Modern Farming Methods and Cultures Using IOT: A Review

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Abstract

Agriculture is considered as one of the major sources in maintaining a nation's GDP. Farming in India is done using the mundane ways. The main reason behind this is the lack proper knowledge and awareness among the farmers. A large portion of farming and agricultural activities are based on the predictions, which at times fail. Farmers have to bear huge losses and at times they end up committing suicide. Since we know the benefits of proper soil moisture and its quality, air quality and irrigation, in the growth of crops, such parameters cannot be ignored.

Therefore, this new idea of crop monitoring and smart farming using IoT will act as a benchmark in the agribusiness due to its reliability and remote monitoring capabilities. We analyzed the various standard IoT techniques used in Agriculture sector based on hardware and software, and thereby, deriving the existing challenges for making farming much smarter and efficient.

Keywords: Smart farming; Modern farming; Modern agriculture; IOT

Introduction

Agriculture in India is still a traditional procedure. Most of the developing countries and under developed countries are relying on cultivation to improve their economic wealth. In this modern technology era, technology can play a tremendous role in the agriculture sector. The advanced technology has the capability to automate various cultivation phases like watering, fertilizing, harvesting and much more. In order to make the cultivation phases smarter, we deploy smart sensors in the fields to sense the water level, photo sensors to ensure sufficient sunlight is available for plant's growth, sensors to sense the nitrogen content and thereby to inform the farmer to initiate steps for proper fertilizing, etc. But when you compare India with the other foreign countries, they call it as modern agriculture. The difference between both is the use of technology methods in agriculture. Technology and modern methods in agriculture has a huge scope in India, slowly, there is a shift that we can observe. But still, it is not on a par level when we compare with the other overseas countries due to lack of awareness among the farmers [1].

In modern agricultural systems farmers believe they have more central roles and are eager to apply technology and information to control most components of the system, a very different view from that of traditional farmers. Modern machines can control the hard work of farmers.

Our idea tries to digitalize farming and agricultural activities so that the farmers can check on the requirements of the crops and accurately predict their growth. This concept will surely accelerate their business to reach new heights and also be more profitable. The implementation of our project largely depends upon the awareness among farmers, which, we believe will be easily created due to its numerous advantages.

Different Types of Modern Farming Methods

In modern agricultural systems farmers believe they have more central roles and are eager to apply technology and information to control most components of the system, a very different view from that of traditional farmers. Modern machines can control the hard work of farmers. Various types of modern and smart farming methods are as below:

Aeroponics system of modern farming methods

Aeroponics is the process of growing plants in an air or mist environment without the utilization of soil or an aggregate medium. The word "Aeroponic" is from the Greek meanings of aer and ponos. Aeroponics is a subset of hydroponics, and works by suspending plant roots in the air and misting them with nutrient water. This method can provide a better level of control over the amount of water that is used throughout the growing

process, but may leave plant roots vulnerable to pathogens, if not carefully controlled [2].

Aeroponics system culture differs from conventional hydroponics, aquaponics, and in vitro growing. Unlike hydroponics, this uses a liquid nutrient result as a growing medium and essential mineral to maintain plant growth; or aquaponics which uses water and fish waste, aeroponic is conducted without a growing medium. It is considered a type of hydroponics, since water is used in aeroponics to transmit nutrients.

Aeroponic systems are additional cost efficient than other systems. Because of the reduced volume of solution throughput, less water and fewer nutrients are needed in the system at any given time compared to other nutrient delivery systems. The need for substrates is eliminated, as is the need for many moving parts [3].

Benefits of using the aeroponic farming:

• Ease of working with plants.

• Cost effective since it eliminates the expenditure on irrigation channels.

• Limited plant-to-plant contact leads to disease-free cultivation and if a plant gets infected, it can be simply removed from the support structure without disrupting the other plants.

