

Artificial Intelligence in Agriculture-A Review

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ABSTRACT: Though AI aids agriculture in several aspects, there seem to be worries regarding the influence of AI on agricultural jobs and personnel. This sector serves around 1.5 billion workers, roughly about 20% of the world's population, and it is a \$3 trillion business. As a result of AI's influence on the agriculture business, it is predicted that millions of fields laborer's would be unemployed in the future decades. Boring field labor can be easily automated, rendering certain occupations obsolete over time. Smart robots will be able to travel the space safely, identify and move agricultural goods, and perform simple and complex field tasks, therefore replacing people.

Keywords: Machine Learning, Agriculture, Unsupervised Learning, Artificial Intelligence

I. INTRODUCTION

Artificial Intelligence (AI) is defined as the concept and application of computer systems that can perform which often involve human intellect, such as vision, speech recognition, decision making, as well as language processing. Computer science, data mining, deep learning, image processing, and neural networks are among the topics covered. Changing climate, rising population, and food security issues have driven the agriculture industry to discover more innovative methods to preserve and enhance agricultural production. Consequently, AI is progressively becoming a part of the technical evolution of every growing industry [18].

With its fast technological advancement and wide range of applications, AI is among the most important areas of research in computer science. Agriculture is one of the most important domains where artificial intelligence is essential. Agriculture is typically a major occupation that needs a lot of hard work, resilience, and persistence even in the face of low pay and an undesirable lifestyle. Farmers strive harder to grow appropriate crops, which takes a lot of time and are therefore

forced to accept agribusiness as their primary income. Even so, low-income and often no benefit from a property due to weather conditions as well as resource scarcity, farmers are forced to face economic loss and significant drop, which eventually can lead to severe depression. The main cause of the same problem is a failure to select a suitable secondary profession, resulting in increased time consumption and energy depletion. AI in agriculture will contribute towards the solution of these critical topics by cutting process time and decreasing the amount of hard effort required [21].

India is an agrarian country and its primary resource is soil. Soil plays an imperative position in the financial system of the country, as the agriculture sector plays a lead in a large fraction of the Indian economy. Agriculture is the science with the skill of cultivating vegetation as well as livestock and soil are the most important component in the agriculture field for efficient crop yielding. Agriculture is the most significant area of the Indian economy, accounting for 18% of the nation's GDP and employing 50% of the country's youths. Agriculture generates around \$330 billion annually, according to the US Environmental Protection Agency (EPA). India is indeed the world's largest supplier of pulses, cereals, spices, and spice goods, as well as the world's second-largest supplier of vegetables and fruits. However, due to several agricultural issues, it is a substantial change from the country's conventional farming practices, which have led to low harvests and overreliance on the rainy season, keeping Indian farming at a minimal level [32].

Varying climate, rising population, and food security issues are examples of reasons that have pushed this sector to explore new ways to safeguard and improve agricultural productivity. Rising demand as well as the need for higher yields of sparse vegetation and basic food are expected towards being some of the prominent reasons encouraging the use of robotics and other software-

based projects in agriculture. Increased consumption encourages producers to expand their agricultural techniques, putting pressure on them to modernize agricultural processes. This will be opening doors for the most prominent technology AI to enter the field and assist farmers in attaining sustainable agriculture with the minimal risk factor. [17].

Artificial intelligence (AI) is progressively becoming a component of the sector's technical growth. Under Prime Minister Narendra Modi's flagship plan, Pradhan Mantri Fasal Bima Yojana, the government began utilizing AI in crop harvesting and productivity assessment on a pilot basis in February 2016. Their major goal is to reduce agricultural expenses while increasing productivity per unit area. As per the authorities, new technology can assist farmers in receiving information and suggestions that will help them increase output. "The government has conducted various pilot projects for standardized harvesting trials under the Pradhan Mantri Fasal Bima Yojana, during which AI was employed for optimizing and yield estimates," added the government [25].

In the last few seasons, several technology businesses and start-ups have arisen with focused agriculture-based methods to help the farmer, with AI being one of the most prominent uses in Indian agriculture [14]. AI can indeed diagnose a disease with 98% accuracy, AI equips farmers with the technology which prevents or works against crop pests that are mostly cereal attackers and sensors which monitor fruit's growing process with a built alerting mechanism to increase or decrease the light in relevance to the ripening process. This type of farming needs a lot of computing power. Crop production will improve significantly due to AI-powered solutions, as well as a shorter cycle time [22].

