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Artificial
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Agri Outlook



Artificial Intelligence in Agriculture: Advancing Crop Productivity and Sustainability

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Abstract

Climate change and population growth have presented agriculture with previously unheard-of difficulties that call for creative and long-term solutions. With its potential for robotics, machine learning and precision farming in crop production. This article examines how AI-powered solutions facilitate data-driven decision-making, predictive analytics, and real-time monitoring for pest control, fertilization, and irrigation. Although high costs, infrastructural gaps, and sociocultural barriers prevent widespread adoption, research shows that AI increases productivity, conserves resources, and supports climate-resilient practices. The ramifications highlight the necessity of cooperative regulations, farmer education, and moral frameworks in order to incorporate AI into agricultural systems.

Keywords: Precision farming, Crop productivity, Machine learning, Agricultural robotics, and Artificial intelligence

Introduction

By 2050, there will likely be close to 10 billion people on the planet, putting unprecedented strain on agriculture to produce more food with fewer resources. The industry also has to deal with shrinking farmland, diminishing water supplies, and climate change, all of which call for creative and sustainable solutions. Artificial Intelligence (AI) is one of the most revolutionary technologies changing this environment. Precision farming, made possible by AI, helps farmers make well-informed decisions about irrigation, fertilization, and pest control by using drones, sensors, and Internet of Things devices to gather real-time data on crop, soil, and weather conditions.

While robotics automates labor-intensive tasks like sowing, weeding, and harvesting, machine learning models go beyond this by forecasting yields, identifying diseases early, and optimizing resource use. When combined, these apps not only increase productivity but also lessen resource waste and environmental impact.

Large-scale adoption is still constrained by issues like exorbitant prices, gaps in digital infrastructure, the need for farmer training, and regulatory barriers. AI is still a vital component of data-driven, sustainable agriculture in spite of these obstacles, with the potential to improve resilience, secure food supplies, and encourage environmental stewardship globally.

Definitions

Artificial intelligence (AI) : Is the process by which machines mimic human intelligence in order to carry out tasks like learning, reasoning, and problem-solving. AI drives disease detection, resource optimization, and predictive models in agriculture.

Precision Farming: Precision farming is a technology-driven method that constantly monitors crop conditions, water levels, and soil health using GPS, IoT sensors, and AI algorithms to ensure sustainable yields and the best possible use of inputs.

Machine Learning (ML): Machine learning (ML) is a branch of artificial intelligence (AI) in which systems use vast datasets to identify patterns and forecast outcomes. Machine learning is used in agriculture for climate modeling, pest detection, and yield forecasting.

Agricultural Robotics: AI-powered devices that increase productivity while lowering labor costs by automating manual processes like planting, weeding, watering, and harvesting.

Crop Productivity: Crop productivity is the amount of agricultural output (yield) per unit of input, like fertilizer, water, or land. By anticipating risks, allocating resources

effectively, and optimizing inputs, AI increases productivity.

Sustainability in Agriculture: Sustainability in agriculture is the use of resource efficiency, less environmental impact, and AI-supported resilient crop systems to meet present food demands without endangering future generations.

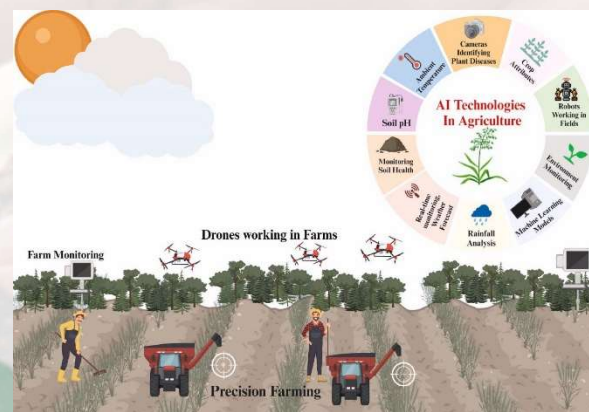


Fig. 1. Visual Representation of AI integration in agriculture: Monitoring, analysis, and precision farming.

(Source : <https://surl.it/jailcy>)

Type of Application in Agriculture

Precision Farming

Precision farming tracks crop health, water levels, and soil health using IoT soil sensors, satellite imagery, and drone-based spraying. Reduces waste while optimizing inputs such as pesticides, fertilizer, and water.

Predictive analytics and machine learning

Uses climate models, pest/disease detection systems, and yield forecasting models. These tools decrease crop losses and increase decision accuracy at the farm level.

Robots in Agriculture

Consists of drones for planting, weeding, and harvesting as well as robotic harvesters and driverless tractors. These increase operational effectiveness and lessen the need for human labor.

Genetic Improvement & Breeding

AI-assisted CRISPR and genomics hasten the creation of high-yielding, pest-resistant, and climate-resilient crop varieties.

