ARTIFICIAL INTELLIGENCE – A MULTI-DIMENSIONAL APPROACH TO SMART FARMING

Abstract

A sustainable and secure food supply is a challenge in this changing world with rapid population growth, which is estimated to reach 9 billion people in 2050. However, due to climate change and other factors like limited land resources, the agriculture industry is facing a number of challenges and obstacles in terms of increasing and diversifying production. The farmers' traditional methods were unable to meet these demands. This led to the introduction of new automated techniques. These innovative techniques have the potential to supply the world's food needs while simultaneously giving billions of people access to jobs. The introduction of artificial intelligence to agriculture has revolutionised the whole sector. It can also bring about a paradigm shift in how we see farming today. Artificial intelligence applications in agriculture include automated irrigation, weeding, and spraying using sensors and other tools built into robots and drones. These technologies reduce the overuse of water, pesticides, and herbicides, thereby preserving soil fertility, assisting in the effective use of human resources, increasing output, and enhancing product quality. Hence, artificial intelligence is not a static sector but a dynamic one, opening new doors of research and innovation in the agriculture sector every day.

Keywords: AI, Artificial intelligence, Smart agriculture, Smart farming, Agricultural robotics, AI in soil sciences"

Authors

Jagriti Patel
Research scholar Department of Soil Science and Agricultural Chemistry
College of Agriculture
IGKV Raipur Chhattisgarh, India
pateljagriti06@gmail.com

Jyoti Bala
Research scholar Department of Soil Science and Agricultural Chemistry
College of Agriculture
IGKV Raipur Chhattisgarh, India

I. INTRODUCTION

Agriculture is the backbone of the Indian economy in light of the fact that more than 50% of the population of India is dependent on agriculture for their livelihoods (India economic survey, 2018). The agriculture sector also serves as the source of raw materials for agriculture as well as non-agricultural sectors like the textile industry, the food processing industry, etc. To serve the above purpose effortlessly, we need higher production levels, which can be achieved by efficient utilisation of resources and good practices. Agriculture's age-old methods have undergone modifications over time. People have become more inventive and efficient in the direction of agriculture as a result of the growing population and limited land availability. Utilizing the limited land as well as possible has become essential. Earlier, individuals had a hard time adjusting to technological advancements. However, they must now adapt to these developments in order to survive in the market. Artificial intelligence, machine learning, and other new technologies have evolved to advance a wide range of industries.

The term "artificial intelligence" (AI) was coined by an American scientist, John McCarthy, in 1956. According to him, artificial intelligence is the science and engineering of making intelligent machines. As the name suggests, artificial intelligence refers to the ability of computers to accomplish tasks in a manner that is similar to human intellect and to iteratively improve upon themselves in response to the data they gather. The term is frequently used in reference to the process of creating artificial intelligence (AI) systems that possess human-like cognitive abilities, such as the capacity for reasoning, meaning-finding, generalisation, and experience-based learning. With the use of this technology, computers may be taught to carry out certain jobs by analysing enormous amounts of information (data) and identifying patterns in the data. This can be efficiently utilized in the farming system as the agriculture sector is expanding day by day.

II. COMPONENTS OF ARTIFICIAL INTELLIGENCE

We generally do not characterize anything by just one trait, we do so by the combination of many of its abilities. Therefore, researchers in AI have also focussed in the following characters depicted in the figure 1.

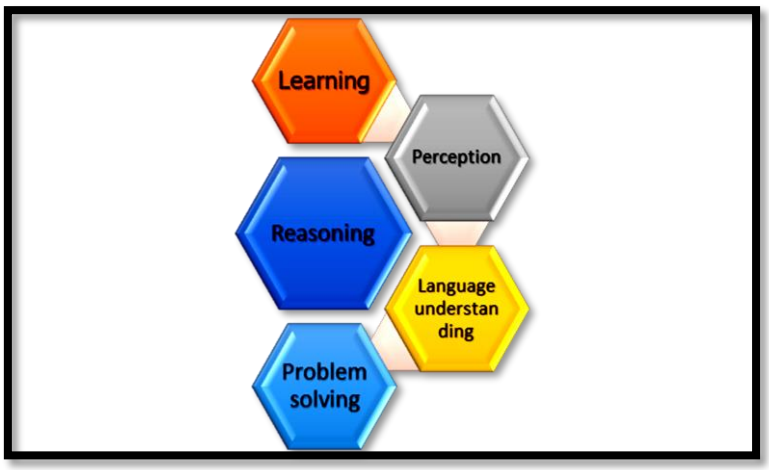

Figure 1: Components of Artificial Intelligence

Software engineers and developers have been able to produce a wide range of products and services that people all over the world have come to adore in different sectors of the society (including agriculture sector) by putting these five fundamental principles into practise. Let's talk in detail about these components and how they keep the AI going.

