agricultural University, and the Entrepreneurship Development Institute of India.

The GI tag officially recognises that these spices possess unique qualities and a reputation linked to the Unjha region of North Gujarat. It provides legal protection against unauthorised use of the names and helps preserve the authenticity of these traditional agricultural products. The recognition is expected to strengthen consumer confidence while improving the branding and market value of Unjha cumin and fennel in both domestic and international markets. It also enhances the identity of the region as a trusted source of premium-quality spices.

Unjha is one of Asia's largest spice trading centres and serves as the principal marketing hub for cumin and fennel produced across Gujarat and neighbouring Rajasthan. Gujarat is the largest producer of cumin in India and among the leading producers of fennel, with cultivation concentrated in the arid and semi-arid districts of Mehsana, Patan, Banaskantha and Gandhinagar. India is also the world's largest producer and exporter of cumin, with Gujarat contributing a significant share of national production and exports. The GI recognition is expected to improve export competitiveness, support better price realisation for farmers, and reinforce the global reputation of Gujarat's spice industry.

ICAR Reaffirms Commitment to Climate-Resilient Agriculture on 98th Foundation Day

The Indian Council of Agricultural Research (ICAR) celebrated its 98th Foundation Day in New Delhi on 16 July, reaffirming its commitment to science-led, climate-resilient and farmer-centric agricultural development in line with the vision of Viksit Bharat 2047. Established in 1928, ICAR has played a pivotal role in strengthening India's agricultural research, education and extension systems. Over the past nine decades, the organisation has significantly contributed to increasing agricultural productivity, ensuring food and nutritional security, promoting technological innovations and improving the livelihoods of millions of farmers across the country.

Addressing the celebration, Union Agriculture and Farmers' Welfare Minister Shivraj Singh Chouhan described ICAR as the driving force behind India's agricultural transformation. He highlighted that the Council's scientific research has contributed to record production in foodgrains, horticulture, milk and fisheries. During the past year, ICAR developed 386 improved varieties across 44 crops, of which 94 per cent are climate-resilient and 29 are biofortified. These achievements reflect the organisation's growing focus on developing technologies that address climate change while improving nutritional security and farm productivity.

Emphasising the importance of scientific innovation, Shri Chouhan stated that farmers are the soul of agriculture, while scientists are its brain. He called for demand-driven research, greater self-reliance in pulses and oilseeds, improved agricultural education, commercialisation of research outcomes and wider dissemination of technologies through the nationwide network of Krishi Vigyan Kendras (KVKs). The Foundation Day celebrations highlighted ICAR's continued role in supporting sustainable agricultural growth through research, innovation and effective technology transfer, reinforcing its commitment to building a resilient and prosperous agricultural sector for the future.

PRAGATI Initiative Launched to Empower 20,000 Agri-Entrepreneurs and Support 20 Lakh Farmers

Union Minister for Agriculture and Farmers' Welfare and Rural Development, Shivraj Singh Chouhan, launched the **PRAGATI (Promoting Regenerative Agriculture through Agri-Entrepreneurship and Transformative Innovation)** initiative, marking a major step towards strengthening India's rural economy through regenerative and climate-resilient agriculture. The programme aims to create a nationwide network of 20,000 agri-entrepreneurs who will directly support more than 20 lakh smallholder farmers. Designed to promote sustainable farming practices, improve farm productivity and enhance rural livelihoods, the initiative seeks to build a resilient agricultural ecosystem while contributing to the vision of Viksit Bharat.

PRAGATI is a collaborative effort involving several leading national and international organisations, including the PepsiCo Foundation, State Bank of India Foundation (SBIF), Gates Foundation, IDH, Heifer International, Environmental Defense Fund (EDF), Global Agri Entrepreneurship Academy, The Sustainable Agriculture Foundations International Association (SAFIA), Agri Entrepreneur Growth Foundation (AEGF), and Transform Rural India Foundation (TRIF). The programme builds on the experience gained from successful agri-entrepreneurship initiatives implemented across different states and aims to strengthen the existing network of more than 26,000 agri-entrepreneurs. It also places special emphasis on inclusive participation by encouraging balanced representation and expanding opportunities for diverse farming communities.

The initiative will be implemented across major agricultural states, including Madhya Pradesh, Bihar, Uttar Pradesh, Assam, West Bengal, Jharkhand, Maharashtra and Rajasthan. Through training, technical support and entrepreneurship development, PRAGATI will enable agri-entrepreneurs to provide farmers with access to improved technologies, sustainable farming practices and market linkages.

PMFME Scheme Supports Over 2 Lakh Food Processing Enterprises, Creating 11 Lakh Jobs

The Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME) Scheme has achieved a significant milestone by supporting more than 2 lakh micro food processing enterprises since its launch in 2020. According to the Ministry of Food Processing Industries, the scheme has generated over 11 lakh employment opportunities across the country, with women accounting for nearly 44 per cent of the beneficiaries. So far, the government has provided around ₹6,000 crore as credit-linked subsidies, reflecting its commitment to strengthening the food processing sector, promoting entrepreneurship and improving rural livelihoods.

Implemented by the Ministry of Food Processing Industries (MoFPI), the PMFME scheme aims to formalise and modernise unregistered and unorganised food processing businesses. Under the scheme, eligible entrepreneurs receive a 35 per cent credit-linked capital subsidy on project costs, up to a maximum of ₹10 lakh per unit. Beneficiaries contribute at least 10 per cent of the project cost, while the remaining amount is financed through bank loans. The scheme also facilitates access to training, technology, branding, marketing support and improved infrastructure, enabling micro-enterprises to become more competitive and sustainable.

The scheme has also played an important role in bringing enterprises into the formal economy, with more than 75,000 supported units obtaining Udyam, FSSAI and GST registrations. Recognising its success, the government has extended the PMFME scheme until September 2026 and is considering the launch of **PMFME 2.0** with suitable modifications to attract greater investment and expand support for the sector. The initiative is expected to further strengthen India’s food processing industry by encouraging value addition, reducing post-harvest losses, creating employment and increasing income opportunities for farmers and rural entrepreneurs.

