APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) IN AGRICULTURE: AN INDIAN PERSPECTIVE

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The World Government Summit report published in 2018 *Agriculture 4.0 – The Future of Farming Technology* point out that four key developments viz., demographics, scarcity of natural resources, climate change, and food wastage, pressing our future needs from agriculture. Making use of concepts like big data analytics, precision agriculture, and Internet of Things (IoT) to measure agriculture quantitatively *Agriculture 4.0* envision improved crop yield with less exploitation of environment, low input use, and cost. *Agriculture 4.0* emphasises organization of farm inputs (fertilizers, seeds, farm fuel, and herbicides) through distributed management practices.

In a scenario where demand for agricultural produces keeps on increasing along with population growth and changes in lifestyle of people, production of enough material using limited resources is hard without the help of some innovative concepts. Man-machine interaction especially, Artificial Intelligence (AI) is the concept that can potentially transform the present day agriculture to a 'produce more from less inputs' model. Figure 1 illustrates some uses of AI in agriculture.

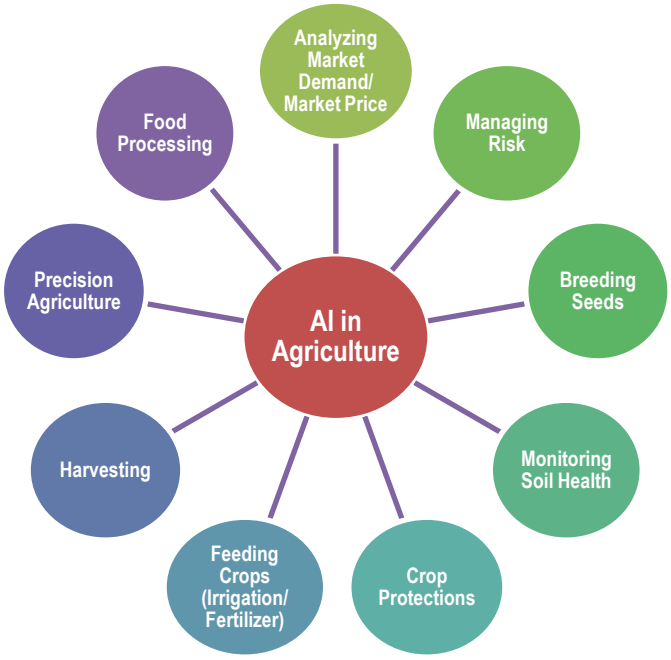

Figure 1. Application of AI in agriculture

At the farm level, AI influences crop production many ways; particularly through proper distribution of seeds, fertilizers and other agricultural chemicals, automated irrigation scheduling, monitoring soil, crop and animal health, surveillance of pests and diseases, and farm machinery positions in the field.

APPLICABILITY OF AI IN AGRICULTURE

- **Diagnostic Application Service:** Identification of symptoms of water stress, pest and diseases infestation etc. in farm fields.
- **Prescriptive Application Service:** Soil health analysis and prescription of fertilizer recommendation or any other agricultural inputs
- **Advisory Application Service:** Weather advisory and Irrigation scheduling
- **Predictive Application Service:** Yield prediction, disease and pest attack forecasting (early warning system)

POTENTIAL OF AI IN INDIAN AGRICULTURE

Agricultural Growth driven by IoT: AI and IoT (sensors) can be used to create intelligent systems that can be embedded in machines to make it work with higher accuracy. These technologies help in the spatial and temporal evaluation of individual plots or plants.

Image-based Insight Generation: Using the satellite and drone imagery real-time alerts can be generated in precision farming. These artificial intelligence systems not only save time but also increase safety and reduce potential human error while improving effectiveness.

Computer Vision: Computer vision technology can be used to grade the agricultural produce (grading of fruits and vegetables), enhance the quality of produce, and fetch high market values and profit to farmers. This will help to reduce post-harvest losses of perishable commodities. Also, the technology can make use in the procurement, storage, and distribution of food grains.

Identification of Optimal Agronomic Product Mix: AI helps to generate farm specific recommendations analyzing different parameters like soil health, weather forecast, type of seeds, and pest infestation in the area. Though the recommendation include best choice of crops and technologies for a specific farm, it can be further personalized based on the farm's requirements, local conditions, and past data on successful farming.

