**Smart IoT Applications for Growing Agriculture Business.**

Dr. Priti Subramanium

Assistant Professor: dept. of Computer Science and Engineering

Shri Sant Gadge Baba College of Engineering & Technology Bhusawal, India.

Email Id: pritikanna559@gmail.com

Dr. Gajanan Uttam Patil

Assistant Professor: dept. of Electronics and Telecommunication

Shri Sant Gadge Baba College of Engineering & Technology Bhusawal, India.

Email Id: gajanan.bsl @mail.com

## ABSTRACT

With the increasing adoption of the Internet of Things (IoT), connected devices have penetrated [every facet of our life](https://easternpeak.com/blog/6-cool-examples-of-internet-of-things-applications-and-how-to-develop-one/), from fitness and health care, [automotive](https://easternpeak.com/blog/connected-cars-top-5-iot-automotive-apps-and-how-to-develop-one/), home automation, and logistics, to industrial IoT and smart cities. Therefore, it makes sense that IoT, linked devices, and automation will find use in agriculture and as a result, significantly improve almost every aspect of it. In recent years, farming has seen a significant amount of technical change that appears to be more industrialised and technology-driven. Farmers can benefit from increased control over the process of producing livestock and cultivating crops by using a variety of smart agriculture tools, which also increases predictability and efficiency. As a result, the global spread of smart farming technologies has expanded along with the rise in consumer demand for agricultural products. The IoT market share in agricultural grew to $5.6 billion in 2020.

**Keywords**— IoT,AI, ML, GPS, ICT

## INTRODUCTION

An emerging idea called "smart farming" advocates abandoning conventional farming practises in favour of embracing technology. To increase the amount and quality of the harvest, it makes use of geospatial AI approaches along with robots, IoT, drones, and AI. These days, efficient farming also emphasises the best use of labourers. Thanks to incredible breakthroughs in AI and IoT devices, smart farms, which use these technologies, are no longer just a distant fantasy but rather a reality. The agriculture industry has changed significantly over the last few decades, and today it is possible to produce plants even in the most inhospitable climate zones. cultivation of crops that are better able to withstand weeds, insects, and climate change

 [1].

## SMART FARMING

The idea of "smart farming" aims to make the practise dependable, sustainable, and predictable. Although smart farming is still one of the farming industry's top priorities, using conventional farming techniques frequently makes it impossible to achieve this goal. But with to innovations in the internet of things, robotics, drones, sensors, and actuators, this transformation is a thing of the past. Utilising a variety of technologies, such as UAVs, AI, machine learning, robotics, and IoT, smart farming management oversees agricultural operations, reduces the need for human labour, and increases the quality and output of agricultural products. These applications give farmers complete control over the level of activity on their farms. Additionally, it helped them make decisions that would show off their cattle and harvests. Internet use is coupled with smart farming.

Farmers may now manage their fields using a variety of technology, such as satellite imagery, geographic information systems, and GPS location systems.

1. To track sensors for humidity, water levels, soil pH, sunlight, and temperature.

2. Software designed specifically for agriculture that combines agronomy and cybernetic to make farm management 3. Use of cellular IoT solutions and low-power wide-area networks (LPWANs) for communication.

4. Real-time information on crop and animal health is made available to farmers via data analysis systems.hassle-free.

Precision agriculture, sometimes known as smart farming, is one of the major application cases of spatial data science. It envisions using the satellite images and LandSat data of fields to anticipate weather and make forecasts about crop health. Future applications like artificial intelligence and machine learning have the potential to reduce this gap. In order to enable farm management and boost production, the AgTech sector is developing ways to use satellite imaging data, Landsat data, IoT data, visual image, and drive through spatial analytic methodologies. Finally, it will improve agricultural productivity and efficiency while lowering food production costs. Nowadays, there are many AgTech startups that want to benefit investors by adding farmland to their portfolios of investments.

**A. Smart farming versus conventional farming methods**

 Smart farming differs greatly from traditional agricultural practises. Let's look into the traditional vs. smart farming argument.

**B. Predicated on Farming Methods**

 With conventional techniques, crop output is uniform throughout the region. To ensure resource optimisation, smart farming techniques go one step further and investigate potential crops and their water needs.

**C. Depending on Maintenance**

 In traditional farming, the field data is manually kept, which may result in mistakes. There is no possibility of foreseeing soil issues. Intelligent agricultural practises aid in overcoming this challenge and avert financial losses.

