Role of Artificial Intelligence in Agriculture: A Comparative Study

Rijwan Khan, Niharika Dhingra, and Neha Bhati

1 Introduction

Agriculture is the basis of the supportability of any economy. It has a key impact on long-term monetary development and basic change, which, however, may differ based on nations. Previously, rural exercises were restricted to food and harvest creation. Yet, over the most recent two decades, it has advanced to preparing, creation, advertising, and conveyance of yields and domesticated animal items. As of now, rural exercises fill in as the essential wellspring of work, improving gross domestic product (GDP), being a wellspring of national exchange, decreasing joblessness, giving crude materials to creation in different businesses, and by and large building up the economy [1, 2]. The Internet of Things (IoT) technology is growing rapidly as a number of physical objects are linked at an exponential pace to the Internet, understanding the definition of the Internet of Things (IoT). The apps provide travel, agriculture, hospitals, factory automation, and emergency response to natural and human-made disasters, where it is impossible to make human decisions. Even cloud computing applications [3] are applied to the agriculture sector in different ways to help it grow. With the worldwide geometric populace rise, it becomes basic that agricultural practices are surveyed with the point of proffering inventive ways to deal with supporting and improving farming exercises. As the development of AI execution in agriculture proceeds, a fascinating and significant inquiry emerges with respect to the jobs of various actors. Given the particular aptitude required to use AI, one may ponder whether it is workable for farmers to build up these abilities in-house. Our investigation recommends that not all farm associations will be required to build up the innovation and calculations. Rather, they might have the option to lease or gain a couple of AI administrations, which would be

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adequate to serve the long haul of destinations of the association. Farmers are finding it difficult to decide the best time to plant seed as climatic conditions change and pollution rises. With the aid of artificial intelligence, farmers can analyze weather conditions using forecasting techniques [4], which allows them to schedule the type of crop that can be grown and when seeds can be sown. New farming companies are rising with creative arrangements, adding to the intensity of the part [5, 6].

1.1 Literature Review

AI could give an edge to the current practices and procedures to accomplish profitability and supportability objectives. For instance, dynamic abilities as AI can help in detecting market value changes of agrarian items and give explicit headings the planting and reaping to stay away from critical crop losses. Early disease identification and altered water system plans could improve general efficiency and viability. Artificial intelligence–empowered weather forecasts give exact, noteworthy bits of knowledge in regard to day-by-day farm exercises continuously.

Programming calculations associate explicit foliage designs with dietary and soil defects, pests, and different diseases. ML is applied in anticipating climate patterns and assessment of farms for pests and weed. One of the most predominant uses of AI is identified with planned and effective irrigation system frameworks. ML calculations dissect the dirt dampness and give sufficient water system procedures relying upon the yield, soil types, and ecological conditions [7–9]. These frameworks, thus, assist in safeguarding with watering and increment yield. The underlying use of AI is by all accounts in developing explicit yields. The outcomes exhibit the utilization of AI strategies to screen the development of yields that are normal and popular and those that require overwhelming and ordinary water system, for example, cotton and grapevines. The goal is to send AI in developing crops that include bigger land mass to empower productive, cost-effective, less-work-concentrated farming practices.

Intelligent AI apps such as the one designed by the authors in [10] are being used by the agriculture industry to help produce healthy crops, manage pests, track soil and developing conditions, organize data for farmers, reduce workload, and enhance a wide variety of agriculture-related activities in the food supply chain. The study of agricultural information from drones and sensors can give valuable data and direction with respect to the water system, crop losses, crop diseases, and pests. In order to reduce energy demand and decouple it from economic development, energy conservation is an essential component of sustainable energy management as implemented in a study by the authors in sensor networks [11]. As a result, increasing agricultural energy production is critical for lowering energy demand and, as a result, prices. Through the exact utilization of manures, pesticides, and systemized water system, AI takes into account the decrease of ecological effects [9, 12].

1.2 How Can AI Bring Revolution in Farming?

The use of AI is changing the method of activities and the executives of homesteads, the key territories of progress being ongoing estimating and reevaluation of business forms. The fast business changes got because mechanical developments drove associations to alter, create, and stretch out their operational abilities to improve effectiveness. That being stated, the essential objective of accomplishing the advantages of AI is intensely dependent on forms used by associations to adequately activate their specialized assets [13]. As per the UN Food and Agricultural Organization (FAO), the worldwide populace will likely stretch around 9.2 billion constantly by 2050. With accessible land assessed at only an extra 4%, it appears that it is not, at this point, a choice to just plant more harvesting fields or breed more steers. What is required is essentially more prominent proficiency than the current cultivating strategies as farmers will be needed to "accomplish more with less."

