

Role of Internet of Things in Modern Day Farming

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Introduction

With the world's population growing by the day, according to UN Food and Agricultural Organization sources, the world needs to increase food production by 70% by 2050, compared to current statistics. However, with the shrinking of agricultural land and changes in the climate that support farming due to dwindling natural resources, the agricultural sector is experiencing a downtrend, with many traditional farmers looking to other sectors for sustainability, which is a concerning situation.

To address workforce issues, many of them began automating agricultural processes through the use of machinery and technology. One such technology is Internet of Things (IoT), which is used to fill gaps in the supply-demand chain. This technology paved the way for farmers to increase crop yield and profits while also addressing environmental concerns. IoT Technology in agriculture has resulted in advancements in the development of smart machinery, wireless connectivity, and the use of IT services.

Intelligent farming based on IoT technology assists farmers in increasing productivity by taking into account critical parameters such as keeping track of soil testing, understanding environmental conditions, the amount of fertilizer used, the number of times agricultural vehicles were used, and the use of resources such as water and electricity.

Assessing these parameters assists them in improving their business and increasing their efficiency. The use of sensor technology in conjunction with IoT enabled them to gain knowledge on crop health and monitor the condition of the field from any location. Because it has addressed many issues in traditional farming procedures, smart farming has become an obvious choice for many of them. In the following sections, we will look at how IoT has changed the agriculture sector in various ways.

Agriculture Sensors

This section focuses on various sensors used in agriculture, also known as agriculture sensors. Based on their usage and application, these sensors can be classified into several types. The table 1 below shows a variety of sensors and their applications.

Table 1. A Variety of Sensors and Their Applications [URL-1].

Agriculture Sensors	Usage and Application
Placement Sensors	The latitude, longitude, and angle of any location within the required area are determined by these sensors. For this, they use GPS satellite help and support.
Laser Sensors	These sensors measure the soil's characteristics using light. To measure the amount of clay, organic matter, and moisture in the soil, they are mounted on satellites, drones, or robots.
Sensors based on electro-chemical	These sensors aid in the collection of chemical data from soils by accurately identifying charged particles in the soil. They supply data in the form of pH and soil nutrient concentration.
Machine-based Sensors	These sensors are used to gauge mechanical resistance or soil compaction.
Detectors of Dielectric Soil Moisture	These sensors gauge soil's dielectric constant to determine moisture levels.
Sensors for Air Flow	Air permeability is measured using these sensors. They can be utilised in mobile or fixed positions.

Sensors of light

Optical sensors, as its name suggests, use light to detect the characteristics of the soil. They are able to ascertain the soil's organic matter, clay content, and moisture content. Satellites, robots, and drones all use this sensor. There are a variety of commercially accessible optical sensors with slightly different traits and structures.

Sensors based on electrochemistry

Two of the most important soil factors to examine are the pH levels and nutrient content. These sensors use electrodes to measure the voltage difference between two locations in order to calculate the maximum ion concentration like H^+ , K^+ , NO_3^- , and others. In order for this method to function, the electrode needs to be in contact with the soil sample. Chemical soil analysis is the customary process, which is time-consuming and expensive. ISFET stands for ion selective field efficient transistors and chemically modified electrochemically active area efficient transistors. ISE is for ion-selective electrode.

Sensors for location

Using GPS, location or inertial measurement units are utilised to properly map farms. Farmers use these tracking devices to determine where and how much pesticides and fertiliser to apply. This can be used to identify irregular landscapes, uneven ground, and leveling issues that cause water logging, among other things.

Sensors for airflow

Sensors that measure airflow are used to gauge soil air permeability (Figure 1). How well soil prevents air escaping all over it is determined by its permittivity. The kind, shape, and water content content of the soil can all be determined using this component. In these sensors, silicon chips measure temperature and heating. They adjust their direction and speed in response to wind and gases moving thru the soil.