**D. Using Fertiliser and Pesticide Use**

 Farmers that practise smart farming techniques adjust their usage of fertilisers and pesticides as necessary. Such opportunities do not exist in conventional farming. Systems for distributing fertiliser make crop recommendations based on soil sample data and NPK (nitrogen, phosphorus, and potassium) concentrations, as well as forecast yields.

**E. Using satellite-based imaging**

 A clever agricultural approach aids in locating impacted regions so that remedial action may be taken. Traditional farming cannot use zone detection, geotagging, or related technologies. Satellites and associated imaging data may monitor soil parameters, such as moisture content and ground temperature, to identify the best circumstances for growing crops when we talk about the impacted areas. Additionally, satellite photography may be used to monitor a farm's natural surroundings. enabling more precise targeting of insecticides and fertilisers.

**F. Using Predictions of the Weather**

 Farmers are unable to anticipate the weather using conventional ways due to a lack of technology. Smart technology aids in weather analysis and forecasting to prevent agricultural damage from excessive rain or drought. Similar to this, pest attack prediction models allow for planning ahead for the anticipated onslaught.

**G. Problems with Smart Farming**

 Tools like satellite imaging data and Landsat data are used to describe the landscape of agriculture and the food sector. They portend well for implementing agriculture in a sustainable way, which can provide food security. It will also be possible to produce food without harming the environment. It does not, however, come without its fair share of difficulties.

## IOT DEVICE ENABLEMENT

 Only until processing power grows and sensor energy consumption falls can IoT truly function at its best. The gadgets won't become energy independent till then. Additionally, smart features that provide self-configuration and self-management are required for devices. There is desire for these sensors to be affordable while also taking the financial element into consideration. If the price of the food product is on the cheap side, it might not always be possible to include sensors with RFID and NFC tags. Focusing on device attributes is also necessary due to decreased advantage margins.

1. **System operations**

 Devices with stable standards and proprietary designs have an opportunity for mainstream adoption. It is as a result of problems like system compatibility component. There are instances where systems having standards don't need to be modified.

1. **Network accessibility**

 High-grade connectivity choices are required for IoT devices to work at their best. There is a connection issue when IoT techniques are used in farms located in remote regions. It makes the case for the requirement of communication devices that can run on lower power.

1. **Advanced Data Capabilities**

 IoT devices may produce a lot of data, therefore it's crucial to draw insights from that data. The agriculture industry's degree of data generation is still in its infancy, though. The Decision-support systems work best with data that already exists. Innovative data, such as that used in production planning and predictive modelling, is still a far shot.

**D. Security of Data**

 Anytime there is data, there is always anxiety over its security. Protecting sensitive data related to predicting crop yield and soil fertility is necessary. Such data is best processed and stored using cloud-based technologies. The security of individual farm data must be taken into consideration when combining data from several farms.

**E. System Operations**

 Devices with proprietary architectures and fixed standards pose a situation for widespread adoption. It is because of issues like compatibility constituent with other systems. There is a situation to find systems with standards that do not require any modifications.

**F. Network accessibility**

 High-grade connectivity choices are required for IoT devices to work at their best. There is a connection issue when IoT techniques are used in farms located in remote regions. It makes the case for the requirement of communication devices that can run on lower power.

**G. Advanced Data Capabilities**

 IoT devices may produce a lot of data, therefore it's crucial to draw insights from that data. The agriculture industry's degree of data generation is still in its infancy, though. The data currently available works well with decision-support systems. Innovative data, such as that used in production planning and predictive modelling, is still a far shot.

**H. Data Security**.

 Anytime there is data, there is always anxiety over its security. Important details for estimating crop production and soil quality Fertility requires defence. Such data is best processed and stored using cloud-based technologies. The security of individual farm data must be taken into consideration when combining data from several farms.

## GROW AGRICULTURE BUSINESS WITH SMART IOT SOLUTIONS FROM EASTERN PEAK

By 2050, the UN Food and Agriculture Organisation (FAO) projects that there will be more than 9 billion people on the planet. Agriculture output volumes must rise by 50% to produce adequate food for the current population. The only method to increase volume in agricultural operations is to boost production efficiency because the available resources are limited (the majority of areas suitable for farming are already in use). There is no doubt about the extent to which smart farming can assist in meeting this need; in fact, it would appear that it would not be feasible without it. At Easterly Peak, we provide specialised IoT solutions for agriculture that are catered to your specific requirements.