Climate Smart Agriculture

AI, IoT, and big data are all combined in climate smart agriculture to create adaptive farming systems that lessen environmental impact while adjusting to climate variability

Process of AI Integration

1. **Data Collection** : Sensors, drones, and satellites gather data on soil health, crop growth, and environmental conditions.
2. **Data Analysis** : Machine learning algorithms process these datasets to generate predictive insights.
3. **Decision-Making** : AI systems recommend irrigation, pesticide use, and fertilization.
4. **Automation** : Robots and drones implement these recommendations.
5. **Consumer Connection** : Supply chains integrate AI for traceability and waste reduction.

Importance

- **Precision farming:** is the practice of monitoring crop health, irrigation, fertilization, and pest control in real time using drones, GPS, and Internet

of Things soil sensors. aids in resource optimization and input waste reduction.

- **Predictive analytics and machine learning:** Models predict crop yield, identify illnesses early, and maximize resource utilization. aids in making decisions in real time for improved planning.
- **Agricultural Robotics:** AI-powered devices, robotic harvesters, and autonomous tractors lower labor costs, boost productivity, and enhance crop quality.
- **Breeding and Genetic Improvement:** AI supports CRISPR-based crop editing to create disease-, pest-, and climate-resilient cultivars.

Benefits

- Increases crop productivity (for instance, AI helped Californian vineyards save 20% more water and increase yield by 25%).
- Increases resource efficiency through more accurate use of pesticide , fertilizer and water.
- Reduces waste, lessens the impact on the environment, and increases resilience to promote sustainability.

CURRENT GLOBAL SCENARIO

Aspect	Estimate of Aspect (2024)	Source & Notes
AI-based crop monitoring systems	~25 % of large farms globally	World Bank Reports, 2024
Market growth of AI in agriculture (2024–2030)	~20 % CAGR	Allied Market Research, 2024
Autonomous tractor usage	>100,00 units worldwide	John Deere Reports, 2024
AI-enabled mobile apps for farmers	~50 million downloads	CGIAR Adoption Studies, 2024

Environmental Policies Encouraging AI in Agriculture Policy Framework.

- Data security, ethics, and GMO control to guarantee AI use that is sustainable and safe.
- **Incentives:** Tax breaks and financial aid for the adoption of environmentally friendly AI.
- **Training & Extension:** To promote sustainable practices, conduct farmer education, on-farm demonstrations, and outreach in rural areas.

- **International Cooperation:** unified international guidelines for AI in sustainability and agriculture.
- **Sustainability Focus:** Laws that support AI-based climate risk management, water conservation, and less chemical use.

Future Outlook

Precision breeding, digital farming, and robotics are predicted to accelerate the adoption of AI in agriculture. Global farm management may be dominated by integrated AI systems by 2035, which would improve yields, lower emissions, and increase food security.

Conclusion

By increasing crop yields, increasing resource efficiency, and lessening environmental effects, artificial intelligence (AI) is revolutionizing agriculture. AI makes it possible for sustainable crop management, early disease detection, and more efficient use of water and fertilizers through robotics, machine learning, and precision farming. By assisting farmers in maximizing production and adapting to climate change, it also significantly contributes to the improvement of global food security. Large-scale adoption is hampered by obstacles like high costs, poor infrastructure, concerns about data privacy, and farmer resistance, despite these advantages. To address these, comprehensive training programs, financial incentives, and supportive policies are needed. It will be essential for farmers, researchers, policymakers, and technology developers to work together.

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Tariff Tussle: Impact of US Tariffs on India's Agriculture and Food Sector

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Abstract

Global trade is deeply interconnected, and tariff policies from major economies such as the United States create ripple effects across world markets. India's agricultural exports surpassed USD 53 billion in FY 2023–24, with the US as a primary destination. This paper examines the consequences of new US tariff measures on India's agriculture, agri-inputs, and food processing industry. It discusses competitiveness challenges, inflationary pressures, and investor reactions, while highlighting strategies such as trade diversification, WTO engagement, and domestic innovation.

Keywords: Agriculture, Exports, Food industry, Tariffs, Trade policies

Introduction

The United States remains one of India's largest trading partners, accounting for nearly 17% of Indian agri-food exports (FAO, 2018). Given such dependence, even marginal tariff adjustments disrupt bilateral flows, directly impacting farmers, agri-industries, and consumers. India's agricultural export basket—spanning rice, spices, processed foods, dairy, and beverages—is especially vulnerable to these shifts.

The effects extend beyond direct trade; supply chains, global competitiveness, and foreign investor sentiment are all shaped by US trade decisions. Thus, understanding tariff impacts is critical to formulating policy and business responses.

