A Study on "Exploring the Role of Artificial Intelligence in the Transformation of Indian Agriculture "

Smt. G.R.N.S. Sujatha[1], Smt. B. Kumari[2], Dr. P. Swamy Naidu[3]. , Dr D. Madhu Sudhakar[4]

[1]Lecturer in Botany Dr. V.S Krishna Govt. Degree college. Visakhapatnam.

[2]Lecturer in Botany Govt. Degree college for Women. Marripalem.

[3]Lecturer in Botany Dr. V.S Krishna Govt. Degree college. Visakhapatnam.

[4]Lecturer in Botany Govt. Degree college for Men Kurnool.

ABSTRACT

Over half of India's population depends upon agriculture for their livelihoods, although it faces many obstacles as water scarcity, low productivity, and land fragmentation. Due to restricted access to contemporary equipment, over 86% of farmers cultivate small plots, which results in inefficiencies. Unpredictable weather, deteriorating soil health, pest outbreaks, low production, and soil degradation from chemical fertilizers are some of the major issues facing Indian agriculture. Furthermore, post-harvest losses due to insufficient storage, inefficient markets, and transportation reduce farmer earnings, and many are unable to obtain essential market data, leaving them vulnerable to price manipulation.

AI is a field of computer science that develop systems that can learn or be taught to make judgments and predictions within specific context,.Numerous intelligent behaviours, like process optimization and predictive modelling, pattern recognition, natural language processing and machine translation may be carried out by AI applications. To overcome these, Artificial Intelligence (AI) is emerging as a game-changing tool, helping Indian farmers shift from traditional to data-driven, precision-based agriculture

With the use of predictive forecasting, this approach will assist farmers in understanding market demand. In the future of tomorrow, artificial intelligence and its related sciences are geared to "AI Agro technology."

Keywords: Artificial Intelligence, water scarcity, Inefficient markets AI Agro technology, AI applications

INTRODUCTION

"Artificial intelligence is a tool, not a threat."

AI is a branch of computer science that creates systems that can be trained to make decisions and predictions in certain situations (Smith and Neupane, 2018). Artificial intelligence (AI) applications may perform a wide range of intelligent behaviors, including pattern recognition, natural language processing, machine translation, process optimization, and predictive modeling. Applications of artificial intelligence (AI) are being used in many areas of agriculture, from Internet of Things (IoT) networks of tools and sensors that generate data and image recognition systems that test and grade commodities and crops to gene sequencing in seed development.

AI technology may be used to address major industry challenges like market volatility, suboptimal pesticide use, inconsistent irrigation, and declining soil health, according to other Industry estimates.

Farmers will be able to do more with less because to technologies like artificial intelligence (AI), which will improve crop quality. Using AI in all agricultural application areas will also result in a positive shift in the current methods of agricultural research and development.

AI-powered drones and robots enhance farming operations' efficiency and reducing dependency on manual work. Indian agriculture can overcome its hurdles and improve sustainability and productivity for a better future by implementing AI technologies.

