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# AGRICULTURAL APPLICATIONS LEVERAGING IOT AND SMART SENSORS: AN EXPLANATORY STUDY

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## ABSTRACT
The incorporation of Internet of Things (IoT) and intelligent sensors in agriculture is transforming conventional farming methods by offering instantaneous data and automated solutions. These technologies provide accurate monitoring of environmental conditions, crop vitality, and resource utilization, resulting in enhanced efficiency and sustainable farming practices. Through the utilization of IoT technology and intelligent sensors, farmers have the ability to maximize irrigation efficiency, minimize resource wastage, and improve agricultural productivity. This investigation's chief goal is to probe the utilization of IoT and intelligent sensors in agricultural applications. This study utilized qualitative research approach. This novel strategy tackles the increasing worldwide need for food while advocating for ecologically sustainable methods. Ultimately, the utilization of IoT and intelligent sensors in agriculture possesses significant capacity for revolutionizing the sector. These technologies have notable advantages, such as enhanced efficiency, increased yields, and diminished environmental impact. Nevertheless, additional investigation and advancement are required to surmount obstacles associated with expense, expandability, and compatibility. As these technologies advance, they hold the potential to be essential in establishing sustainable and efficient agriculture practices globally.
***Keywords:*** *Agricultural applications; IoT; Sensors; Productivity; Technologies; Efficiency.*

## INTRODUCTION
The convergence of agricultural and modern technology has led to the emergence of inventive implementations of the IoT and intelligent sensors, with the goal of augmenting efficiency and sustainability in farming (Ayaz et al., 2019). The research basis of this topic involves the development of precision agriculture, which utilizes data-driven methods to enhance farming techniques. IoT devices and smart sensors have been created to monitor many parameters, counting soil moisture, and temperature, humidity, and crop health (Ray, 2017; Navulur & Prasad, 2017). These devices offer farmers up-to-date information and data that can be acted upon. These technologies provide accurate irrigation, pest control, and nutrient distribution, minimizing resource inefficiency and enhancing crop productivity. The motivation for this technological integration arises from the urgent necessity to tackle worldwide food security, limited resources, and environmental issues (Namuduri et al., 2019). Preliminary research has shown notable advantages, such as increased efficiency in water usage, improved monitoring of crops, and expanded capacity to make informed decisions (Namuduri et al., 2019; Ray, 2017; Navulur & Prasad, 2017). Nevertheless, the implementation of these technologies poses obstacles, including the requirement for reliable data transmission infrastructure, precise sensor accuracy, and the substantial upfront investment expenses. Current research is dedicated to surmounting these obstacles through the creation of affordable, long-lasting, and user-friendly IoT and sensor systems that can be extensively implemented in various sizes of agricultural activities (Farooq et al.,

2019). The background emphasizes the significant impact that IoT and smart sensors can have on agriculture, emphasizing the crucial importance of ongoing innovation and research in achieving sustainable agricultural practices. The subsequent part provides a detailed analysis of the previous literature pertaining to this topic.

## LITERATURE REVIEW

The subsequent part provides a detailed analysis of previous literature about the utilization of IoT along with smart sensors in agricultural applications.

Table 1: Related Works

| AUTHORS AND YEARS | METHODOLOGY | FINDINGS |
|---|---|---|
| Sinha et al., (2019) | This study presented a user-centric Internet of Things (IoT) architecture to tackle the different challenges encountered in the agriculture sector. The suggested technology enables farmers to monitor their agricultural areas in real-time and obtain suggestions for cultivating high-quality crops. | The described use cases clearly illustrated the suitability of the proposed architecture in several agricultural process scenarios. |
| Johnson et al., (2020) | This study examined several sensor technologies and Internet of Things (IoT) platforms employed in the context of smart agriculture. | Explored the importance of data science in the agriculture industry and the different techniques used to handle sensor data collected for agricultural purposes. |
| Gagliardi et al., (2021) | The project's objective was to design all the necessary hardware and software components to construct a precision farming architecture. This architecture would enable farmers to effectively manage and monitor the health status of their vines. | The conducted experiments demonstrated that the implemented intelligent agriculture framework enabled farmers to effectively plan and organize the different stages of planting and harvesting. |

**Research Gap:**Although there have been notable advancements in smart sensors along with IoT technology for remote sensing in agriculture, there remains a substantial research void in assessing their long-term efficacy and incorporation into current agricultural systems. Many current studies fail to consider the socio-economic factors that are crucial in designing effective irrigation plans that are suitable for different farming communities. In addition, there is a scarcity of research on the practical techniques and optimal strategies for implementing IoT and smart sensor technologies to enhance productivity in different agricultural settings. To address these deficiencies, it is necessary to do thorough and interdisciplinary research in order to create practical and cost-effective solutions that can be widely implemented by farmers globally.