AI provides statistics on humidity, rainfall, wind velocity, and sunlight, as well as historical data for every location on the agricultural globe. Traditional farmers' occupations will not be eliminated by AI, but this will enhance their processes and give them effective ways to grow, harvest, and export essential crops. The government has set up a committee to examine the role of digital technology in modernizing and organizing how rural India conducts its agricultural activities. The right application of AI will undoubtedly result in higher yields, uniform planting, and optimal crop growth, leading to a better standard of living for farmers. AI in agriculture will assist farmers in devising a supplementary source of income, so bolstering their morale, and preventing depression and suicide [24].

1.1 AGRICULTURE'S CHALLENGES AND POSSIBILITIES

Today's food and agricultural systems are unsustainable both for humans and the environment. They have a serious environmental cost, destroy a lot of goods, and put numerous new emerging farmers in poverty or near the poverty line. Stakeholders from all regions and sectors have acknowledged the critical need for a major change in food and agriculture systems. Such a shift would provide long-term social benefits and provide greater fairness to the most marginalized. Agriculture is a high-priority sector of the Indian economy, having 58 % of all Indian households relying on this for their living, either explicitly or implicitly. The industry is at a crossroads, with several problems throughout the value chain. Although the use of digital technology can help solve some of the issues, progress in this area has been limited and has not been scaled up sufficiently [19]. The agriculture industry is confronted with the following issues:

- Small-scale farmers (86%) own less than 2 hectares, resulting in inappropriate earnings and unemployment.
- Inappropriate agricultural methods lead to soil deterioration and water scarcity.
- The lack of data at the agricultural, farmer, and industry levels, resulting in greater operational costs.
- Market connectivity gaps, price discovery issues for producers, and market price volatility.
- Increased waste caused by lack of food processing, logistical, and warehousing facilities near farm gates.
- Barriers to digital and financial inclusion
- Inadequate farm mechanization owing to financial constraints.

Technical advances such as the Internet of Things (IoT), AI, Machine Learning (ML), and many more digital innovations, which are results of the 4th industrial revolution, are influencing many sectors resulting in enhanced and sustainable growth in them. So far, agriculture has indeed been reluctant to use these technologies' benefits. Low levels of adoption of technology in agriculture are partly due to the sector's sophistication, which includes small farm sizes, an absence of communications services facilities in rural areas, high regulatory barriers that drive up costs, and earnings restricted by customers' limited ability and willingness to pay [17].

1.2 AI'S POTENTIAL IN AGRICULTURE

By 2050, the UN Food and Agriculture Organization predicts a population growth of 2 billion people. Whereas, just 4% of the remaining land will be cultivated by then. In this context, one of the most important imperatives is to adopt the most up-to-date technical solutions to make

farming more efficient. While AI has a wide range of practical applications across industries, has the potential to change the way farming has been executed in past, or can say it has the potential to transform traditional farming into smart farming. It will allow accomplishing more in less along with enhanced crop quality and reduced time frame [24].



Figure 1: Agriculture's Emerging Technologies [2]

As demonstrated in fig 1, agriculture is rapidly adopting AI in terms of off and field farming operations. Computer science is on track to be the most revolutionary technology in the agriculture sector, as it can comprehend, adapt, as well as react to a variety of scenarios to improve efficiency. Supplying several of these technologies as a service to all farmers, such as a chatbot and other intelligent systems, will enable farmers to stay up with technology breakthroughs and use these in their everyday farming to appreciate the advantages of these systems [2]. The top domains where cognitive solutions may help agriculture are listed below:

I. IOT-DRIVEN GROWTH

Every day, massive amounts of organized and unstructured data are created. These include information such as weather patterns, soil reports, rainfall, pest attack, and images from cameras and other capturing devices, among other things. All of this data may be sensed by cognitive IoT systems, which can then deliver actionable insights to increase yield. Soil testing is one well-known application of this data analytics technology. It can be done using remote sensing necessitates the integration of sensors into aerial or satellite systems or immediate sensing which requires sensors to be in direct touch with the ground or at very close range. This aids in the classification of soils depending on surface and other parameters.