Here and there the development turns out to be more regrettable by unexpected climate change, pesticide use, and monocropping. Farmers are utilizing AI strategies to defeat these issues and develop food crops by battling against sicknesses and irritations.

2 Applications of Artificial Intelligence in Agriculture

AI is utilized in various enterprises, from assembling to car, one of the fascinating businesses that AI is breaking into is agribusiness; agriculture is a significant industry and an immense piece of the establishment of our economy; as atmospheres are changing and populations are expanding, AI is turning into a technological innovation that is improving and ensuring crop yield [14]. The most well-known uses of AI in the agricultural industry are crop management, weed and pest detection, soil management, etc. Machine learning models are used to follow and anticipate distinctive regular impacts on crop yield, for instance, the atmosphere changes, as shown in Fig. 1.

2.1 Crop Monitoring

Crop monitoring and management begin with planting and proceed with observing development, collecting crops, crop storage, and conveyance of crops. It is summed up as the exercises that improve the growth and yield of agricultural items [6]. Top-to-bottom comprehension of a class of crops as indicated by their planning and flourishing soil type will unquestionably build crop yield. To redesign the yield's proficiency in a way that it supports both farmers and the nation, we have to use the development that assesses the nature of crops and give recommendations. Remote

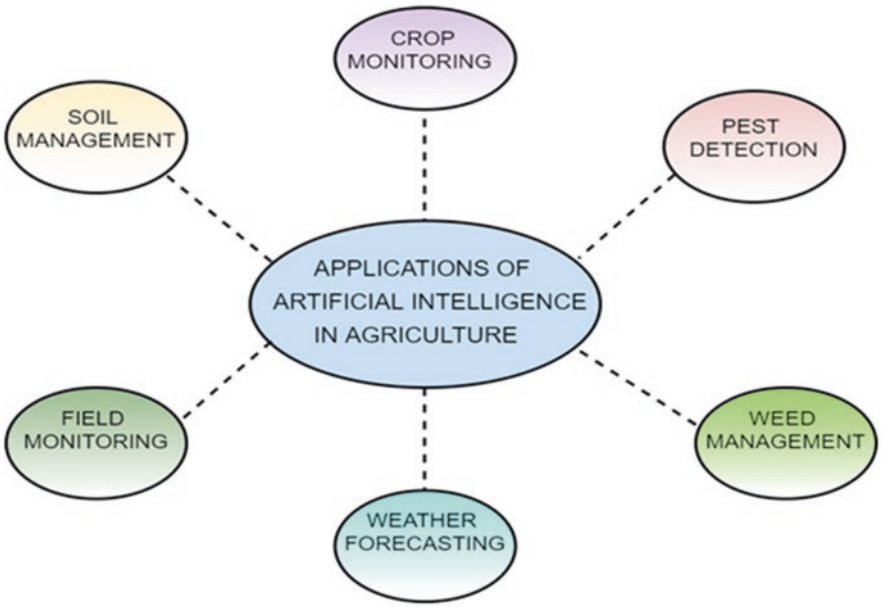

Fig. 1 Applications of artificial intelligence in agriculture

sensors of different sorts are used to assemble the information of yield conditions and environmental changes; then, this information is sent through the framework to the farmers or devices that begin restorative activity. The part of the crop monitoring system is shown in Fig. 2.

2.2 Pest Detection

Pest detection is a significant test in the agribusiness field. The simplest way to control pest infection is the utilization of pesticides. Yet, the extreme utilization of pesticides is injurious to plants, creatures just as people. The procedure of machine vision and advanced image processing [15, 16] are broadly applied to agrarian science, and they have an extraordinary point of view particularly in the plant insurance field, which eventually prompts crop management. Pictures of the leaves influenced by pests are procured by using an advanced camera. The leaves with pest pictures are handled to get a dim-shaded picture, and afterward, highlight extraction and image classification strategies are used to distinguish pests on leaves.

