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Application of Artificial Intelligence and IOT for Increasing Productivity of Agricultural Sector

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Abstract: Agriculture is the major sector that feeds the ever-growing population in the world. As the population is increasing day by day globally increased food demand will be faced. Thus, agricultural productivity should be increased in a robust way. In the environment, the next green evolution has the approaches related to health of the plants, productivity and growth. By understanding the mechanism of agricultural productivity by the farmers requires automation in every stage of farming. The sustainability and productivity in forms can be expanded through technologies. Emerging strategies for improving the activity and survival of the crops can be enhanced from the seedling stage till harvesting. Through Internet of Things and artificial intelligence productivity in agriculture can increased by automated process in crop production for assessment of seed and crop qualities, diagnosing the diseases, automated irrigation system, alarm system for pesticide and fertiliser application, analysing soil fertility and erosion and applying precision farming using robotic and drone systems. By maintaining the crops at the right time major losses of crops can be reduced as well as the reduction of cost. The scope of the study for analysing the application of IOT and artificial intelligence through the proposed crop maintenance model for increasing productivity in agriculture sector.

Keywords: Artificial intelligence, agriculture, Internet of Things Productivity

1. INTRODUCTION

Farming is considered as the major source of food as well as wealth in most of the world nation and regarded as the source for existence of humans. Agriculture production is essential to nation's economy since it gives its citizens access to food, raw resources, work opportunities, etc. Recent observations show the production of crops in agriculture field which is not significantly changed. Food prices are also rapidly rising as a result of the crop's insufficient output compared to consumer demand. Farmers' usage of cultivation by the conventional methods results in less yield of crops is one of the factors contributing to the decline in crop production. The features of soil for crop cultivation are not sufficiently understood by new farmers in the agricultural industry. They are unaware that agricultural land must be evaluated before cultivation (Ahmed & Hussain., 2018).

The amount of total yield produced as the result of agricultural practices after cultivation is known as agricultural productivity. Reflection in advanced efficiency in production and farming technologies is known as long-term productivity. Farm productivity improvement helps farmers produce more output with fewer inputs, which boosts profitability and competitiveness. The world's population is expanding at the same time that urbanization is continuing. The patterns of consumption include disposable income and shifting which gradually increases, farmers require new strategies for boosting up the output through the more pressure that satisfies the rising demand. In the upcoming years, more population should be fed through farming procedures and food production. Additionally, less supply of food in in the soil through standard farming methods which needs to be changed. We must seek methods to lessen or at the very least control the dangers faced by farmers. One of the most interesting possibilities is the global application of artificial intelligence in agriculture. The ability for transforming the agricultural practices

through AI with the number of advantages that allows the farmers for producing more yield with less pressure and work. However, steps into the next face of transition from the conventional farming to creative farming. AI and IOT can support already used technology.

Tremendous applet obligation boosters the output of food grain and productivity in the agricultural industry for the effective changes in climate and the expanding population. Automation in agriculture is the sole choice which is urgently required in the majority of nations where expanding crop land is simply impossible. All industries, including agriculture, have already begun to profit from the AI and IOT. Through development of intelligent system which can manage, visualise and monitor numerous agricultural strategies in the real time operation and intelligent system compared to that of the human workers with the advancement in digital technologies have brought the revolutionary advances in the sector of agriculture. Smart agricultural equipment, crop health monitor, plant protecting drones, structures of storage, culture of greenhouse, application of fertilizers pest and weed control smart irrigation system development are the potential applications of IOT and AI (Subeesh & Mehta., 2021).

Along with other cutting-edge computing technologies, artificial intelligence and Internet of Things is used in agriculture in recent years. However, the application of such smart technologies is now receiving more focus. For thousands of years agriculture is the significant source for producing food for the people that includes the practical techniques practised in agriculture in different types of crops. New cutting-edge IOT technologies are starting to develop, and they have the ability for monitoring the agriculture environment by ensuring high-quality output. Fragmentation in the process of agriculture includes operation and control of devices using AI and IOT, management and data sharing, interoperability of storage and data analysis continue to pose difficult challenges to the advancement of Smart Sustainable Agriculture (SSA). In order to identify IOT/AI technical architecture that can support the creation of SSA platforms, this study first examines existing IOT/AI technologies used for SSA. This study analyses SSA research and development, adds to the body of knowledge, and offers an IOT/AI architecture to create a platform for smart, sustainable agriculture as a solution (Alreshidi., 2019).

