Potential of Artificial Intelligence (AI) in improving Agriculture

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Abstract

The demand for food products is increasing globally with the rise in the world's population. Agriculturalists are facing numerous challenges to maximize the outputs. To fight with all the challenges in the agriculture sector like Crop management, irrigation, soil infertility, pest infestation, diseases in crops, climate monitoring, field monitoring etc new technologies were introduced. Application of Artificial intelligence (AI) in agriculture was first reported in 1983 to prognosis effective solutions of these problemsand build up sustainable agriculture practices. Introduction of digital technologies including Internet of things (IoT), AI, bought a golden revolution in the sector of Agriculture. It has mainly focused on the Sustainable development which is really crucial for the survival. Use of chemicals in the form of fertilizers and pesticides has been reduced effectively by Artificial Intelligence which was the major cause of the soil infertility and soil erosion. From use of drones for the field monitoring to use of satellites for the data transmission, everything is made convenient. The use of AI gives high-accuracy results in weather forecasting approaches as well as in the detection of plant diseases. Technologies are being used to bring the best results of the agriculture sector and itpossess the vast tendencies to grow in upcoming time and improve food industries. This chapter provides a comprehensive literary survey of the impacts and applications of artificial intelligence or technology in the field of agriculture.

Keywords: artificial intelligence, farming, agriculture, food, technologies

1.Introduction

The world population is increasing at an alarming rate of 70 million per year, and if this trend continues, there would be 10 billion people at the end of this century (Wik et al., 2008). With the growing population in the world, the demand of food is also growing. The vision of agricultural industries along with the food sciences is to create a world free from hunger and lack of food

resources. Computer Science is working towards generating such technologies that can create solution of all the problems faced in agriculture. During this, agriculture sectors face numerous challenges which results in the high input and low output. Degraded soil, pest attack, crop management, diseases in crop, challenges in rearing the stock due to diseases, are the common reasons for the backlash in the productivity.

The application of Artificial Intelligence (AI) in agriculture was first reported in 1983. It is the fourth revolution in the field of agricultural science. AI is bringing the outcomes of the agricultural industries back. AI uses computational knowledge to solve the major issues which human knowledge and traditional methods usually fails to solve. With the advance technologies and vast researchs, AI is growing very rapidly because of its adaptivity, relevant data, computational ability, and algorithms. The major issues such are pest and disease attack, lack of application of chemicals, maintaining the soil health, poor drainage system, improper irrigation, weed control, keeping record of the data, etc. are being solved with the help of AI.

Recent studies show that in the past few years, the use of AI has grown drastically (Bannerjee et al., 2018). Agriculturists are switching from traditional methods to new technologies. The use of Artificial Intelligence gave positive impacts in the Agricultural Industries. There is radical shift in the productivity.

2. Major roles of the Artificial Intelligence in the Agriculture Sector

AI in agriculture mainly focuses on the crop yield by protecting the crop from various factors like the climate changes, soil infertility, pests, irrigation along with dealing with the tremendous growth in the population, and the food scarcity problems. The various applications of Artificial intelligence in agricultureare to generate automated irrigation facilities, and to install automatedrobotic system or machineries that can control the spraying of pesticides, fertilizers, weedicides. Drones are also installed in the field for a large view and control the systems. These technologies not only save the water, but also maintain the use of pesticides, herbicides to protect the soil fertility, and saves the time and labour cost. The major roles of the artificial intelligence in the agriculture sector have been summarised in Fig. 1.

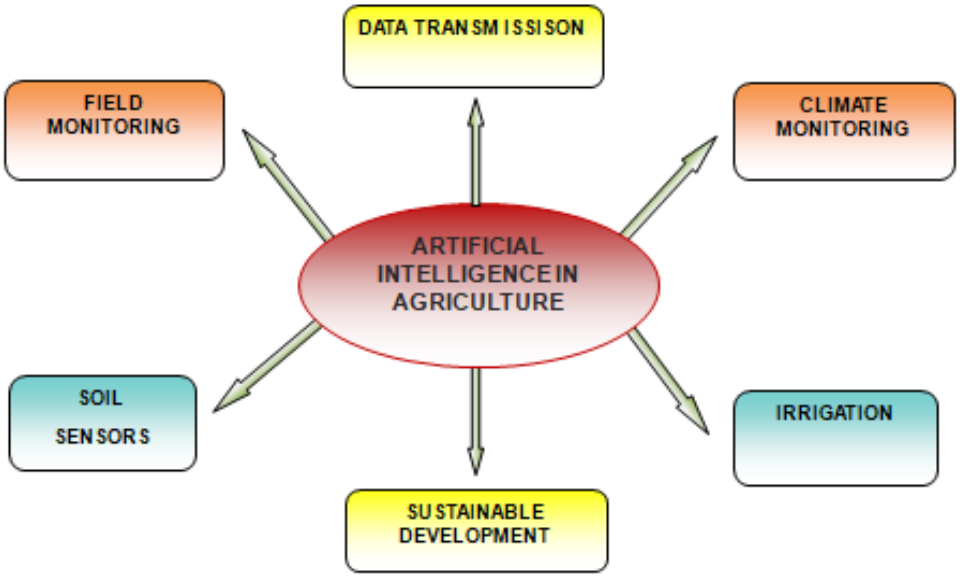

Fig. 1. *The major roles of the artificial intelligence in the agriculture sector*