Hardware solutions such as Rowbot (for corns) are already combining data gathering software with robotics to provide optimal fertilizer suggestions for corns and also suggesting measures to maximize production [2][16].

II. INSIGHT GENERATION BASED ON IMAGES

Precision Farming is one of the most debated topics of agriculture today. Farmers may use a combination of technologies, IoT, and drone data to assure quick responses. Data from drones can create a real-time system to assist precision farming. Images captured using drones can result in a deep analysis of the field, crop, and several other factors. Aerialtronics, for example, has integrated the IBM Watson IOT platform and Visual Recognition APIs into commercial drones for picture processing [19]. The following are some examples of applications using computer vision technology:

- **DISEASE DIAGNOSIS:** Image preprocessing separates the leaf pictures into sections such as contextual, healthy portion, and infected portion. After that, the infected area is clipped and sent to distant labs for further analysis. It also aids in pest detection, nutrient deficit detection, and other tasks.
- **CROP MATURITY RECOGNITION:** Under white/UV-A light, images of various crops are collected to identify how ripe the green fruits

are. Before shipping their crops to market, farmers can develop several checking factors based on product type and stack them separately.

- **FARM ADMINISTRATION:** Real-time estimations may be created during the cultivation period using high-definition photographs from aerial devices (drones or copters). This significantly aids resource optimization.

III. ANALYSIS OF THE BEST AGRONOMIC PRODUCT COMBINATION

Cognitive solutions assist farmers in selecting the best crops and seeds based on various characters such as soil condition, weather, kind of seeds, disease in that particular location, and many more. The advice may be personalized even further depending on the farm's need, areas' condition, and previous data on successful farming. Farmers may also consider external elements like as market trends, pricing, or customer wants to make an informed decision [27].

IV. CROP MONITORING

AI has the potential to bring about a fundamental shift in how farmers monitor fields, both in terms of time and effort. AI can be used to track the crop during its entire growing period from seed to the final product, along with providing real-time reports regarding the variations in health and weather conditions [20].

V. IRRIGATION AUTOMATION TECHNOLOGY AND FARMER EMPOWERMENT

Irrigation is one of the most labor-intensive operations in agriculture. Irrigation may be automated and total productivity increased using machines that are educated on past weather patterns, soil conditions, and the type of crops to be cultivated. Irrigation uses over 70% of the world's freshwater, therefore automation might help farmers better manage their water challenges [23].

1.3 APPLICATION OF AI IN AGRICULTURE

Agriculture is turning to AI to assist in producing healthier crops, manage pests, monitor soil, analyze data for farmers, reduce labor expenses and help in a variety of agriculture-related operations to achieve sustainable agriculture [16]. Some of the most important AI applications in agriculture are listed here:

I. 3-D FIELD MODELS AND SAME-DAY AERIAL MAPS

In agriculture, drone-based solutions are critical for controlling unfavorable climatic situations, yield improvements and management, and precision farming. Drones can be utilized in creating 3-D maps of the cultivable land showing detailed terrain, drainage, soil viability, and irrigation requirements before beginning the crop cycle. The drone can also be used in regulating nitrogen levels as plants receive vital supplements through aerial spraying. Aerial spraying pods can be used to provide nutrients to plants and crops.

Drones may also be automated to spray required liquids from varying heights depending upon the area's topography. Crop surveillance, as well as physical examination, is among the most important sectors in agriculture where drone-based systems may be used in conjunction with AI and analytics tools. Drones with high-resolution cameras acquire precise field photos that may be sent into a convolution neural network to detect weedy regions, crops that need water, and crop stress levels in the ingrowth stage [17].

In the case of sick plants, spatial and spectral pictures may be generated with drone technology by scanning in both RGB and near-infrared light. This allows farmers to quickly identify which crops have indeed been infected, as well as their position in a large field, and administer cures. The time-based component gives direction for the plant's full lifespan [26]. The following are some of the most well-known drone software programs:

- **DRONEDEPLOY:** Anyone can pilot a tiny drone and examine the acquired mapping photos using a computer or smartphone thanks to software developed by DroneDeploy, a San Francisco-based business. Agriculture, construction, inspection, and insurance are some of the areas that the organization concentrates on. Users may send practically any commercially available drone on an automated course for same-day aerial maps and 3-D field models with only one click. They may use the technology to detect where their crops need attention, predict yields, and record correct data for future comparisons. [1]
- **SENSEFLY'S EBEE:** The SenseFlyBee drone is a small drone that is meant to eliminate human mistakes in crop surveying. Farmers can examine more acres faster with the fixed-wing UAV, which also captures near-infrared band data for vegetation assessments. It's also almost fully self-contained. If you throw it into the air, it will soar, gather photos,

and then land on its own. On the same day, as it flies, it can swiftly build crop maps, detect problem regions, tailor agricultural application maps, and develop drone-to-tractor work processes for crop treatments [12].