1.1 RESEARCH OBJECTIVES

- The novelty of the research is the development of crop maintenance system for increasing productivity in the agriculture sector using artificial intelligence and Internet of Things.
- Artificial Intelligence technologies are applied in the agriculture sector
- Recent advancement of IOT devices and approaches to increase productivity.

2. LITERATURE REVIEW

Raj et al., (2021) Agriculture is the study, practice, and art of raising plants. Agriculture has a long history dating back thousands of years. Depending on the climate and topography, it started independently in different places of the planet. Compared to things that could be sustained by hunting and gathering, the human population might increase by a factor act as a boon to agriculture. Precision farming has enhanced production in modern agriculture during the twentieth century. Precision farming is a technologically supported method of farming that assesses, monitors, and evaluates the requirements of specific fields and crops. The primary objective of the style of farming as opposed to traditional farming is the exact use of inputs to raise crop yields and profitability. The progress and function of Internet of Things and artificial intelligence in the precision farming are described in detail in the paper. The modern application in day-to-day life heavily relies on AI and IOT. Modern agriculture uses AI and IOT to its advantage and benefit.

Jha et al., (2019) the primary issue as well as the developing topic is automation in agriculture in every nation. The necessity of food in the rising population of the world which is rapidly growing in the extreme rate. Farmers should apply the toxic fertilizers and pesticides most frequently in the tradition methods to meet the growing demand for food as it is insufficient for the growing population. The damage are occurred in the soil through the harmful fertilizers and pesticides and has much impact on the agricultural practices as the result land remind to be desolate and unproductive. Different types of automation techniques are discussed in the study which include deep learning come artificial intelligence, machine learning, wireless communications and IOT. Control of weeds, use of pesticides, management of poor storage common crop diseases, inadequate irrigation as well as poor water management is just a few of the issues affecting the agriculture industry. All of these issues can be resolved using the many approaches stated above. Interpreting concerns including the use of dangerous pesticides, controlled irrigation, pollution management, and environmental consequences on agricultural practice are urgently needed nowadays. Automation of agricultural processes has increased soil profit and improved soil fertility, according to research.

Dharmaraj & Vijayanand., (2018) In 2050, there will be an additional 2 billion people on the planet, but there will only be 4% more land that is being farmed. In such a situation, more effective agricultural practices can be achieved using recent technical developments and fixes for the industry's current bottlenecks. Using machine intelligence or artificial intelligence in the field of agriculture may represent the shift of paradigm in forming way can be carried out successfully. A farmer may accomplish more with fewer resources according to AI-powered farming solutions, which also improve quality and ensure speedy go-to-market strategies for produced crops. The study offers a perspective of the

way AI might fuel various agricultural sectors. Additionally, it looks into future AI-powered concepts and upcoming difficulties.

Goel et al., (2021) The three main pillars of smart agriculture are research, space and innovation technologies. These pillars are regarded as national building for feeding the population. Space technology is essential for enhancing soil quality, cutting irrigation water waste and providing farmers with agricultural knowledge. A significant amount of geospatial data through the gathered source are analysed as well as useful for crop production and smart farming with satellites, aerial sensors, tools for surveillance, aquatic and terrestrial equipment. The force in technology introduced the innovative technology like using unmanned vehicles in agriculture, gene processing in the plants, big data, epigenetic and IOT for utilising it effectively through different types of energy that include solar energy and smart wind energy, robotics using artificial intelligence, desalination technology in mega scale. In industrialised countries several of these ideas are already in use. The adoption of smart farming in the small areas benefit the agriculture industry because agriculture is crucial to a developing economy.