According to estimates from the UN Food and Agriculture Organisation (FAO), there will be more than 9 billion people on the earth by 2050. For agriculture to generate enough food for the existing population, production volumes must increase by 50%. Increasing production efficiency is the only way to expand agricultural operations because there aren't many resources accessible (the bulk of land suitable for farming is already occupied). There is no question about how much smart farming can help in fulfilling this demand; in fact, it seems like it wouldn't be possible without it. We at Easterly Peak offer specialist Internet of Things (IoT) solutions for agriculture that are tailored to your unique needs.

You may define the project's complete scope and create a roadmap using the product discovery phase. You can also set a clear budget for your MVP and organise your resources.

• test the waters with your audience by utilising a prototype sensory system.

• create an effective investment pitch[2].

**Top of Form**

**Bottom of Form**

1. **Devices Used for Smart Farming**

Here is a list of several tools that are frequently used for data analysis in smart farming.

1. Sensors for soil testing: They measure the soil's moisture and water content to determine if it is suitable for growing crops.

2. Humidity sensors: By determining the soil's moisture content, they assist farmers in assessing the health of their crops.

3. Farmers use permafrost testers to examine and validate the existence of permafrost surfaces in the soil.

4. Nutrient sensors: They aid in determining the soil's nutrient content to improve crop yield.

5. Precision harvesters: They increase the effectiveness and economy of harvesting activities.

6. Sprinklers: They aid in providing crops with the best irrigation possible.

7. Drones: Farmers may use drones to monitor crop growth and improve agricultural operations[3]

Farmers can precisely calculate the quantity of pesticides and fertiliser they must apply to achieve maximum efficiency, for instance, by employing smart farming techniques where sensors are used to monitor the condition of crops. The definition of smart farming uses the same methods.

The market is still quite impulsive even if smart farming IoT and industrial IoT in general aren't as popular as consumer-related gadgets. IoT technology is increasingly being used in agriculture. In particular, COVID-19 has a beneficial effect on IoT market share in agriculture. The supply chain's interruptions and a shortage of trained staff have driven up the CAGR to 99%. In fact, according to current farming data, the market share for smart framing is anticipated to reach $6.2 billion by 2021.

At the same time, it is anticipated that the global smart farming market would triple in size by 2025, from a little over $5 billion in 2016 to $15.3 billion.

Because the industry is still growing, there are still plenty of opportunities for companies who want to participate. In the upcoming years, creating IoT goods for agriculture can help you stand out as an early adopter and, as a result, pave the road for success. [3]

1. **The Benefits of smart farming**

 IoT technology have the potential to change several facets of the agriculture industry. There are specifically 5 approaches to enhance IoT agriculture:

• Data, a tonne of data, gathered by sensors used in smart farming, such as weather conditions, soil quality, crop growth status, or cow health. This information may be utilised to track the overall health of your company as well as employee productivity, equipment effectiveness, etc.

• Better internal process control, resulting in decreased production risks. With the ability to predict your production's results, you can make better distribution plans for your products. You can ensure that your goods won't sit on the shelf unclaimed if you know exactly how much of your crops you will harvest each year.

• Cost management and waste reduction made possible by the increased the ability to direct production. You will be able to reduce the likelihood of losing your produce if you are able to spot any irregularities in crop growth or livestock health.

• Enhanced operational effectiveness thanks to process automation. You may alter a number of processes involved in your production cycle utilising smart devices, such as irrigation, fertilisation, and insect control.

• Increased production quantities and quality. using automation, improve control over the production process and uphold greater criteria for crop quality and growth potential [2].

All of these elements can therefore result in increased income.

Let's look at how the stated advantages may be used in daily life now that we have outlined how IoT can be usefully implemented in the field of agriculture.

**C. IoT application cases in agriculture**

 IoT sensors for agriculture and IoT applications in agriculture often come in a wide variety of forms:

**A. Climate conditions are being monitored**

The weather stations that incorporate numerous smart farming sensors are perhaps the least common smart agricultural technology. They are spread out around the area and gather various environmental data before sending it to the cloud. Using the measurements supplied, one may map the climatic conditions, select the appropriate crops, and take the necessary steps to increase their capability (for example, precision farming). The agricultural Internet of Things (IoT) gadgets allMETEO, Smart Elements, and Pycno are a few examples.