II. PRECISION AGRICULTURE

Precision farming is summed up by the expression "Right Place, Right Time, Right Product." This is a more precise and regulated process that takes the place of the labor-intensive and repetitive aspects of farming. Crop rotation, optimal planting and harvesting times, water management, fertilizer management, insect assaults, and other topics are covered. These new technologies, which include GPS services, sensors, and big data calculations, will make farming much easier. As a result, they can make decisions based on extensive information regarding water, climate change, soil quality, crop and animal health, and mechanical maintenance [22].

Precision farming is a means of managing farms and resource management via the use of the Internet of Things and Information and Communication Technologies (IoT and ICT). It collects real-time data on the stage of agricultural elements to safeguard the environment while assuring profitability and long-term viability. Smart farming is a technique for improving the efficiency of irrigation systems and decreasing water losses [16][27].

Drones are used in a variety of agricultural applications, such as monitoring field crops and animals, as well as scanning broad regions, while sensors on the ground capture a wealth of data [19].

- THE FOLLOWING ARE SOME OF THE KEY TECHNOLOGIES THAT ENABLE PRECISION FARMING:
 - System for high-precision positioning
 - Automated steering system
 - Geospatial mapping
 - Remote sensing and sensor technology
 - Electronic communication that is integrated
 - Technology with a variable rate
- PRECISION FARMING OBJECTIVES:
 - Profitability is determined through carefully identifying crops and markets, as well as projecting ROI based on cost and margin.
 - Efficiency: Investing in precise algorithms allows for better, faster, and less expensive agricultural options. This ensures overall accuracy and resource efficiency.
 - Improved social, environmental, and economic performance guarantees that all performance measures improve incrementally each season.

- HERE ARE SOME EXAMPLES OF PRECISION AGRICULTURE MANAGEMENT:

- High-resolution photos and numerous sensor data on plants are used to determine a plant's stress level. To allow data fusion and feature identification for stress recognition, this enormous quantity of data from numerous sources must be used as an input for Machine Learning.
- Plant stress levels may be detected using machine learning models trained on plant pictures. To make better judgments, the complete technique may be divided into four stages: identification, categorization, quantification, and prediction.

III. IRRIGATION AND WATER CONSERVATION

It's vital to have real-time systems that can monitor soil moisture and water availability, and so control water expenses. Precision farming may reduce waste while also producing valued crops, enhanced production, and a competitive edge [21].

IV. MAINTAINING LIVESTOCK RECORDS

Farmers can follow their herds using their phones or laptops thanks to collars on grazing animals and cameras in the fields. Livestock tags may transmit information on everything from the animals' health to their breeding habits [27].

V. SENSORS ON CROPS AND FARM MACHINES

Sensors may be connected to agricultural gear such as combine harvesters, tractors, and other devices, allowing farmers to collect fresh data on their crops and soil. Precision agriculture makes farms more innovative and connected thanks to sensing technologies. This is only one method for improving the quality and quantity of agricultural output. The data generated by sensors benefits not only the farmers but also the agriculture industry as a whole [19].

VI. INSECTICIDES THAT ARE SAFE FOR THE ENVIRONMENT

The food and agriculture businesses are working hard to discover a more efficient and cost-effective alternative to chemical pesticides. Natural pheromones, which are compounds generated by animals and alter the natural behavior of other animals of the same species, are currently being employed to disrupt the mating habits of fruit-eating pests [16].

VII. THE FUTURE OF AG BOTS AND THE CONNECTED TRACTOR

Telemetric software on board that tracks the hours of usage and maintenance requirements of farm machinery also aids in increasing productivity. Once the data is collected, it can be used to predict cropping patterns in a specific site and helps in planning other farm inputs such as nutrients, fertilizers, and equipment according to the soil and crop needs [19].