Misra et al., (2020) the enormous amount of streaming data is generated by Internet of Things is also known as big data that creates potential for agriculture processes and monitoring the food. The food business starts from the social media also initiated from big data with addition to the sensors. The big data, artificial intelligence and Internet of Things technologies are discussed in the review that has greater impact in the Agri food industry in the future. After providing an overview of AI big data and IOT it discusses about the use of big data analysis and IOT in agriculture that includes digital traceability using blockchain, gene sequencing for food safety, sensor fusion and spectral methods for assessment of food quality, sentiment analysis and open innovation for food industries in social media, modernization in the supply chain, crop imaging with the help of drones, smart equipment for farming and greenhouse monitoring. The viability in the commercial state as the application and the result of research with particular attention.

Vincent et al., (2019) reported that Food and Agriculture organization the world population increases by 2050 around 2 billion more people as it is predicted as 5% of the total land. Increase in the agricultural productivity should be effective and Clover way of farming methods record the key instruments in agricultural growth assessment in land suitability of agricultural field. Internet of Things is considered as the viable tool for decision making and automation in agricultural field that has been sparkled construction of compact sensor devices and low-cost devices. For analysing the suitability in the agriculture land research study presenting the expert system for combining the sensor networks with the AI system like the multilayer perceptron and neural networks. The four decision classes in the system are unsuitable, moderately suitable, suitable and more suitable that assist the farmer in classifying the cultivation land for agriculture. The study evaluation is concluded with gathering of data from the number of sensor devices which is utilised for training the system. The proposed model is compared with the existing models through utilization of MLP and hidden layers and the actual output is produced. It is considered as effective classification system were the trained model includes the assessment of subsequent evaluations through categorization of different types of crops.

3. METHODOLOGY

The methodology introduces and analyses the research on IOT, smart sensors and Artificial intelligence used in agricultural applications for increased productivity. Precision agriculture makes use of managed and processed data from big data and remote sensing. Demonstration of technologies in the precision agriculture through remote sensing data can improve the management of crops, farmland agriculture is applied and crop classification is achieved. However, the work focuses on implementations that occur in close to real-time, and it can be expanded for use in precision agriculture that occurs in real-time. The use of modern applications in post harvesting and sensors for management of farm is further examined and described. The sensors are utilized technology of infrared thermography for collecting the data are used in sensing of data. The performance of digital and precision agriculture can be further enhanced by using diverse and robustness range in the IOT sensors and AI application in agriculture. IOT smart soil moisture sensor technologies and unmanned vehicle act as the tool for smart agriculture and precision farming however the substrate in the soil, lack of production and the long-term stability are the major difficulties addressed in farming procedures. Applications for surveillance and security employ deep learning to analyse multimodal data. Using sensors, IOT, ZigBee, and Arduino effectively, rural agriculture is explained. Over the purpose of advising farmers on the crop suitability according to the type and related issues with environmental characteristics that includes soil quality, temperature, content of moisture seedling quality, irrigation timing is estimated. Automated robots and drones can cover large areas of agricultural land using AI and IOT. Utilizing temperature, humidity, smart farming and moisture sensors based on sensors and the Internet of Things is described. IOT is used to understand the sensory data, enabling better planned and monitored agricultural production.

3.1 APPLICATION OF AI IN AGRICULTURE

- AI helps in efficiently selecting the crops and assist the farmers for determining the most profitable products for farming.

- Predictive analytics and forecasting can be used by the farmers to reduce the risk of crop failure and operational errors.
- AI helps in crop production according to the disease resistant and weather resistant type through collection of data from various sources regarding plant growth.
- AI assist in studying the chemical substances in the soil and to provide the precise estimate of nutrients present and missing in the soil.
- AI always monitors the health of the plants for detecting and predicting the type of disease by spotting out the condition and helps in getting rid of pest and weeds through effective measures for pest control.
- AI helps determine the best irrigation schedules, times to apply nutrients, and agronomic product combinations.
- AI can be used to automate harvesting and even predict when it will be most effective.