India and Seychelles Strengthen Agricultural Cooperation with New ICAR Agreement

India and the Republic of Seychelles have strengthened their agricultural partnership with the signing of a Memorandum of Understanding (MoU) between the Indian Council of Agricultural Research (ICAR) and the Agriculture Department of Seychelles during Prime Minister Narendra Modi's official visit to the island nation. To implement the agreement, both sides also signed a five-year Work Plan covering the period 2026–2031. The collaboration will focus on key areas such as climate-smart agriculture, horticulture, livestock development, post-harvest management and food security, reflecting the shared commitment of both countries to promoting sustainable agricultural growth.

The MoU aims to enhance cooperation in agricultural research, education, capacity building and technology transfer. It provides a framework for joint research programmes, exchange of scientists, researchers and students, and the sharing of advanced agricultural technologies and best practices. The agreement is expected to facilitate knowledge exchange between the two countries while promoting innovation and the adoption of modern farming techniques suited to changing climatic conditions. It also reinforces India's role in supporting agricultural development through international scientific collaboration.

The partnership seeks to strengthen institutional linkages and improve agricultural productivity by combining scientific expertise with practical field applications. It is expected to enhance technical capacity, encourage sustainable farming practices and contribute to long-term food and nutritional security in both countries. By addressing emerging challenges such as climate change, resource management and agricultural resilience, the collaboration is set to benefit researchers, policymakers and farming communities alike. The agreement also reflects India's continued commitment to expanding global cooperation in agricultural research and technology for sustainable development.

ICAR-CIBA Demonstrates India's First Blue Swimmer Crab Farming Technology

The ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA), Chennai, has successfully demonstrated Blue Swimmer Crab farming technology for the first time in India, marking a significant advancement in the country's brackishwater aquaculture sector. Conducted on 22 June 2026 at the institute's Muttukadu Experimental Station, the demonstration utilised hatchery-produced seed of the Blue Swimmer Crab (*Portunus reticulatus*) along with a scientifically formulated pelleted feed named **BSCrabPlus**. The initiative aims to diversify aquaculture practices, improve productivity and create new income opportunities for coastal farming communities through the cultivation of this high-value marine crab species.

ICAR-CIBA has developed a comprehensive technology package covering every stage of Blue Swimmer Crab farming, including hatchery seed production, nursery rearing and grow-out culture practices. The Blue Swimmer Crab is widely farmed in several Asian countries due to its rapid growth, adaptability to brackishwater conditions and strong market demand. The institute's newly developed feed, **BSCrabPlus**, has been specifically formulated to meet the nutritional requirements of the species, ensuring better growth, survival and production efficiency under farming conditions.

The demonstration trial recorded an impressive productivity of **1,100 kg per hectare** after a 105-day culture period. The harvested crabs attained an average marketable weight of **150 grams** and fetched a market price of around **₹500 per kilogram**, highlighting the species' commercial potential. During the harvest programme, revenue amounting to **₹1,22,500** was transferred to the **Success Self-Help Group** of Pudhunemmelikuppam village in Chengalpattu district under the Scheduled Caste Sub-Plan programme.

Indori Malwi Potato Receives GI Tag, Strengthening Farmers' Market Opportunities

The **Indori Malwi potato**, one of Madhya Pradesh's most important rabi season crops, has been granted the **Geographical Indication (GI)** tag, marking a significant achievement for the state's agricultural sector. Selected under the Madhya Pradesh Government's **One District One Product (ODOP)** initiative, the GI recognition is expected to enhance the crop's identity, strengthen its brand value and improve market access in both domestic and international markets. The certification is also likely to help farmers secure better prices by protecting the unique geographical identity and quality of the crop. With this recognition, 12 of the 18 agricultural products proposed by the state have now officially received GI status.

Along with the Indori Malwi potato, **Garadu** and **Balam cucumber** from Ratlam district have also received GI certification based on proposals submitted by the district administration. The Malwi potato is widely recognised for its low sugar and low starch content, making it particularly suitable for processing. It retains its white colour after frying, making it an ideal raw material for chips and French fries. The potato is also an integral part of Indore's famous street food culture, featuring in popular dishes such as Aloo Chaat, Poha, Aloo Bada and Khopra Petis.

The Indori Malwi potato is cultivated over nearly **45,000 hectares** in Indore district by approximately **30,000 to 35,000 farmers**, making it an important source of rural income. Its consistent quality has attracted major food processing companies, including **ITC, Mahindra, PepsiCo, Balaji, McCain and HyFun Foods**, which procure processing-grade potatoes directly from local growers. The GI tag is expected to further strengthen market linkages, promote exports, encourage value addition and enhance the economic prospects of potato farmers while reinforcing Madhya Pradesh's reputation as a producer of high-quality agricultural products.

India–US Trade Talks Focus on Agriculture as Both Nations Work Towards Balanced Agreement

Agriculture has emerged as one of the key areas in the ongoing India–United States trade negotiations, with both countries working to conclude a mutually beneficial bilateral trade agreement. Recent discussions indicate that negotiations are nearing completion, although a few issues related to tariffs and market access remain under consideration. Both governments have reiterated their commitment to reaching a balanced agreement that promotes trade while safeguarding the interests of sensitive sectors. Officials have indicated that the agreement could be finalised in the coming months once the remaining issues are resolved.

Agricultural trade has been a major focus of the negotiations. India has consistently maintained that sensitive sectors such as dairy and several staple agricultural commodities must be protected while seeking greater export opportunities for its own farm products. The discussions are expected to expand market access for selected agricultural commodities and processed food products, while ensuring that domestic farming interests remain protected. The proposed framework also aims to strengthen cooperation in agricultural technology, food processing, value addition and supply chains, creating new opportunities for farmers and agribusinesses in both countries.

The proposed trade agreement is expected to boost India's agricultural exports by improving access for products such as spices, fruits, coffee, cashew, processed foods and other value-added farm products in the US market. At the same time, the government has emphasised that the agreement will not compromise the interests of Indian farmers and that negotiations are being guided by the objective of protecting agriculture while enhancing export competitiveness. If concluded successfully, the pact is expected to strengthen bilateral trade, encourage investment in agriculture and food processing, and deepen long-term cooperation between the two countries in the agri-food sector.

COVER STORY

MANUFACTURING DRONES for India's AGRICULTURAL TRANSFORMATION

About the Author

Agnishwar Jayaprakash

Founder & Director

Garuda Aerospace

India's agricultural future will be shaped as much by technology as by the determination and resilience of its farmers. While agriculture remains the backbone of the Indian economy and the primary source of livelihood for millions, the sector is increasingly challenged to produce more with fewer resources. Rising input costs, labour shortages, shrinking landholdings, and climate variability are redefining the realities of farming across the country.

