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# Smart Farming Revolution: Harnessing IoT for Enhanced Agricultural Yield and Sustainability

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**Abstract**

The study examined how the Internet of Things, such as sensors, could improve agricultural intelligence and yields. The focus was on irrigation, temperature, and water data collected in cotton fields. The goal was to showcase real-world data from IoT devices transforming agriculture. With a spread of 149 humidity data points very dry to wet entered at 25 degrees, and pump activity divided into on and off phases, the data included in the findings showed trends such as an increase in overall reflected humidity and dry effluent in particular. The study also showed the relationship between humidity and pump efficiency. All considerations, simple field data and visualizations demonstrated the ability of IoT devices to accurately monitor agricultural conditions. This allows you to perform specific tasks such as spraying when needed. Smart farming uses IoT sensors to automate computers and create data-driven products that increase farm sustainability.

**Keywords:** Internet of Things (IoT), Smart Agriculture, Precision Farming, Sustainable Practices.

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## Introduction

Agriculture is changing thanks to "smart farming" techniques made possible by a combination of Internet of Things (IoT) devices and sensors Precision agriculture is a way of exploring, and collecting real-time data mouth for more focused irrigation, low fertilizer cost, yield -Automatic irrigation systems driven by IoT moisture sensors and weather data are becoming more and more popular in data-driven irrigation tailored plans for each field in order to maximize harvest. These systems save water and improve crop health. The sustainability benefits of this technology have been measured in many studies. The adoption of smart agricultural practices has been shown to reduce water consumption by 30-80% and more than 40% reduction in fertilizers and pesticides compared to traditional methods of monitoring or feeding improved production This reduces costs to farmers, increases profit per acre, Reduces fertilizer erosion and optimizes water and land use.

## Literature Review

According to the author Mahajan (2021), the development of smart agriculture can be supported through the integration of dark computing and the Internet of Things (IoT), as explored in this study. Many countries, including China and India, have a large part of their economy based on agriculture. Due to issues such as erratic rainfall and changing soil conditions, as well as increasing demand for food, IoT can be used to innovate agriculture. Real-time production, weather, and other consumption features beyond prediction and monitoring can be achieved through the integration of dark computing with IoT. Through the Internet, physical components such as sensors and actuators can be monitored and controlled remotely.

The Internet architecture consists of five layers: perception, interaction, infrastructure, service, and performance. Through sensors, the perception layer collects data from the outside. Through the Internet, the network layer transmits this data to the world. This data is stored and analyzed at the processing level, usually using cloud computing. The user interface for implementing the IoT system is provided at the application layer. Finally, applications are managed operationally to meet business needs [1]. IoT sensors in agriculture can automate irrigation, fertilization and harvesting while targeting pests, crop development, soil moisture, and other factors so this is enhanced by dark computing, which enables local information processing in real time. Together, fog computing and IoT can improve agricultural productivity. Yields are increased while costs are reduced through efficiency. As the world's population grows, smart agricultural solutions will become essential to sustainable food security.

According to the author Kirubanand (2022), to produce enough food to feed the world's growing population which is predicted to reach 9.6 billion people by 2050 agriculture is important but issues such as the environment and climate change cost on. Using Internet of Things (IoT) technologies, "smart agriculture" can be used to address these issues in agriculture. IoT sensors can be used to track vital indicators such as soil moisture, pH, nutrient levels, and crop growth rate and cattle health. Targeted interventions such as disease control, fertilizer application and irrigation are made possible by data. Agricultural drones can instantly assess crop health over large areas. Sensors can measure soil pH, indicating the optimum levels of acidity and alkalinity for the growth of a particular crop.

