Application Of Artificial Intelligence in Modern Crop Production and Protection Technologies

Ishanu Mandal* and Sonalika Dey

Faculty Of Agriculture, JIS University, Kolkata, 700109, West Bengal, India

Corresponding Author
Ishanu Mandal
Email: ishanumandal80@gmail.com

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ABSTRACT

The history of artificial intelligence (AI) in agriculture traces back several decades, marked by gradual advancements and increasing integration of technology. Agriculture could undergo an evolution thanks to artificial intelligence which would enable farmers to grow more food with less resources. It helps to improve new strategies in crop production and protection. Artificial intelligence helps to inform us about weather forecasting, evaluating plant health, assessment of soil health, better market access and it has an effective role in plant protection strategies like pest control, disease diagnosis, weed management etc.

INTRODUCTION

Agriculture is the backbone of every economy in the world specially in developing countries like India, Bangladesh, Nigeria. It also serves as the primary source of employment to the rural population. But currently, agriculture faces many challenges like scarcity of natural resources, labour shortage, impacts of climate change, rapid growth of population with increase in demand of agriculture produces, lack of proper marketing, sudden outbreak of diseases and pests. In the era of digitalization, with the introduction of artificial intelligence in agriculture can help overcome these challenges and improve the way agriculture is conducted. Artificial intelligence can be defined as computer models which are designed to mimic how human thinks and

solve problem. It can be used to develop various models for farmers which can analyse data from multiple sources and assist in decision making process of farmer.

Role of AI in Crop Production Technology:

AI aims at increasing crop productivity by improving crop yields, early detection of deficiency, optimum utilization of resources like water, agrochemicals, adapting to impacts of climate change, assessing crop and soil health.

- **Weather forecasting**: AI system can help predicting weather patterns through evaluating different weather elements, which helps the farmer to decide sowing time, harvesting time. This will protect the crop from adverse weather conditions.

- **Evaluating plant health**: Models based on AI uses images from satellites and plant sensors to monitor plant health which will help in early detection of infection.

- **Assessment of soil health:** Sensors embedded in soil can detect nutrient deficiency. Artificial neural network-based models can be very helpful in detecting soil texture, soil moisture, mean soil temperature, classifies soil structure. Management-oriented modelling (MOM) is applicable in reducing nitrate leaching.

- **Efficient utilization of resources:** Input monitoring system like irrigation monitoring system, fertilizer monitoring system can be development to increase input efficient in field. This system can also schedule irrigation and recommend fertilizer doses.

- **Supplementation to human labour:** AI-powered systems can help in operating various farm operations by automated tractors, harvesters, agribots.

- **Better market access:** AI enhances market access by developing digital platforms that facilitate connections, like National Agricultural Market (e-NAM) create a unified market for agricultural commodities.

Role of AI in Crop Protection Technology:

Crop protection includes a range of elements that significantly affect crop health and yield, in as well as weeds and diseases. Crop protection technologies heavily depend on factors like plant physiology, proper nutrition, cultural activities, and temperature.

- **Appropriate Spraying:** Herbicide sprayers can be used to destroy weeds, but spraying robots are additionally effective to prevent pests and manage liquid fertilisers. As a result, even with protective measures, the farmer is exposed to elevated levels of those dangerous active ingredients.

- **Crop disease diagnosis:** Using AI to diagnose crop diseases increases the frequency and accuracy of complete oversight. In order to provide farmers with as much information about the harvests as possible, it makes use of a variety of technologies, predictive analytics, and machine learning. Effectiveness is high in a variety of test settings. With an accuracy of 87% to 100%, AI could identify leaf mould, spider mites, downy mildew, verticillium wilt, powdery mildew, and other conditions.

- **Weed Control:** Artificial Intelligence has the potential to create image detection systems that are highly accurate in identifying weeds. This can assist farmers and producers in promptly recognising and categorising various weed species so that the proper control methods can be implemented. Robots, drones can be utilised for targeted weed removal. Using

these technologies, weeds can be identified by scanning the fields, and only the affected areas can be sprayed with herbicides or alternative management techniques. This minimises the total amount of herbicide applied and its negative effects on non-target organisms.