In this evolving landscape, agricultural drones are emerging as a transformative force. More than just another technological innovation, drones are becoming critical enablers of precision, efficiency, and sustainability. Across India's farmlands, they are helping farmers make faster, smarter, and more informed decisions, ushering in a new era of data-driven agriculture.

The Role of Drones in Agricultural Transformation

Agricultural drones are rapidly becoming an integral part of modern farming by addressing some of the sector's most pressing challenges. They offer practical solutions that improve operational efficiency, reduce resource wastage, and enable farmers to manage larger areas of land with greater precision.

As the global population continues to grow, the need for sustainable and productive agricultural practices has become increasingly urgent. Drones are helping bridge this gap by integrating advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), and remote sensing into everyday farming operations. Their ability to collect, process, and analyse data at scale is enabling farmers to transition from traditional methods to technology-driven agriculture.

Beyond individual farms, drones are supporting crop insurance assessments, disaster response, land mapping, and agricultural research. As adoption increases, they will play a vital role in strengthening agricultural resilience, enhancing food security, and accelerating the sector's digital transformation.

Enabling Precision Farming Through Technology

Precision farming is built on the principle of making informed decisions using accurate, real-time information. Agricultural drones make this possible by providing detailed aerial insights into crop and field conditions that would otherwise be difficult, time-consuming, and expensive to obtain.

Equipped with advanced sensors, high-resolution cameras, and imaging technologies, drones can identify variations across fields, detect early signs of crop stress, monitor plant health, assess irrigation requirements, and pinpoint areas affected by pests and diseases. This allows farmers to move beyond uniform treatment methods and allocate resources exactly where they are needed.

Drones are also revolutionising field operations through precision spraying and targeted application of fertilizers, pesticides, and micronutrients. By reducing over-application and minimising wastage, they improve efficiency while lowering operational costs. These capabilities enable timely interventions, higher productivity, and a more proactive approach to farm management.

Why India Must Manufacture, Not Just Import

As drones become increasingly important to the future of agriculture, India faces a critical choice: continue relying on imported technologies or build a robust domestic manufacturing ecosystem.

While imports may satisfy immediate demand, long-term agricultural transformation requires solutions designed specifically for India's diverse farming conditions. Manufacturing drones in India enables the development of technologies tailored to local crops, farm sizes, terrain, and climatic conditions.

A strong indigenous manufacturing ecosystem will reduce dependence on foreign suppliers, strengthen supply-chain resilience, and provide greater control over critical technologies. It will also accelerate innovation by fostering collaboration among manufacturers, agricultural institutions, research organisations, and farmers.

Such collaboration can lead to the development of more affordable, efficient, and application-specific drone solutions that directly address the challenges faced by Indian agriculture. Increased local production will further reduce costs, making advanced drone technologies accessible to a larger segment of the farming community.

The importance of building domestic drone capabilities has also been emphasised by Defence Minister Rajnath Singh, who has highlighted India's potential to emerge as a global drone hub.

While this vision is often viewed through the lens of strategic self-reliance, it carries equally significant implications for agriculture. A strong manufacturing base can help ensure affordable access to drone technology while positioning India as a leader in precision farming solutions.

Government Support Driving Adoption

The growth of agricultural drone technology in India has been significantly supported by progressive government policies and reforms. The introduction of the Drone Rules, 2021, simplified regulations, reduced compliance requirements, and created a more conducive environment for innovation and adoption.

The government's Kisan Drone initiative has further accelerated deployment by promoting the use of drones for crop assessment, precision spraying, land record digitisation, and farm monitoring. Financial assistance and subsidy programmes have also helped make drone technology more accessible to farmers, Farmer Producer Organisations (FPOs), cooperatives, and rural entrepreneurs.

Aligned with the vision of Atmanirbhar Bharat, these initiatives are encouraging Indian companies to develop and manufacture drone technologies locally. By strengthening research, production, and skill development capabilities, India is laying the foundation for a self-reliant drone ecosystem that can drive agricultural productivity and economic growth.

Economic Impact Beyond Farming

The impact of agricultural drone manufacturing extends far beyond the farm gate. A thriving drone ecosystem can stimulate growth across multiple industries, including electronics, batteries, sensors, software, artificial intelligence, and advanced manufacturing.

The sector also has immense potential to generate skilled employment opportunities. From drone pilots and technicians to maintenance specialists, software developers, and data analysts, the industry is creating new career pathways for India's youth.

Drone-based service models are also opening entrepreneurial opportunities in rural India, enabling technology-driven livelihoods while bringing advanced solutions closer to farmers. As domestic capabilities expand, India can position itself as a supplier of affordable, high-quality drone technologies to global markets, unlocking significant export potential.

Overcoming Challenges Through Collaboration

Despite their immense promise, agricultural drones still face certain barriers to widespread adoption. High initial costs, limited awareness, and the need for specialised training remain challenges, particularly for small and marginal farmers.

There is also a need to improve digital literacy and provide guidance on how farmers can effectively utilise drone-generated insights. Access to financing, maintenance services, and skilled operators must continue to expand across rural regions.

Operational factors such as battery limitations, weather conditions, connectivity gaps, and component availability also require ongoing attention. However, these challenges are not roadblocks; they are opportunities for innovation and collaboration.

Through coordinated efforts between government, industry, educational institutions, and technology providers, India can build an ecosystem that makes drone technology accessible, affordable, and scalable for farmers nationwide.

The Road Ahead

Agricultural drones are no longer a futuristic concept—they are rapidly becoming an essential tool for the future of Indian farming. By enabling precision agriculture, improving resource efficiency, and supporting data-driven decision-making, drones have the potential to transform farming practices while helping farmers meet growing food demands sustainably.

However, technology adoption is only part of the journey. Unlocking the full potential of agricultural drones will require continued investment in awareness, training, and support systems that empower farmers to integrate these solutions into their daily operations.

For India, the next chapter of agricultural transformation lies not only in using drones but also in building them. A strong domestic manufacturing ecosystem will make drone technology more affordable, accessible, and customised to local needs while strengthening India's technological capabilities and economic self-reliance.

By investing in indigenous innovation today, India can lead the global precision agriculture revolution and create a future where technology and farming work together to drive prosperity, sustainability, and food security for generations to come.