## METHODOLOGY

The study utilizes a qualitative research methodology. Here, the secondary data is assembled from online databases spanning the period from 2016 to 2021. A qualitative research methodology utilizing secondary data collecting for this topic entails examining pre-existing literature, research studies, and reports on the implementation of IoT and smart sensors in agriculture. This technique facilitates a comprehensive comprehension of modern technological advancements, socio-economic factors in irrigation schemes, and methods to boost productivity, all without the necessity of gathering primary data. Through the synthesis of information from many sources, researchers can discern patterns, find areas of improvement, and determine the most effective methods for incorporating IoT along with smart sensors into agricultural applications.

## RESULTS AND DICSUSSIONS

In this study, the following themes were taken into consideration:

- Advances in Smart Sensors and also IoT for Remote Sensing in Agriculture
- Socio-Economic Impact of Irrigation Schemes
- IoT and Smart Sensors in Agricultural Productivity Enhancement

### Advances in Smart Sensors and IoT for Remote Sensing in Agriculture

The progress in intelligent sensors and IoT for remote sensing in agriculture has completely transformed the methods by which farmers see and control their crops. These technologies provide accurate and immediate data gathering on many factors like soil moisture, temperature, humidity, and crop health. Intelligent sensors, frequently linked via IoT networks, send this data to centralized systems where it can be examined to support decision-making. Such a high level of precision aids in irrigation optimization, the reduction of water waste, and the enhancement of crop yields. In addition, remote sensing technologies enable the early identification of pests and illnesses, enabling prompt responses. The incorporation of IoT technology and intelligent sensors not only enhances the efficiency and sustainability of farming operations but also facilitates the use of resource-conserving methods. As these technologies progress, they can revolutionize agriculture by building it to be more reliant on data, improving efficiency, and promoting environmental sustainability.

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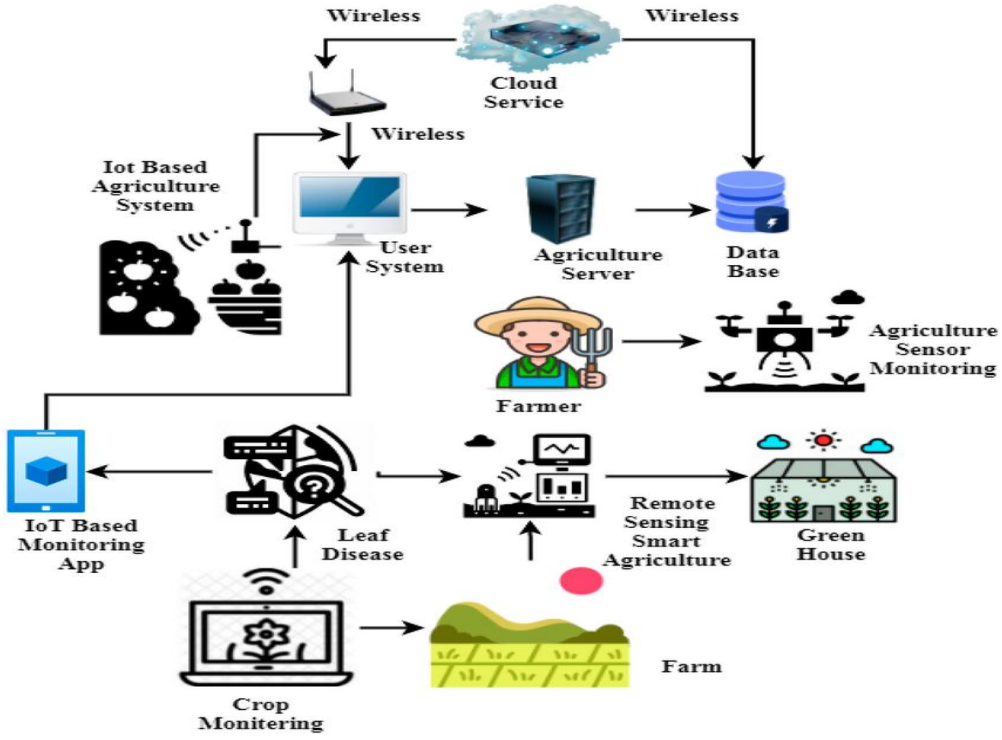