Image processing is examining and controlling graphical pictures from sources, for example, photos and recordings. There are three primary steps in image processing: The first is the transformation of caught pictures into twofold quality that a personal computer (PC) can process; the second is the picture improvement and

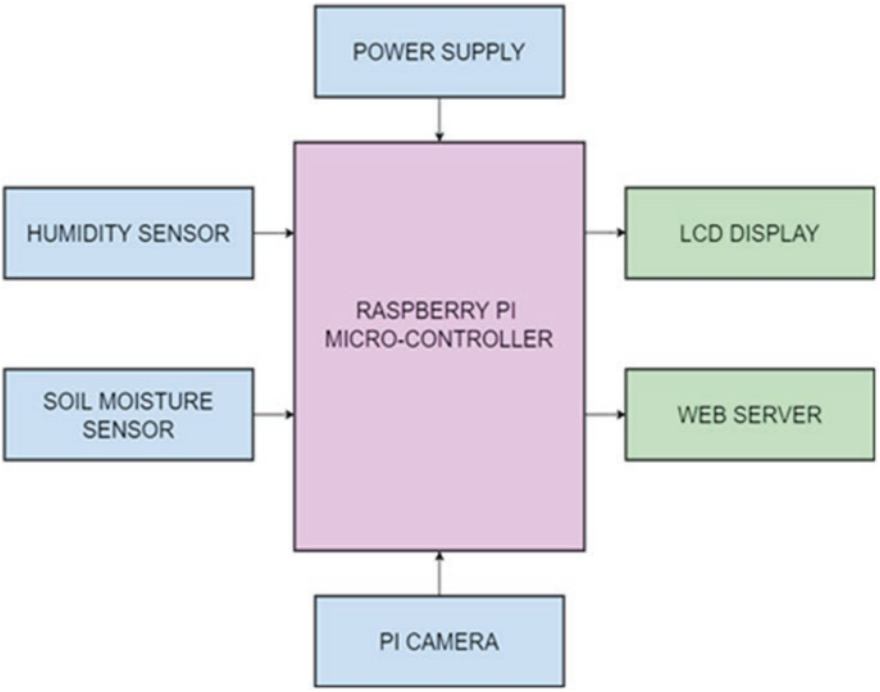

Fig. 2 Block diagram of crop management using the Internet of Things (IoT)

information pressure; and the third is the yield step that comprises of the showcase or printing of the prepared picture [16].

2.3 Weed Management

Weeds are one of the significant obstacles in supporting the harvest profitability. Weeds contend with crops for supplements, soil dampness, sun-oriented radiation, and space and diminish the yield and nature of produce [17–19]. Furthermore, they likewise go about as interchange has for creepy crawly irritations and ailment causing life forms. Weed issues change in various yields, seasons, agrobiological conditions, and the executives' rehearses. Multiple techniques for weed the board in field crops including preventive, social, mechanical, concoction organic and biotechnological, are being utilized with changing level of accomplishment. Because of consistent utilization of a single technique for weed control (particularly herbicide), weeds create opposition and become hard to control.

2.4 Weather Forecasting

Weather forecasting is a procedure of distinguishing and anticipating specific climatic conditions utilizing numerous innovations. A significant number of the live frameworks depend on climatic conditions to make essential modifications in their frameworks [20, 21]. Forecasting assists with taking important measures to forestall harm to life and property to a considerable degree. Quantitative measures like temperature, dampness, and precipitation are significant in an agriculture zone, just as to merchants inside item advertises.

The model proposed in this chapter for weather forecasting utilizing artificial neural network (ANN) is given in Fig. 3. The region for input information can be any meteorological station territory wherein all the information is constrained to a specific area. The diverse information boundaries are taken, viz. temperature, relative mugginess, gaseous tension, wind speed and bearing, cloud height, precipitation, etc.

2.5 Soil Management

Soil management is a vital piece of farming exercises. Sound information on different soil types and conditions will improve crop yield and save soil assets. It is the utilization of tasks, practices, and medicines to enhance soil execution [22, 23]. Urban soils may contain contamination, which can be examined with a conventional soil overview approach. The use of fertilizer and excrement improves soil porosity in total. The use of natural materials is necessary to enhance the quality of soil.

