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Revolutionizing Agriculture: The Rise of IoT-Enabled Smart Irrigation Management Systems

(*Aniket Sharma[1], Losa Lajeo[2], Anand Kumar[3] and Abinash Kumar Patel[4])
[1]Departmernt of Horticulture (Fruit Science), SHUATS, Prayagraj
[2]Department of Horticulture (Vegetable Science), SAS, NU. Medziphema
[3]Dept. of Agronomy, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut
[4]Dept. of Horticulture, Dr. Rajendra Prasad Central Agricultural University, Pusa
*Corresponding Author's email: sharma.aniket2122@gmail.com

Abstract
The population of India now exceeds 1.32 billion, and the population growth rate is steadily growing. Subsequently, in about 25-30 years, a significant food scarcity will arise, therefore making the advancement of agriculture imperative. Approximately 70 percent of India's population relies on agriculture as their primary livelihood. Currently, farmers are experiencing the negative consequences of insufficient rainfall and water scarcity, which are exacerbated by climate change. The only resolution to this predicament is in the implementation of intelligent agriculture, which involves upgrading the existing conventional techniques of farming. The Internet of Things (IoT) is crucial in the agricultural sector, since it has the potential to provide sustenance for 960 million people worldwide by the year 2050. Implementing smart agricultural waste management techniques may lead to a reduction in the excessive use of fertilizer, resulting in increased crop output. This study focuses on the development of a system that enables the monitoring of agricultural fields and the automation of irrigation processes via the use of sensors, namely those measuring soil moisture, temperature, humidity, and light levels. This technology will be particularly beneficial in forested regions characterized by limited water availability. The technology exhibits a 92 percent increase in efficiency compared to the old technique. Agricultural practitioners have the capability to remotely see and assess the state of their fields from any location. The Internet of Things (IoT) is crucial in the implementation of smart agriculture. Smart farming is an emerging idea. IoT sensors may provide data about agricultural lands.

Introduction
The geometric growth of population, rapid urbanization, industrialization, and agricultural development are putting pressure on world water resources. Agriculture is the largest consumer of pure water resources. Therefore, expanding water productivity is a priority area of research in this climate change era. In the current situation, there are around 75.3 million people in the world, including an average of 33 percent of the global population, who suffer from some form of water scarcity. By 2030, this figure is likely to increase to 50 percent, underscoring the alarming rate at which the problem of water scarcity is expanding. Interestingly, farmers should concentrate on reducing water waste as irrigation accounts for about 70% of the world's total water withdrawal. We use about 80 percent of the water for irrigation. The global depletion of clean water resources has necessitated their optimal utilization. Agriculture is the main basis of India's economic growth.

Climate change is the primary barrier to conventional farming. The implications of climate change include increased precipitation, heightened storm intensity, heatwaves, and reduced rainfall. As a result of these factors, productivity significantly decreases. Climate change also results in environmental ramifications, including alterations in the seasonal patterns of plant life cycles. The agricultural industry, also known as the Internet of Things, requires the use of novel technologies and processes to enhance production and alleviate bottlenecks. This refers to the use of contemporary Information and Communication Technology (ICT) in the field of agriculture. This is the application. A sickness exists. As to the Food and Agriculture Organization of the United Nations, in order to provide food for the increasing global population, the world would have to raise food production by 70 percent by 2050. To fulfil this need, farmers and agricultural corporations will need to enhance their production capacity. It is embracing the Internet of Things. The Internet of Things (IoT) has the potential to significantly enhance productivity. One may access the vast worldwide market and get insights into the latest trends in crop production. Nowadays, several agricultural sectors are embracing IoT technology for intelligent farming in order to enhance efficiency, production, marketability, and other aspects such as reducing human involvement, time, and costs.

Smart irrigation management systems are necessary due to the current and escalating water constraint caused by the increasing global population and demand for fresh water. The present global population is at around 72 million and is projected to surpass 90 million by the year 2050, according to the United Nations (2013). The agriculture industry, particularly in Tsinghai, accounts for a significant proportion of freshwater use. Developing nations are using more water compared to wealthy countries in order to get the same output, mostly because they lack cost-effective clever irrigation technologies. Marat has fresh water resources that amount to around 17 percent of the global population. Nevertheless, the water consumption for several key agricultural products in this country is 2-4 times higher than that of nations such as China and the USA. Hence, it is essential to develop intelligent methods and systems using cutting-edge technology to optimize the use of freshwater. In addition to this, the alternating occurrences of floods and droughts have shown that the escalating expenses associated with fluctuating weather patterns provide a significant burden for farmers. As we progress with conventional approaches, the expense of agriculture likewise rises. There may possibly be a period in the future when this occurs. When agricultural profitability becomes obsolete for farmers. These innovations in the field of IoT play a crucial role in agriculture, as they may effectively address the growing issue of water scarcity worldwide.