Figure 1: Advances in Smart Sensors and IoT for Remote Sensing in Agriculture – An overview[1]

**Socio-Economic Impact of Irrigation Schemes**

Agriculture irrigation schemes have a major socioeconomic influence on farmers and the community. Effective irrigation techniques maximize crop water availability, increasing yields and harvest reliability. Productivity boosts farmers' wages, reduces poverty, and improves food security. Well-planned irrigation projects can also promote sustainable water use, safeguarding water resources for future generations. They also help farmers diversify crops, stabilizing revenue and reducing economic vulnerability. Some small-scale farmers, especially in developing countries, cannot afford these schemes due to high implementation and maintenance expenses. Addressing these gaps necessitates incorporating socio-economic elements in irrigation system design and deployment to enable inclusive and beneficial community growth and development.

[1] https://www.researchgate.net/figure/Remote-Sensing-in-Smart-Agriculture-with-IoT-Technologies_fig3_356830781

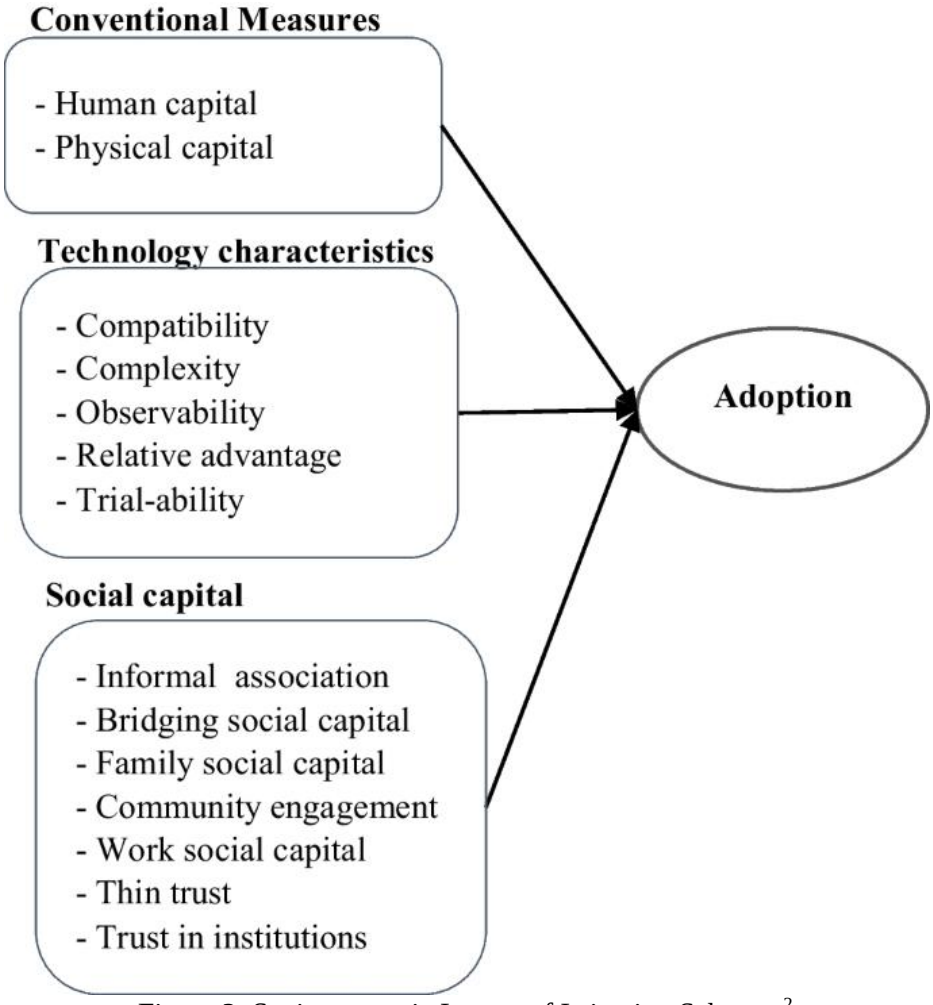


Figure 2: Socioeconomic Impact of Irrigation Schemes[2]

**IoT and Smart Sensors in Agricultural Productivity Enhancement**

IoT and smart sensors provide real-time data on soil moisture, temperature, and crop health, boosting agricultural productivity. These technologies help farmers optimize irrigation, fertilization, and pest control. Internet of Things and smart sensors automate these procedures to increase crop yields and quality while reducing resource waste and labour expenses. Monitoring and responding quickly to environmental changes provides healthier crops and more effective farming operations, increasing agricultural production and sustainability.