1. **Learning:** Learning is the very first step in the development process associated with artificial intelligence, just like it is in human beings. Artificial intelligence relies heavily on learning, which can take many forms. Learning through doing, or alternatively, trial and error, is the most basic method. In this arrangement, the programme retains the portion that produced the desired results and discards the other trial actions, then learns itself. For example, in games like Ludo or Chess (a software programme), when the competitor tries out some random moves and achieves success, the next time, when the same problem is presented to the computer again, it can rapidly generate the desired result since the programme remembers the successful move from the previous games. Artificial intelligence-based programmes are able to record all activities or decisions that produced successful outcomes through this learning process. This information may then be used by the computer to solve similar challenges in the future by drawing on its data. Conclusively, the process of learning in the context of the creation of artificial intelligence comprises the memorization of specific information, such as various approaches to problems, vocabulary, and foreign languages, among others.

2. **Reasoning:** The next major tool of artificial intelligence is reasoning. It is also known as "logic" or "making judgements" based on a given set of facts. The reasoning is conducted in accordance with a precise rule of validity to carry out a specific task. Two types of reasoning are identified – inductive or deductive. In deductive reasoning, the premises' truthfulness ensures that the conclusion's assertions are accurate, as opposed to inductive reasoning, where the premises' validity helps the conclusion but prevents it from being completely dependent on them. In the AI programming generally, deductive reasoning is utilized, where reasoning involves drawing inferences that are relevant to the given situation or task.

3. **Problem solving:** A wide range of issues are addressed by AI. Problem-solving is possibly the most important aspect in terms of the development of artificial intelligence because the fundamental premise of AI is the development of computer programmes and systems that handle issues in a way comparable to that of human beings. Alternatively, in more sophisticated applications, problem-solving methods in the context of AI might involve creating effective algorithms or doing root cause analysis with the purpose of finding a suitable solution.

4. **Perception:** Perception is the way an individual perceives the outside world in order to deal with the situation that has been presented to them. In artificial intelligence, perception is achieved through the utilization of different sensors or sensory objects, whether real or artificial. It is the way through which a programme interacts with the environment, and more importantly, how it perceives the world around it. An optical sensor is one such sensory object popular nowadays in the field of artificial intelligence.

5. **Language understanding:** Language understanding in the development of an artificial intelligence is defined as a collection of numerous system signs that use convention to

facilitate their varied means or procedures. Software developers are able to make sure that computer programmes can effectively carry out their respective functions and operations by using this language understanding. The ability of a computer programme to understand human language as it is spoken and written and infer the knowledge from the speech input is referred to as Natural Language Processing (NLP). Some of the examples include the speech recognition and response of Amazon's Alexa and Apple's Siri.

III. INTERNET OF THINGS (IOT)

The term "Internet of Things" (IoT) refers to a network of physical items, or "things," that have sensors, software programs, and other technologies built into them in order to connect to and exchange data with other systems and devices through the internet. These coming-of-age devices range from ordinary household items at a small level to sophisticated industrial tools at a large scale. In simple words, Internet of things is an idea from the world of computers that enables us to connect ordinary things like lights and doors to a computer network to make them "intelligent. It is an embedded system or a computer programme that connects everything together in a network and to the internet. It is also known by the names – Machine to Machine (M2M), Skynet, mesh nets, etc.

Some of the examples where internet of things (IOT) has become successful:

1. Postal and courier companies offers tracking services to the customers to enable them to see the real time location of their package (figure 2(a)).
2. Devices like Amazon echo having a virtual assistant Alexa is a device that interacts with individual to improve your living conditions. It is also well-versed in tasks like playing songs, turning on/off lights and much more provided it is connected to the internet.
3. A fitness band or smart watch are popular nowadays. They might also be counted as an IOT devices.
4. Smart doorbells offering a real-time video of your front door to prevent undesirable trespassing and that adds to an extra level of security to the residents.
5. In agriculture sector, the IOT helps monitoring the crop fields with the use of sensors, automated irrigation systems etc that have been discussed later in this chapter.
6. The other example of IOT in agri-sector is soil health card which connects fields to a smartphone and brings them to a single platform.

Figure 2: (a) Booking receipt (Courtesy - www.quora.com/), (b) amazon echo (Courtesy – www.notebookcheck.net) (c) Smart watch (Courtesy – www.self.com)

1. **Artificial intelligence of things (AIOT):** AIOT is the combination of Artificial Intelligence (AI) and the Internet of Things (IOT). Although the Internet of Things (IoT) is a technology that is assisting us in reimagining daily life, artificial intelligence (AI) is the true power that will enable the IoT to reach its full potential. Without AI-powered analytics, the IOT devices and the data they produce throughout the network will have a limited value. According to Forbes, the Internet of Things can be thought of as a digital nervous system, while artificial intelligence is the brain of the system.

