Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 03, Issue: 03 (MAY-JUNE, 2023)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Smart Farming: The Future of Indian Agriculture

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Abstract
The basis of the Indian economy is agriculture, which also meets the basic requirements of people and is essential to the country's survival. As the nation's population has increased and there has been a greater need for food security, there has been an increase in the demand for agricultural products over time. The application of contemporary technology in Indian agriculture is required to meet the enormous food grain demand of 480 million tons (Mt) by 2050 due to the growing issue of biotic and abiotic stressors faced by crops. Agriculture has transitioned to a knowledge-based period from one that was resource-based, like other industries, and will likely become more competitive and market-driven in the future.

Introduction
According to Bacca et al. (2019), the implementation of smart agriculture technology depends on the usage of IoT and Al in cyber-physical farm management. Since smart agriculture enables monitoring of changes in climate conditions, soil properties, soil moisture, etc., it covers a wide range of concerns relating to crop production. The Internet of Things (IoT) technology enables devices to be linked together via the internet and be run automatically, enabling it to link a variety of distant sensors including robots, ground sensors, and drones (AlMetwally et al., 2020). Precision agriculture's major goal is to boost spatial management techniques for crop production while minimising the abuse of fertilizers and pesticides (Amato).

Benefits of Smart Farming
1. A Few Advantages of Smart Farming in Agriculture Include

1) High agricultural production is ensured through the use of newer, more effective farming techniques, or "smart farming," which places a focus on maximizing input productivity and minimising waste.
2) Lessening the use of pesticides, fertilizers, and water: Farmers have historically used water, fertilizers, and pesticides even if they are aware of where those materials are required on the field. But if you use water and other chemicals wisely—applying them when, and in the proper amounts—you can lower your usage of water and other chemicals, which lowers the cost of producing food.

Figure 1. Internet of Things in smart farming

3) Reduce negative environmental effects: Modern smart farming practices increase productivity while reducing the loss of water, pesticides, and other crop inputs.
4) improved machinery and improved technologies are made possible by smart farming, which reduces the need for fieldworker interaction and so improves safety for both farmers and employees.
5) Low chemical deposition into groundwater and rivers: Smart farming encourages the use of environmentally friendly agricultural practices and minimal pesticide use. Accordingly, little to no toxins can be spilled into rivers or generally have an impact on the climate.

2. Smart Farming Technologies

1) sensors for managing temperature, light, and water as well as soil conditions
2) GPS and sophisticated networking are examples of telecommunications technologies
3) Hardware and software for Internet of Things (IoT)-based solutions, robotics, automation, and specialized applications
4) Decision-making and forecasting tools using data analytics
5) Data collecting using satellites and drones.

3. Smart farming approaches in developing countries

The incorporation of SF technology is seen as being crucial all over the world, however poor nations face difficulties when trying to implement smart systems due to the lack of public infrastructure and other human resources (Glaroudis et al., 2020). Consequently, the following might be used to summarise the challenges that developing nations have in using smart agriculture technology:

1) The most important component in terms of data transfer between sensors over the Internet is the existence of a sufficient fourth- or fifth-generation network.
2) The accessibility of sensors, since these are used to gauge numerous farm-related occurrences and traits.
3) Access to tools and equipment for doing agricultural operations.
4) Skilled professionals based in smart farms. However, there are numerous techniques in developing nations, and in India, a number of issues, such as weak socio-economic backgrounds and confront numerous problems owing to rising costs of cultivation, affect the majority of farmers regarding the use of smart farming technology. Climate change is another significant natural issue that has an impact on agricultural productivity (Srivastava and Singh, 2016). The same authors employed GIS-based integrated modelling, which includes modules for system loss, rainfall-runoff, soil moisture accounting, irrigation water demand, and groundwater flow system.

Present Scenario

In spite of the fact that smart farming is a hot topic in wealthy nations, India is only now beginning to adopt these technologies. This technology has already begun to be implemented in a number of distinct ways. Smart farming is one of India's main concentration areas, according to the Working Groups (WGs) of the country. . The "Tamil Nadu Precision Farming Project" has been started by the state government of Tamil Nadu. It will initially cover 400 hectares in the districts of Dharmapuri and Krishnagiri, and then it will be expanded to six more districts (Mondal &Basu, 2009). On the farms owned by the institute, Indian Agricultural Research Institute intends to conduct trials in intelligent farming. The Project Directorate for Cropping Systems Research (PDCSR) in Modipuram and Meerut (Uttar Pradesh) began using variable rate technology in various cropping systems in conjunction with the Central Institute of Agricultural Engineering (CIAE), Bhopal. The Central Potato Research Station fields in Jalandhar, Punjab, are the subject of studies being

conducted by the Ahmedabad Spatial Application Centre (ISRO) to determine how remote sensing may be used to map spatial and temporal variability.

Future Possibilities

India's fundamental issue is that most of its farmers are subsistence farmers with small landholdings. More than 57.8% of farmers in India have smaller land holdings than this. More than a quarter of the population, however, has an operating holding size of more than 4 hectares in important agricultural states like Gujarat, Punjab, Haryana, and Uttar Pradesh (Shanwad et al. 2004). Considering adjacent fields with the same crop, even if these are independent landholdings, the field sizes are substantial. Aerial data shows that in Punjab's Patiala area, more than half of continuous field sizes are more than 15 hectares. These adjacent fields can be viewed as a single field for the purposes of smart farming.

Especially in Punjab and Haryana, smart farming has the potential to be applied to significant food-grain crops like rice and wheat. But India has a great potential for smart farming with a number of profitable horticulture crops. Major food-grain crops like rice and wheat have the potential to be grown using smart farming techniques, particularly in the states of Punjab and Haryana. However, there is a lot of room for clever farming with numerous horticultural crops in India that produce large profits.

Figure 2. Robotics in smart farming

Conclusion

The current work served to highlight the significance of intelligent agriculture in raising agricultural output and helping to close the gap between supply and demand for food. Since loT connects every component of smart systems, including those in the agricultural sector as well as other applications, it is regarded as the foundation of smart agricultural technology. Regarding the application of loT in agriculture, it can be applied to a variety of procedures, including harvesting, irrigation, pest management, and farm monitoring. The Internet of Things (IoT) links various sensors with computing devices, processes data, then makes appropriate decisions in real-time. This work examined the constraints of their utilization in developing nations as well as the integration of IoT with UAV and robotic systems controlled by Al methods. Recently, the speed of data transfer has been linked to SF performance success. As a result, the 5G network, which has a very high speed compared to fourth generation networks, created the smart agriculture industry and offered flexible and effective solutions. The use of smart agricultural technology benefits developing nation.

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