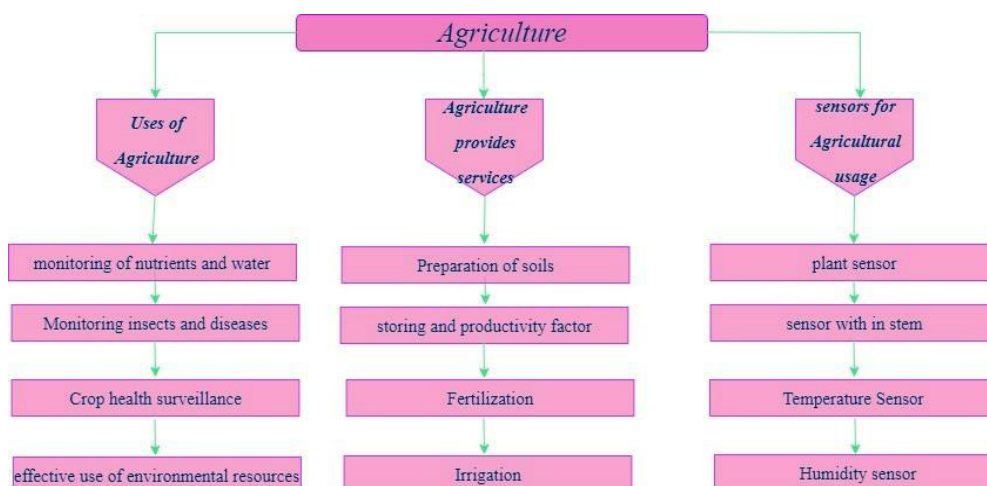


Figure.1. Agriculture related sensors, services, and applications

These sensors help with conserving and field mapping, which leads to higher productivity. They are easier to use and less expensive. Farmers can use these agricultural sensors to take an innovative and data-driven approach to each and every stage of the crop's life span, from seed production to cultivation. Field and IoT sensor data can be linked and incorporated into the centre console of any responsive system that delivers real-time farm analysis..

Drones for Agriculture

The recent agricultural revolution has been fueled by precision farming. Agronomists, agricultural engineers, and farmers are turning to unmanned aerial vehicles (UAVs) to acquire extra successful crop insights and more precisely plan and manage their operations, and crop monitoring from the air with farmland drones appears to be the next big thing. Global positioning system (GPS) technology and geographic information system (GIS) tools are heavily used in precision farming techniques to empower fine scale monitoring and mapping of yield and crop parameter data within fields. These provide more intensive and effective farming techniques, enabling farmers to modify fertilizer application recommendations or spot crop diseases early on. With more data at their disposal, farm owners can make choices based on both economic and environmental factors. For instance, increase the project and environmental savings can be actually realized by maximizing fertilizer care and attempting to implement only the proper level at the right time (URL-2).

There isn't a single agricultural mapping drone that works for everyone. Thinking about the particular use case is the first step in selecting the best drone for agricultural use. When choosing a drone for a particular application, it's crucial to take into account its cruise speed, form factor, payload capacity, physical range, and flight time with sensor payload. From emergency and early growth assessments to yield forecasting before harvest, durable drone technology adds value throughout the growing season. Drones typically fly at a height of 150 meters above the ground while taking pictures

with cameras. The image resolution on the ground with this flight height and camera is approximately 30 cm per pixel. Then, for large fields, this data is revised down to one metre per pixel in order to shorten delivery time. The drones map crops at a rate of about three hectares per minute, depending on the size of the field.

Crop non-visible data are gathered by a camera with multi-spectral sensors in four different portions of the spectrum: green, red, red-edge, and near infrared. Agronomists are then able to provide a precise crop evaluation for each square meter of a farmer's field using the highly accurate maps created from this data. The amount of dry matter in the field and nitrogen absorption at crucial stages of crop development are determined using data from the drone in Figure 2.



Figure 2. Dusting/Spraying with Drones

When contrasted to farms studied utilising conventional, nondrone methods, drone utilisation led to an average higher yield of 10%. By 2024, 200,000 agricultural drones will have been shipped, and the market will be worth over \$1 billion, predicts Global Market Insights. According to GMI, farmers' increased awareness of the advantages and disadvantages of employing drones in agriculture will contribute to the growth through 2024.

The following agricultural drones are offered for sale commercially:

- Precision Hawk's DJI Matrice 200 v2: Since working with DJI in 2016, Precision Hawk has prospered in the industry and is a well-liked drone option for farmers.
- The M200, according to Precision Hawk, is perfect for "the hardest farming settings" since it has sophisticated obstacle detection and can operate in below-freezing temperatures.
- SenseFly's eBee SQ is marketed as a "sophisticated agriculture drone," and the company's own emotion software, which makes developing a flight plan simple, is its key selling feature.
- In a single trip, the drone can record footage covering hundreds of acres.
- Sentera PHX Complete System: The PHX can gather data from 700 acres and features a lengthy unidirectional communication link.

