Artificial Intelligence based Smart Agriculture for Sustainable Development

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Abstract:

In India, the agriculture industry has changed dramatically during the last few decades. We have come a long way from traditional farming methods to smart farming. Rural agriculture's issues have finally been conquered by technology, which is always developing improved methods to boost production and increase efficiency. The ultimate goal is to assist farmers in producing high-quality crops to fulfill the requirements of the world's growing population. In this article, we will look at how Artificial Intelligence is bringing innovations in agriculture by using more effective methods that are helpful in achieving sustainable development goals. Specific focus is given to the important applications, government initiatives and challenges for implementation of this technology in India.

***Key words**: Traditional farming, Artificial Intelligence, Revolutionize, Sustainable development goal*

1. Introduction:

Food production is declining globally due to a scarcity of resources. Moreover, the world's population continues to rise, and urbanization continues. With the increase in the income of people, their consumption habits also change. Farmers are under a lot of pressure to satisfy rising demand. Therefore, in the agriculture industry, there is a pressing need to apply technical developments (Awan et al., 2021)[1]. The adoption of Artificial Intelligence (AI) in agriculture is required for sustainable development (Nayal et al., 2021)[2]. It has the potential to alter our perceptions of farming by allowing farmers to get more output by putting in comparatively less effort while also giving a plethora of additional benefits (Intellias, 2022)[3].

[1] Awan, S., Ahmed, S., Ullah, F., Nawaz, A., Khan, A., Uddin, M. I., Alharbi, A., Alosaimi, W., & Alyami, H. (2021). IoT with BlockChain: A Futuristic Approach in Agriculture and Food Supply Chain. *Wireless Communications and Mobile Computing*, *2021*. https://doi.org/10.1155/2021/5580179

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2. Review of Literature:

Previous Researchers have advised the United Nations and other organizations working on sustainable development to deploy novel artificial intelligence-based solutions to assist avoid food security problems (Bierbaum et al., 2020)[4]. Researchers at a university in Thailand devised an effective AI-based traceability solution for food safety and management of the supply chain. These experts questioned whether this strategy would contribute to long-term agricultural growth across the country (Surasak et al., 2019)[5]. (Malarvizhi, 2019)[6] noted that India has a large amount of natural resources that are conducive to agriculture. With the rise of technology in agriculture, this potential could transform into opportunity. The researchers in this study concentrated on the creation of small-scale businesses based on palm trees in Tamil Nādu for the state's economic prosperity. The European Commission envisions a sustainable Europe by 2030, taking artificial intelligence into account (Raboaca et al., 2020)[7]. As a result, digital transformation in agriculture is the most essential driving element for national and global prosperity (Vadlamudi, 2019)[8]. Agriculture digitalization proposes a fourth industrial revolution. (Liu et al., 2021)[9]. ICRISAT, based in Hyderabad, India, is partnering with Microsoft to help Indian farmers use artificial intelligence to boost agricultural output while ensuring environmental sustainability. National Education Policy, 2020 requires the universities, Boards and other educational institutes to incorporate 'Artificial Intelligence' subject in their syllabus. This initiative of Government of India will increase the use of artificial intelligence-based technologies in all the spheres including agriculture and will India lead towards becoming a sustainable and developed economy.

3. Relevance of the Study:

Available literature depicts that Artificial Intelligence based solutions have helped in growth of agriculture sector in different economies. India is also on the path of revolutionizing agriculture to increase agricultural product and turn into a sustainably developed economy. But there is no

[4] Bierbaum, R., Leonard, S. A., Rejeski, D., Whaley, C., Barra, R. O., & Libre, C. (2020). Novel entities and technologies: Environmental benefits and risks. *Environmental Science & Policy*, *105*, 134–143. https://doi.org/10.1016/j.envsci.2019.11.002

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particular study which talks about applications of artificial intelligence in Indian agricultural sector. Thus, present study is descriptive research presenting important applications, Government initiatives and challenges for implementation of artificial intelligence in agriculture in India.

4. Objectives of the Study:

- To identify important applications of artificial intelligence in agriculture;
- To identify the initiatives taken by Government of India for AI implementation in agriculture;
- To study the challenges for AI implementation in agriculture in India.

5. Methodology:

The present study employs descriptive research methodology to identify the characteristics of artificial intelligence in Indian agricultural sector. It is entirely based upon secondary data collected from journals, e-newspapers and blogs.