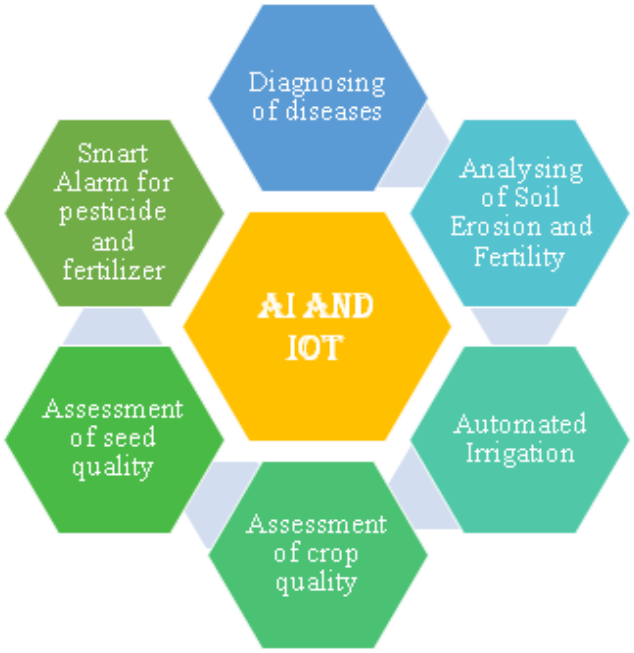


Figure 3.1 Application of AI and IOT for increasing productivity

Enormous amount of organised and unstructured data is generated in every day. The application fact includes captured camera images with the help of drones, susceptibility of insect attacks, novel researches, soil reports and weather information. Cognitive IOT technologies that recognise, produce and sends the solutions using smart devices for increasing the yield of crops.

In intelligent data fusion remote sensing and proximity are there two major technologies used. Testing the soil is a significant application of this high-resolution data. Contrary to distant sensing, proximity sensing just crackers the intelligent sensors using IOT and AI to have close contact with soil. Farmers do not require sensor for integrating satellite or aerial system. This makes it easier to characterize the soil in a specific area based on the dirt below the surface. In order to create the optimal fertilizer for corn cultivation and maximize crop production, hardware solution like robot for concerning the crops that started combining data-collection software with robotics.

3.2 MONITORING CROP HEALTH

To build matrix of crops in the arable land of 1000 acres using remote sensing techniques, 3D laser scanning and hyperspectral photography are essential for monitoring the crop health. From a time and effort standpoint, the potential in agriculture in bringing about the revolutionary changes in the farmer monitors in the agricultural lands. Additionally, the technology helps in tracking the crops throughout the entire existence till harvesting that include the creation of reports in the event of anomalies.

3.3 AUTOMATED IRRIGATION SYSTEM

The most labour-intensive farming practices are irrigation. Devices trained using artificial intelligence has enough knowledge about soil quality, weather patterns, crop type to be cultivated with automated irrigation system and boost overall productivity. Irrigation uses world freshwater of about 70 percentage; automation can help farmers manage their water problems while also saving water.

3.4 DECISION-MAKING USING AI

Real game-changers can be found in predictive analytics. With AI, forming can be processed with increased data. Farmers can use artificial intelligence for addressing major type of issues that includes choosing of the best window for harvesting and planting, predictions for pricing, demand analysis in the market. AI can also monitor the weather, track the readiness of crops, make fertilizer suggestions, and acquire insights into the condition of the land. All of that enables farmers to choose wisely during the entire process of crop cultivation.

3.5 OVERCOMING LABOUR SHORTAGES

Agricultural work is demanding, and there have always been labour shortages in the agricultural sector. The issue in farming is resolved by the farmers using automated equipment. Farmers can able to do the work not adding additional employees with the use of driverless tractor, fertilizer system and intelligent irrigation, smart spraying, harvesting robots based on AI and vertical farming software. Machines driven by AI are tougher, faster and precise than the farm workers.