Farmers can increase operational effectiveness and carry out plant health analytics thanks to SenetraUnmanned aerial vehicles (UAVs) are quickly becoming acknowledged as a more precise and costeffective alternative to satellites and manned aircraft, which have historically been employed to monitor farmland. Studies show that even on overcast days, drone imagery has a greater rate of accuracy and resolution. Accurate crop health checks utilising UAVs can be done all year round, but traditional terrestrial approaches to data collecting in difficult weather conditions could possibly delay projects for days.

Livestock Monitoring

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Figure 3. Monitor and manage huge livestock

Common issues in the livestock sector include animals ingesting harmful materials like plastic and getting sick, a high animal fatality rate, no record of livestock if there are a lot of them, and if a farm animal goes missing there is no way to know where they went and therefore no record. A cuttingedge solution called a livestock monitoring system is created and constructed utilising sensors, GPS, and other technologies that are all combined with a protocol stack for communication.

Using this surveillance device, farmers can keep an eye on their livestock from a distance. The tracker gadget, which can be fastened to collars, can keep an eye on the wellbeing of the animals as well as their chewing habits, geographic information, and pasture management. The Internet of Things-enabled cattle monitoring system could be a boon to livestock farming. It aids in the administration of farm animals as well as other farm equipment.

IoT-enabled herd management solutions provide data on numerous facets of cattle health.

Animals' position, temperature, pulse rate, and heart rate are tracked via a wearing collar or tag with sensors, which wirelessly communicates the information to farmers' devices in almost real-time. Each of the farm animals has a movable tracker on them. To avoid sticking out from the animal's body, the tracker gadget is made to be compact and low in weight. The device includes a GPS tracker and sensors that enable round-the-clock monitoring of the animals' movements and well-being. The technology is designed to monitor the behaviour of livestock. Farmers can use the system's behavioural tracking capability to see what their cattle are consuming. In addition to the equipment, there are mobile apps, online apps, and IoT Dashboards. Farmers may safeguard areas where cattle can wander freely by using the smartphone's associated application to establish virtual borders with geofencing. The tracker notifies the mobile application if the cattle departs from the predetermined bounds.

If the livestock ingest something harmful or unsuitable, it will also transmit alarms. In this way, farmers may prevent disease in their cattle. The system can run on LPWAN, which is widely available and guarantees proper connectivity. LPWAN protocols come in a variety, and the one picked depends on the application.

Farms today have a lot of animals, making direct connection between personnel and all of the animals unfeasible. It can be used to track farmed equipment to avoid theft. IoT-enabled livestock monitoring makes it possible to remotely monitor all animals and offers reliable data on each one on the farm.

GPS Tracking of Livestock Movement

These days, it's crucial to observe animal behavior and their movements. The whereabouts of cattle may be followed around-the-clock, every day of the week, thanks to the livestock monitoring system. A lost animal can also be found and saved right away. The solution makes it simple to set up grazing borders for cows and other farm animals by integrating a GPS tracker with a geofencing capability.

Monitor Livestock Health

In order for us to obtain nutritious goods from cattle, the animals must be in good health. The cattle remote monitoring assists in keeping track of the wellbeing of the cattle. To make smarter choices about cattle weight, timing of meals, and other issues, the feeding pattern can be observed. It is possible to monitor the time and behavior of the medication as well as the birthing, lactation, and other events if cattle become ill, such as lameness. If livestock are properly fed and digested, they can produce milk that is more nutrient-rich. Animals can receive better care if feverish symptoms are caught early thanks to temperature sensors.

Lower the Livestock Mortality Rate

Farmers may force their animals to consume antibiotics or steroids in order to obtain additional products from farm animals. These antibiotics can harm livestock in ways that can result in the animal's death. With the livestock monitoring system, you can

track your livestock's eating habits and provide them with nutritious feed to produce better results. In addition, if farm animals become ill, the illness can be detected and treated before it is too late. In this way, the monitoring system contributes to lower livestock mortality rates.

Livestock Identification and Better Security

With livestock monitoring systems, animal identification becomes easier. You can easily track birth information, breed, identification marks, and so on. The livestock's production history can be tracked. The tags make it easier to identify the livestock and improve their security. This can reduce the likelihood of theft and lost cases (URL-3).