6. Key Applications of Artificial Intelligence in Agriculture in India:

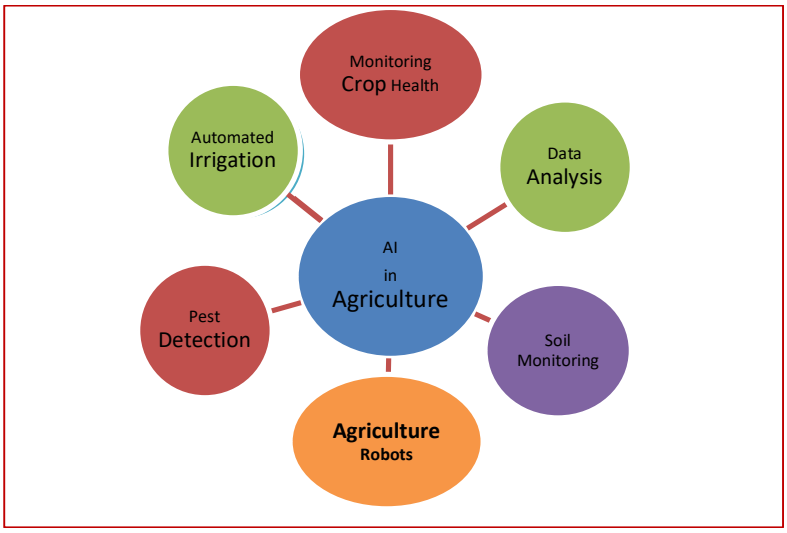

Figure 1: AI Applications in Indian Agriculture

Source: Authors' compilation

6.1 Weather Forecasting:

As the climatic conditions vary throughout the year and pollution is also increasing, it becomes difficult for farmers to decide the right time to sow seeds. But now, due to artificial intelligence technologies, farmers are able to forecast weather conditions. As a result, they may schedule when to plant seeds and what kind of crop should be grown. Even in India, Meteorological

department has collaborated with IIT Kharagpur (The Economic Times, 2020)[10] for the implementation of artificial intelligence in weather forecasting.

6.2 Soil Monitoring:

The soil quality and its nutritious value are crucial factors in determining the crop to be planted. But it is very difficult to identify the quality of soil as soil quality is deteriorating day by day due to increased deforestation. According to a report presented by Express Computers, Google and nurture farm have launched a research cooperation to find scalable and cost-effective technologies for measuring soil quality throughout farmland in India, which will enable and expedite the adoption of sustainable agriculture techniques throughout the country (Express Computer, 2022)[11].

6.3 Data Analysis:

In agriculture, data analytics lead to considerable productivity gains and cost savings.(Wolfert et al., 2017)[12] Farmers receive incredible recommendations on the basis of real-time data processing on crop needs with the help of AI technologies. Even farmers may obtain more precise information more quickly by fusing IoT sensors and software with AI agriculture technologies. Better data results in better decisions and less waste.

6.4 Agriculture Robots:

A major challenge in farming is the shortage of manpower; this can be resolved with Internet of Things, autonomous tractors, and artificial intelligence. These technologies could also save money because they are more precise and so eliminate errors. Robotics is another less frequent but a quick technology. These are used for doing different agricultural activities like harvesting, seeding, mowing, spraying, sorting, packaging and irrigation etc. fruits and vegetables and thinning lettuce. Farmworkers have significant advantages of robots. They have more endurance, greater accuracy, and lower error rates. Basic Agricultural robots are available in India only for Rs. 6,000 (Reddy et al., 2016)[13]. Binary Robotics, Robo Technos, and Shpine Technologies (Kushwaha et al., 2022)[14] are some of India's prominent agricultural robot producers.

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[10] India's Meteorological Department plans to use AI to improve weather forecasting. (2020, August 2). *The Economic Times*. https://economictimes.indiatimes.com/news/politics-and-nation/indias-meteorological-department-plans-to-use-ai-to-improve-weather-forecasting/articleshow/77313316.cms?from=mdr

[11] https://www.expresscomputer.in/news/google-and-nurture-farm-collaborate-to-scale-soil-quality-measurement-in-india/85387/

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6.5 Pest Detection:

Pests are one of the most destructive enemies of farmers' crops. To deal with this problem, AI has introduced wonderful technologies of image sensing (Zhang et al., 2022)[15] Under this technique, image sensors classify the image of plant leaves into diseased and non-diseased areas. The diseased area is harvested and diagnosed in the laboratory by experts to detect pests. 'Plantix' is a widely used mobile application in India for detecting pests and crop diseases (Neno, 2022)[16].

6.6 Automated Irrigation:

Irrigation is one of the most time-consuming and labor-intensive agricultural procedures. But AI-based technology solutions with smart embedded systems and moisture sensors (Jha et al., 2018)[17] have supported water management in agriculture in a very efficient manner. These technologies help in identifying whenever there is scarce or excess water supply in the fields. With the help of such technologies, farmers are able to find the optimum water level required in a field based on type of soil, crop and climatic conditions. Thus, this system helps in saving water as irrigation takes place only when water is needed by the land. This system is also linked to soil-moisture sensor to identify the dryness of the land and irrigate accordingly (Hosachiguru, n.d.)[18] A team of IIT professors has developed an automated irrigation system during COVID-19 to help migrant labor in agriculture (The New Indian Express, 2022)[19].

6.7 Monitoring Crop Health:

There are drone-based technologies to monitor crop health (Devi et al., 2020)[20]. The drone gathers information from fields and this data is sent to a computer through a USB drive and then carefully examined by the experts. The collected photographs are processed using algorithms, and the farm's present health is determined. It aids in pests and germs identification for farmers as well as the timely application of pest management and other measures.