3.6 UNMANNED AERIAL VEHICLES

Unmanned aerial vehicles provide a less stressful atmosphere, improve decision-making, present a safer environment, and allow pilots to fly for longer periods as long as the vehicle permits it (human weariness is not present in the aircraft). In the long run, Unmanned Aircraft may fly itself for up to 30 hours while completing repeated duties, such as making the precise, repetitive scanning day

by day, every night for fog and darkness detection and the control over computer. Unmanned aircraft for geological survey with thermal and digital imaging of agricultural area, radio, television and cell phone and television coverage measurements in the terrain and operators and drone pilots easily switched off without interruption to operations. Drones are operated at wider distances with pinpoint accuracy.

Agriculturists and farmers search for high-impact solutions and low cost for the periodical check-up of the crops. Infrared sensors in the drones are configured for assessment of crop health, and opportunities are provided for the farmers in responding and improving the agricultural conditions with addition of fertilizers and insecticides. Moreover, the crop management system enhances the increased agricultural productivity. Drones will make up over 80% of the agriculture business in the coming years. Inspection of pipelines and power, drones can inspect a variety of systems, including electrical lines, wind turbines, and pipelines.

4. RESULTS AND DISCUSSION

IOT connects sensor devices to carry out a variety of fundamental functions, making it one of the fundamental cornerstones of smart systems. Devices for assessment of climatic condition, effectiveness of irrigation and measurement of water level are the part of a smart irrigation system. Sensors, smart controls and the mathematical relationship between the automated system act as the foundation. Furthermore, the robots and unmanned aerial vehicles included in the crop maintenance system for performing various types of tasks in the real-time using wireless communications, artificial intelligence, Internet of Things, machine learning on deep learning technologies that include pesticide spraying, applications regarding livestock, irrigation, detection of weeds, seedling and harvesting. This work highlights the significance of employing crop maintenance system for the maintenance of crops. Despite the difficulties faced by smart agricultural applications in developing nations, various methods were emphasized in this work. Additionally, the use of smart decision support systems in emerging nations facilitates real-time analysis, soil characterization mapping, and also aids in good decision-making.

Precision forming is the most controlled and precise kind of agricultural practice that offers advice on different types of farming procedures like crop rotation which replaces the labour-intensive aspect of farming. The positioning system with high precision management of plant and soil nutrients, management of water resources, estimating time of harvesting, optimal planting procedures, the technology of variable rate, integrated electronic communication, remote sensing technology, geological mapping system and monitoring pest and rodent attacks are among the notable key technologies that enable precision farming.

4.1 PROFITABILITY

Recognize crops, plan your marketing, and forecast the return on investment based upon the gross profit and the cost.

4.2 EFFICIENCY

It is possible to take advantage of enhanced, quick, and affordable agricultural options by implementing a precision algorithm. This enables efficient resource use overall.

4.3 SUSTAINABILITY

Improved socioeconomic and environmental performance guarantees seasonal improvements for all performance parameters.

4.4 EXAMPLES OF MANAGING PRECISION AGRICULTURE

AI-assisted detection of various stress levels in a plant using high-resolution photos and data from numerous sensors. It is necessary to use the whole set of data collected from various sources as machine learning input. This makes it possible to combine these data with feature identification factors to recognize plant stress.

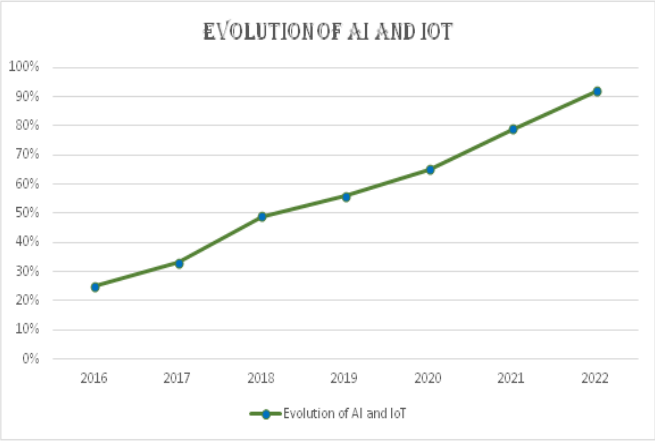
The various levels of stress in plants can be identified by machine learning models using AI that have been trend using different types of plant images. To make better and better decisions, these entire approaches are divided into consecutive stages that include forecasting, quantification, categorization and recognition.