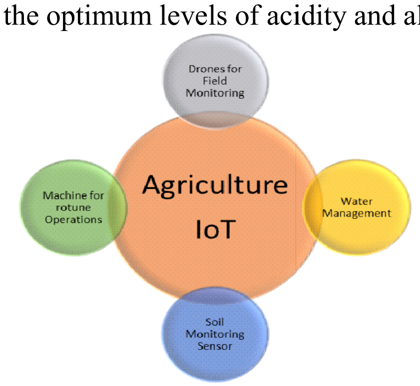


**Fig 1: Use of IOT in agriculture**

While coffee and tea require alkaline soils above pH 8, leafy vegetables thrive in soils with pH 7-8 Sensors can also measure humidity to activate irrigation real. Similarly, "greenhouse farming" technology uses IoT systems that automatically monitor and monitor temperature, humidity, irrigation, and other growing conditions [2]. It enables farms to collect data in real time, intelligently analyze it, and make precise automated adjustments. With the world's food needs increasing, IoT-enabled agriculture can sustainably increase resilience and productivity. Smart agriculture is increasingly being adopted by industry and holds much promise for addressing food safety issues. "Precision agriculture" is another important application due to the flexibility of IoT-based solutions.

According to the author Edwin Prem Kumar and Lydia (2022), Smart farming and precision farming are two ways in which the integration of Internet of Things (IoT) technology is transforming the agricultural industry. Digital agriculture is driven by factors such as climate change, land depletion and population growth. Many smart farming applications are made possible by IoT. The automation system optimizes resource management by controlling irrigation water, fertilizers, pesticides, and other applications using Internet of Things sensors and actuators. Monitoring projects monitor habitats, crop growth rates, soil conditions, and other factors to enable targeted interventions. Using machine learning, predictive systems can predict agricultural practices, identify disease outbreaks, and more.

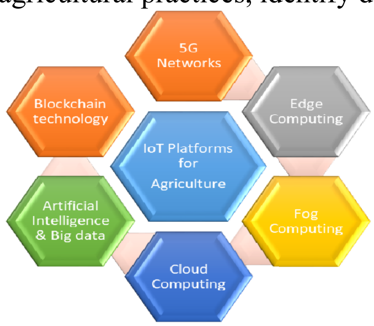


**Fig 2: IoT platforms for agriculture**

Most crop health surveys are conducted using unmanned aerial vehicles equipped with multi-sensor cameras. Block chain technology is being explored to increase anti-counterfeit protocols and transparency in the agricultural supply chain. Large IoT field datasets can be mined for insights through big data analytics [3]. Complementing edge computing with the speed of localized real-time decision making. IoT-enabled precision agriculture reduces costs, improves efficiency, increases productivity, and has a positive impact on the environment. Through the widespread use of technology, global food security problems are being addressed. Ongoing research aims to improve the intelligence and reliability of IoT systems for smart agriculture.

## The Model and Data

Precision farming techniques optimized for cost, yield and sustainability are possible, incorporating sensors, GPS and data analytics Real-time soil irrigation driven by water issues to reduce water consumption by 30–80% without sacrificing crops. Continuous monitoring of crop health in the field can enable early, targeted treatments that reduce pesticide use by 40% and increase outcomes. Considering all things, the smart agriculture enabled by IoT maximizes groundwater use, reduces costs and chemical flows, increases profitability, and becomes essential for sustainable development of food demand in the future [4]. General use of these technologies could transform agriculture and move towards more sustainable, data-driven practices. Precision farming techniques optimized for cost, yield and sustainability are possible, incorporating sensors, GPS and data analytics Real-time soil irrigation driven by water issues to reduce water consumption by 30–80% without sacrificing crops. Continuous monitoring of crop health in the field can enable early, targeted treatments that reduce pesticide use by 40% and increase outcomes. Considering all things, the smart agriculture enabled by IoT maximizes groundwater use, reduces costs and chemical flows, increases profitability, and becomes essential for sustainable development of food demand in the future [5]. General use of these technologies could transform agriculture and move towards more sustainable, data-driven practices.

## Data

Temperature, water, and pump operations measured for cotton crops are included in the dataset. There are a total of 149 data points, with temperatures ranging from 10 to 45 degrees, humidity from 4 to 1022, and pump values of 0 or 1. Most humidity measurements, the wide range, from 500 to 800. The outlier, however, is the values of 4 Lows and about 1022 between the low and high ends [6]. The temperature distribution is normally distributed, with a median of 25 degrees. The active or passive pump state is represented by a uniform distribution of 0 and 1 pump operations. For one or more cotton crops, this appears to represent different environmental and irrigation system conditions.