WHEAT, WEATHER, AND INFLATION

The Triple pressure shaping India's Food Economy

For decades, wheat has been viewed primarily as a staple crop that supports food security and rural livelihoods. Today, however, its importance extends well beyond agriculture. Wheat has become a strategic indicator of India's economic health, reflecting the intersection of climate uncertainty, inflation, government policy, and global commodity markets. Its price now influences household food budgets, manufacturing costs, public procurement strategies, and business decisions across the food value chain.

This transformation reflects a broader shift in India's food economy. Agriculture no longer operates in isolation but within an interconnected ecosystem where climate events, energy prices, supply chains, and international markets shape domestic outcomes. A delayed winter, an unexpected heatwave, or disruptions in global grain trade can quickly influence wheat prices. As India's consumption patterns evolve, wheat has become central not only to farming but also to food processing, retail, logistics, and exports. Understanding wheat is therefore essential for businesses, policymakers, and consumers alike.

Mr. Mahesh Kewlani
Director,
Kewlani Group

Climate Risk Is Reshaping Agricultural Stability

Climate has always affected farming, but its impact is becoming more frequent and severe. Wheat is particularly vulnerable because its critical growth stages coincide with late winter and early spring, when even a short heatwave can reduce grain size, quality, and yields. In recent years, India has witnessed unusually warm winters, erratic rainfall, and unseasonal weather that have disrupted production and increased uncertainty. The effects extend beyond farms. Lower output creates challenges for flour mills, food manufacturers, traders, and procurement agencies. Markets often react to anticipated shortages before harvests are completed, pushing prices higher based on expectations alone. Climate risk is therefore influencing market behaviour as much as actual production.

Building resilience requires long-term investment in climate-smart agriculture. Climate-resilient seed varieties, precision farming, satellite-based crop monitoring, improved weather forecasting, and efficient irrigation systems will become increasingly important. Adaptation is no longer optional since it is essential for ensuring both agricultural productivity and economic stability.

Supply-Side Costs Are Driving Food Inflation

Food inflation is often discussed from the consumer's perspective, but much of the pressure originates within the agricultural supply chain. Wheat prices increasingly reflect rising costs of cultivation, transportation, processing, and storage rather than demand alone.

Diesel prices affect irrigation and transport, fertilizer costs remain linked to global energy markets, labour expenses continue to rise, and warehousing, packaging, and freight have all become more expensive. When these higher costs coincide with weather-related production losses, inflation intensifies across the value chain. Farmers require better prices to offset rising input costs, processors face expensive raw material procurement, retailers adjust prices to protect margins, and consumers ultimately pay more. This highlights an important policy lesson: controlling inflation requires more than increasing production. Improving logistics, reducing post-harvest losses, and strengthening storage and transportation infrastructure are equally important for containing food prices.

Global Markets Are Influencing Domestic Prices

Although India is one of the world's largest wheat producers, its domestic market is increasingly connected to global commodity cycles. International developments now influence pricing, procurement, and policy decisions far more rapidly than in the past. The Russia–Ukraine conflict demonstrated this reality. As global wheat supplies tightened, international prices surged, creating export opportunities for India while raising concerns over domestic food security. Policymakers were forced to balance export potential with the need to stabilize local prices.

Beyond geopolitical events, freight costs, exchange rates, crude oil prices, fertilizer costs, and global grain inventories all shape the economics of wheat production and trade. Businesses can no longer rely solely on domestic crop assessments. Market intelligence and global monitoring have become critical for procurement and risk management.

Infrastructure Is the New Competitive Advantage

Food security depends not only on how much wheat is produced but also on how efficiently it is stored, transported, and distributed. Every year, avoidable post-harvest losses reduce available grain because storage facilities and logistics systems struggle to keep pace with India's agricultural scale.

As commodity prices rise, the value of every tonne of wheat increases, making efficient infrastructure a strategic necessity. Modern silos, scientific warehousing, digital inventory management, and integrated logistics networks can reduce wastage, improve grain quality, and stabilize supply during periods of market uncertainty. The ability to move wheat quickly between surplus and deficit regions also reduces regional price disparities caused by logistical bottlenecks rather than genuine shortages. Investments in post-harvest infrastructure will therefore strengthen both operational efficiency and national food resilience.

Consumer Preferences Are Transforming the Wheat Value Chain

India's wheat economy is also changing because of evolving consumer behaviour. Urbanization, rising incomes, and greater health awareness are increasing demand for packaged atta, fortified wheat products, multigrain blends, premium bakery ingredients, and ready-to-cook foods.

Consumers now expect quality, nutrition, consistency, and traceability alongside affordability. The growth of organised retail and e-commerce has further raised expectations regarding packaging, shelf life, and supply chain transparency. As a result, wheat is evolving from a bulk agricultural commodity into a value-added consumer product. Businesses that invest in quality assurance, branding, innovation, and efficient processing will be better positioned to meet changing market demands.

Policy Must Focus on Long-Term Resilience

Wheat remains central to India's food security through minimum support prices (MSP), public procurement, buffer stocks, and the Public Distribution System (PDS). Yet policymakers face the complex task of balancing farmer incomes, inflation control, consumer affordability, food security, and export competitiveness.

Future policy success will depend less on short-term interventions and more on adaptive systems. Digital procurement, satellite-based crop monitoring, artificial intelligence for production forecasting, and real-time market intelligence can improve decision-making while reducing uncertainty.

Equally important are investments in climate-resilient farming, efficient irrigation, and rural infrastructure that improve long-term productivity without placing additional pressure on natural resources. As India's food economy becomes increasingly interconnected with global markets, resilience must become the guiding principle of agricultural policy.

Building a Future-Ready Food Economy

The convergence of wheat, weather, and inflation represents more than a temporary challenge as it signals a structural transformation in India's food economy. Agricultural production alone will no longer determine food security or market stability. Instead, resilience will depend on climate adaptation, efficient infrastructure, intelligent supply chains, technological innovation, and responsive policymaking.

This changing landscape also creates new opportunities. Businesses investing in predictive analytics, digital supply chains, modern warehousing, and sustainable sourcing will be better equipped to manage uncertainty. Farmers adopting climate-resilient practices and precision agriculture can improve productivity while reducing risk. Policymakers who integrate climate science with agricultural planning can build systems that are more adaptive and less reactive.

Ultimately, wheat has evolved far beyond its role as a staple crop. It now serves as a barometer of India's economic resilience, climate preparedness, and supply chain efficiency. Strengthening every link in the wheat value chain, from production and storage to processing and distribution, will be essential for ensuring both food security and sustainable economic growth in an increasingly uncertain world.

