

AI in Agriculture - Seeds of innovation blooming in digital soil

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Introduction

Agriculture is not only the oldest and most important profession but also a high-priority sector of the Indian economy which accounts for the livelihood of around 58% of the population in our country. Now-a-days it is a great challenge for the farmers, agricultural specialists and scientists to provide the surging population and the irony is that the agricultural lands are shrinking and getting crushed in between capricious weather and uncertain commodities market of farm produces. Thus, the productivity in this sector needs to be hastened. Though Indian agriculture is at a brief juncture, with a cynosure to integrate technologies for improved operations, the sector still faces numerous hurdles. The entire sector needs to adapt to a panoramic approach which can rely on indigenous farming knowledge along with smart farming practices including artificial intelligence (AI) tools. Artificial Intelligence is an area of computer science that emphasises the creation of tangible or intangible systems which not only behave intelligently but also display behaviour to the same level as human beings think and act, achieving human-like performance in all cognitive tasks using purely logical reasoning. In this context, Artificial Intelligence (AI) is paving the way towards achieving healthier crops, controlling pests, organizing data, monitoring soil and growing conditions which in succession doubtlessly affect the crop growth and management efficiency. Thus, implementing AI-empowered approaches will spice up productivity and potency.

AI - A Promising Solution for Agriculture

Proceeding to foresee how AI can help common man in the coming years, internet is giving us a glut of options like information on fingertips, video streaming, etc. The technologies are now advancing at an accelerating pace. This phenomenal leap in innovations should be extrapolated to the development of AI. In agriculture, there is quick adaptation to AI in its various farming techniques. This concept is based on mimicking human brain integrating with accuracy and precision. This results as turbulent technology in AI powered agriculture, furnishing its services in various situations to enhance efficiency. To harvest benefits in the field by holding on to technologies, the farmers can be offered solutions via platforms like chatterbot.

Applications of AI



AI applications in agricultural sector have ameliorated significantly and smart farming has greatly enhanced over the years, allowing farmers to upgrade the means of their work in order to create an independent working environment. The applications include the following sub-domains;

1. Robot Tractors

Driverless tractors are independent tractors which perform all the farm practices autonomously and precisely. They are attached with sensors that are able to perform the needed practices, monitoring obstacles and determining areas of application of farm inputs. Agriculture has now been combining with various off-the-rack technologies such as GPS systems, radars, sensors which promote new route of enterprising farming. Robots are also employed in farmers' field where it decides where to plant, when to harvest and how to cover the farmland. These robots also reduce the wastage of various farm inputs.

2. Nutrient Management

a) Soil Health Assessing: Now-a-days, good soil health is a much needed to encounter the increasing demand for crop production. Artificial Intelligence in soil health monitoring technologies can assist in the protection and conservation of soil quality by allowing for the faster and safer processing of huge volumes of data collected during physical soil sampling and remote imaging. Utilization of AI technologies specifically the programs designed for deep learning helps the farmers to identify probable nutrient deficiencies in soil. Moreover, AI systems provide recommendations and ideas based on the analysed data.

b) Crop Level Spraying: As traditional agriculture depends heavily on manual exertion and imprecise methods, amalgamation of Artificial Intelligence and deep learning technology into crop protection methods is a trailblazer. This introduces a new age of targeted spraying, which enables farmers to target individual plants rather than treating entire field. It entitles farmers to use resources more effectively, reduce crop loss and achieve formerly unobtainable extent of productivity, profitability and sustainability benefits.

3. Pest Management

a) Insect Detection and Alert System: The plant-feeding insects are a great menace as they directly hamper the crop yield. About 30 to 40% of the worldwide agricultural production is being devastated by the pests. Coupled with destroying the crops they also radiate bacterial, viral or fungal infection. Utilization of chemical pesticides renders environmental and health hazards along with contributing to high cost of cultivation. Thus, AI methods can be employed to surveil insect pests and diseases. Their aftermath can also be identified by using image recognition technology based on deep learning. The techniques use image classification, detection and segmentation methods thereupon checking plant health.

b) Weed Management: Artificial Intelligence is being used in weed management for identifying weed, precisely controlling them and weed mapping. The most advanced method is laser weeding. It provides chemical-free, no-till control of weed. This method can locate and eliminate weeds earlier than they are even visible to the human eye. This method targets weeds with millimetre accuracy. It enhances crop yield along with labour efficiency and technological advancements.