Drone Technology in Modern Crop Production and Protection Technologies:

Drone usage is growing rapidly across practically all economic sectors, but it is particularly developing in the agricultural sector. It will take extensive acceptance, funding, and ongoing research to realise the full assurance of the drone technology in agriculture. Policymakers, technologists, researchers, in agriculture must work together to address current issues, provide novel solutions, and simplify regulatory systems.

Application Of Drones in Agriculture

- **Crop monitoring and Management:** With increased precision, farmers can monitor the health, growth, density, colouration as well as general state of their crops. The condition of the field and the condition of the soil are also being monitored using drone field monitoring. Growers can identify any unusual events in the field by using the precise field mapping that drones can give, which includes information about elevation.

- **Nutrient Management:**Farmers can use specific nutrient management strategies by analysing soil data obtained from drones. This includes customised fertilisation schedules that guarantee crops get the correct nutrients in the right places at the right times to promote maximum growth.

- **Irrigation Management:** Drones supply data for irrigation systems that use precision to apply water only where it is required. Such places are identified by drones, conserving water and money on the cost of water. Drones provide vital information for planning.

- **Artificial Pollination:** When the drone finds a flower that suits its needs, it contacts the blossom to spread pollen. The drone can execute pollination by integrating a pollination control device, autonomous flight management for flower search, and AI-based flower detection.

- **Yield estimation:** By evaluating crop health and density, drones help with precise yield estimation. It also helps to inform farmer about irrigation management, conserving water resources and the maturity index of crops in field conditions (Dutta and Goswami, 2020).

- **Pest and disease management:** Advanced sensor-equipped drones are helpful in pest infestation monitoring and early detection. Drones may take high-resolution photos that show the affected regions in detail. This information can then be used to apply herbicides or pest control agents precisely and on time, reducing the need for chemical applications that are applied indiscriminately.

- **Drone AI:** Machine learning is also being used in the invention of another drone technology. Drones' artificial intelligence (AI) needs to be improved if small-scale farmers in developing countries are to find greater use for them. Modern drone technologies are better at keeping an eye on popular crops as maize that appear in expansive monocultural field designs.

Disadvantages of AI in Agriculture:

- **High initial investment costs:** Large financial resources are needed for the development and deployment of AI systems, which may be prohibitive for rural communities and agricultural enterprises. Farmers may find it challenging to implement AI technology due to its high cost, particularly in underdeveloped nations where finance is limited.

- **Job displacement:** The agricultural industry is one of several sectors and vocations that AI is expected to affect as it develops. It might be worthwhile for job searchers seeking for new chances to look into sectors that are not likely to be entirely robotic or that demand human talents that are challenging for AI to duplicate.

- **Limited access:** The cost of implementing and maintaining AI technology can make it unaffordable for numerous small-scale farmers who want the capital to invest in it.

- **Risks of security:** Concerns with confidentiality and privacy have been raised by the need for access to huge amounts of data, particularly sensitive information, in order to employ AI in agriculture. It is therefore important that AI-based technologies be used ethically and responsibly in agriculture, with privacy, transparency, responsibility all being ensured.

Future Direction of AI in Agriculture:

- **Develop new varieties:** AI can be applied to find the genes in crops that are linked to desired characteristics. With this knowledge, new crop varieties which have a greater resistant to illnesses and pests, need less water, and yield more can be created.

- **Improve livestock management:** AI can be utilised for tracking the whereabouts of animals, keep an eye on their health, and improve breeding and feeding practices. Both animal welfare and production may benefit from this.

- **Improve sustainable agriculture:** Farmers can reduce their environmental impact by utilising AI. Artificial Intelligence (AI) has the potential to enhance waste management, reduce pesticide usage, and optimise irrigation schedules (Bergerman,M. *et al, 2016).*

CONCLUSION:

In conclusion, farming could undergo a revolution thanks to artificial intelligence (AI), which could increase agricultural profitability, sustainability, and efficiency. AI can help with even the most difficult and repetitive activities by enhancing currently in use technologies. It can also collect and analyse large amounts of data on digital platforms, suggest the best process of action, and even take the initiative when paired with other technologies.

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