**B. Automation of greenhouses**

 In most cases, growers manage the greenhouse environment manually. They may now obtain very accurate real-time information on greenhouse conditions, including lighting, temperature, soil quality, and humidity, thanks to the deployment of IoT sensors. Weather stations may autonomously change the circumstances to reflect the specified criteria in addition to sourcing environmental data. Automation solutions for greenhouses often operate on a similar premise.

Examples of IoT agriculture products with these features are Farmapp and Growlink. Another intriguing device that makes use of smart agriculture sensors is GreenIQ. With this intelligent sprinkler controller, you can operate your lighting and irrigation systems from a distance.

**C. Crop management**

Crop management is another IoT product category for agriculture and another aspect of precision farming. devices. They should be set up in the field, much like weather stations, to gather information pertaining to crop farming, such as temperature and precipitation as well as leaf water potential and general crop health. As a result, you can keep an eye on both the development of your crop and every individual to successfully ward off any illnesses or pest infestations that might reduce your harvest. Arable and Semios are excellent examples of how this use case may be put to use in practise.

**D. Management and observation of cattle**

 There are IoT agricultural devices that may be connected to the animals on a farm to monitor their health and track performance, just as crop monitoring. Data on the health, wellbeing, and physical location of livestock are gathered through live stock following and monitoring. Such a sensor component, for instance, might identify sick animals so that farmers can remove them from the herd and prevent contamination. Farmers may save labour costs by using drones to follow cattle in real time. This operates similarly to IoT pet care gadgets. SCR by Allflex and Cowlar, for instance, uses smart agricultural sensors (collar tags) to provide data on the temperature, health, activity, and nutrition of each individual cow as well as the herd as a whole.

**E. Precision agriculture**

 Precision farming, sometimes referred to as precision agriculture, is all about effectiveness and making precise data-driven decisions. It's also one of the most popular and successful IoT uses in agriculture. Farmers may gather a vast array of information about every aspect of the field ecosystem and microclimate with IoT sensors, including illumination, temperature, soil quality, humidity, CO2 levels, and insect infestations. This information enables farmers to approximate the ideal water, fertiliser, and pesticide requirements for their crops, cut costs, and produce better, healthier harvests. For instance, CropX creates Internet of Things (IoT) soil sensors that assess soil moisture, temperature, and electric conductivity, allowing farmers to tailor their practises to the particular requirements of each crop. When combined with GIS information, this technique aids in producing accurate soil maps for every area. Similar services are provided by Mothive, which assists farmers in increasing agricultural sustainability by lowering waste and increasing yields.

**F. Agricultural drones**

The use of agricultural drones in smart farming is possibly one of the agritech developments that is most likely to occur. Drones, sometimes referred to as UAVs (unmanned aerial vehicles), are more suited than satellites and aircraft to gather agricultural data. Aside from surveillance, drones may also carry out a wide range of jobs that traditionally needed human labour, such as planting crops, battling illnesses and pests, spraying for agriculture, monitoring crops, etc.

### G. Predictive analytics for smart farming

 Predictive data analytics and precision agriculture go hand in hand. Even while IoT and smart sensor technologies are a gold mine for very useful real-time data, using data analytics helps farmers make sense of it and make critical forecasts, such as when to harvest crops, the likelihood of illnesses and pests, yield volume, etc. Tools for data analytics can make farming, which is innately very dependent on weather, more manageable and predictable. For instance, the Crop Demonstration platform enables farmers to access yield volume and quality as well as their susceptibility to unfavourable weather circumstances like floods and drought in advance. Additionally, it alters the amount of water and nutrients that farmers provide for each crop and even allows them to choose a yield attribute to enhance quality. Solutions like SoilScout, when utilised in agriculture, allow farmers to save up to 50% on irrigation water, reduce fertiliser loss due to overwatering, and provide actionable data regardless of the time of year or weather.

**H. End-to-end farm management systems**

 The so-called farm productiveness management systems may be viewed as a more complicated method of IoT production in agriculture. They often feature a number of on-site sensors and IoT devices for agriculture, as well as a potent dashboard with analytical capabilities and built-in accounting/reporting capabilities. This gives you the ability to remotely monitor your farm and streamline the majority of your company activities. FarmLogs and Cropio both show equivalent solutions. In addition to the IoT agriculture use cases mentioned, additional noteworthy prospects include logistics, storage management, vehicle tracking (or even automation), etc.