2. **Artificial intelligence in agriculture:** The agriculture sector plays an important role in building the economic and financial status of any country. The farmers' traditional methods are currently insufficient to meet the world's food demand. In order to meet these needs and give many individuals in this industry fantastic career prospects, new automation techniques have been developed. Artificial intelligence is becoming an important technology in every sector of our society, including education, finance, robotics, business, agriculture, etc. It is having a significant impact on the agriculture industry and playing a very important role in the agriculture sector. AI protects the agricultural industry from a number of challenges, including climate change, population increase, labour shortages in this industry, and food safety. Today' agriculture has attained a different level with the help of AI.

   Artificial intelligence has enhanced real-time monitoring of different crops, crop production, harvesting, processing, and selling of the crops in the market. In order to identify numerous important criteria, including weed identification, yield monitoring, crop quality, and many more, different high-tech computer-based systems have been developed, which employ different tools to provide an effective output through AI systems.

Smart tools of AI used in agriculture sector

- **Sensors:** A sensor is a tool that collects physical input from its surroundings and transforms it into information that can be used by either a machine or a human to understand. They play a prominent role in the artificial intelligence world of the agriculture sector. In modern agriculture, sensors are frequently employed to gather information on all stages of crop growth, including germination, growth, and harvest. These sensors measure soil moisture, soil pH, light intensity, and carbon dioxide. Different types of sensors help in building a bridge between the crop environmental factors (like humidity, temperature, whether, etc.) and the humans controlling the whole system. Most commonly used sensors in agriculture include thermal sensors, visible light sensor, hyperspectral and multispectral sensors, etc. Some of the examples of these sensors are QGIS, ArcGIS, Pix4D, ERDAS, MATLAB, Adobe Photoshop, and Agisoft Photoscan.

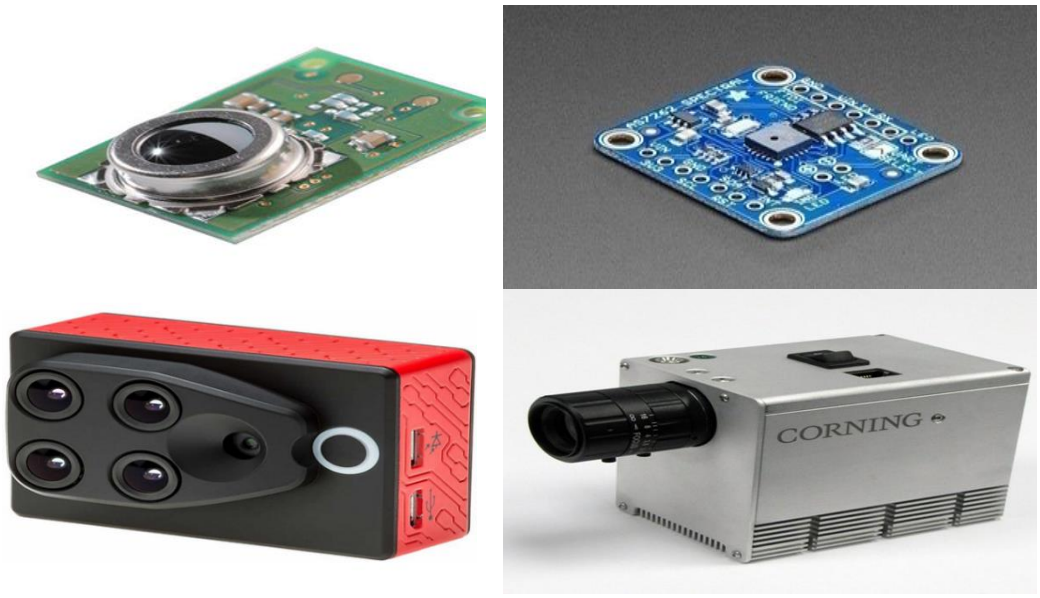

Figure 3: (a) Thermal sensor, (b) Visible light sensor (RGB), (c) Multispectral sensor and (d) Hyperspectral sensor

- **Unmanned Aerial Vehicle (UAV):** It can be defined as an aircraft without any pilot. The aircraft is controlled remotely by a human operator with the help of a remote, software application, etc. UAVs are also known as drones, remotely piloted aircraft (RPA). The drones are capable of a wide range of activities, from military missions to package delivery. Drones can be as small as the palm of your hand or as large as an aeroplane. Drones can assist farmers in a number of ways, including maximising the use of inputs (seed, fertiliser, and water), responding more quickly to threats (weeds, pests, and fungi), saving time during crop evaluation (validating treatment or actions taken), improving variable-rate prescriptions in real time, and estimating yield from a field. They are also useful in spraying pesticides on the crop, which has become a trending practise nowadays.