AI in Indian Modern Agriculture

Artificial intelligence (AI)-enabled agricultural robots can counsel farmers on issues like soil quality, when to plant seeds, and where to apply herbicide. AI, machine learning, and computer vision developments enable the development and use of remote sensing technologies to detect and manage plants, weeds, pests, and diseases (Agrawal and Agrawal, 2021). In addition to reducing waste, AI technologies can assist farmers increase quality and guarantee market access. Farmers will be able to do more with less because to technologies like artificial intelligence (AI), which will improve crop quality. Using AI in all agricultural application areas will also result in a positive shift in the current methods of agricultural research and development. (Sharma, Y., & Priyadarshi)
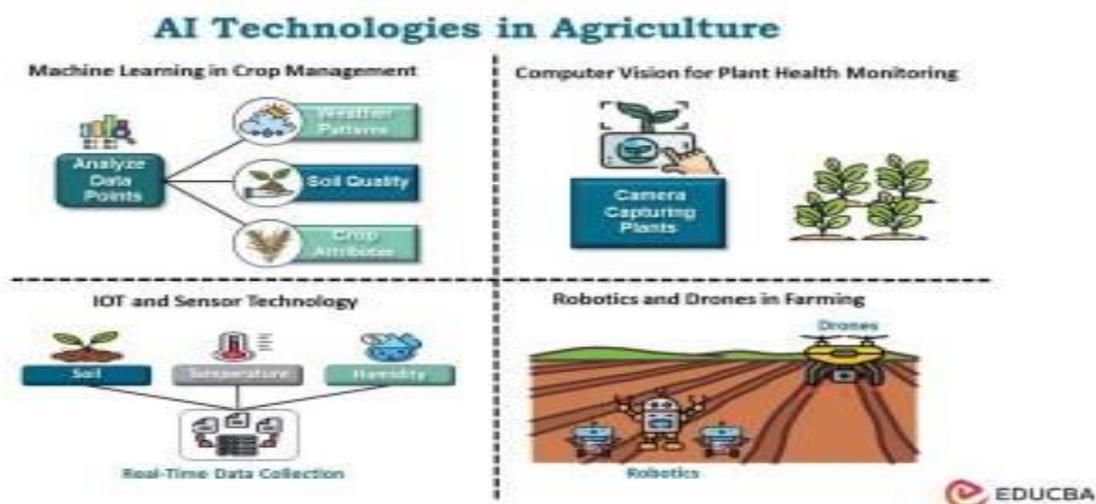
Crop health monitoring services

AI, high-resolution meteorological data, and remote sensing data can be used to monitor crops holistically and provide farmers with more information about their farms as needed.

AI platforms and technologies that guarantee increased income and stability for the farming sector. 2. Application for farmers to sow

An Andhra Pradesh-specific village guidance dashboard is part of a sowing application for farmers developed by Microsoft India and ICRISAT. Farmers are advised by the sowing app when to plant crops based on soil, weather, and other factors. 1. Monitoring soil health

Deep learning models and image recognition have made it possible to monitor soil health remotely without the need for infrastructure for laboratory tests. Farmers are able to use the

swiftest feasible response to improve soil health using AI solutions that are combined with data signals from far satellites and local farm photographs

Drones and robotics in agriculture

Agri Rbots increase production efficiency and decrease reliance on human labor by automating farmers' duties.Drones can monitor crop stress, forecast yield, and track plant development thanks to their multispectral and photographic sensors. Drones that are more sophisticated can transport and deliver. 1. Drone tractor robot A robot will choose the optimal routes for crisscrossing the farms, the best times to plant, and the best times to harvest. The goal of these robots is to reduce the amount of water, fertilizer, pesticides, and herbicides used.

Efficiency of the supply chain

With AI, farmers would be able to understand consumer preferences, seasonality, and market demand for their produce. By reducing the expenses related to overseeing scattered logistics and numerous intermediaries, AIpowered supply chains can boost their profitability. This clever routing will also help small farmers better plan their route to market and increase their profits. They might send their perishable goods to market faster without the use of middlemen, which would lower wastage and losess

Improving the inputs for Maximum Yield in Precision Farming

Precision farming is a cutting-edge kind of farming that uses AI-powered technologies to increase crop yields while using less water, fertilizer, and pesticide. Precision farming enables farmers to make well-informed, data-supported decisions that increase productivity and sustainability in their operations by combining data from sensors, satellite imaging, drones, and machine learning algorithms. AI-driven precision farming technologies maximize insect control, fertilizer, and irrigation, resulting in lower input costs and a less environmental effect. AI-driven irrigation systems and variable rate technology (VRT) are two examples of technologies that enable accurate resource utilization, leading to increased crop yields and water conservation.

Crop and Soil Monitoring: The instantaneous Knowledge for Improved Development for long-term sustainability and maximum agricultural productivity, crop and soil health monitoring is crucial. Real-time insights on crop and soil conditions are provided by technological advancements such as AI-driven systems that make use of sensors, drones, and machine learning. These developments enable farmers to keep optimal growth conditions, make well-informed decisions, and address problems before they affect output. Farmers are using AI to replace manual monitoring with accurate, data-driven techniques that increase productivity and crop yield.