##  1. Things to conceive before developing your smart farming solution

 As we can see, there are countless ways that IoT may be used in agriculture. You may increase the productivity and income of your farm in a variety of ways with the aid of smart technologies. It's not simple, though, to enhance IoT applications for agricultural.

If you're contemplating investing in smart farming, there are some issues that you need to be aware of.

###  2. The hardware

 You must choose the sensors for your device (or design a bespoke one) in order to establish an IoT solution for agriculture. Your decision will be based on the kinds of data you wish to gather and the overall goal of your solution. In any event, the success of your product will depend on the precision and dependability of the data that is acquired, thus the quality of your sensors is crucial.

###  3. The brain

 All solutions for smart agriculture should be built on data analytics. If you can't make sense of the acquired data, it won't be any use to you. In order to get useful insights from the gathered data, you must thus have strong data analytics skills and utilise prediction algorithms and machine learning.

###  4. The Maintenance

 Due to the sensor element's frequent usage in the field and ease of damage, hardware maintenance is a difficulty that is crucial for IoT production in farming. You thus insist on having gear that is both unbreakable and simple to maintain. If not, you'll have to replenish your sensors more frequently than you'd want.

###  5. The mobility

 For usage in the field, intelligent agriculture apps should be tailored. It should be possible for a business owner or farm manager to access the data locally or remotely using a smartphone or desktop computer. Additionally, each linked device has to be independent and have a sufficient wireless coverage area to communicate with other connected devices and transmit data to the main server.[ 2] [3]

1. **Smart Farming Techniques**

Some of the leading techniques concerned in smart farming with AI.

 **V. MONITORING OF REMOTE EQUIPMENT**

 The tool connects to the agricultural equipment using a communications controller or computer. Data buses and other machine controls are connected through a connection. Sensor alerts are transmitted to the controller through the data bus, which is connected to controllers. Additionally, it creates information snapshots and summaries that are sent to central information servers. Finally, the user of the programme receives the information.

**A. Resource and Field Mapping**

 Remote sensing is now the ideal data source for applications and their revision thanks to sensor-based mapping. Farmers greatly benefit from the sensors that provide information to a smartphone application. Such a chance to obtain cutting-edge information or support from agricultural professionals wasn't available in the past.

**B. Statistical Prediction**

The tool has a communications controller or computer related to the agricultural machine. There is a link provided to data buses and other controllers of the machine. The connection between controllers and data bus ensures that alerts from sensors get communicated to the controller. It additional generates snapshots and summary information that go to central information servers. The information finally reaches the user on the application.

1. Resource and Field Mapping

 Sensor-based mapping has made remote sensing an perfect data source for applications and their revise. The sensors that make available information to the application on a smartphone prove a lot beneficial for farmers. In the past, there was no such opportunity to get advanced data or assistance from agricultural experts.

1. Predictive Analytics

 It is credible to analyze chronological as well as existing farming data to prepare for future yield. Satellite imagery helps in appreciative and managing the natural environment of farms, which gives them cues for sustainable agricultural practices. Yield maps further allow for better targeting of fertilizers for improved crop production standards. Data-driven decision-making is essential to improving the bottom line. So predictive analytics helps farmers make informed decisions for better profits.

1. **Crop Monitoring**

 Crops may be remotely observed using field data and remote sensing data. It aids in the evaluation of crucial aspects such as crop production, yield, and condition, as well as cropping intensity, planting status, and drought prediction.

1. **Weather Prediction**

 Crop productivity is impacted by unpredictably weather patterns. Historical climate data is used in statistical weather forecasts to illustrate the link between various time periods. Therefore, using information about summertime temperatures, it is feasible to forecast wintertime temperatures. Any change in the former will probably also apply to the latter.

1. **Using Predictive Analytics in Smart Farming**

 Data analytics is used in smart farming to gather information from various farming operations. It facilitates the development of algorithms for better, more sustainable farming. The many elements of predictive analytics in smart farming approaches are listed below.

 **F. Data Collection**

 Cloud computing in agriculture enables extensive data collection and retrieval from many sources. Soil conditions, crop mapping, agricultural environment monitoring, satellite photos, yield information management, and many more sorts of data are just a few examples. They provide information quickly and precisely. Since the data is still kept on the cloud, it is always available. Farmers may solve agricultural production issues by using historical data.