Pasture Management Improvement

The livestock monitoring system can help to improve the pasture or grass that animals eat. Farmers can track the movement of the animals as well as the area in which they graze. Animals will eat better grass as a result, and we will get better products from them. It will increase the profit earned by farmers from livestock

GEO Fencing

Crop destruction caused by wild animal intrusion into farm fields has recently become a common challenge for farmers all over the world. Wild animals straying into farm fields and squashing crops are becoming more common, posing an economic challenge for farmers. Animal intrusions cause crop damage; therefore, farmers must be constantly vigilant to protect their crops. Farmers suffer a significant loss of crops and resources required for crop expansion as a result of this. As a result, preventing animal aggression is critical for crop protection. This problem can be addressed with the aid of a WSN (Wireless sensor network). Together with the IoT (Internet of Things), the sensor network lets the farmers stay connected to their farms anytime, anywhere. Emerging IoT technology with IoT devices can be used to capture wild animal detection and environmental information for human observations through the smartphone application. The IoT enhances things to be detected and/or remotely controlled through the current network infrastructure, generating opportunities for more direct interaction with the physical environment through computer-based systems and contributing towards precision, performance, and economic benefits.

Smart Green Houses

The world's agriculture sector is under intense strain as a result of climate change, diminishing resources, and rising population. It should come as no surprise that growers are utilizing cutting-edge techniques to enhance crop resiliency and operational efficiencies as the degree of unpredictability rises. Smart greenhouses serve as a perfect example of how the Internet of Things (IoT) is much more commonplace nowadays in agriculture. A greenhouse offers a regulated environment that is tailored to the needs of the vegetation being grown within. Microclimate and agronomic factors have

historically been recorded somewhat manually and unevenly. What can be quantified has a limit, and farming operations follow a predetermined, speculative schedule. On the other hand, the climate in the greenhouse is constantly influenced by changing weather patterns and “invisible” factors like doors open or early-stage infections that could harm crops. Smart greenhouses, which are outfitted with contemporary sensor and communications technology, automatically record and disseminate information on the environment and crop around-the-clock. In order to find bottlenecks and anomalies, collected data is sent into an Iot ecosystem where analytical algorithms transform it into useful insight. As a result, on-demand control over HVAC, lighting, and irrigation as well as spraying operations is possible. The creation of predictive models to evaluate the risks of agricultural disease and infection is made easier by continuous data monitoring. A smart greenhouse enables growers to optimize yield rates while reducing labor requirements and increasing resource and chemicals use efficiency in Figure 4 (URL-4).

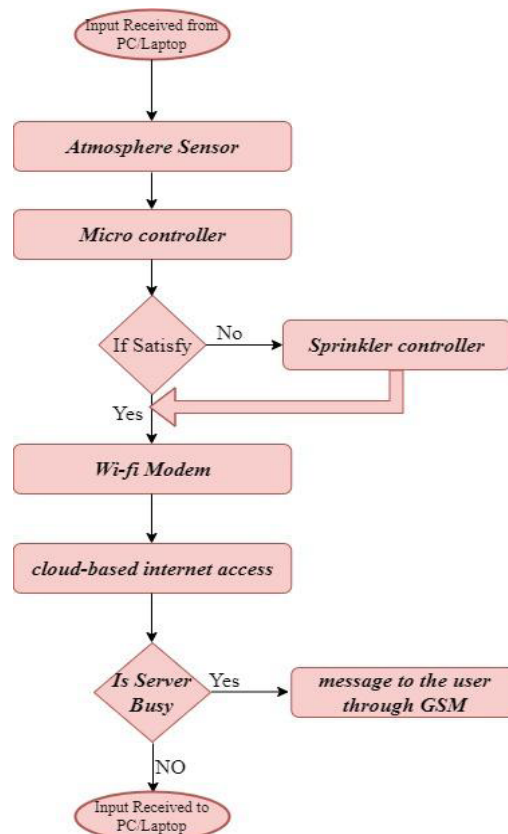


Figure 4. Flowchart of Smart GreenHouse

Keep optimum microclimatic conditions.

Farmers may gather multiple data points with previously unheard-of granularity thanks to IoT sensors. In the greenhouse, they offer real-time data on important climate variables like temperature, humidity, light exposure, and carbon dioxide. The ideal conditions for plant growth are maintained while promoting energy conservation thanks to the data that prompts pertinent adjustments to HVAC and lighting settings. To maintain a strictly controlled atmosphere, motion/acceleration sensors assist in identifying doors that are mistakenly left open.