Figure 4: Drones used in Agricultural Field

IV. APPLICATION OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

The agriculture sector is experiencing rapid adoption of artificial intelligence in terms of farming techniques and agricultural products. With each passing day, technology expands its wings, providing farmers with solutions to even the most minor field problems. AI-based technical advancements have made it possible for farmers to produce more goods with less resources and even to improve the quality of those goods, ensuring a faster time to market for the harvested crops (Talaviya et al., 2020). Following are some of the applications of artificial intelligence in agriculture:

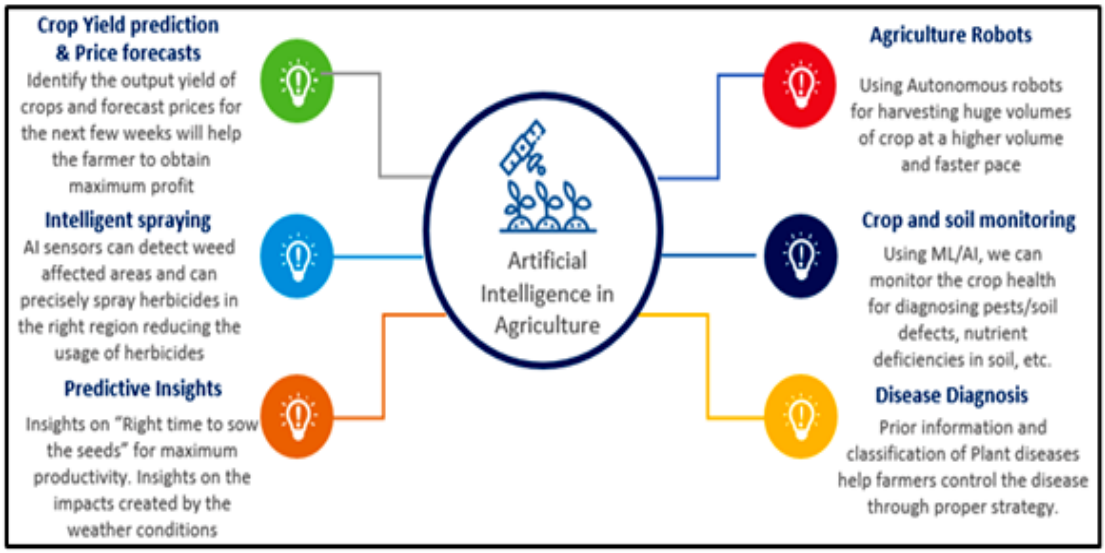

Figure 5: Prospects of AI in Agriculture

1. **Weather and price forecasting:** It is difficult for the farmers to take the right decision for harvesting, sowing seeds, and soil preparation due to climate change. But with the help of AI weather forecasting, farmers can have information on weather analysis, and accordingly, they can plan for the type of crop to grow, seeds to sow, and harvesting the crop. With price forecasting, farmers can get a better idea about the price of crops for the next few weeks, which can help them get the maximum profit.

2. **Automated/Autonomous tractor:** A driverless tractor is an automated farm machine used for tillage and other agricultural operations. It provides a high tractive effort (or torque) at slow speeds. They are designed to complete their work while independently determining their position, choosing their pace, and avoiding obstructions like other people, animals, or field items. There are two categories of driverless tractors: fully autonomous technology and supervised autonomy. The tractors can also cultivate land without a driver using GPS and other wireless technology. They work simply with a supervisor in a control station keeping an eye on the action, or with a lead tractor that is manned.

Figure 6: An autonomous tractor (Courtesy – www.cnbc.com)

3. **Monitoring of crop health:** The kind of soil and the soil's nutrient content have a significant impact on crop quality. The quality of the soil is deteriorating day by day due to the rapid deforestation, although it is difficult to measure. To address this issue, a new AI software called "Plantix" has been released. It was created by PEAT to detect nutrient deficiencies in soil, as well as plant pests and diseases. This application can give farmers ideas on how to apply better fertiliser to increase the quality of their produce. Farmers may use this app to take pictures of their plants and learn information about their quality thanks to AI's image recognition capability.

4. **Identification of pest outbreak and disease management:** The global share of production losses due to pests and disease is quite high, i.e., 20–40%. Many applications have emerged in this regard. They use AI algorithms to identify health issues and help companies locate and treat crops affected by diseases and pests. The procedure used computer vision technology to pre-process photos of plants. This guarantees that plant photos are appropriately segmented between the healthy and diseased sections. The infected area is cut off after identification and sent to the laboratory for further diagnosis. One of the applications demonstrating the benefits of this AI agricultural advancement is Plantix. A database of 100,000 images of diseased plants was compiled by the app's creators, and it is utilised by AI-powered picture recognition to detect over 60 different diseases. In that way, the app Plantix can identify powdery mildew and such diseases within seconds.

5. **Abiotic stress management:** The farmer is being assisted by powerful AI in keeping up with weather predicting data. Farmers that don't want to jeopardise their crops might enhance yields and revenues by using forecasted or predicted data. By comprehending and using artificial intelligence (AI), the study of the data produced enables the farmer to take precautions. Implementation of such practises helps in making smart decisions at the right time.