 **G. Data Analysis**

 Data analysis assists in gaining knowledge that improves decision-making. Examples include information on the availability of water, soil moisture content, and GIS. The AgTech sector may use this knowledge to better estimate ideal water needs, soil moisture levels, and many other things. The system would also notify the concerned party to take remedial action if there are any anomalies. Additionally, the system will issue a warning if a pest attack is possible.

 **H. Data Storage**

 A crucial component of predictive analytics is it. It was difficult to maintain physical infrastructure in the past when storage demanded it. Any hardware issue meant that data may be readily compromised. However, in a situation including contemporary agriculture, cloud solutions eliminate this issue. Purchasing pricey gear is not necessary right now. Additionally, anyone at any moment may view the data on their devices. Large volumes of high-quality data provide superior insights for better decision-making. [2][3]

 **VI. BENEFITS OF SMART FARMING USING SAAS SOLUTIONS?**

 Here are some advantages of using SaaS solutions in smart methods of farming.

1. It is a flexible and comprehensive system for farm management
2. Data remains accessible to anyone at anytime
3. Alerts to overcome problems like pest attacks
4. Weather-related guidance
5. Better yield possibilities through constant monitoring of farm activities
6. Predictability of results
7. Comprehensive reports and insights
8. Improved accountability and efficiency in operations
9. Geo-tagging for easy tracking
10. Better resource utilization leading to reduced production costs
11. Adherence to compliances and norms
12. **AI Yield Prediction and Optimisation**

Predicting crop output is challenging since so many variables, including environment and genetics, are involved. After gaining a grasp of how these factors affect agricultural yields, we can accurately estimate future yields. Artificial intelligence can help with it.

Crop production may be predicted by providing the proper datasets to the right computers. AI systems have the ability to effectively predict agricultural production over time by using past crop yield data and comparing it to more recent data.

Growers will be able to make data-driven decisions about managing their farms with the help of accurate yield forecast. Let's not overlook their financial situation.

1. **IoT Smart Plant Monitoring**

 Farmers may use AI systems to determine how much light the foliage of their crops receives. Crop spacing can be changed to make enough room for sunlight penetration if certain plants are not getting enough sunlight. The foliage gap must be manually observed, which is expensive and time-consuming.

AI systems with visual capabilities may also track and analyse the daily changes in plants to estimate their growth rate. These systems can employ information from thermal cameras, satellite imaging, and infrared sensors.

1. **Role of Artifical Intelligence in Agriculture**

 The technology can track and gauge how the crops react when farmers apply fertilisers and insecticides. Utilising the data, farmers may see crops that aren't doing well and take the appropriate action to solve the issue.

Autonomous tractors can use IoT and AI technologies to assist in gathering real-time data regarding soil health, including water levels, temperature, and PH. Farmers may monitor the health of their crops using various sensors, satellite pictures, and drone cameras. The findings, when analysed, can assist producers in locating nutritional deficiencies in the soil as well as crop pests and illnesses.

 **VII. AI AND AUTOMATION ARE TRANSFORMING FARMING**

 Big companies are already leveraging the power of AI to develop autonomous tractors that a farmer can control remotely. Self-driving tractors will not only reduce labor costs but also increase the efficiency of farm operations and crop yield.

1. **Automated Robotic Farming**

 Farmers will be able to remotely monitor crop conditions and take pictures of their crops using autonomous drone technology. Growers may spray agricultural treatments like fertiliser and insecticides from the air using UAVs. Large-scale farms can use drones equipped with AI-powered cameras. The cameras will aid farmers in identifying agricultural problems, counting fruits, and even predicting crop production.

Other farming tasks including harvesting, sowing, weeding, and crop sorting may also be automated thanks to AI. In fact, a farm in Australia uses robotics and artificial intelligence to perform hands-free farming.

Farmers may employ strong and effective AI technologies to manage all the incoming data. The power of data may boost productivity, decrease waste, and lower labour costs environmental impact of agriculture.

Additionally, it can assist farmers in assessing their resource management plans for optimum production and profitability. [2] [3]

1. **IoT Solutions to Agricultural Problems**

 Many people think that IoT can improve all facets of farming, from grain production to forestry. Precision farming and farming automation are two of the key ways that IoT may revolutionise agriculture, while there are many more methods as well [3]

1. **Precision Farming**

 Precision farming, often known as precision agriculture, is a general term for IoT-based strategies that improve farming's accuracy and control. Simply said, plants and animals receive the precise care they require, which is decided by machines with superhuman accuracy. The primary distinction between precision farming and the conventional method is that decisions may be made per square metre, or even every plant or animal, as opposed to per field.