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[15] Zhang, Z., wen, F., Sun, Z., He, T., & Lee, C. (2022). *Artificial Intelligence-Enabled Sensing Technologies in the 5G/Internet of Things Era: From Virtual Reality/Augmented Reality to the Digital Twin—Zhang—2022—Advanced Intelligent Systems—Wiley Online Library*. https://onlinelibrary.wiley.com/doi/10.1002/aisy.202100228

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7. Government of India Initiatives:

Government of India has taken three major initiatives for implementation of artificial intelligence in agriculture. These initiatives and their important features are explained in detail in figure 2. These initiatives of government will boost the usage of AI technologies by farmers and will ultimately increase agriculture output.

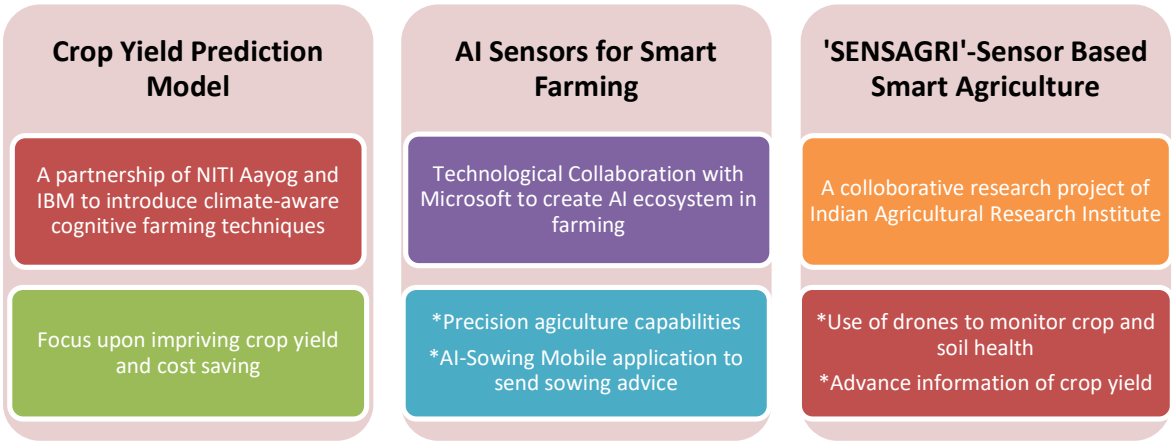

Figure 2: Government Initiatives

Source: indiaai.gov.in

8. Challenges for adopting AI in India:

8.1 Availability of Data:

AI systems require a huge amount of data related to crops, humidity level, weather conditions etc. to train robots and produce exact predictions (Shamshiri et al., 2018)[21]. But, obtaining meaningful data at the farmer level in India, is also a significant difficulty. Not only is data collecting difficult, but consumers are generally hesitant to volunteer their information due to privacy concerns. As a result, a technological solution to data collection is also required. So there is a need to figure out how to collect data in an automated method without invading the farmers' privacy.

8.2 Small lands:

In terms of technology, the bulk of Indian farmers have relatively small landholdings and are unable to afford the expense of purchasing seeds and other needs. So, we cannot expect them to invest in a technology that is costly, unproven, and may not be required for a small piece of land in such a situation.

8.3 Dependence:

[21] Shamshiri, R., Weltzien, C., Hameed, I., Yule, I., Grift, T., Balasundram, S., Pitonakova, L., Ahmad, D., & Chowdhary, G. (2018). Research and development in agricultural robotics: A perspective of digital farming. *International Journal of Agricultural and Biological Engineering*, *11*, 1–14. https://doi.org/10.25165/j.ijabe.20181104.4278

Our farmers bear the entire risk of their business. They are fully reliant on others for their land's produce, whether it's money for seeds, fertilizers, pesticides, or the weather; they are plagued by water scarcity, a lack of qualified labour, and so on. Even the money from their produce is uncertain, and because the produce is perishable, they must accept whatever amount they receive due to a lack of storage space.

8.4 Lack of Trust in Technology:

Because of high illiteracy and orthodoxies among Indian farmers, they have very less trust in technology Most of them believe that technology is a foreign thing and is not their cup of tea. They always believe that implementing technology is a very costly affair. Even if technologies are available at cheap rates, they suspect upon their implementation.

8.5 Security Issues:

So far, there is no set government policy and rule related to use of artificial intelligence technologies in the domain of agriculture. Cyber-attacks and data leaks may pose severe privacy and security risks to farmers. Many farmers, unfortunately, are subject to these hazards.

9 Conclusion and Suggestions:

Agriculture will undoubtedly benefit from AI in the future. But farmers require a technology infrastructure before they can reap the full benefits of AI. That infrastructure will take some time to construct, potentially years. Technology providers also need to improve their tools. They should assist farmers with their concerns, and clearly communicate the benefits of machine learning in solving actual problems faced by the farmers in traditional methods of farming. Government needs to devise strict policies to protect data security and avoid leakage of data. There is also a need to run awareness drives to educate the farmers using traditional methods to shift to smart agricultural techniques. With these positive measures, AI technologies in agriculture will certainly lead towards achievement of sustainable development goals.

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