## Results

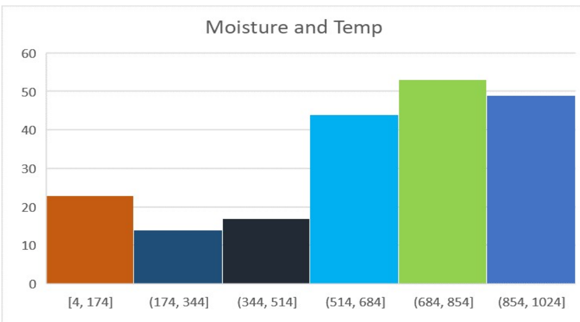


**Fig 3: Moisture and Temp**

The number of readings falling into each of the five groups is shown on the graph. Ranges 4-174, 174-344, 344-514, 514-684, and 684-854 are labeled on the x-axis. Up to 60 frequencies or counts are displayed on the y-axis for water level readings in that range [7]. Orange, dark blue, light blue, green and navy navy blue are among the many colors available in the graph.

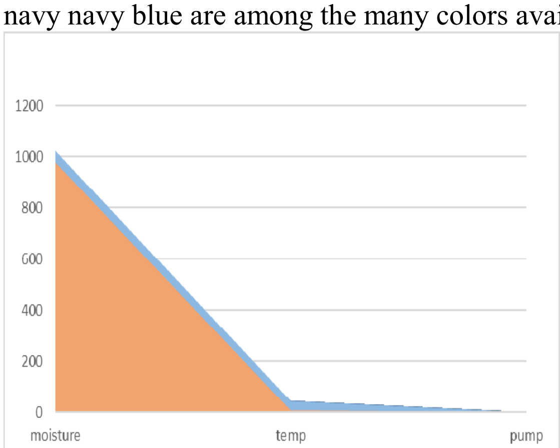


**Fig 4: Triangular Plot**

The orange rectangles in this figure represent the temperature, moisture content, and pump activity data. Pumps, temperatures, and temperatures are labeled on the x-axis. The y-axis range is from 0 to 1200. Initially, the orange region increases with moisture, filling all the systems along the y-axis to a value of 1200 [8]. The orange region falls uniformly in the mountains on a straight downward slope as you reach the center, when the temperature drops to zero. Then when you pump on the x-axis, it stays at 0 with no orange spot.

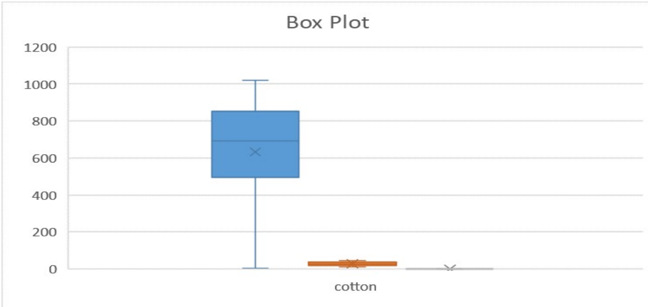


**Fig 5: Box Plot**

In this graph, the cotton moisture data range from 0 to 1200 is shown on the y-axis. As the main blue box image shows, most of the stories are grouped between 600 and 800, with a price of 700. The left and right edges of the box indicate the lower and upper quartiles, or 25% and 75% points, respectively [9]. The median value is indicated by an "X" at 700. The end of the blue whiskers indicates a change from the box; they extend from about 500 to just below 1000. Then, there is another orange line at about 0, which stands out more from the previous area moisture readings

## Conclusion

Cases and research show how Internet of Things technologies like automation and sensors can transform agriculture. Cotton crop data on temperature, irrigation, and pump operations reflect real-world monitoring of crop conditions. Patterns in the data are illustrated by diagrams. For example, most readings were in the range of 500 to 800, but there were also some extremes that were much lower or higher. The triangle diagram also showed a correlation between decreased pump activity or higher flow rates and lower temperatures. Finally, the driest outlier humidity measurements in a typical data range were shown with box plots. All things considered, this IoT-enabled insight into crop conditions can move focused initiatives to improve outcomes. In smart agriculture, such field data are used to guide specific actions, such as irrigation when the soil is too dry. According to the findings, these sustainable agricultural practices that maximize water use and use land efficiently will be essential to ensuring food security in the future

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