2.6 Field Monitoring

In agricultural field, natural factors, for example, temperature, dampness, sunlight-based radiation, CO_2, and soil dampness, are fundamental components that impact on development rate, efficiency of produce, sugar substance of organic product, sharpness, and so on. If we deal with the previously mentioned natural factors

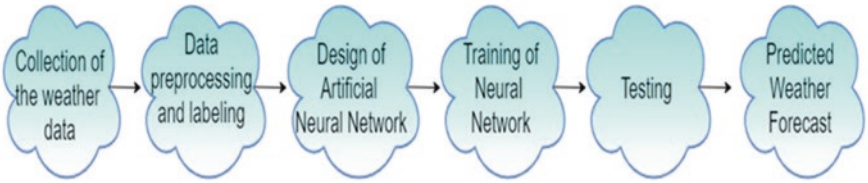

Fig. 3 Weather forecasting using artificial neural network (ANN)

productively, we can accomplish improved outcomes underway of the agricultural items. To check and deal with the development conditions, this chapter recommends the field monitoring server system (FMSS), which can work with sunlight-based force. This FMSS upgraded or improved the force utilization, the portability, and easy-to-understand condition observing techniques [24, 25]. The framework gathers ecological information legitimately acquired from condition sensors, soil sensors, and closed-circuit television (CCTV) camera. To show the area of this framework, a global positioning system (GPS) module is introduced in the framework. At last, we affirmed that the FMSS screens the field conditions by utilizing different offices and effectively works without outside backings.

In this chapter, we have used satellite images for the purpose of field monitoring. The images from the satellite are geo-referenced, and then, they are sent to the communication commission. After this, they pass through the geographic information system (GIS) processing. Then, there is a Web service for online field data collection. It basically includes crop parameters, soil parameters, climatic changes, etc. All the data collected above are being collected in real time. All these real-time data are then fed into a data integration model. Then, there is a Web service that collects the data from the sensors employed in the field. Then, it generates suitable data for a particular field, including crop type, soil type, weather conditions, etc. This method also generates an accurate price for growing a particular crop in the field, including the cost of soil, fertilizers, etc. (Fig. 4)

3 Comparative Study

3.1 Comparison Between Different Crop Management Techniques

- CALEX
- Advantage: It defines adequate scheduling rules for crop management activities.
- Disadvantage: It is time-consuming.
- Artificial neural network (ANN)
- Advantage: It predicts the yield of crop and nutritional disorder in crops.
- Disadvantage: It requires a lot of data for prediction, and it is time-consuming [26].
- Fuzzy logic
- Advantage: It detects the insects that attack the crops.
- Disadvantage: It fails to differentiate between pests and weeds.