Improve Fertilization and Irrigation Techniques

Farmers can monitor agricultural status as well as environmental measurements thanks to intelligent conservatories. This ensures that fertilization and irrigation practices are in accordance with the actual requirements of grown plants for best yields. Soil volumetric water content measurements, for instance, can indicate that crops are under moisture stress. Similar to that, measurements of soil salinity assist determine whether fertilization is necessary. With the least minimum of user input, watering and sprinkling systems can be programmed to respond automatically to the group's needs in real time.

Infection control and disease outbreak prevention

Harvest disease is a recurring problem for farmers, with every epidemic having a negative impact on crop margins. Although farmers have access to agrochemical treatments, they frequently don't know when to use them. A failure to utilize treatments could result in harmful disease outbreaks, whereas applications performed too frequently create ecological, safety, and financial problems. Data on greenhouse settings, outside weather, and soil properties are combined with a machine learning platform to gain significant insights into current insect and fungal concerns. By using this knowledge, farmers may use the least amount of chemicals while still providing a healthy crop.

Improve Security and Prevent Theft

Crops grown in greenhouses with high value are a tempting target for burglars. Many farmers lack a reliable security system since installing typical CCTV surveillance networks is expensive. In this situation, Wearables in smart greenhouses offer a cost-effective infrastructure to track door status and spot shady activity. When a safety issue occurs, they immediately alert growers because they are connected to an automatic alarm system.

Components of an Intelligent Gardener

What therefore is required to put a smart greenhouse in place? There are a few crucial aspects you need to consider:

- a) Battery-powered, low-power sensors that can record different meteorological, agronomic, and safety datasets
- b) Trustworthy, affordable wireless communication to send information from cross-greenhouse detectors to a distant gateway
- c) A diagnostic deep learning platform that extracts information from sensor data and presents it on preferred UIs to enable decision-makers to make well-informed decisions about farming activities. The platform can be quickly integrated with conservatory control systems that have already been put in place to get HVAC, illumination, watering, and sprayer networks working on their own.

Because they are spread out over large geographic areas, advertising greenhouses facilities need protracted wireless connection with excellent penetration capabilities. By using this method, a gateway can be placed closer to the power source, saving money

on trenching for wires while assuring dependable data delivery. Scalability, which minimizes the number of ports necessary to reduce the cost of hardware, installation, and operation, is another factor to consider.

Predictive Analytics

The agricultural value chain provides a wide range of use cases and specific applications for analytics. Analytics solutions make use of Big Data, IoT, Cloud, GPS, and other technologies to produce pertinent data from which actionable insights can be derived. Farmers and financial institutions may now make much better information decisions thanks to this. Basic data from Information Management Systems should be requisitioned to unleash the potential of analytics. In order to reap the benefits, this will ultimately encourage smart farming and better decision-making. The benefits of analytics-enabled smart farming are outlined in the framework shown in Figure 5.

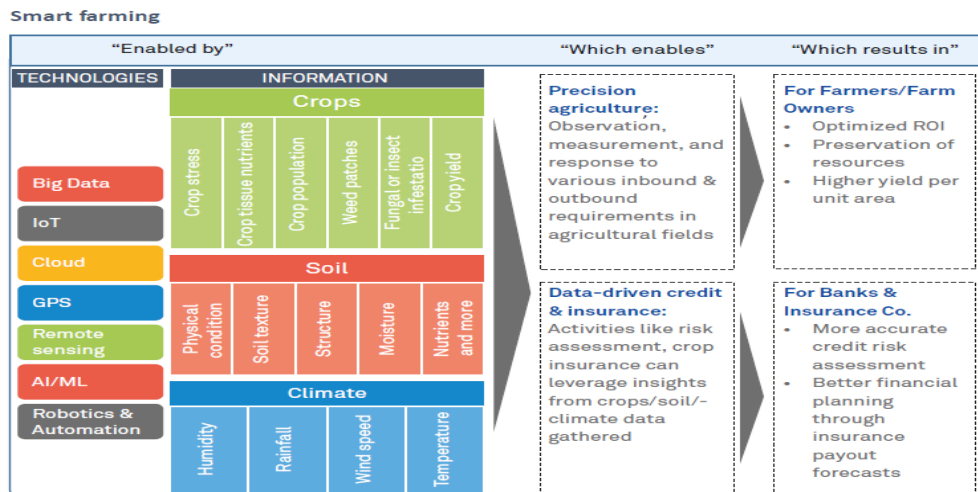


Figure 5. Information of Management system

Challenges in Building The IOT Platform

IoT technology and smart farming both demand constant internet access. In many other parts of the world as well as underdeveloped nations, this is not accessible. Market speculation holds that consumers aren't always eager to acquire the newest Internet of Things gadgets outfitted with agricultural sensors. There aren't always the necessary pieces of infrastructure, such smart grids, transportation systems, and cell towers. This makes it more difficult for its use to increase. Above all, the link needs to be very energy-efficient so that sensors can be left in place for years with little need for upkeep.