VIII. YIELD MANAGEMENT

New generation technologies such as AI, machine learning, satellite imagery, and data analytics are forming a smart agricultural environment. Farmers can attain greater average yields and better pricing management because of the combination of all of these technologies. Microsoft is now collaborating with Andhra Pradesh farmers to deliver advisory services using the Cortana Intelligence Suite, which includes Machine Learning and Power BI [22].

The Pilot projects resulted in around a 30% increase in average crop output per hectare by employing AI-based sowing software to advise farmers regarding sowing dates and depth, field preparation, soil test-based fertilization, farmyard manure application, seed treatment, and many more. Technology can be utilized to determine the most preferable sowing season based on existing climatic data to improve predictability. [14].

Microsoft is developing a Pest Risk Prediction API in conjunction with United Phosphorus Limited to identify possible pest assaults. They will use AI and machine learning to predict the risk of pest attacks in advance. Pest attacks will be classified as high, medium, or low depending on the weather and crop growth stage [16].

II. AGRICULTURE AI STARTUPS

The introduction of AI in the agricultural field has made huge remunerations in the research field using analysis techniques. The AI techniques play an important role in any field of science in establishing the fundamental variations by finding the eminent relationship present among the objects and concepts. It furthermore provides necessary information in the course of which research can be processed by following an orderly approach. Many technology businesses and start-ups have developed in recent years with focused agri-based solutions that assist farmers, with the most prevalent AI applications in agriculture including:

I. PROSPERA

This Israeli firm, which was formed in 2014, has changed the way people farm. It has created a cloud-based system that combines all of a farmer's existing data, such as sensor recorded data and drone images. The data is then combined with the on-the-ground gadget that decodes everything and develops predictions and establishes a link between different data labels [28].

II. BLUE RIVER TECHNOLOGY

Blue River Technology is a California-based firm that uses AI, and robotics to create efficient farm equipment which will use fewer chemicals and are economically feasible. In this the computer vision studies unique plant, machine learning will determine the treatment for it, and robotics will instruct the robots accordingly [29].

III. FARMBOT

This firm, which was created in 2011, boosted up precision farming by allowing environmentally aware farmers to cultivate crops on their land using precision farming technologies. FarmBot is a \$4000 device that allows the owner to perform whole end-to-end farming on his own [30].

IV. aWHERE

aWhere (Satellites for Crop Sustainability and Weather Prediction), a Colorado-based firm, combines machine learning and satellites to forecast weather, analyze crop sustainability, and analyze farms to safeguard them from pests and diseases [4].

V. FARMSHOTS

Crop Health and Sustainability are Monitored by Satellites Farm Shots, based in Raleigh, North Carolina, is another firm that analyses agricultural data generated from satellite and drone photographs. The startup wants to "identify illnesses, pests, and inadequate plant nutrition on farms," in particular [7].

VI. PEAT

To a large extent, agriculture is dependent relatively on soil quality, but the recent boost in agricultural production is somewhere resulting in the loss of soil quality. Berlin-based agri-tech start-up named PEAT, designed a deep learning application named Plantix, claiming to detect possible threats and deficit nutrients in the soil. In this image recognition software, certain algorithms are used to associate or correlate leaf patterns with specific soil deficiencies, pests, and diseases [9].

VII. TRACE GENOMICS

Machine Learning for Soil Defect Diagnosis Trace Genomics, situated in California, provides soil analysis services to farmers, similar to the Plantix app. The technology was developed with the support of lead investor Illumina to provide knowledge about the soil's strengths and weaknesses using machine learning algorithms. It results in preventing faulty crops and maximizing the potential for healthy agricultural output are the main goals [15].

VIII. PLANTIX

A machine-based instrument that aids in the detection of crop disease, the growing of valuable crops, and agricultural management [9].

IX. CROP IN

Using AI to increase per-acre value all of the available farms were geotagged to discover the optimal plot area using CropIn's smart farm solution. CropIn essentially employs artificial intelligence (AI) to assist clients in analyzing and interpreting data to extract real-time details of the standing crops and farm projects [31].

X. SKY SQUIRREL TECHNOLOGIES

It is one of the technologies that vineyards must implement to increase crop output and lower expenses. SkySquirrel integrates and analyses the captured photographs and data to develop a full-fledged report of the grapevine leaves because the "health" of leaves is a good factor to study to receive insight into the plant's overall health.[13].