Farmers can increase the efficacy of pesticides and fertilisers or apply them selectively by carefully tracking differences within a field.

1. **Precision Livestock Farming**

 Similar to precision agriculture, smart farming methods let farmers better monitor the nutritional requirements of specific animals and modify their diets appropriately, reducing sickness and improving herd health.

Wireless IoT apps may be used by large farm owners to track the whereabouts, comfort, and health of their livestock. With this knowledge, they can recognise unwell animals and isolate them from the herd in order to stop the spread of disease.

1. **Automation in Smart Greenhouses**

 Traditional greenhouses usually employ a proportional control system or manual intervention to regulate the environmental parameters, which frequently leads to output loss, energy waste, and higher labour costs.

Intelligent climate management and monitoring are both possible with IoT-powered smart greenhouses, negating the need for physical intervention. In accordance with the unique needs of the crop, a variety of sensors are installed to detect the environmental conditions. The data is kept on a platform that is located in the cloud for easy future processing and management.

 **VIII. AGRICULTURAL DRONES**

 Agriculture is one of the major verticals to incorporate both ground-based and aerial drones for crop health assessment, irrigation, crop monitoring, crop spraying, planting, soil and field analysis, and other spheres.

Since drones collect multispectral, thermal, and visual imagery while flying, the data they gather provide farmers with insights into a whole array of metrics: plant health indices, plant counting and yield prediction, plant height measurement, canopy cover mapping, field water pond mapping, scouting reports, stockpile measuring, chlorophyll measurement, nitrogen content in wheat, drainage mapping, weed pressure mapping, and so on.

Importantly, IoT-based smart farming doesn’t only target large-scale farming operations; it can add value to emerging trends in agriculture like organic farming, family farming, including breeding particular cattle and/or growing specific cultures, preservation of particular or high-quality varieties, and enhance highly transparent farming to consumers, society and market consciousness.

 **A. What’s Next in Smart Farming**

 Of course, none of these advancements are useful if they don't address societal issues. Here are two positive effects that smart farming will have in the future.

**1. Internet of Food, or Farm 2020**

 Why not establish an Internet of Food Things if we already have the Internet of Things (IoT) and the Internet of Medical Things (IoMT)? Through research and recurring conferences, the Internet of Food and Farm 2020 (IoF2020) project of the European Commission, which is a component of Horizon 2020 Industrial Leadership, examines the potential of IoT technology for the European food and agricultural sector.

The Internet of Things (IoT) has encouraged the idea that a network of intelligent sensors, actuators, cameras, drones, robots, and other connected devices could enable agriculture to experience an unparalleled degree of control and automated decision-making, enabling a long-lasting ecosystem of innovation in this oldest of businesses.

**2. Third Green Revolution**

 A third green revolution is being prepared for by smart farming and IoT-driven agriculture.

The Third Green Revolution is transforming agriculture, coming after the plant breeding and genetics revolutions. The data-driven analytics technologies used in precision agricultural equipment, the Internet of Things, big data analytics, unmanned aerial vehicles (UAVs or drones), robots, etc. are all united in one revolution.

This "smart farming" revolution predicts a decrease in pesticide and fertiliser consumption and an increase in overall productivity. Better food traceability will be made possible by IoT technology, increasing food safety in the process. Additionally, it will help the environment by, for instance, using water more effectively or by optimising inputs and treatments.

So, there is actually a chance for smart farming to produce a more accurate and resource-efficient style of agricultural production that is both more productive and sustainable. The eternal hope of mankind will finally come true thanks to new farms. It will provide food for our population, which might reach 9.6 billion by 2050[3]

**REFERENCES**

[1] Smart Farming using AI and IoT, Sanksshep Mahendra, May 6th 2022.

[2] Smart Farming: How AgTech Industry Can Reap the Benefits of Advanced Agriculture Data

 Analysis, [Gramener Inc](https://blog.gramener.com/author/gramener/), July 6th 2021.

[3] Article IoT in Agriculture by Alexey Chalimov, CEO at Eastern Peak.

[4] Article Smart Farming: The Future of Agriculture, Published on June 22, 2020 and updated

 December 23, 2021.