Crop Health Monitoring Systems: Remote sensing techniques, hyperspectral imaging and AI build crop health monitoring systems that can monitor crop health from both time and effort perspectives. AI facilitates identification of pests, diseases, and weeds problems and automates the management of these problems. AI-enabled agricultural production systems also predict future situations and issue advisories for sowing, pest control and commodity pricing.

Smart Irrigation Systems: Smart irrigation involves providing the right quantity of water at the right place at the right time for the right crop so as to improve crop yield. Using sensor based automated irrigation system issues associated with the low irrigation efficiency of Indian agriculture (around 38%) can be resolved to a greater extent. Also, automated irrigation scheduling is possible using machines trained on historical weather patterns and soil quality of the locality along with the kind of crops to be grown.

Agriculture Risk Management: Climate change issues such as increased temperature, erratic rainfall pattern and other associated problems have increased the importance of the AI system in agriculture in recent years. AI based technologies support farmers in the management of risk and uncertainty in agriculture by facilitating the preparedness of farmers to handle the crisis efficiently.

Natural Language Processing (NLP) for Agro-Advisory: India is a multi-lingual society and majority of farmers are illiterate. A lot of content failed to reach the desired people due to lack of human-resource to convert it to the end-user's language. This gap can be effectively filled through natural language processing.

Attract Youth to Agriculture: Decreasing agriculture labour force due to migration of youth to other jobs can be well addressed using AI based agriculture. AI based technologies will attract the tech-savvy youth, reduce drudgery and save natural resources and agriculture

HURDLES IN THE ADOPTION OF AI IN INDIAN AGRICULTURE

Policy: Incomprehensive data governance and data rights regime, and lack of enforcement of data regulations, privacy, and transparency.

Culture and Society: Barriers were recognized and prioritized i.e., risk-aversion and resistance to change, lack of trust in technology, and insufficient support of universities in data digitization and digital agriculture.

Education and Skill: factors identified as inhibitors of AI adoption include language barrier, high illiteracy rates, and the digital divide, lack of formal, non-formal, and informal education in data engineering, data analysis, data science and insufficient proficiency.

Information and Communications Technology (ICT) and Data Infrastructure: Inhibiting factors related to ICT and data infrastructure include lack of supporting ICT and data infrastructure (data collection, transmission, storage, processing, cleaning, and analysis devices, missing historical data and insufficient digitization and labeling of data), deficient telecommunication networks and poor internet connectivity, low bandwidth and slow network performance, limited access to cloud-hosted data, irregular and erratic electricity supply, fragmentation of data and lack of data standards.

Finance and Investing: Barriers related to finance and investing are insufficient capital to invest in ICT devices and data infrastructures, fund deficiency for the maintenance of existing infrastructures, lack of public investments to bridge gaps in data engineering, data analysis, and data science education, low awareness and clarity regarding return on investment in AI systems, and no financial assistance schemes for small farms to adopt and deploy ICT devices and embedded systems.

FUTURE OF AI IN INDIA

Applications of AI based tools in agriculture have initiated in India by several start-ups working in this area to help farmers with improved productivity and profitability from agriculture. India's burgeoning start-up ecosystem has been actively playing its part in developing the agriculture sector. Since, opportunity in agritech exists across the value chain from improving farmers' access to markets, inputs, data, advisory, credit and insurance; India can tackle the issues associated with adoption of AI based technologies by providing a suitable ecosystem to these start-ups to access the data and market. Moreover, National Strategy for Artificial Intelligence released by NITI Aayog in June 2018 identifies agriculture as one of the focus areas.

To maximize farm output from limited resources agriculture in India should to make use of sophisticated deep techs in future. Deep-Tech innovations support farmers to grow crops even in arid areas with high resource use efficiency, using technologies like AI and ML, robots, temperature and moisture sensors, aerial images, and GPS. An important aspect of AI is the system's response time and accuracy. Even behavioral changes in field crops due to changes in microclimate conditions can be analyzed in the quickest response time with accurate information. However, concerns about durability of AI technologies may discourage farmers from its adoption as technologies are changing very fast in this digital era, and changing devices and sensors quickly with advancement in the adopted technologies is not going to be economical for the small-scale farmers of India. It is certain that digital innovation can transform Indian agriculture if there are proper efforts to convince the vend users about the potential of AI based technologies in agriculture sector; not only from the user and consumer side but also to the governance and policy side.

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