ARTIFICIAL INTELLIGENCE

in Crop Disease Monitoring

Dr. Vishal D. Pawar[1] and Kishor T. Thakre

[1]Assistant Professor, Plant Pathology Section, College of Agriculture, Nagpur, Maharashtra

1. Introduction

Artificial Intelligence (AI) is transforming modern agriculture by providing intelligent and efficient solutions for crop production and protection. In plant pathology, AI has become a valuable tool for the early detection, identification, and monitoring of plant diseases using image analysis, machine learning, and deep learning techniques. AI-based crop disease monitoring systems enable rapid and accurate diagnosis, helping farmers take timely management decisions, reduce crop losses, and improve productivity. This technology is playing a significant role in promoting precision agriculture and sustainable disease management.

2. History of Artificial Intelligence

The development of Artificial Intelligence (AI) began in the 1940s with the concept of artificial neurons and early computing systems. A major breakthrough came in 1956, when John McCarthy introduced the term Artificial Intelligence at the Dartmouth Conference. Since then, AI has evolved from expert systems to advanced machine learning and deep learning technologies. Today, AI is widely applied in agriculture, particularly for crop disease detection, precision farming, and intelligent decision-making, making farming more efficient and sustainable.

3. Types of Artificial Intelligence

A. Machine Learning (ML)

Machine Learning is a branch of AI that enables computers to learn from data, identify patterns, and make decisions with minimal human intervention. It is widely used for plant disease detection and diagnosis.

Types of Machine Learning:

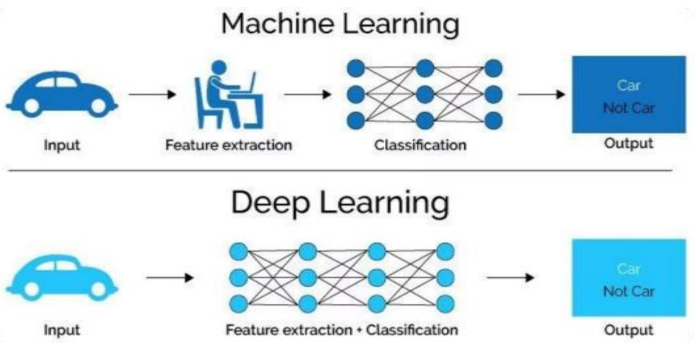
- **Supervised Learning:** Learns from labeled data to accurately identify and classify plant diseases.
- **Unsupervised Learning:** Analyzes unlabeled data to discover hidden patterns and relationships.

- **Reinforcement Learning:** Learns through trial and error by receiving rewards or penalties, improving its performance over time.

B. Deep Learning Algorithms

Deep Learning is an advanced form of machine learning that uses artificial neural networks to process complex data, especially images.

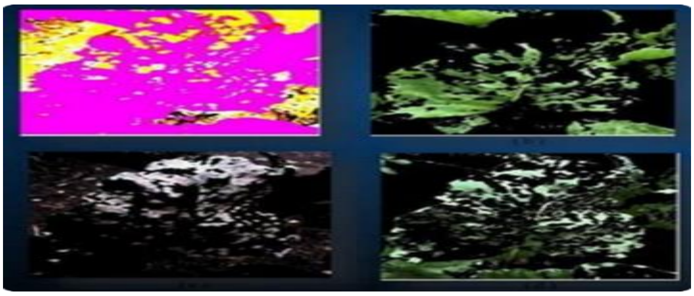
- **Artificial Neural Network (ANN):** Mimics the functioning of the human brain and forms the foundation of deep learning.
- **Convolutional Neural Network (CNN):** Extracts image features and is widely used for plant disease detection and classification.
- **Recurrent Neural Network (RNN):** Processes sequential data and is mainly used for prediction and forecasting applications.



4. Mechanism of AI in Disease Detection

AI-based disease detection follows a series of systematic steps to identify plant diseases accurately.

- **Image Acquisition:** High-quality images of healthy and diseased plant parts are captured using smartphones, digital cameras, or drones.
- **Image Pre-processing:** The captured images are enhanced by removing noise, adjusting brightness, and resizing them to improve image quality.
- **Image Segmentation:** The diseased region is separated from the healthy portion of the plant to enable detailed analysis.
- **Feature Extraction:** Important features such as colour, texture, shape, and lesion characteristics are extracted from the segmented image.
- **Classification:** The extracted features are compared with trained datasets using AI models to accurately identify and classify the disease, enabling timely disease management.



5. Drones in Agriculture

Drones are widely used in modern agriculture for efficient crop monitoring and precision farming. Equipped with high-resolution cameras and advanced sensors, they provide real-time information about crop health and field conditions.

Uses of Drones in Agriculture:

- Crop health monitoring and disease detection
- Pest and weed surveillance
- Soil and field mapping
- Precision spraying of pesticides and fertilizers
- Estimation of crop growth and yield

6. Applications of Artificial Intelligence in Agriculture

Artificial Intelligence is transforming agriculture by improving productivity, reducing crop losses, and supporting precision farming. The major applications of AI in agriculture include:

- **Crop Yield Prediction and Price Forecasting:** AI analyzes weather, soil, and crop data to predict crop yield and market prices.
- **Agricultural Robots:** AI-powered robots perform activities such as sowing, harvesting, and weed control with greater accuracy and efficiency.
- **Intelligent Spraying:** AI identifies diseased or weed-infested areas and enables precise application of pesticides and herbicides.
- **Crop and Soil Monitoring:** AI continuously monitors crop health, soil conditions, nutrient deficiencies, and pest incidence using sensors and drones.
- **Disease Diagnosis:** AI-based image analysis helps detect and identify plant diseases at an early stage, allowing timely management.
- **Predictive Insights:** AI provides recommendations on the optimum time for sowing, irrigation, fertilization, and disease management based on weather and field data.

7. AI in Plant Pathology

Artificial Intelligence plays a significant role in modern plant pathology through the following applications:

- Early detection and accurate diagnosis of plant diseases.
- Image-based disease identification using computer vision and deep learning.
- Disease prediction and forecasting based on weather and field data.
- Monitoring disease spread for timely intervention.
- Recommendation of suitable disease management practices.
- Reduction in excessive pesticide use through precise disease detection.