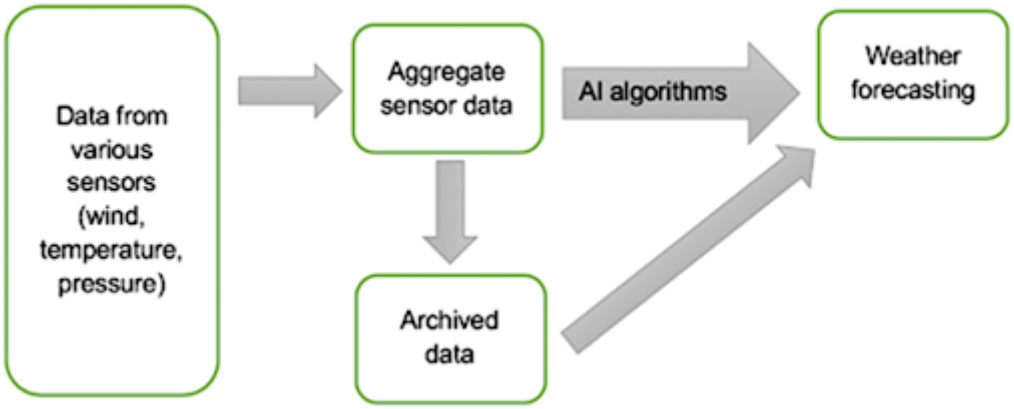

Figure 7: AI in Weather Forecasting

6. **Robotics in agriculture*:*** Robotics is widely employed in many industries, mostly in manufacturing, to carry out complex jobs. Currently, several AI companies are creating robots for use in the agriculture industry. These AI robots are designed so that they can do a variety of farming activities. AI robots are also taught to inspect the quality of crops, find and eradicate weeds, and harvest harvests more quickly than a person.

Figure 8: Agricultural robots (Courtesy - www.idtechex.com and www.techslang.com)

7. **Automated weed eradication:** Weeds can be quickly and readily recognised with AI sensors, which can also identify weed-affected locations. Herbicides may be accurately applied in these locations after locating them, which reduces the need for herbicides while also saving time and crop. Various AI start-ups are developing weed-spraying robots that are accurately guided by computer vision and AI. AI sprayers can significantly reduce the amount of pesticides that must be applied to fields, improving crop quality and lowering costs.

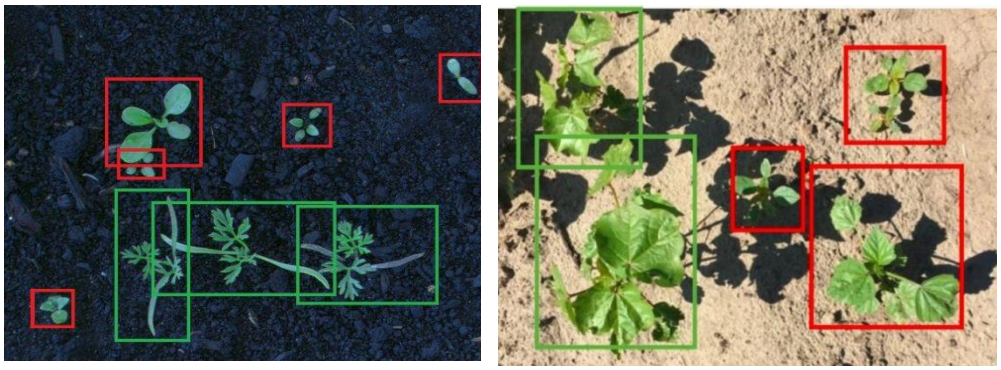

Figure 9: Detecting weeds through Computer Vision by the Start-Ups Weedbot and Blue River Technologies

8. **Artificial intelligence in soil science:** The utilization of AI in this field is very diverse. Several AI-based technologies like robotics, drones, predictive analysis, sensor-based soil monitoring devices, satellite imagery, automated irrigation system, etc. help in enhancing the soil health with their different approaches. Different fields of soil science in which AI has proven its efficiency are

    - **Soil testing and monitoring:** IBM (2018) developed a mini soil testing system, 'Agropad' that can successfully test five soil indicators based on colorimetric tests. It is done by farmers by putting a drop of soil or water on the test strip. The five indicators change colour based on the levels of pH, nitrogen dioxide, aluminum, magnesium, and chlorine that are present in the sample. The app makes a recommendation to the farmer for fertiliser adjustments that will help optimise the crop's growth.

    - **Soil fertilization and assessment of soil quality:** Neural networks in AI can quickly measure the parameters that would otherwise take hours to estimate. It is possible to predict soil hydraulic conductivity, which is difficult to measure, using quantifiable soil factors such as bulk density and effective porosity, soil texture data (sand and clay components), and soil water retention curves, for example, vG retention model parameters (Ghanbarian-Alavijeh et al., 2010).