XI. SEE AND SPRAY

Weed management is a major concern for farmers, and it will get more difficult as herbicide resistance spreads. Automation and robots can assist farmers in developing more effective and precise methods of protecting their crops from abiotic stressors, particularly weed. It accurately monitors herbicide spraying on weeds and sick crops, assisting in weed management and crop protection [11].

XII. HARVEST CROO ROBOTICS

To assist the strawberry farmers, Harvest CROO Robotics has designed a robot for picking and packing the strawberry farm produce. According to the reports, California and Arizona have faced millions of dollars lost due to lack of labor. The Harvest CROO robotics claim that its robot can harvest 8 acres in a day, which roughly means that one robot can replace 30 human employees[6].

XIII. AI AND ROBOTS FROM PICKING FRUITS TO HARVESTING PLANTS

Various industrialized nations throughout the globe have created machines or robots that can operate with the same precision and care as a human, assisting in the picking of apples, tomatoes, and other crops, and boosting harvest by 3-4 percent. It also analyses sudden death syndrome for soy fungal disease and asks for the observation's location and intensity [14].

2.1 AI ADVANCEMENT IN AGRICULTURE IN INDIA

Agriculture may be the oldest profession, but with the prospect of food insecurity looming, its importance has only grown. Artificial intelligence-powered technology is assuring the long-term viability of high-quality agricultural production. Artificial intelligence is being used to detect pests, anticipate the optimal time to plant and estimate crop pricing. Drones, hydroponics, artificial lighting, and AI-powered cameras are all being used to keep wild animals away from crops. In India, the following are the major AI agricultural schemes [5]:

I. KISAN SUVIDHA MOBILE APPLICATION

Under the Kisan Suvidha mobile application, the market knowledge is used to inform farmers about the markets to sell their produces, current market selling price (MSP), and amount. As a result, they can make well-informed decisions about when and how to sell the product. The essential criteria covered weather, market prices, plant protection, machinery, weather warnings, soil health card, and many more [3].

II. FARM MACHINERY PACKAGE

This package provides information on farm machinery applications accessible state-by-state, agro-climatic zone-by-agro-climatic-zone, district-by-district, cropping pattern-by-cropping pattern, and power source-by-power source [3].

III. MYCIPHER

This smartphone application was created to assist farmers in obtaining correct information about post-harvest technologies, goods, and machinery [3].

IV. ICAR, STATE AGRICULTURE UNIVERSITIES, AND KRISHI VIGYAN KENDRAS

They on whole have developed more than 100 mobile applications in various fields to provide

farmers with valuable information which will result in providing better crop management and pre-plan the required irrigation activities [8].

V. mKISAN PORTAL

Developed to provide SMS alerts to enrolled farmers about various crop-related issues [3].

VI. THEE-NATIONAL AGRICULTURE MARKET PLAN

It will offer farmers an electronic internet trading platform, will be launched [3].

VII. SOIL HEALTH CARD SCHEME

This scheme was created to help the state governments in providing soil health cards to all the farmers once every two years. Soil health cards offer farmers information on the nutritional condition of their soil as well as advice for the proper application of fertilizers to improve crop yield and soil fertility [10].

Some of the well-known companies that assist in the advancement of agriculture in India are discussed below:

I. INTELLO LABS

The business claims on its website, that by clicking on an image, the system will provide information regarding crop health in the growing phase and estimation about the harvest, and this will aid small farmers in gaining a scientific understanding of the crop and its life cycle [14].

- **IT AIDS IN THE CLASSIFICATION OF AGRICULTURAL PRODUCTS:** It is an accurate approach for the categorization of fresh items (fruits, grains, veggies, etc.) defined by color, size, and form since it is an automated quality analysis of photographs of food products. Without any manual involvement, its system recognizes an image shot on a farmer's phone and recommends product quality in real-time.
- **CROP INFESTATION WARNINGS:** Farmers can comprehend the challenges and utilize their solution to identify pests, illnesses, and weeds in their fields by clicking on an image of a crop. Agricultural illnesses and pest attacks can be identified using deep learning and image processing algorithms. This also includes advice for how the condition can be healed or treated, as well as how it can be avoided from spreading further.