Utilizing Drones and Sensors: To Monitor the Health of Crops and SoilFarmers can track soil and crop conditions in real time with the use of sensors and drones in agriculture, which helps them identify Early detection of nutrient deficiencies and water stress enhances soil fertility and crop development.

AI-assisted early detection of pests and illnesses through the analysis of sensor data and drone imagery allows for targeted interventions that reduce pesticide use and stop extensive crop damage.

Barriers to digital literacy and high costs

For many small-scale Indian farmers, AI-driven technologies such as drones and precision farming tools are unaffordable. As many farmers find it difficult to acquire and use AI solutions efficiently, adoption is further hampered by financial limitations, issues with digital literacy, and language obstacles.

Rural Areas' Infrastructure Challenges: The use of AI in agriculture is severely hampered by inadequate infrastructure in rural India, particularly by insufficient internet connectivity and energy, in addition to financial and literacy constraints.

Companies that Provide Precision Farming Solutions as Examples

In India, a number of businesses are leading the way in AI-powered precision agricultural solutions that assist farmers in improving resource management and productivity

CropIn: Agritech startup CropIn offers a smart farming platform powered by artificial intelligence (AI) that gives real-time weather updates, data on soil health, and crop development tracking. This maximizes yields and minimizes waste by empowering farmers to make knowledgeable decisions about pest control, fertilization, and irrigation.

Fasal: Fasal is a precision agriculture platform driven by AI that tracks environmental variables like temperature and soil moisture using Internet of Things sensors. It helps farmers maximize resources, cut expenses, and increase productivity by providing them with personalized, real-time irrigation, fertilizing, and spraying advice. For horticultural crops, where accurate management is crucial to attaining greater yields, Fasal's technology is very beneficial.

Intello Labs: Intello Labs assesses crop quality and identifies diseases early on by using AI and computer vision. Using satellite imaging and smartphone cameras, farmers may identify stressed regions for focused assistance and track the health of their crops. In order to guarantee that farmers receive fair rates for their produce, the platform also helps with crop sorting and grading.

Aibon: Aibono offers a precision farming platform powered by AI that gives data on soil conditions, crop health, and consumer demand. It helps farmers plan when to sow, harvest, and use inputs in order to maximize yields and minimize expenses. In order to help farmers obtain better prices and reduce market risks, Aibono also links them with buyers. AI Startups in the Farming Sector

Worldwide initiatives are underway to automate agricultural processes and employ artificial intelligence (AI) to streamline agriculture based on data inputs. Consequently, a large number of new companies have been founded. Among these stat-ups are:

Prospera: A cloud-based system developed by this business collects all the information available to farmers, such as aerial pictures, soil and water sensors, etc. The input from these sensors is used to determine how the various data labels relate to their predictions.

Next, it connects to a field device that evaluates the information and suggests the appropriate. Prospera may be used both in greenhouses and outside, utilizing a variety of sensors and technology such as computer vision and can be utilised both in greenhouses and in the field.

Technology from Blue River

To cut expenses and the quantity of pesticides used, Blue River Technology combines computer vision, robotics, and artificial intelligence. Computer vision defines each plant separately, and machine learning determines how to study each plant's characteristics. This enables the robot to function appropriately and intelligently while operating the agricultural machinery.

Formbot

By engaging with the community, Farmbot has increased precision research through the use of precision farming techniques for home farmers. It allows farmers to do a range of tasks, including soil testing, plant watering, weed detection, and seed planting, by using robots that are operating with open source software.

CROO Robotics

HarvestIt is a robotic strawberry harvesting system that recognizes and detects ripe berries for plucking using AI and machine vision. Strawberry farmers face a significant labor shortage, which drives up crop costs and increases the risk of underharvesting. Manufacturers will need less manual labor, harvesting costs will be reduced, and overall competitiveness will be increased with the use of more artificial intelligence and automated harvesting techniques.