Impact on Agricultural Inputs

Tariffs imposed on agricultural inputs not only reduce India competitiveness in the US market but also burden domestic producers.

Fertilizers and Agrochemicals: The US is a key market for India's guar gum, castor oil, and organic chemicals. India exported agrochemicals worth USD 1.6 billion in 2023. An 8–12% fall in competitiveness due to tariffs not only hurts exporters but also shrinks margins for allied industries (Khushi, 2018).

Seeds and Farm Machinery: Tariffs on tractors, harvesters, and irrigation pumps imported from the US push up farm mechanization costs in India. Smallholder farmers, who constitute 86% of India's farmers, are particularly disadvantaged, leading to reduced adoption of technology (Ahana & Khushi, 2018).

Ripple Effects: Higher machinery costs ripple into cooperatives and custom-hiring centers. The long-term impact is reduced efficiency and slower agricultural modernization.

Global Context: Compared to Indian exporters, Latin American suppliers benefit

from lower tariffs, shifting US demand away from India.

Case Example: In 2024, tariffs on tractor components raised domestic tractor prices by 7%, which disproportionately affected marginal farmers who rely on shared machinery services.

Rising input costs threaten farm productivity and weaken India's cost advantage in international markets.

Impact on the Food Industry

The Indian food processing sector—valued at USD 300 billion—faces multifaceted challenges.

Processed Foods: Products such as ready-to-eat curries, instant mixes, and frozen parathas have seen consistent growth. However, a 5–8% tariff hike makes them less price-competitive compared to Southeast Asian suppliers (APEDA, 2018).

Dairy and Beverages: Dairy exports are small (USD 150 million) but growing. Tariff hikes reduce margins by 12–15%, discouraging cooperatives like Amul from aggressive global expansion. Beverage exports worth USD 180 million also face downward pressure.

Spices and Rice: The US is a significant market for Indian spices (USD 1.6 billion exports) and basmati rice (USD 4.8 billion globally). Tariffs combined with strict sanitary standards risk market erosion to countries like Pakistan and Vietnam.

Frozen Seafood: India's shrimp exports to the US—valued at USD 2.6 billion—face competition from Ecuador and Indonesia.

Any tariff change amplifies risks.

Machinery Costs: Tariffs on packaging machinery increase costs by ₹5–7 lakh per unit, raising consumer food prices by 3–4% (MOFPI, 2018).

These shifts reduce India's competitiveness relative to tariff-exempt suppliers such as Mexico and Vietnam.

Stock Market and Investor Reaction

The August 7, 2025 announcement of a 25% US tariff hike caused mixed reactions in Indian equity markets.

Pressured Sectors: Agriculture, automobiles, and textiles witnessed declines.

Stable Sectors: IT and FMCG displayed resilience due to limited exposure.

Pharma Surge: The Nifty Pharma Index rose 2.73% since pharmaceutical exports were exempted (Ahana et al., 2018).

Investor Sentiment: Foreign institutional investors (FIIs) reduced short-term inflows due to currency volatility. The rupee depreciated by 1.4% in the week following the tariff announcement, raising fears of imported inflation.

Challenges in Managing Tariff Impacts

- India faces structural hurdles in adapting to tariff shocks:
- Escalating input costs undermine farm profitability.
- Reduced export competitiveness in the US market.
- Inflationary pressures increase consumer prices.
- Volatile exchange rates amplify risks for exporters.
- Overdependence on a few markets heightens vulnerability.

Policy Responses and Strategic Outlook

Addressing tariff-related vulnerabilities requires coordinated policy and industry actions.

Diversification of Export Markets: Africa and the Middle East present growing demand for rice, spices, and processed foods. Diversifying exports reduces vulnerability to US-centric tariffs.

Trade Agreements: Strengthening bilateral pacts with the EU, UAE, and ASEAN can offset tariff shocks. India's trade agreement with the UAE in 2022 boosted basmati rice exports by 18% in just one year.

WTO Engagement: India must actively challenge tariff distortions through WTO forums, ensuring a rules-based order.

Domestic Innovation: Schemes such as PMKSY (Pradhan Mantri Kisan Sampada Yojana) and e-NAM (National Agricultural Market) must be expanded to improve efficiency.

Case Example: India's diversification of basmati rice exports to the Middle East

cushioned 2022 tariff-driven losses in the US.

As global trade walls rise, India's resilience lies in adaptability, innovation, and strategic diplomacy.

Conclusion

Tariffs represent more than just numbers, they alter global trade dynamics, affect millions of farmers, and reshape consumer markets. For India, the challenge is twofold: sustaining its competitiveness in traditional markets while preparing for a protectionist global order. Strategic diversification, innovation, and strong trade diplomacy will decide whether India can withstand future tariff tussles.

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