    - **Identification of nutrient deficiencies:** Current methods for treating nutritional deficiencies are both costly and inefficient. A helpful indicator for AI to consider when predicting nutritional deficiency in advance is photosynthetic activity. The function of photosystems I and II and the electron transfer chain between them are reflected in the chlorophyll fluorescence, which is used to quantify the photosynthetic activity and ultimately predict nutrient deficiencies effectively (Aleksandrov, 2019).

    - **Monitoring of soil or land cover:** The utilization of AI driven autonomous vehicles are used in soil/ land cover/ land management (Saiz-Rubio *et al.,* 2020)

    - **Carbon sequestration:** ARIES (2018) employed a variety of models as inputs, including carbon sequestration source models, potential stored carbon release sink models, carbon flow models, greenhouse gas emission models, and evaluated carbon

mitigation and carbon deficit on a local scale basis. Also, the neural networks are a promising and cost-effective tool for estimating organic carbon in soil (Spencer et al.)

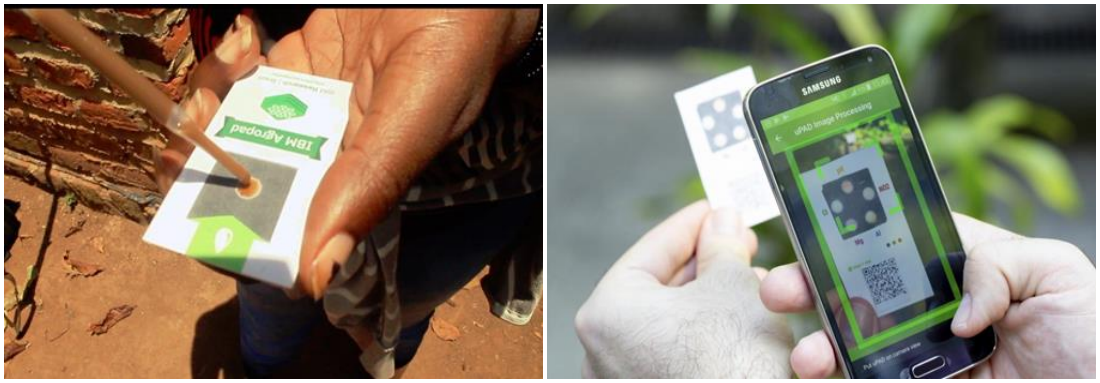

Figure 10: Agropad

V. PUBLIC-PRIVATE PARTNERSHIP FOR DIGITAL FARMING

1. **AI sowing app by Microsoft:** Microsoft and a local non-profit agricultural research organization, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), collaboratively developed an AI-sowing app. The app is powered by Microsoft's Cortana Intelligence Suite and Power Business Intelligence. Technology in the Cortana Intelligence Suite aids in enhancing the value of data by transforming it into easily usable formats. With the use of this technology, the app can more precisely estimate and suggest to nearby farmers when they should plant their seeds by using meteorological models and information on area crop production and rainfall. A test trial for the AI-sowing app involving 175 farmers in Andhra Pradesh began in June 2016. The farmers who benefited from this application only needed a basic mobile phone that could send and receive text messages; they didn't need to invest any upfront cost in buying smartphones or placing sensors in their fields. The software delivered farmers SMS messages with seeding advice during the summer in their native language, Telugu. The SMS messages about sowing provided important details about planting schedules, weed control, fertiliser application, and harvesting. A customised village-advising dashboard was set up in conjunction with the app to allow local government representatives to offer insights into overall soil health, fertiliser suggestions, and seven-day weather forecasts. The 175 farmers in this study experienced a 30% increase in their crop yield per hectare. Therefore, in the following year, the number of beneficiary farmers was increased to more than 3000.

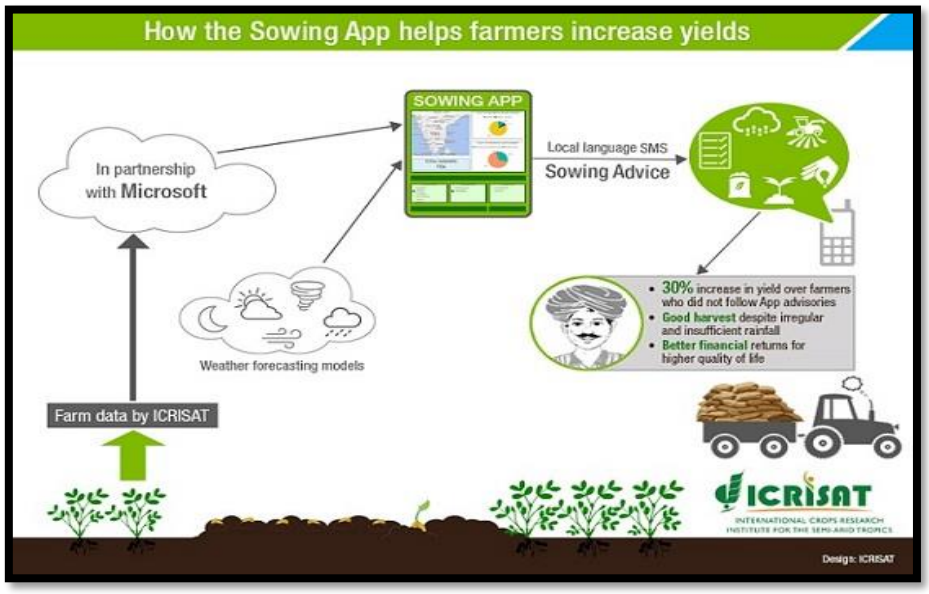

Figure 11: Model on which the sowing app operated (Source – ICRISAT)