Need for Internet of Things based smart irrigation management system: In India, the traditional irrigation system mostly relies on surface irrigation, which is the oldest and extensively used kind of poly irrigation. In this method, water is evenly dispersed throughout the whole field or in specific areas such as furrows, borders, or basins, using the force of gravity. Surface irrigation results in a significant loss of water, with over 50 percent being wasted via deep runoff, evaporation, and surface runoff. As a result, the efficiency of irrigation is rather poor, ranging from 38 to 40 percent. To achieve this, irrigation techniques such as drip irrigation and sprinklers, which have a high watering efficiency ranging from 85 to 90 percent, are used. Furthermore, the majority of farmers choose for manual or semi-automatic control systems since they demand little investment and low levels of competence to operate. However, ensuring consistent distribution of water and fertilizer applications is a challenging task that demands significant attention.

To overcome these problems: Modernizing agricultural processes is necessary in order to enhance crop water yield and optimize resource use. Studies demonstrate that implementing effective water management strategies may result in water savings of up to 50

percent. Precise water delivery using sprinkler and drip irrigation may produce high irrigation efficiency, ranging from 75 to 95 percent, respectively. In order to enhance agricultural output in the nation, it is crucial to encourage the use of novel technologies and embrace the principle of 'increased crop yield per unit of water' while also ensuring broader availability of cutting-edge technology. Hence, it is important to establish accurate scheduling for the control of irrigation water.

How Iot Works: This device is used to measure the moisture level in the soil and regulate the water flow in irrigation pipelines. Once the moisture level falls below a pre-established threshold, the irrigation system will activate automatically. The irrigation system may be automated by using soil moisture sensors, a data logger/microprocessor, a controller, and a pressurized water supply with regulator valves. An automated irrigation system may have its operating details configured either via software or manually using a control device. The Internet of Wings-based irrigation system is a cost-effective approach that enhances water usage efficiency by optimizing water utilization. It also ensures high-quality crop production, minimizes water waste, and contributes to water conservation, therefore benefiting the economic position of farmers. Enhances productivity and reduces time consumption.

Benefits of IoT based smart irrigation system

- ✓ Water management can be done efficiently using Internet of Things which does not lead to wastage of water by using sensors.
- ✓ Internet of Things helps in continuously monitoring the land so that precautions can be taken at an early stage.
- ✓ It increases productivity, reduces manual work, saves time, and makes farming more efficient.
- ✓ Crop monitoring can be easily done using IOT to observe crop growth. Soil management like pH level, moisture content etc. can be easily identified so that farmers can sow seeds as per the soil level.
- ✓ Sensors and RFID chips are used to identify diseases occurring in plants and crops. In this, crops can be automatically protected from incoming diseases.
- ✓ Crop sales can be increased in the global market. With these features, smart farming can help farmers grow the market with a single touch and minimal efforts.

Conclusion

An Internet of Things (IoT) based smart irrigation system minimizes water loss in agricultural irrigation. Implementing automated irrigation systems on big agricultural areas not only saves time but also enhances efficiency. This solution may effectively address the issue of labor scarcity in the agricultural sector. This method enables automated operation of irrigation in the fields. This technique is a significant achievement in the era of climate change. Prioritizing the promotion of innovation in agriculture is crucial, and the solution to the challenges faced by farmers lies in adopting IoT-based smart farming techniques. Smartphones can facilitate all of these tasks, and they can support up to 10 devices simultaneously.

Currently, the agricultural business is being transformed by the Internet of Things (IoT), which is allowing farmers to effectively address the significant obstacles they encounter. Farmers may get extensive information and expertise on current trends and technologies by using 10. IoT solutions, which rely on the collection and intelligent analysis of sensors designed for particular applications, are connecting the digital and physical realms. The smart irrigation management system, based on the Internet of Things, efficiently utilizes water resources in precision farming.

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