Aquaponics of modern farming methods

Aquaponic systems combine the two forms of agricultural production mentioned above, recirculating aquaculture and hydroponics. Aquaponics provides a solution to the main issues which these two systems face; the need for sustainable ways of filtering or disposing of nutrient-rich fish waste in aquaculture and the need for nutrient-rich water to act as a fertilizer with all of the nutrients and minerals needed for plants grown through hydroponics. Combining these two systems provides an all-natural nutrient solution for plant growth while eliminating a waste product which is often disposed of as wastewater. This nutrient-rich effluent is used to irrigate a connected hydroponic bed while fertilizing its plant crops at the same time. The nutrients, largely in the form of ammonia are converted by denitrifying bacteria in the hydroponic grow bed into forms readily up taken by plants for energy and growth. Essentially, the hydroponic bed and its crops serve as a biofilter for the fish waste water before it is returned, cleaned back into the fish tank [4].

Benefits of using Aquaponics Farming:

• All normal fertilizer sources from fish waste.

• No reliance on mined and affected fertilizers.

• Efficient, sustainable and extremely productive.

• Fish are free of expansion hormones and antibiotics.

• Allows continuous making of food.

• It produces both a protein and vegetable crop.

• Integrated method is sustainable and earth-friendly.

• Eliminating soil eliminates soil borne diseases.

Hydroponics system of modern farming methods

The hydroponics method is a soil-less type of farming because it requires no soil for the plants to grow. Instead, it uses water as its growing medium. The knowledge of soil-less gardening is called hydroponics. It essentially involves growing healthy plants without the use of a traditional soil medium by using a nutrient like a mineral rich water solution instead. A plant needs, choose nutrients, some water, and sunlight to grow [5]. Not only do plants grow without soil, they often develop a lot better with their roots in water instead.

The use of hydroponics gardening in growing of vegetables, fruits and other plants has been so common in the world today. Many farmers are going into this advanced technology of plant growing because they believe that plants grown hydroponically have better quality than the ones grown under the normal soil planting. The extensive use of hydroponics systems is also attributed to the many reported problems related to soil. Scientists decided to come up with technology where the use of soil would be reduced or find an alternative for the soil in a bid to curb the many soil related problems.

Hydroponics farming method is a subset of hydro culture, which is a method of growing plants without soil by using mineral nutrient solutions in a water solvent. Terrestrial plants may be developed with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite.

The nutrients used in hydroponic farming systems can come from an array of different sources; these can include, but are not limited to, byproduct from fish waste, duck manure, or purchased chemical fertilizers [6].

Benefits of using hydroponic farming:

• By providing constant and readily available nutrition, hydroponics allows plants to rise up to 50% faster than they would in soil. Also, fresh produce can be harvested from a hydroponic garden through the year.

• Great for both the environment and the mature product, hydroponic gardening virtually eliminates the need for herbicides and pesticides compared to traditional soil gardening.

• Any water that is used hydroponic farm gardening stays in the system and can be reused, reducing the constant need for a fresh water supply.

Arable land is often in small supply and gardening space continues to decrease. A huge option when you lack yard space or have a tiny balcony, hydroponics also lends itself really well to indoor gardening.

Different Cultures of Modern Farming Methods

There are four cultures in modern farming methods:

• Monoculture

• Tissue culture

• Drones

• Vertical farming

• Hybrid seed technology

Monoculture in modern farming

Monoculture farming method is the raising of a single crop within a specified area. Most of the commercial farms in the United States are now monoculture in nature, with crops like corn and soy taking top billing. This is in contrast to the traditional technique of farming, which relied on multiple crops being planted within a specific area. Many indoor farms growing medicinal herbs and flowers are measured to be monoculture farms.