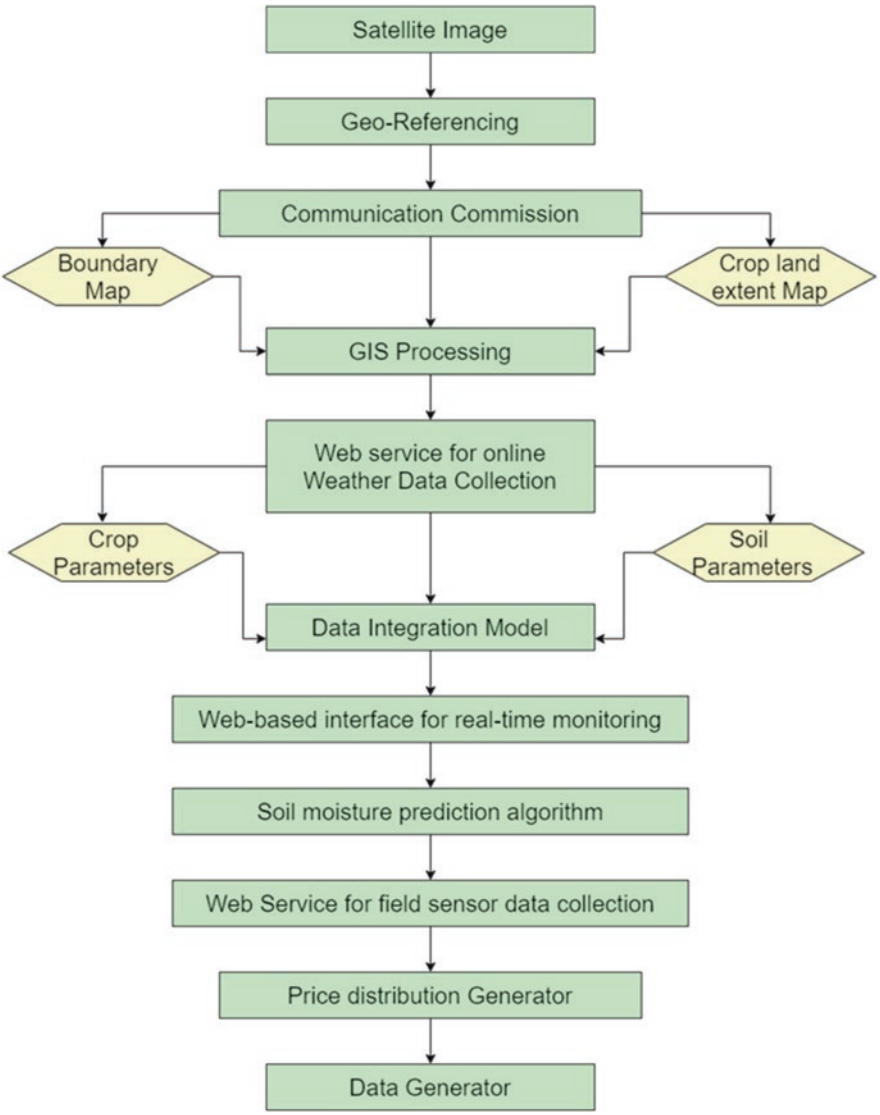

Fig. 4 Flowchart for field monitoring using the Internet of Things (IoT) and Geo-referencing

3.2 Comparison Between Different Soil Management Techniques

- Management-oriented modeling (MOM)
- Advantage: It reduces nitrate leaching, thereby increasing production.

- Disadvantage: It is time-consuming and works only with nitrogen.
- Decision support system (DSS)
- Advantage: It minimizes soil erosion to a large extent.
- Disadvantage: It requires a large amount of data.
- Artificial neural network (ANN)
- Advantage: It is cost-efficient and can predict soil moisture and soil texture.
- Disadvantage: Prediction depends on weather conditions.

3.3 Comparison Between Different Disease Management Techniques

- Computer vision system (CVS)
- Advantage: It supports multitasking and works with a high speed.
- Disadvantage: Its magnitude-based detection affects the quality of some crops.
- Web-based expert system
- Advantage: It is cost-effective and provides a high performance.
- Disadvantage: It depends upon the Internet service.
- Fuzzy logic
- Advantage: It provides more accuracy, and it is eco-friendly.
- Disadvantage: It is expensive and time-consuming.

3.4 Comparison Between Different Weed Management Techniques

- Digital image analysis (DIA)
- Advantage: It provides an accuracy rate of more than 85%.
- Disadvantage: It is time-consuming.
- Support vector machine (SVM)
- Advantage: It detects stress in the crops in a concise time.
- Disadvantage: Only low levels of nitrogen are detected.
- Learning vector quantization (LVQ)
- Advantage: It provides a high weed detection rate.
- Disadvantage: It is quite expensive.

4 Conclusion

Artificial intelligence arrangements need to turn out to be progressively suitable to guarantee that this innovation arrives at the cultivating network. On the off chance that the AI intellectual arrangements are offered on an open-source platform that would make the arrangements progressively moderate, which in the long run will bring about the quicker selection and more prominent knowledge among the farmers. AI presents massive open doors in agricultural applications. Farming arrangements that are AI-fueled empower a farmer to accomplish more with less, upgrading the quality of the crops. In this chapter, the emphasis is on more brilliant, better, and progressively productive yield, developing strategies to fulfill the country's developing food requirements. Worldwide, the population is relied upon arriving at more than eight billion by 2045, which will require an expansion in rural creation by 70% to satisfy the interest. Just about 10% of this expanded creation may originate from unused lands, and the rest ought to be satisfied by current crop production. In this specific circumstance, most recent farming techniques can bring a huge change in agricultural practices. This chapter thought about every one of these viewpoints. It featured the job of different innovations, particularly IoT, to make agriculture more brilliant and progressively effective to meet future desires. For this reason, remote sensors, unmanned aerial vehicles (UAVs), distributed computing, correspondence advancements were discussed altogether.

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