8. Popular AI-Based Plant Disease Detection Apps

Several AI-powered mobile applications help farmers and researchers identify plant diseases quickly and accurately. Some of the widely used applications are:

- **Plantix** – Detects plant diseases, pests, and nutrient deficiencies from images and provides management recommendations.
- **Plant Village Nuru** – Uses AI to diagnose diseases in crops such as cassava, potato, and maize through smartphone images.
- **Leaf Doctor** – Measures disease severity by analyzing infected leaf images.
- **AgroAI** – Assists in crop health monitoring and disease diagnosis using AI technology.
- **AI-DISC App** – Supports image-based disease identification and provides recommendations for effective disease management.

These applications enable rapid disease diagnosis, improve decision-making, and promote precision agriculture.

9. Future Prospects

The future of AI in plant disease monitoring is highly promising. Some potential developments include:

- Development of more accurate and faster disease detection models.
- Integration of AI with drones, IoT, and remote sensing technologies.
- Real-time disease monitoring through smartphones and smart devices.
- Early disease forecasting using weather and climate data.
- AI-based decision support systems for precision disease management.

10. Conclusion

Artificial Intelligence has emerged as a powerful technology for modern crop disease monitoring and plant disease management. By integrating machine learning, deep learning, computer vision, and drone technologies, AI enables rapid and accurate disease detection, early diagnosis and timely decision-making. These advancements help reduce crop losses, optimize pesticide use and improve agricultural productivity. With continuous technological developments, AI is expected to play an increasingly important role in precision agriculture, ensuring sustainable farming practices and strengthening global food security.

DRONES IN THE LIVESTOCK SECTOR and their applications

Salam Prabex[1], *Ranjani Priya K[2], Umashankar Rawat[3], Tamal Chandra Dhara[4], Tarun Kumar[5], Harideep Verma[6], Nirbhay Bhawsar[7]

[1,2,3,4,5,6]PhD Scholar, Division of Extension Education, ICAR-Indian Veterinary Research Institute, Izatnagar

[7]PG Scholar, Division of Extension Education, ICAR-Indian Veterinary Research Institute, Izatnagar

The widespread utilization of Unmanned Aerial Vehicles (UAVs) across various industries is booming due to their user-friendly nature and continuous technological advancements. Over the past few years, numerous studies have demonstrated that drones can effectively encompass nearly 10 to 15 times the terrain that traditional ground-based methods can cover. Among the numerous applications of UAVs, one of the most promising is in livestock agriculture, where they streamline various tasks to enhance animal management efficiency. Farmers in the livestock industry can employ drones to gain an aerial perspective of their animal enclosures or grazing fields. Livestock management research involved the functioning of UAVs to monitor farm animals via detection, counting, tracking animals, etc. Equipped with a high-definition camera, drones can capture sharp and detailed images, while the use of thermal imaging software enables the detection of heat anomalies among the livestock. These technologies play an important role in enhancing efficiency, improving animal welfare, and ultimately contributing to the sustainability and profitability of the livestock industry.

Introduction

The increasing curiosity of users in drone technology has led to the emergence of novel application areas. Currently, drones are being employed in various sectors, including medicine, the military, forecasting, and surveillance, with a wide array of potential uses. Agriculture and livestock farming have not been exempt from this trend. Population growth, urbanization and income growth in developing countries are the locomotives of increased demand for livestock products. Worldwide, expanding population pressure, urbanization, economic growth, and increasing income are leading to increased consumption of animal-based foods and greater commercialization, with a subsequent need for increased livestock production (Sidahmed, 2008).

The livestock sector supports the livelihoods of around 1.3 billion people globally and makes up 40 percent of the world's agricultural GDP (FAO, 2025). It is essential to have a thorough understanding of one's livestock to successfully manage them and ensure efficient reproduction. Animal management remains one of the most time-intensive aspects of livestock husbandry. Traditional farming practices continue to dominate the sector, with many farmers showing limited eagerness to adopt new technologies, largely due to long-standing habits and traditions passed down through generations, which often make farmers hesitant to try unfamiliar approaches (Simamora *et al*., 2025). Managing large-scale extensive livestock production systems remains particularly challenging, with the adoption of improved practices shaped by a combination of socio-economic, institutional and environmental factors, including education level, farming experience, land tenure security and access to credit and extension services (Nontu *et al*., 2025)

It is compulsory to adapt to the modern ways of livestock farming in order to reduce labour expenses, time consumption which leads to increase in the productivity (Dileep *et al.*

2020). The current imperative is to streamline livestock farming, making it less reliant on labor, more time-efficient, and economically viable. Drone technology, given its diverse range of applications, has the potential to play a pivotal role in addressing this challenge. The current requirement is to make livestock farming more efficient, less demanding in terms of labor and time, and more cost-effective. Drone technology, with its diverse range of applications, could be instrumental in addressing this challenge. Keeping track of the livestock population is a vital aspect of farm management. However, this may not be a trivial task, especially in very large properties adopting extensive (Barbedo and Koeningkan, 2018).

Drones

A drone, also known as an Unmanned Aerial Vehicle (UAV), is an aircraft that operates without a human pilot on board, distinguishing it from traditional airplanes. Its flight path can be predetermined or managed independently by on-board computer systems known as autopilots, or it can be directed remotely by a human operator on the ground using GPS coordinates. While these tools and technologies have certain inherent constraints, they have the potential to furnish valuable data that can subsequently shape policies and choices. The benefits of having an aerial perspective, when coupled with analytical tools capable of translating data and images into actionable insights, have heralded a new era. Nevertheless, ensuring the sustainable adoption of these technologies hinges on addressing concerns related to privacy, safety, and security as a top priority.

Role of Drones in Livestock Management

Drones, originally developed for military use, are now widely applied across industries, including agriculture, where they help cattle ranchers to efficiently monitor herds and enhance livestock management. Their key applications in this sector primarily include health monitoring, herding, population counting, tracking pasture and farm security surveillance, and real-time livestock monitoring.

