Smart Farming and Its Application

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***Abstract*— Smart farming, also known as precision agriculture, is a modern approach that integrates cutting-edge technologies into agricultural practices to optimize productivity, reduce resource consumption, and enhance sustainability. This research paper explores the concept of smart farming and its diverse applications across various agricultural sectors. It highlights the technological components and techniques employed in smart farming, such as the Internet of Things (IoT), data analytics, remote sensing, and automation. Additionally, the paper examines the benefits and challenges associated with implementing smart farming techniques and provides insights into the future prospects of this transformative agricultural paradigm.**

***Index Terms*—Smart farming, Agricultural sectors, Internet of Things (IoT), Data Analytics, Remote sensing, Automation**

I. INTRODUCTION

Agriculture plays a critical role in sustaining human life and meeting the global demand for food. With the world's population expected to reach 9 billion by 2050, an urgent need is to optimize agricultural practices for increased productivity and sustainability. Smart farming, a modern agricultural paradigm, emerges as a solution that harnesses the power of technology to make farming more efficient, economical, and environmentally friendly. This research paper aims to explore the concept of smart farming, its applications, and the potential impacts on the agricultural sector.

II.DEFINITION AND SCOPE OF SMART FARMING

Smart farming is a management concept focused on providing the agricultural industry with the infrastructure to leverage advanced technology – including big data, the cloud, and the Internet of things (IoT) – for tracking, monitoring, automating and analysing operations. Smart farming helps farmers to better understand the important factors such as water, topography, aspect, vegetation and soil types. This allows farmers to determine the best uses of scarce resources within their production environment and manage these in an environmentally and economically sustainable manner. Smart farming based on IoT technologies enables growers and farmers to reduce waste and enhance productivity ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made, and enabling efficient utilization of resources such as water, electricity, etc. Also known as precision agriculture, smart farming is software-managed and sensor-monitored. Smart farming is growing in importance due to the combination of the expanding global population, the increasing demand for higher crop yield, the need to use natural resources efficiently, the rising use and sophistication of information and communication technology and the increasing need for climate-smart agriculture.

III.ROLE OF TECHNOLOGY IN SMART FARMING

IOT in agriculture involves sensors, drones, and robots connected through the internet which function automatically and semi-automatically performing operations and gathering data aimed at increasing efficiency and predictability. With increasing demands and shortage of labour across the globe, agriculture automation and robots or commonly known as agribots are starting to gain attention among farmers. Crop production decreased by an estimated 213 crores approx. ($3.1 billion) a year due to labour shortages in the USA alone. Recent advancements in sensors and AI technology that lets machines train on their surroundings have made agri-bots more notable. John Deere, the 200-year-old American farm equipment company is already connecting its ubiquitous tractors to the internet. Farmers now know

their tractor productivity on their phones. John Deere extended this to help display crop yields on farmers' smartphones. Thanks to Tesla, the smart car bug has hit tractors too. John Deere is in the works to develop self-driving tractors, which would not just free up farmers' time but also improve farm safety. The world is in the early stages of an ag-robotics revolution with most of the products still in R&D and trial phases. Smart greenhouses are revolutionizing the agricultural industry by creating a self-sustaining microclimate perfect for crop production. Controlled environments allow farmers to eliminate worries of unpredictable weather or predators while harvesting real-time data that maximizes efficiency and improves yields with precision irrigation, temperature control, lighting adjustment, and more.

IV. APPLICATION OF SMART FARMING

4.1 Drone Spray:

A defining aspect of precision agriculture is cutting down on unnecessary usage of agri-inputs. Smart Farm aids in this with 360-degree monitoring of farms via data gathered from farms, satellites, drones, and sensors. Implementing 5G in these devices can aid in efficient crop monitoring — an activity performed & executed by autonomous drone sprayers.

These drone sprayers, fairly new technology in agriculture, comprise crop and weed scanners and sprayers. ICT-based platforms can also integrate with IoT devices to use the insights generated by the latter to limit the application of agrochemicals to only where required, instead of blanket spraying.

Restricted, targeted use of chemicals will lead to reduced input costs and help minimize water pollution, soil damage, and crop losses.

Similarly, farmers can determine the exact harvest time using colour and size analysis via AI and 5G-enabled drone sprayers.