2.1 Irrigation:

The data says that about 85% of world's freshwater is used in agriculture. Improper irrigation can lead to the damage to the crop by exposing their roots, waste the water and can also cause environmental issues like soil erosion. Artificial Intelligence has enabled the agricultural industries to install such methods of irrigation that are more effective than the traditional one. Various techniques are being introduced that made watering the crop easy on large scale without unnecessary wastage of water. Automated irrigation and the use of mobile and sms was reported in various studies (Varatharajalu and Ramprabu, 2018; Suman et al., 2019; Talaviya et al., 2020). In this sensors were generated for different purposes like the soil moisture sensor to detect the moisture content in the soil. Some of the best irrigation techniques introduced by AI are mentioned in Table 1.

Table 1. Various irrigation techniques along with their usage.

S.No.	Technique	Usage
1.	Soil Moisture Sensor	They are installed in the root zones which detect the moisture in the soil before the irrigation and aids good irrigation management.
2.	Sprinkler System	They are widely used by the farmers across the world. It sprinkles water just like rain and it's mostly used in large crop sections and helps in water conservation.
3.	Drip Irrigation	It is the most productive method of Irrigation as it saves tons of water. This system includes watering direct to the root area which results in saving water.
4.	Center Pivot Irrigation	This device uses the AI system to manage the irrigation by adjusting the angle as well as flow of the water by itself. This method helps in watering the plants that are difficult to reach.
5.	Sensor Based Irrigation Methods	This technique uses the sensors and detects the ratio of water. It automatically Irrigates when the water level in the soil goes down.

2.2 Climate Monitoring:

Climate change is very unpredictable these days. Due to increase in global warming and pollution, the climate is usually unstable and is affecting the crop production also. Agriculturist are facing major challenges due to the abnormal change in the climate as majority of them still make profit out of seasonal crops and majorly depend upon rainfall for irrigation. So, Artificial Intelligence came to rescue and it developed such devices which can monitor the changes and alarm the agriculturist for any change in the climate. Excess rainfall can destroy the crops and low rainfall can cause drought and famine. Various sensors and satellites are installed which helps in the climate monitoring and keeps the record for the same. Hence, Artificial Intelligence has also helped a lot in the case of climate monitoring as well.

2.3 Field Monitoring:

Drones and various types of sensors are installed by the farmers these days to monitor their fields (Daponte et al., 2019). Nowadays, the application of small unmanned aerial vehicles (UAVs) is growing at a very fast rate in agribusiness. Drones are semi-automatic devices that are continuously shifting toward fully automatic devices. These devices have an enormous potential for agricultural planning and related spatial information collection. In spite of some innate barriers, this technology can be utilized for productive data analysis (Radoglou-Grammatikis et al., 2020).These are available at affordable prices and are capable of imaging ground data with corresponding geographic locations. That helps the user to have a complete and clearer picture of the ground information. Field monitoring is crucial to achieve maximum productivity and to protect the crop from the weeds, pests or insects. It also helps in the estimation of the total yield level. Artificial Intelligence has generated such types of drones that can monitor the crop while spraying or watering the crop at same time. Monitoring the crop growing stages and regional yield comparisons are very important. The different field monitoring techniques have been summarized in Table 2.

Table 2. Different field monitoring techniques.

S.No.	Technique	Usage
1.	Satellites	Monitor the field from a farther view by capturing field pictures.
2.	Drone	It provides accurate image of the field. Widely used by the farmers to monitor their large field by 3D mapping system
3.	GPS Sensors	These sensors are mainly used for mapping the field boundaries, irrigation systems and locate the livestock

2.4 Soil Sensors:

Artificial Intelligence is used to check the quality of soil by various devices. Soil health is really important factor for the growth of the plants and AI uses best of its technologies to diagnosis the soil status and give the best treatment. Major soil problems include change in the pH of the soil which affects the crop drastically. Some other soil issues include deficiency of nutrients in the

soil. These issues are also detected using the artificial intelligence and using various soil sensors (Table 3).

Table 3: Various soil sensors along with their features.

S.No.	Soil Sensors	Features
1.	Optical Sensors	• Light wavelengths are used to detect and monitor crop heat, moisture and water levels.
2.	Electrochemical Sensors	• Electrical signals are used by electrochemical sensors to measure the chemical properties of the soil such as the pH of the soil, nutrient level. • Monitors the level of pesticides and fertilizers in the soil.
3.	Mechanical Soil Sensors	• Interact with the physical conditions of the soil and • Detect the soil conditions like the texture and compaction of the soil.
4.	Temperature Sensors	• Use transmissions and • Detect the soil temperature • Used for the greenhouse temperature monitoring.
5.	Airflow Sensors	• Measures the air penetration into the soil.