For livestock management, drones can be used for:-

A) **Monitoring health:** Manually monitoring the health of numerous animals is labour demanding and time-intensive. However, contemporary drones are now employed to oversee the health of livestock. Outfitted with cameras and thermal imaging devices, these drones can capture images of livestock from a distance and assess vital health indicators such as temperature, weight, dimensions and visual ailments. This assists farmers in identifying and treating potentially ailing animals before their condition deteriorates. Facial recognition technology combined with multiple can track changes in an animal's body condition over time, while Radio Frequency Identification (RFID) repeater capture temperature data transmitted from ear tags (Webb *et al*., 2017). Drone-based video analysis has also been used to measure heat stress and respiration rate in feeding cattle (Mufford *et al*., 2021), and to estimate feeding frequency as an indicator of feed intake (Nyamuryekung'e *et al*., 2016). The use of drones for health monitoring enables farmers to isolate sick animals from the herd to prevent the spread of diseases, enabling timely treatment, vaccination and reducing overall livestock losses.

B) **Herding:** Managing a sizable herd, preventing dispersion and ensuring they remain within a designated area pose a challenge for farmers. Accomplishing this task might necessitate a greater workforce for effective management. To mitigate this, drones equipped with highly accurate cameras are employed for herd management in pastures. This involves:

a. Tallying and preserving the overall herd size.

b. Monitoring individual animals to locate any that may have strayed.

c. Preventing wandering, as the sound generated by drones prompts livestock to move in the desired direction.

d. Streamlining the process, saving time and reducing the need for extensive human labor.

Gathering scattered livestock involves bringing them together from dispersed locations and this task can be achieved using multiple drones. Jung and Ariyur (2017) simulated a cattle roundup using four coordinated UAVs, which used satellite-derived GPS coordinates (supplemented by GPS-tagged cattle) to calculate optimal flight paths for guiding animals toward a target location while continuously adjusting spacing between the aircraft and herd.

C) **Population counting and monitoring**: The adoption of drones for livestock surveillance is gradually increasing in different countries. Drones can be utilized for identifying and tallying the cattle population. They are capable of swiftly circling cattle enclosures or fields, capturing images and videos at any given moment. These visuals can be conveniently reviewed to ascertain cattle numbers or monitor farm activities. These drones enable remote individuals to access live video feeds from various locations, providing remote surveillance capabilities. They are especially helpful for night time monitoring due to human eye's inability to see in the dark (Veroustraete, 2015). In the context of cattle monitoring and tracking using drones, farmers can employ drones equipped with thermal sensing technology, which can detect the animals based on their body heat signatures. An observer drones hovering at 90–270 feet use stereo cameras to track herd position and movement, allowing farmers to remotely assess animal location and wellbeing.

D) **Pastures and Livestock Tracking:** Ensuring the welfare of every animal necessitates mitigating potential risks such as wild animals, toxic plants and damaged fences within and around the pasture areas. Drones conduct routine perimeter inspections to detect these hazards and prevent livestock escape or theft. Tracking from a video or a sequence of frames introduce an additional temporal dimension to the detection phase. Drones have been used to detect poachers in Kaziranga National Park in Assam, thereby giving the priority for Forestry and Wildlife Conservation as well as maintaining ecological landscape features. Forest department used drone over Sirumugai in Karnataka and Mettupalayam forest ranges in Tamil Nadu to find the sick wild elephant in that area.

E) **Farm Security:** To simplify monitoring vast pasture or fodder production areas and ensure security against trespassers or intruders, deploying drones is a highly effective solution. These drones offer a comprehensive 360° view of the land, aiding farmers in not only observing their surroundings but also detecting unlawful activities. Moreover, they play an important role in deterring theft in cattle fields as thermal drones can easily identify potential intruders. This method is not only quicker and safer than involving individuals but also saves considerable time and labour. When combined with RFID tagging, drones can autonomously locate specific animals and herd stray animals back to the main group by its tag number and assess its condition remotely (Ahlawat & Sorathiya, 2020).

F) **Real-time livestock monitoring:** Drones equipped with thermal imaging cameras have revolutionized livestock management by enabling a single pilot to efficiently monitor herds with minimal staffing, quickly identifying injured or missing animals, observing births and detecting predator threats. Drones contribute significantly to farming management by providing real-time data for observation, measurement and informed decision-making. Sanitizing farm areas and the interiors of animal sheds by spraying sanitizers, conducting behaviour studies and phonemics and delivering semen, vaccines, medications and fertile eggs on-site are some of the tasks being carried out by drones. Drones can also serve the purpose of reaching remote areas to deliver essential supplies and collecting data on livestock and poultry management practices. They are particularly valuable for population counts among nomadic and pastoralist livestock systems, tracking herd movement, and mapping feed and fodder availability (Prakash *et al*., 2022).

Concerns

Since animals cannot communicate distress the way humans do, several factors warrant attention before wider drone adoption in livestock systems. Drone proximity and low-altitude flight have been shown to change animal behavior in multiple studies and monitoring stress hormone levels could help gauge this impact, since stress directly affects productivity. Compared to manned aircraft, drones reduce costs and noise disturbance to animals (Christie *et al*., 2016), but they bring their own set of practical limitations.

Battery-dependent flight time remains a major constraint, typically 10 to 30 minutes per charge, requiring frequent recharging for continuous operation. Cost is another barrier: expenses for equipment, training and technical expertise can put drones out of reach for small and resource-constrained farmers, particularly in India, where shrinking grazing and pastureland already limits their practical applicability. Operators also need appropriate licensing and awareness of airspace regulations, along with the technical skill to handle flight control and data processing.

Additional operational challenges include (adapted from Prakash *et al*., 2022):

1. **Stability**: Frequent payload changes during monitoring can affect balance and flight stability.
2. **Weather sensitivity**: Wind, rain and temperature extremes can impair performance; high altitude and heat reduce air density and lift.
3. **System reliability**: Substandard motors, rotors or controllers increase failure risk, and loss of communication with the control station can compromise data and safety.
4. **Safety and security**: Risks include collisions, accidents and encounters with trespassers or theft in the field.
5. **Privacy**: Extensive aerial data collection may be perceived as intrusive by the public.

Finding The Best Drone For Cattle Farming

There are a few things that should be considered when buying a drone for checking cattle:

1. Drones used in livestock management should possess sufficient battery life. Typically, around 30 minutes of flight time is adequate for tasks like inspecting fences, locating cows, checking mineral feeders and surveying ponds in a pasture. Nevertheless, if you require extended flight time for more advanced operations, consider drones with enhanced battery capacity.
2. It is advisable to have a high-quality camera for recording videos and capturing images. Since you need an aerial perspective of your herd or pasture, the camera should be of superior quality to ensure you get high-resolution videos and images.
3. The drone should be capable of withstanding winds of up to 25 mph. It's important to assess the prevailing wind conditions in your area

before making a purchase. If your drone can't handle strong winds, there's a risk of losing or damaging it.