Monoculture is the agricultural practice of producing a single crop, single plant, or livestock species, variety, or breed in a field or farming system at a time. Polyculture, where more than one crop is grown in the similar space at the same time, is the alternative to monoculture. Monoculture farming is widely used in both industrial farming and organic farming and has allowed increased efficiency in planting and harvest. When one crop is grown alone in a field, it is called a monoculture farm. Monoculture farming makes it easier to cultivate, sow seed, control weeds, and harvest, as well as expand the size of the farm operation and improve aspects of profitability and cost. At the same time, monocultures tend to promote the use of the other basic practices of modern agriculture. Monocultures in grassland are a moderately recent phenomenon. Many grassland systems, such as hay meadows and chalk grasslands, have a more diversified. In case of chalk grasslands, this diversity has arisen following several years of grazing.

Monoculture is the growing of one type of crop in a given tract of land. It makes the cultivation of land easier. Because the crop to be planted is of the same type, the land is tilled in the same style. This makes cultivation and land preparation very simple. Sowing of seeds on the soil is easier as the seeds to be sowed are of the same type. This helps to save time as there is no careful selection of the type of seeds to be planted and where the seeds should be sowed. Weeding is a bit easier in monoculture as the plants type grown is specific. When the method of weeding is chosen, it is employed to all the crops on the tract of land. Harvesting and storage is easier too as the produce are packed easily with no fear of mingling with different products. The style of storage is also the same and this is due to the advantage of uniformity.

Expansion of the size of the firm is easier and this helps in the improvement of produce, hence increment in profit and reduction in the cost used in production. Monoculture also tends to enhance the use of the other five modern methods of agriculture.

Advantages of monoculture in modern farming:

• Reduced plant opposition for nutrients, space and solar radiation.

• Control of undesirable or unprofitable organisms.

• Reduction of costs by controlling of specialized machinery required for arable operations.

• Maximize profit from the increasing of higher gross margin crops.

Tissue culture in modern farming

Tissue culture refers to a method in which fragments of a tissue plant are introduced into a new, artificial environment, where they continue to function or grow. While fragments of a tissue culture are often used, it is important to note that entire organs are also used for tissue culture purposes. Here, such growth media as broth and agar are used to facilitate the procedure. While the term tissue culture farm may be used for both plant and animal tissues, plant tissue culture is the more specific term used for the culture of plant tissues in tissue culture. Tissue culture is the expansion of tissues or cells separate from the organism. This is naturally facilitated via the use of a liquid, semi-solid, or solid growth medium, such as broth or agar. Tissue culture normally refers to the culture of animal cells and tissues, with the more specific term plant tissue culture being used for plants.

Tissue culture usually refers to the growth of cells from a tissue from a multicellular organism in vitro. These cells may be isolated from a donor organism, "primary cells", or an immortalized cell line. The cells are bathed in a culture medium, which contains necessary nutrients and energy sources necessary for the cells' survival. The tissue culture is often used interchangeably with cell culture.

Advantages of tissue culture:

• Tissue culture is a fast technique. Thousands of plantlets can be created in a few weeks' time from a small amount of plant tissue.

• The new plants formed by tissue culture are disease free.

• Tissue culture can produce, plants round the year, irrespective of weather or season.

• Very little space is needed for increasing new plants by tissue culture.

• It helps to speed up the creation of new varieties into the market place.

Drones in modern farming

An agricultural drone technology is an unmanned aerial vehicle applied to farming in order to help increase crop production and monitor crop growth. Sensors and digital capabilities can give farmers a richer picture of their fields. This information may prove useful in civilizing crop yields and farm efficiency. Drone technology has been around for decades, taking to the skies to capture movie sequences, collect scientific information and scout territory. But there's a different industry where drones are really beginning to take off farming.

Advantages of drones in modern farming:

• More information, less time

• Improving crop health and efficiency

• Water efficiency and other environmental benefits

Vertical farming

Vertical farming is the urban farming of fruits, vegetables, and grains, within a building in a city or urban center, in which floors are designed to accommodate certain crops. These heights will act as the future farms, land and as architects; we can figure these high-rises to sow the seeds for the future. Vertical farming is, growing food indoors, in vertical layers; a concept global company has been experimenting with over the past 10 years filling old warehouses and disused factories with structures that develop vegetables and herbs in cramped, artificially lit quarters out of the warm glow of the sun [7].