4. Environmental Conservation



AI has emerged as a pivotal tool in addressing environmental challenges and guiding us towards a sustainable future, making it a key player in AI for environmental sustainability. It allows more efficient ways to yield, harvest and sell crops, as well as focus on inspecting defective crops consequently improving agricultural practices for eco-friendly crop production. Environmental protection through pesticide reduction is a major operational advantage of AI technology. Thus, AI technology helps farmers in pest control and pesticide residue reduction. It can also address climate change by scrutinizing data on greenhouse gas emissions, weather patterns and other environmental factors. This helps in alleviating the climate change.

5. Advancements in Harvesting Techniques

AI assists farmers in harvesting crops keeping an eye on qualitative and quantitative factors. This technology offers tailored recommendations and insights, fine-tuned according to farm condition, crop variety and time and other factors. Consequently, enhanced logistic planning, superior quality control and timely operations are maintained. These methods reduce food wastage, guarantying that fresh products reach consumers. AI algorithms can be used to predict the proper time of harvesting and route trucks and optimize inventory levels.

6. Livestock Health Supervision

The significance of animals in agriculture can't be neglected in our agricultural system. AI has also excelled in this sector by employing cameras and UAVs for data collection. Animal health tracking, identifying unusual behaviour and monitoring important activities like giving birth, etc are possible with ease and accuracy by deploying overhead cameras and computer vision algorithms. Cattle Eye is an excellent demonstration of an AI-first agricultural company. Remote tracking and observation of cattle is used for quick spotting of issues and informing farmers about their health and access to food, water and shelter.

7. Agri-food Sector

AI sorts fruits and vegetables according to their size, colour, texture, etc and check for any available contaminants in food products. Computer vision systems in grain inspection include advanced imaging techniques to analyse images for identification of defects or impurities. AI is used to safeguard food by data analysis from sensors and cameras to detect potential contaminants or other hazards. It can also analyse individual consumer data and provide personalised nutritional recommendations. It as in other industries can also be used in agri-food sector to enhance efficiency and produce new more nutritious crops, reduce waste and ensure safety.

8. Weather and Price Prediction

AI is now propelling another revolution within numerical weather forecasting. Weather forecasting has been improved by teaming up supercomputers with weather services. Generally, the predictions for 5-7 days are error-free, especially temperature and general weather conditions. AI can also help streamline the supply chain by forecasting demand, optimizing logistics and reducing wastage. AI methods predict market price and the tendencies regarding the agri-food sector that will be in the channel soon, by analysing the market behaviour. Moreover, they efficiently boost the supply chain performance, increase productivity and profit, optimise stock management and resource allocation and reduce costs and waste.



9. Support Framework for Farmers

a) **Chatbot:** Union Ministry of Agriculture and Farmers' Welfare, Government of India launched AI chatbot for the PM-KISAN Scheme. It provides farmers with prompt, accurate, clear responses to their queries.

b) **Agri-E Calculator:** This calculator can be used to choose the desired crop to be grown over the preferred area of coverage. Useful data on the estimation of seed, fertilizer cost and quantity, cultivation equipment, etc are also estimated with this calculator.

c) **Crop Loan and Insurance Service:** The farmers are facilitated workability of getting crop loan, processing support, loan limit, etc as per the estimation made for the desired crop. Moreover, it helps to get the crop insured as a mitigation plan for crop loss due to any calamities or uncertainties.

The Complexities of AI in Agriculture

Bearing in mind that, AI is startlingly progressing and yet to be fully derived, there are potential challenges for its execution. These include;

- Data sharing risks make the farmers wary of using AI technologies, making it hard to increase the benefits that these tools provide.
- If the farmers depend on AI tools for everything, any disarray or technical faults could put their operation and productivity at risk.
- Small scale farmers cannot afford these technological tools which will lead to inequality putting them at a pitfall.
- The automation of machines and AI tools could put the workers at risk of losing their job, resulting in wider economic and social hardness.

Conclusion

In summary, the infusion of Artificial Intelligence and agriculture announces a transformative age for an industry tussling with multifaceted challenges. Aiding the livelihoods of the majority, around 58% of our population, agricultural sector faces a pressing need to amplify productivity against the backdrop of a surging population. AI with its assemblage of applications from soil health to pest detection, intelligent spraying and animal health monitoring offers innovative solutions that can revolutionize age-old predicaments. The unification of AI and agriculture not only improves operational efficiency but also square up to pressing issues like climate change, food security and pest management. The adoption of cutting-edge technologies such as AI powered drones and robot tractors, epitomize a seismic shift towards a technologically cosmopolitan and sustainable agricultural prototype. Nevertheless, the swoop into AI comes with its own share of complications. In driving this evolving landscape, a judicious approach to AI implementation is essential, one that recognises the potential while addressing the nuanced challenges for a resilient and inclusive agricultural future.

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