2.5 Data Transmissions:

There are various satellites that are installed in the fields over a large area which collect the data from the various sensors installed in that field. These data are collected for the further research by which the technologies can be improved and productivity can be increased. LoRa, Sigfox and

Zigbee are the widely used devices that collect the data. Various data transmissions with their network range, lifespan and specialities have been summarized in Table 4. LoRaWAN stands for the low-power, wide area networks which is cheap and provides the best connectivity to the IoT sensors installed in the field. It covers a long range and provides wide-area networking. Sigfox have also similar features like LoRaWAN. It is mostly used to monitor the water pumps and moisture sensors. On the other hand, Zigbee cover short range and supports multiple devices at a time (Davcev et al., 2018).

Table 4: Various Data Transmission with their network ranges, lifespans and specialities.

S.No.	Protocol	Network range	Lifespan	Specialities
1.	LoRaWAN	2.5 kms in urban areas while 15 kms coverage in the rural areas	10 years	• Low cost data monitoring upto wide range. • Secure Data transmission.
2.	Zigbee	10 to 100 meters	2-5 years	• Short coverage. • Provides facilities in cheap prices.
3.	Sigfox	3 to 10 kms in Urban areas and 30-50 kms of range in rural areas	10 years	• Low energy consumption. • Low data rates as compared to LoRaWAN.

2.6 Detection of Diseases:

Diseases in crops as well in livestock are the major cause of the backlash in the productivity. In order to overcome this, Artificial Intelligence is playing a major role in implementing such

technologies that can control the diseases. The technologies are generating pest resistant crops that are increasing the productivity. Various types of hybrid crops are generated which are disease resistant and multiplies the output. With the use of IoT we can sense and monitors the agriculture field parameters in remote cloud environment. With modified Resnet model deployed on the cloud for the purpose of building a smart disease prediction. This system achieves 99.35% accuracy for the dataset. Overall, this approach will provide an opportunity for agriculturists to test the plant disease with a smart phone connected to Internet and take appropriate actions to control the disease in the plants (Murugan et al., 2021).

2.7 Sustainable Development:

To create a smart green planet, Artificial Intelligence is playing a key role in improving the conditions of the agriculture sector. Sustainable Development mainly focuses on the growth without harassing the natural resources. Agriculture is the only sector which is directly connected with the nature and directly or indirectly it is causing harm to the nature because the farmers are focusing on their profit and output and neglecting the harm caused to the nature. So, Artificial intelligence has created many devices that help in conservation and don't adversely affect the productivity of the crops.

Creating pest resistant crops has resulted in decreased use of pesticides which were affecting the plants, soil and water too. Using devices to check the fertility of the soil has resulted in less use of the fertilizers which also protects the environment. AI based Irrigation devices helps in saving tons of water and it also prevents soil erosion because of excess irrigation. Hence AI has resulted in Sustainable development in the agriculture.

3. Benefits of Artificial Intelligence in Agriculture:

Artificial Intelligence have many positive impacts on the agriculture sector. It has also improved the productivity of the crops. Along with this, it has benefitted the agriculturalist in many ways. Agricultural robots are providing high class service in order to deliver best results possible. Digitalisation in the agriculture sector has also resulted in boosting the market sector. Now farmers across are world are connected globally through AI and are able to meet the market

trends, yearly outcomes, and are able to understand the consumer needs, thus farmers are efficiently able to maximize their outputs. From improved data and understanding come improved predictions, enabling more optimal decisions about how to manage farm systems and stimulating the development of decision support and recommender systems. In many cases, robotics and automated systems will remove much of the need for human decision-making and improve farm efficiencies and farm health.

4. Drawbacks of Artificial Intelligence in Agriculture:

In this world, 80% people are engaged in agricultural activities. Artificial Intelligence is causing various cybercrimes like data theft and scams. People are using excess of technologies which is affecting the nature also. Some of the devices generate toxic by-products which are harmful for the farmers as well as for the nature. Use of products that result in disturbing the natural cycles and challenging the lives of other organisms has increased in the past few years. Nature is in agony with excess use of technology. More and more implementation of the drones in the fields are affecting the birds. Satellites that are installed for the climate detection are emitting harmful rays which indirectly affecting the environment only (Smith, 2018). Due to automated agriculture system, the robots are doing major human work which is reducing labour work making them unemployed.

5. Conclusion

The population is increasing rapidly, which is making food security a challenging task. According to Food and Agriculture Organization (FAO) of the United Nation, more than 815 million people are chronically hungry and 64% of the chronically hungry are in Asia. The world needs to increase food production by approximately 50% by the year 2050 to feed a population of nine billion (Ehrlich et al., 2015). All things considered; we can say that Artificial Intelligence bought a revolution in the sector of Agriculture. It has mainly focused on the Sustainable development and bought many changes in the Agriculture Sector. According to the researchers, between 1960 and 2015 the world's population has grown from 3 billion people to 7 billion and with that the agriculture growth has also tripled.All of this is possible because of revolution in the agriculture system with the introduction of the Artificial Intelligence.

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