Vertical farming is producing food and medicine in vertically stacked layers, vertically inclined surfaces and integrated into other structures. The ideas of vertical farming use indoor farming techniques and Controlled-Environment Agriculture (CEA) technology, where all environmental factors can be controlled. These facilities develop artificial control of light, environmental control and fertigation.

Hybrid seed technology

A hybrid seed technology is a cross between two or more unrelated inbred plants. The two dissimilar varieties are cross bred, resulting in a seed that carries one or more favorable traits. Hybrid seeds are commonplace in commercial farming, mainly to increase crop yields. In agriculture and gardening, hybrid seed is used to form by cross-pollinated plants. Hybrid seed production is major in modern agriculture and home gardening. All of the hybrid seeds planted by the farmer will construct similar plants, while the seeds of the next generation from those hybrids will not consistently have the desired characteristics. Controlled hybrids provide very regular characteristics because they are produced by crossing two inbred strains.

Hybrids are chosen to develop the characteristics of the resulting plants, such as better yield, greater uniformity, improved color, disease resistance. A main factor is the heterosis or combining ability of the parent plants. Crossing any exacting pair of inbred strains may or may not result in superior offspring. The parent strains used are therefore suspiciously chosen so as to achieve the uniformity that comes from the uniformity of the parents, and the superior performance that comes from heterosis.

Advantages of hybrid seed technology:

• Additional vigorous plants

• Enhanced disease resistance

• Improved crop yields

• Increased taste of fruits and vegetable.

Literature Survey

Aeroponics farming is an efficient and effective process for growing plants without using soil. When we apply IoT technology to an aeroponics system, it is expected that there will be many improvements such as decreasing water usage, increasing plant yield, minimizing rate of growth and reducing the workforce. In this paper, they have designed and implemented a new automatic aeroponics system using IoT devices which is comprised of three main components: A mobile application, service platform and IoT devices with sensors. The mobile application provides the user a graphical user interface to monitor and adjust the aeroponics system. The service platform is a middleware system that provides information for the mobile application to store the gathered information from IoT devices using sensors within the aeroponics system. The IoT device uses sensors within the aeroponics system to control each pump and access data [8].

Aquaponics systems focused on increasing economically and sustainability of indoor and outdoor fish farming. Aspect like sustainability, development and economically efficiency improve of farmer health we must reconsider the agriculture sciences, by this we understand that we must develops technologies friendly for the environment. Combining aquaculture with hydroponics they obtained a new innovation named aquaponics which respects principles of sustainable agriculture (wastewater bio filtration by plants) and gives the possibility to increase economic efficiency with an additional production (organic vegetables) to produce the nutrient rich food. The additional design decision are expected considerably improve water quality, thereby positively affecting fish growth and production. Food security poses a very real and serious threat in the world today. What makes aquaponic food production so attractive is its ability to address these issues of resource conservation and access to a reliable and quality food source. In addition to this, the simplicity of an aquaponic system makes it accessible and user friendly so it has the potential to help families who are most in need of it.

Researchers discussed in their research that the industry is expected to grow exponentially also in future, as conditions of soil growing is becoming difficult [9]. Specially, in a country like India, where urban concrete conglomerate is growing each day, there is no option but adopting soil-less culture to help improve the yield and quality of the produce so that we can ensure food security of our country. However, Government intervention and research institute interest can propel the use of this technology. Soil fertility status has attained a saturation level, and productivity is not increasing further with increased level of fertilizer application. Besides, poor soil fertility in some of the cultivable areas, less chance of natural soil fertility build-up by microbes due to continuous cultivation, frequent drought conditions and unpredictability of climate and weather patterns, rise in temperature, river pollution, poor water management and wastage of huge amount of water, decline in ground water level, etc. are threatening food production under conventional soil-based agriculture. Under such circumstances, in near future it will become impossible to feed the entire population using open field system of agricultural production only. Naturally, soil-less culture is becoming more relevant in the present scenario, to cope-up with these challenges.