4.2 Water Management and Irrigation:

Water management could be considered a highly imperative concept with regards to irrigation. The scarcity of clean water has turned out to be a concern globally and so the agricultural sectors along with other industries must give keen attention and focus on this issue. Water management could be considered as the management of soil moisture in order to make sure that optimum level and quantity of water is applied at the right time. Effective water management is extremely crucial for the agricultural sector as it could decrease cost and augment crop production. Water management is also critical as it allows the organizations in the agricultural sector to manage the resources and carry out the required activities in accordance. The fact that various projects are being carried out at different scales, it is essential to understand if these projects will be carried out effectively or not. An increasing number of organizations today have been focusing on conserving natural resources as the scarcity of these have led to develop a huge concern for all. In this regard, water is one of the most critical and useful resource that needs to be saved and protected by all means. The fact that ample water consumption is involved in irrigation processes, the organizations involved and associated to these activities must be highly keen and considerate about developing ways through which usage of water could be optimized. Thus, effective solutions of water management are required to provide numerous benefits to agriculture industry.

4.3 Soli Health Monitoring:

Soil temperature is an essential factor in belowground plant activity, influencing root growth, respiration, decomposition and mineralisation of nitrogen. IoT sensors can estimate soil temperature by measuring air temperature and other factors; however, the most accurate measurement is to use a probe buried in the soil. The moisture content of soil can also be monitored using buried probes with electrodes. In hydrology, soil science and agricultural moisture content play a vital role in soil chemistry, plant growth and groundwater recharge. Soil moisture content is essential for several reasons. Rainfall/precipitation, wind, humidity and atmospheric pressure all play an essential role in plant growth. Our Smart Agriculture systems support several advanced weather stations. Weather stations and soil sensors give you a 360 view of your farming operation.

4.4 Pest and Disease Management:

Fungi cause the great majority, estimated at two-thirds, of infectious plant diseases.

They include all white and true rusts, smuts, needle casts, leaf curls, mildew, sooty moulds and anthracnose. They are responsible for most leaf, fruit, and flower spots, cankers, blights, wilts, scabs, and

root, stem, fruit, wood rots among many others. Parts of plants or the total crop plant can wither and die. Bacteria cause any of the four following main problems. Some bacteria produce enzymes that breakdown the cell walls of plants anywhere in the plant. This causes parts of the plant to start rotting (known as 'rot'). Some bacteria produce toxins that are generally damaging to plant tissues, usually causing early death of the plant. Others produce large amounts of very sticky sugars; as they travel through the plant, they block the narrow channels preventing water getting from the plant roots up to the shoots and leaves, again causing rapid death of the plant. Finally, other bacteria produce proteins that mimic plant hormones.

4.6 Farm Automation and Robotics:

Agriculture is humankind's oldest and still its most important economic activity, providing the food, feed, Fiber, and fuel necessary for our survival. With the global population expected to reach 9 billion by 2050, agricultural production must double if it is to meet the increasing demands for food and bioenergy. Given limited land, water and labour resources, it is estimated that the efficiency of agricultural productivity must increase by 25% to meet that goal, while limiting the growing pressure that agriculture puts on the environment. Robotics and automation can play a significant role in society meeting 2050 agricultural production needs. For six decades robots have played a fundamental role in increasing the efficiency and reducing the cost of industrial production and products. In the past twenty years, a similar trend has started to take place in agriculture, with GPS- and vision-based self-guided tractors and harvesters already being available commercially. More recently, farmers have started to experiment with autonomous systems that automate or augment operations such as pruning, thinning, and harvesting, as well as mowing, spraying, and weed removal. In the fruit tree industry, for example, workers riding robotic platforms have shown to be twice as efficient as workers using ladders. Advances in sensors and control systems allow for optimal resource and integrated pest and disease management. This is just the beginning of what will be a revolution in the way that food is grown, tended, and harvested.

V. FUTURE OF SMART FARMING

Smart farming combines traditional agricultural practices with Information and Communication Technologies (ICT) to enhance farm produce and quality. The usage of new technology in agriculture can help farmers reduce labour and cut down on costs while improving crop yield and production at the same time. ICT includes a wide range of components under digital and computer technologies to facilitate all these agricultural benefits. These include robotics, sensors and actuators, drones, GPS, etc. The latest addition to this list is a 5G network. Although mobile networks are already implementing many of these ICT technologies to offer the mentioned agricultural benefits, 5G will enhance the impact by manifolds due to low latency, high bandwidth, and support for many simultaneously communicating sensors.

VII. CONCLUSION

The goal of smart farming is to produce more with less. By using technology to increase yields and reduce inputs, farmers can save money and resources while still producing high-quality crops. Smart farming also reduces the impact on the environment by reducing the amount of chemicals and water used in agriculture.

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