2. **Price forecasting model:** The model employs remote sensing information from geo-stationary satellite photos to forecast crop yields at every stage of the agricultural process while taking into account statistics on past sowing areas, production yields, weather patterns, and other pertinent information. The Karnataka government and Microsoft signed a memorandum of understanding (MoU) in October 2017 in relation to the pricing difficulties, confirming their commitment to developing technology-driven smart farming solutions for Indian farmers as well as a proposal to build an AI price forecasting model. A multi-variate commodity price forecasting model was created by the Karnataka Agricultural Price Commission (KAPC) and Microsoft by integrating artificial intelligence, cloud machine learning, satellite imagery, and other advanced technology. According to Microsoft, the model is now scalable, efficient, and ready to be applied to other crops and to other regions around India. The summer 2018 harvest season was the first season in which the model was applied.

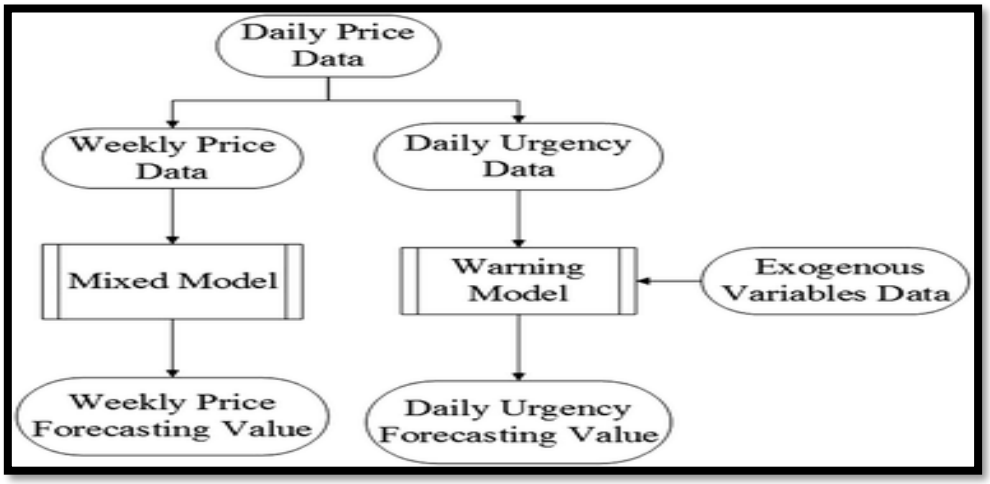

Figure 12: Forecasting Model

3. **Infosys precision crop management:** The demand for India's already insufficient food supply is rising as a result of the country's fast population growth. The agricultural industry is challenged by the need to find innovative ways to increase output while spending less, especially in view of the increasing effects of climate change and the scarcity of arable land. To address this issue, Infosys has built a precision crop management testbed using the Internet of Things (IOT). This testbed will improve crop productivity through the analysis of highly granular, real-time sensor data. The testbed will initially focus on improving crop yield through the analysis of real-time data from environmental sensors located in commercial crop fields.

VI. ADVANTAGES AND CHALLENGES OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE ADVANTAGES

1. **AI is cost-effective technology:** Equipment with AI capabilities enables farmers to produce more harvests with less resources and expenses. Farmers' right decision-making at every level of the farming process is made possible by real-time information provided by AI. With this wise choice, there will be less product and chemical loss and more effective use of both time and money. Additionally, it enables the farmers to identify the precise locations that require irrigation, fertilisation, and pesticide application, preventing the overuse of chemicals on the crop. Together, these factors lead to a decrease in the usage of pesticides, improved crop quality, and more profit while using fewer resources.

2. **AI enhances decision making:** Finding the best times to plant and harvest crops, projecting prices, and analysing market demands are just a few of the major problems that predictive analysis helps farmers overcome. Additionally, AI-powered equipment can assess the health of the soil and the crops, suggest fertiliser applications, track the weather, and assess crop quality. The farmers can make better judgments and practise effective farming owing to all these advantages of AI in agriculture.