4. The accompanying mobile or tablet app that comes with the drone should be user-friendly and equipped with features for ranch management tasks. Although originally designed for military purposes, these drones are now widely used in various industries.

5. An integral feature for most drone applications in livestock management is an integrated camera or thermal scanner, as it facilitates image capture. Some benefits of using drones were mentioned, including time savings and reduced human labor. Nevertheless, there are various challenges that limit the widespread use of drone's, with cost being the most prominent among them.

Conclusions

The outdoor aspect of cattle farming can be improved and modernized mainly with Drones. Farmer can easily get a birds-eye view of the entire herd, which is impossible to have with traditional or conventional methods. The structure of the cattle detection and counting algorithm, along with the hardware and software used in agricultural drones, should also be applied in the livestock sector too. As drone technology continues to gain popularity in developed countries for various agricultural tasks, India too must recognize and invest in its potential. This way the livestock sector can benefit from the same technological advancements that are boosting efficiency and productivity elsewhere.

ARTIFICIAL INTELLIGENCE and REMOTE SENSING for Irrigation Scheduling in Agriculture

Nikita Kumari Meel[1*], Seema[2]

[1]Department of Agronomy, College of Agriculture, Jodhpur, Agriculture University, Jodhpur, Rajasthan

[2]Department of Soil Science & Agricultural Chemistry, College of Agriculture, Jodhpur, Agriculture University, Jodhpur, Rajasthan

Water scarcity and climate variability have made efficient irrigation scheduling one of the most important challenges in modern agriculture. Conventional irrigation practices often result in excessive water use, reduced crop productivity and environmental degradation. Artificial Intelligence (AI) combined with remote sensing technologies offers an innovative solution by enabling precise, real-time irrigation decisions. AI algorithms analyze satellite imagery, drone data, soil moisture, weather information and crop health indicators to determine the optimum time and quantity of irrigation. This integrated approach improves water-use efficiency, reduces production costs and enhances crop yield while supporting sustainable agriculture.

Introduction

Agriculture accounts for nearly 70% of global freshwater withdrawals, making efficient irrigation management essential for ensuring food security and conserving water resources. Traditional irrigation scheduling is generally based on farmers' experience or fixed irrigation intervals, which may not accurately reflect crop water requirements. Recent advances in Artificial Intelligence (AI), remote sensing and precision agriculture have transformed irrigation management by providing timely, data-driven recommendations. AI-powered irrigation scheduling helps farmers optimize water application according to crop growth stage, soil moisture status and prevailing weather conditions, thereby minimizing water losses and improving crop performance.

Role of Remote Sensing

Remote sensing involves collecting information about crops and soil without direct physical contact through satellites, unmanned aerial vehicles (UAVs) and aerial sensors. Satellite platforms such as Sentinel and Landsat provide high-resolution images that help monitor vegetation indices (NDVI), canopy temperature, evapotranspiration and soil moisture. Thermal and multispectral sensors can detect crop water stress before visible symptoms appear. This information enables farmers to identify water-deficient areas and apply irrigation only where it is required, thereby improving irrigation efficiency and conserving water resources.

Artificial Intelligence in Irrigation Scheduling

Artificial Intelligence uses machine learning, deep learning and predictive analytics to process large volumes of agricultural data. AI models integrate remote sensing data with weather forecasts, soil characteristics and historical crop information to estimate crop water requirements accurately. These systems automatically recommend the optimal irrigation timing and quantity, reducing both under-irrigation and over-irrigation. Advanced AI-based decision support systems continuously improve their predictions through real-time data analysis, making irrigation scheduling more accurate and adaptive under changing climatic conditions.

Benefits and Future Prospects

The integration of AI and remote sensing offers numerous advantages, including:

- Improved water-use efficiency,
- Enhanced crop productivity,
- Reduced labor requirements,
- Lower energy consumption,
- Enabling site-specific irrigation management and
- Minimizing environmental impacts.

However, challenges such as high initial investment, limited technical knowledge, internet connectivity and access to quality datasets remain barriers to widespread adoption. Future research should focus on developing affordable AI-based irrigation systems, integrating IoT sensors with satellite observations and creating user-friendly decision support tools suitable for smallholder farmers. With continued technological advancement, AI and remote sensing are expected to become key components of sustainable irrigation management and climate-smart agriculture.

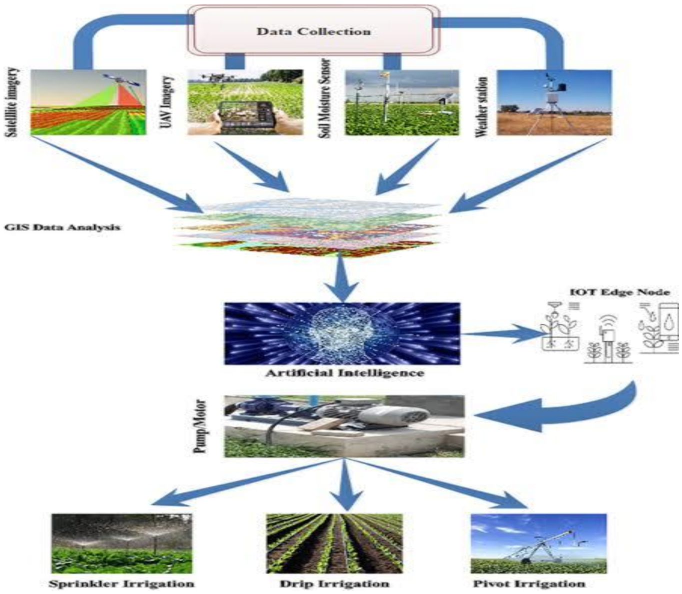


Figure 1. Variable Rate Irrigation Through Digital Agriculture for Sustainable Water Management (Source- https://link.springer.com/article/10.1007/s11269-026-04616-0)

Conclusion

Artificial Intelligence and remote sensing have emerged as transformative technologies for irrigation scheduling in modern agriculture. Their integration enables accurate monitoring of crop water requirements and supports precise irrigation decisions based on real-time information. Adoption of these technologies can significantly improve water productivity, increase crop yield, reduce production cost and promote sustainable use of limited water resources. Wider implementation of AI-driven irrigation systems will play a vital role in ensuring agricultural sustainability under future climate change scenarios.

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