Conclusion

According to FAO forecasts, the globe would need to produce 70% extra foodstuff in 2050 as the human population grows exponentially. As a result, increasing crop yields becomes crucial. As a result, IoT may play a significant role in this process. Farmers and ranchers can now practise smart farming thanks to the use of IoT. Smart farming has two advantages: farmers can spend less time in the fields while increasing crop yields.

In a nation like India, in which farming is the foundation of the business and the industry is founded on it, this contemporary farming strategy has the ability to usher in a new era of agricultural revolution and pave the way for progress. Additionally, the utilization of various sensor types in IoT is illustrated using general scientific principles. This study's objective was to introduce the Internet of Things and discuss how it might be applied to agricultural practices. The main objective was to provide a more thorough explanation of the various agricultural sensors utilized to gather data. The advantages of many frequently made sensors were briefly discussed. The report also covered the uses, advantages, disadvantages, and restrictions of agricultural sensors.

References

- Sai Xu, Xiuxiu Sun, Huazhong Lu, Hui Yang, Qingsong Ruan, Hao Huang and Minglin Chen, (2018) Detecting and Monitoring the Flavor of Tomato (*Solanum lycopersicum*) under the Impact of Postharvest Handlings by Physicochemical Parameters and Electronic Nose, MDPI,.
- A. Bseiso, B. Abele, S. Ferguson, P. Lusch, and K. Mehta, (2015) "A decision support tool for greenhouse farmers in low-resource settings," in Global Humanitarian Technology Conference (GHTC), 2015 IEEE, pp. 292–297.
- K. A. Czyzyk, S. T. Bement, W. F. Dawson, and K. Mehta, (2014) "Quantifying water savings with greenhouse farming," in Global Humanitarian Technology Conference (GHTC), 2014 IEEE, pp. 325–332.
- Z. Xiaoyan, Z. Xiangyang, D. Chen, C. Zhaohui, S. Shangming, and Z. Zhaohui, (2013) "The design and implementation of the greenhouse monitoring system based on gsm and rf technologies," in Computational Problem-solving (ICCP), 2013 International Conference on,, pp. 32–35.
- M. Mahdavian, M. B. Poudeh, and N. Wattanapongsakorn, (2013) "Greenhouse lighting optimization for tomato cultivation considering realtime pricing (rtp) of electricity in the smart grid," in Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), 2013 10th International Conference on,, pp. 1–6.
- Demmers, T.G., Gauss, S., Wathes, C., Cao, Y., Parsons, D., et al., (2012). Simultaneous monitoring and control of pig growth and ammonia emissions. In: The Ninth International Livestock Environment Symposium (ILES IX). International Conference of Agricultural Engineering-CIGR-AgEng 2012: Agriculture and Engineering for a Healthier Life, Valencia, Spain, 8-12 July 2012. CIGR-EurAgEng.

Dr. K. Gayathri Devi, N.Sowmiya, R.K.Yasoda, Dr.K.Muthulakshmi, B.Kishore, (2020) Review On Application Of Drones For Crop Health Monitoring And Spraying Pesticides And Fertilizer, Journal of Critical Reviews, ISSN- 2394-5125, Vol 7, Issue 6,.

S.R.Kurkute, B. D. Deore, Payal Kasar, Megha Bhamare, Mayuri Sahane, (2018) Drones for Smart Agriculture: A Technical Report, International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653, Volume 6 Issue IV,.

[URL-1]: <https://www.analyticssteps.com/blogs/5-applications-iot-agriculture>

[URL-2]: <https://tropogo.com/blogs/application-of-drones-in-agriculture-in-india>

[URL-3]: <https://www.digitalmatter.com/applications/livestock-tracking/>

[URL-4]: <https://www.community.ruggedboard.com/post/iot-smart-agriculture>

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