Jivabhumi

Jivabhumi is a platform for agricultural technology that connects farmers with consumers and institutions. This cutting-edge food aggregation system blends agricultural products, innovation, and e-marketplace services. In order to make agricultural products traceable, Jivabhumi works with farmers and farmers' organizations, collects them, and employs a platform called Foodprint that is enabled by blockchain technology.

Gobasco

This AI-powered platform offers agricultural companies tools for procurement optimization and production forecasting. The objective is to enhance the Indian agri-supply chain by utilizing AI and big data. With this approach, farmers and agricultural SMEs have a Occupational health risks of workers' networks and platforms that provide access to data-rich technology to boost revenue and provide new opportunities.

Benefits of AI Implementation in Agriculture:

The use of AI in agriculture aids farmers in comprehending data insights.

Benefits of AI Implementation in Agriculture The use of AI in agriculture aids farmers in comprehending data insights like temperature, wind speed, sun radiation, and precipitation. Among the advantages of AI are:

1. It provides more efficient methods for cultivating, harvesting, and marketing essential crops.

2. The focus of AI implementation is on detecting faulty crops and increasing the likelihood of producing healthy crops.

3. AI has improved the efficiency of agro-based enterprises.

4. Technologies such as automated machine changes for weather forecasting and illness or pest detection use machine learning and artificial intelligence.

5. Solutions based on artificial intelligence (AI) could help farmers with their problems. such as fluctuations in the temperature and pest and plant infestations that lower productivity.

Obstacles to AI Adoption

Even while AI has a lot of potential for the agricultural industry, many farms still lack access to sophisticated machine learning methods.

AI is used in agricultural products including seeds, fertilizer, and insecticides in place of field solutions. For AI systems to train their algorithms and generate accurate predictions, a large amount of data is required. Finding time data is difficult for large agricultural areas, while gathering geographical data is simple.

The creation of a strong machine learning model takes time because data infrastructure must mature. In terms of regulating farmers' decision-making and enabling them to make their own assessments and estimations, this is just one of the numerous reasons why agriculture is still in its very early stages.in order to address the situation. To explore a broad range of AI applications in agriculture, apps must be durable. They ought to be able to adjust

to environmental changes, facilitate in-the-moment decision-making, and use the appropriate platform to obtain relevant data. More affordable solutions are needed if technology is to be available even at the farm level.

Government Initiatives Driving AI Adoption

Implementing AI into agriculture has been a proactive move by the Indian government. Union Education Minister Dharmendra Pradhan has announced the creation of three AI Centers of Excellence (CoEs) with a focus on sustainable cities, healthcare, and agriculture.

The "Make AI in India and Make AI Work for India" concept is embodied in this effort, which is funded with Rs. 990 crore between FY 2023–2024 and FY 2027–2028. As evidenced by the following initiatives, one of its main goals is to equip farmers with AI-driven solutions:

- Kisan e-Mitra Chatbot: A farmer's AI-powered helper that offers multilingual assistance for inquiries about the PM Kisan Samman Nidhi program and other government programs.

- Utilizing soil, weather, along with satellite data, AI-based crop health monitoring moisture levels for comprehensive crop health (Indiaai.gov.in/article/ai-in-agriculture-in-2025-transforming-indian-farms-for-a-sustainable-future)

CONCLUSION

While it maximizes resource utilization and efficiency, artificial intelligence can be both acceptable and effective in the agricultural sector. The problem of resource scarcity is mainly resolved by it. and a lack of workers. AI will help and challenge farmers to make the best choices possible. Agriculture is being revolutionized by artificial intelligence, which is turning conventional farming into a data-driven, effective, and sustainable industry. AI technologies, from automated irrigation and pest management to precision farming and crop monitoring, are assisting farmers in making better decisions and increasing output while reducing their negative effects on the environment. AI integration in agriculture is becoming more than just a technological achievement; it is a requirement as issues like resource scarcity, food security, and climate change intensify. To guarantee that this shift benefits all parties involved in the agricultural ecosystem, it will be crucial to implement AI tools responsibly, provide fair access, and train farmers.

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