3. **AI curbs the problem of labour shortage:** In the agricultural sector, there has always been a labour shortage problem. With farming automation, AI can address this problem. Driverless tractors, intelligent irrigation and fertilisation systems, intelligent spraying, vertical farming software, and AI-based harvesting robots are a few examples of how farmers may complete tasks using automation and AI without adding more staff. When compared to human agricultural workers, AI-powered machinery and equipment are significantly faster and more precise.

VII. CHALLENGES IN ADOPTION OF AI IN AGRICULTURE

1. **Lack of experience with emerging technologies:** The adoption of AI and emerging technologies in agriculture in developing countries can be a challenging task. Selling such technologies in regions where they are not currently being used in agriculture would be exceedingly challenging. Farmers in such places require assistance in order to employ this technology.

2. **Privacy and security issues:** AI use may result in a number of legal difficulties as there are currently no clear rules and policies. Additionally, there can be certain privacy and security risks like cyberattacks and data breaches as a result of the use of software and the

internet. For farm owners or farmers, any of these difficulties might lead to serious problems.

3. **Lack of familiarity with AI machines:** Even though employing AI in agriculture has many advantages, most people across the world are not familiar with its usage in solutions and technology. AI companies should provide farmers with the fundamental tools they need to handle the problems, and then, when they've become used to them, give them the more sophisticated equipment.

VIII. CONCLUSION

Artificial intelligence in agriculture is not only assisting farmers with automating their farming but also shifting to precision cultivation for increased crop production and better quality while using less resources. The advancements of artificial intelligence in agriculture have provided numerous benefits to farmers, including increased yield, reduced risk in this sector through the use of weather and price forecasts, and so on. However, its future in agriculture largely depends on the adoption of AI-based solutions. Despite the fact that several applications have already hit the market and that much research is continuously being done, the sector is still quite underdeveloped. When it comes to managing genuine difficulties encountered by farmers and adopting autonomous decision-making and predictive solutions to tackle them, agriculture is still at a very early stage. AI will challenge current decision-making processes in the near future and advance agricultural methods. Such technology interventions are anticipated to result in improved agricultural practises, yields, and qualitatively better farmer lifestyles.

REFERENCES

[1] Aleksandrov, V. (2019). Identification of nutrient deficiency in bean plants by prompt chlorophyll fluorescence measurements and Artificial Neural Networks. *arXiv preprint arXiv*:1906.03312.
[2] ARIES (2018), Model specifications for place-specific carbon sequestration and storage models developed for the Puget Sound, San Pedro, and Rocky Mountains case studies. http://aries.integratedmodelling.org/carbonsequestration- storage/
[3] Ghanbarian-Alavijeh, B., Liaghat, A. M., and Sohrabi, S. (2010). Estimating saturated hydraulic conductivity from soil physical properties using neural networks model. *World Academy of Science, Engineering and Technology*, 62, 131- 136.
[4] IBM (2018) Agropad-AI-powered technology will help farmers health-check soil and water https://www.ibm.com/blogs/research/2018/09/agropad.
[5] "India economic survey 2018: Farmers gain as agriculture mechanisation speeds up, but more R&D needed". *The Financial Express. 29 January 2018*. Retrieved 8 January 2019
[6] Saiz-Rubio, V., andRovira-Más, F. (2020). From smart farming towards agriculture 5.0: a review on crop data management. Agronomy, 10(2), 207.
[7] Spencer, M., McCullagh, J., Whitfort, T. and Reynard, K. An Application into Using Artificial Intelligence for Estimating Organic Carbon https://www.mssanz.org.au/modsim05/papers/spencer_1.pdf.
[8] Talaviya, T., Shah, D., Patel, N., Yagnik, H., & Shah, M. (2020). Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. Artificial Intelligence in Agriculture, 4, 58-73.

WEBSITE LINK

[1] https://caseguard.com/articles/the-five-basic-components-of-ai-new-software-development/
[2] https://techblogmu.blogspot.com/2018/09/components-of-ai.html
[3] https://www.oracle.com/in/internet-of-things/what-is-iot/
[4] https://www.quora.com/What-is-consignment-number-in-India-post
[5] https://www.notebookcheck.net/Amazon-Echo-Dot-Review.221058.0.html
[6] https://www.self.com/gallery/best-fitness-trackers
[7] https://www.technologyreview.com/2016/07/20/158748/six-ways-drones-are-revolutionizing-agriculture/
[8] https://krishijagran.com/farm-mechanization/drones-101-their-use-in-agriculture-price-government-s-schemes-laws/
[9] https://www.javatpoint.com/artificial-intelligence-in-agriculture
[10] https://www.cnbc.com/2016/09/16/future-of-farming-driverless-tractors-ag-robots.html
[11] https://www.idtechex.com/en/research-article/idtechex-outlines-the-future-of-the-agricultural-robotics-industry/25744
[12] https://www.techslang.com/agricultural-robots-are-we-ushering-the-age-of-robot-farmers/
[13] https://thecsrjournal.in/artificial-intelligence-in-agriculture-in-india/