[2] https://link.springer.com/article/10.1007/s10113-023-02147-7

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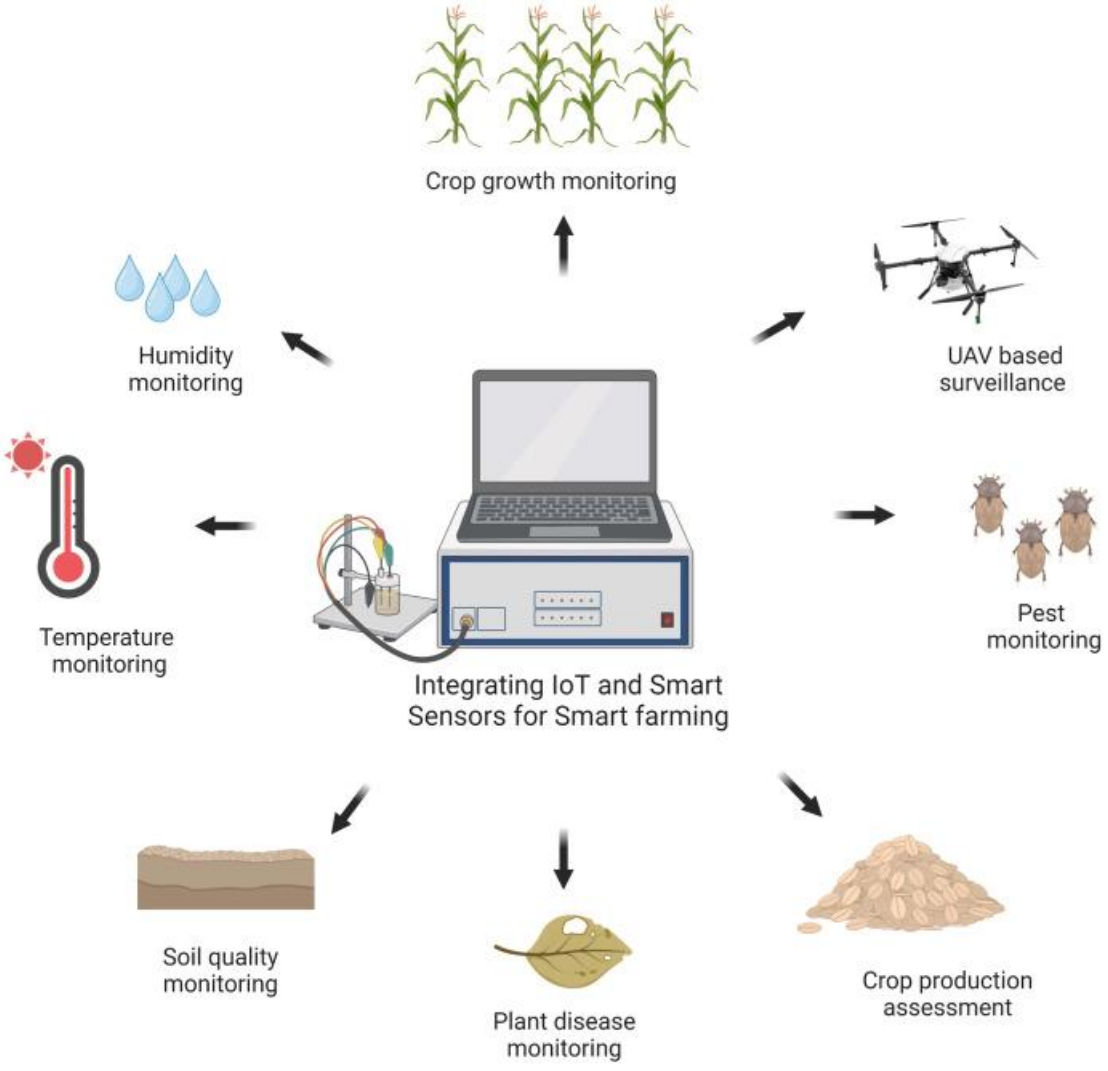


Figure 3: IoT and Smart Sensors in Agricultural Productivity Enhancement[3]

## CONCLUSION

Finally, the IoT-intelligent sensor combination can significantly transform agricultural efficiency. Through the utilization of real-time data and automation, these technologies empower farmers to enhance resource utilization and enhance crop management methods. To satisfy global food demands responsibly, it is vital to continue investing in and researching IoT and smart sensor technologies as agricultural challenges change over time.

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