4.5 AI-BASED MANAGEMENT OF CROP YIELD

Artificial intelligence, machine learning, sophisticated analytics and satellite images are emerging as cutting-edge technologies that are creating an ecosystem for smart, effective, and sustainable farming. Farmers are now able to increase the average yield/hectare as well as have more control overpricing of food grains which ensures to continue to make a profit.

S. No	AI and IOT in Agriculture	New techniques emerged in Agricultural Sector using AI and IOT
1	Monitoring of ubiquitous Sensor network and edge control on IOT (Ferrandez-Pastor et al., 2016)	Development of Precision Agriculture
2	Internet of Things for Smart Agriculture (Ray., 2017)	Devices and wireless communication associated with farming and agricultural application
3	Remote sensing, Big	Agriculture data captured

	Data in Precision Agriculture (Huang et al., 2018)	through IOT and remote sensing with the concept of Big Data in Precision agriculture
4	Smart farming with IOT for monitoring the farming conditions (Doshi et al., 2019)	Optimal farming conditions like humidity. Temperature and soil moisture are monitored using IOT
5	Artificial Cognition in smart agriculture (Pathan et al., 2020)	Disease detection, crop phenotyping, precision farming
6	Artificial Intelligence implementation (Talaviya et al., 2020)	Automated application of Herbicide and Pesticide
7	Agricultural drone (Dutta & Mishra., 2021)	Novel drone with 3D Mapping addressing the issues in agriculture
8	AI based agriculture (Vijayakumar & Balakrishnan., 2021)	Automated monitoring system using WSN
9	Artificial Intelligence and Food Security (Spanaki et al., 2022)	Swarm Intelligence technique in drones for Smart Agri operations
10	Unmanned airboat technology (Liu et al., 2022)	Environmental monitoring and agricultural production tasks
11	Artificial Intelligence Robotics (Mumtaz & Nazar., 2022)	Harvesting crops and Spraying herbicides
12	AI implementation in Agriculture (Sharma et al., 2022)	Automation in spraying, weeding, irrigation



It has been discussed to practice automated farming obtaining data on the effective management of crops. It has been discovered that recent developments for management of data in smart farming which can be acquired using architecture-driven data based on the sensors have increased the efficiency for generating quantitative and qualitative approaches along with the challenges that challenge with current methodologies in agricultural sector. The research demonstrates possibilities for WSN, IOT, and comparable techniques in farming that are practical for monitoring and surveillance from sowing till harvesting as well as comparable packaging procedures. IOT technologies are highlighted in the work through emphasizing creation of the revolutionary drone idea with the help of 3D mapping by solving the challenges and proposing of crop maintenance model as a comparative analysis with the conventional techniques. In order to accomplish this goal, developing technology, and in particular the Internet of Things, is essential. Our study examines how decision-making systems based on artificial intelligence will produce further advantages for precision farming. In terms of managing nutrients, machine learning plays a crucial role in farming. Additionally, it is discovered that IOT-based agriculture automation is a tried-and-true technology, even for small farms (Dutta & Mitra., 2021).

5. CONCLUSION

The present study discusses the adoption of intelligence solutions with the use of artificial intelligence and IOT and proposed crop management system in various aspects of the application in the agricultural field. Though, enough support is not received by the agricultural industry through the conventional method of farming extensive research is carried out for the introduction of automated farming system with the emergence of technologies. The agriculture sector requires robustness to become more potential in farming and increasing productivity. Application of artificial intelligence and Internet of Things for management of changes in the environment which is monitored by the proposed crop monitoring system. The other applications of AI and IOT include decision-making system, predictive solutions, drone system or unmanned vehicle, automated irrigation systems for addressing the demands in the real world and the problems faced by farmers.

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