II. MICROSOFT INDIA

Microsoft created an AI Sowing App in conjunction with ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), which makes use of the Microsoft Cortana Intelligence Suite's machine learning as well as business intelligence. This software provides advice to farmers regarding the best time to seed. It has the advantage of lowering capital investment by removing the need for a sensor in the farmer's field. They merely require a function that allows the phone to receive text messages.

Another application is known as, the Pest Danger Prediction App was developed by Microsoft in partnership with United Phosphorous (UPL), the Country's largest manufacturer of agrochemicals. This application uses AI and machine learning to predict the pest attack in advance. Nowadays, Andhra Pradesh and Karnataka farmers wait for a text message before planting their seeds, thanks to artificial intelligence [16].

III. GOBASCO

Gobasco, is a firm based in Uttar Pradesh that boosts the agriculture supply chain with intelligence with high-tech staff [16]. This firm is beneficial to farmers since it performs the following tasks:

- **QUALITY CONTROL:** For automatically grading vegetables and fruits, AI is used worldwide. The automatic grading tech will help in trustworthy trading across the borders.
- **CREDIT RISK MANAGEMENT:** The most problematic thing in today's supply chain is credit risk management. With the use of AI and data analytics this problem is addressed and resulted in a very low-risk operation. The Agri-Mapping: A real-time Agri map of commodities with a resolution of 1 sq-km is designed using deep learning. It is based on satellite image data analysis and crowd-sourced information fusion.

IV. GRAMOPHONE

Madhya Pradesh-based firm known as Gramophone, promises to use image recognition and soil sciences to assist farmers with timely information, technology and to cover most of the aspects which will result in achieving higher yield.[16].

2.2 AGRICULTURE'S AI ADOPTION CHALLENGES

Though AI aids agriculture in several aspects, there seem to be worried regarding the

influence of AI on agricultural jobs and personnel. This sector serves around 1.5 billion workers, roughly about 20% of the world's population, and it is a \$3 trillion business. As a result of AI's influence on the agriculture business, it is predicted that millions of field laborers would be unemployed in the future decades. Boring field labor can be easily automated, rendering certain occupations obsolete over time. Smart robots will be able to travel space safely, identify and move agricultural goods, and perform simple and complex field tasks, therefore replacing people.[26].

Further, technology like drones is very expensive and is inaccessible to individuals other than government, research centers, and private institutions. The fact that AI offers a wide variety of applications in agriculture, the majority of farmers throughout the world are unskilled to use high-tech AI solutions. Since farming is very vulnerable to environmental factors such as weather, soil conditions, and insect presence, as a result, it is very difficult to say that the automated software's are 100% reliable, because what looks to be a reasonable response at the beginning of harvesting may not be the best selection because to changes in external parameters [21].

AI applications involve the usage of a huge volume of data in the training phase robots, resulting in accurate predictions. Though geographical data is easily obtained in the event of a largely agricultural region, temporal data is more difficult to obtain. Most crop-specific data, for example, can only be collected yearly, and it is well known that it takes time and a good amount of data to design the AI model with precise prediction and a good accuracy rate. This might be a reason for the absence of Ai in in-field precision solutions, as there is a lack of data or inconsistent data isavailable [20].

III. SUMMARY

AI is assisting farmers in automating the farm techniques as well as is also helping them to shift towards precision farming to preserve the resources and increase crop production and quality. It can be stated that AI can be used to attain the sustainable agriculture goal. Several companies are working on developing AI or machine learning-based models, software, applications, and robots to improve the production amount and quality and to save the environment side by side. Keeping in mind the growing population, this is the most important aspect to work on. Another critical factor is the high expense of various cognitive solutions for farming that are accessible on the market. To

ensure that technology reaches the people, solutions must become more inexpensive. An open-source platform will lower the cost of the solutions, resulting in faster adoption and increased penetration among farmers.

The use of cognitive solutions is critical to the future of farming. Although a lot of research on the agricultural sector is going on and there are several applications on board, but the sector is still severely underserved. Farming is still in its infancy when it comes to dealing with practical difficulties it encounters and applying tech solutions to deal with them. The applications that are being designed should be more resilient so that they can cover the gap between smart and traditional farming mindsets. The applications should be able to deal with frequent changes in external conditions while growing crops, it should support real-time decision making depending on those conditions and there should be a suitable platform or framework to gather contextual data, as data is key for AI to sustain.

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