Tembe et al. discussed the hydroponic farming method using IOT approach [6]. They presented the details of hydroponics that is implemented using electronic circuit, water and nutrient solution i.e. soilless. The system automatically supplies nutrient

and nutrients can be monitored. Once the monitoring is done corrections can be done i.e. it can be controlled accordingly leading to higher productivity. This system has no adverse effects on environment or quality on crops. In contrast, it provides better nutrient value and allows controlling the nutrients via nutrient solution. Its main aim is to save water, improve quality of crops avoiding the adverse effects of pesticides and factors affecting quality of soil and save land. This paper provides an overview about the cost-effective implementation of hydroponics for small farmers in India.

Adapting the unsuitable plant species to this environment will be necessary in the next expansion phase. Due to the absence of soil, although pest attacks are reduced, it is not completely vanished. Suitable methods should be incorporated to make the produce organic and healthy. Finding a suitable biological nutrient solution is an economical and healthier option. When crops are cultivated using the hydroponics system of agriculture, the plants show a good healthy growth and gives good yield compared to the traditional farming methods. This method is also promising when looking in the direction of making every household an independent producer of their daily veggies requirement.

Discussion

Shenoy and Pingle proposed an IoT-based architecture for poly-house [8]. IoT can be used to increase productivity by controlling factors like soil ph, soil moisture, humidity temperature, the rate of soil nutrients, etc. They proposed an IoT model for controlling and monitoring the plant growth. Moisture in the soil and ph of the soil is measured using suitable potentiometers at various instances and is transferred to the pumps which provide irrigation using Bluetooth or Wi-Fi. Poly-house opens or closes the flaps to blow air based on the temperature sensed by the temperature sensor. A central server will initiate sprinklers when the humidity is low. PH value is maintained by adding an adequate quantity of alkaline and acidic fertilizers based on the sensed ph value. PH sensor is used to sense ph value. Thus they make the farming phase smarter using the IoT technology. In harvesting level, they use robotic arms embedded with a camera to identify the crops to be harvested. Image recognition algorithm is used to sense the color and the shape of the crop to be plucked. RFID tags are attached to each collected crop. This RFID tag makes the packing and transportation of crops easier. In the destination tags are removed and are sold to the end user. Thus their model addresses almost all phases of a crop from production till delivery to end consumers. They used Arduino based system with integrated shields for sensors, GPS module, and RFID tags. The disadvantage of their system is all about the accuracy of robotic arms and image recognition phases. The claim that the success margin is nearly 60% and can be much improved by using better algorithms and hardware components. One of the researches that based on the results of testing and research conducted conclusions can be drawn that the level of accuracy of the sensors used is quite high with an average success rate of 99.943% for ultrasonic sensors, ph sensor of 92.353% and temperature of 97.907%. The process of sending and receiving sensor data to an internet of things based server runs well using a WiFi connection. Growth of plants and fish on the smart aquaponic system ranges from 25°C to 30°C and pond water ph between 7-7.5 with the intensity of fish feeding 3 times a day. The characteristics of the smart aquaponic system monitoring network system is not very good with the throughput index value is 1, packet loss 4 and delay with index 1. The suggestion for the next research is to make an adaptive aquaponic system where the system can be adjusted according to the type of crop and the appropriate nutrient needs [10].

Conclusion

The main purpose of this paper is to introduce the modern technology adoption, its importance, usage and role in agriculture improvement. In the last century, the basic agriculture technology like machines has changed a little. Though the modern technology, planters and harvesters do a better job or are slightly tweaked from their predecessors. In this paper we discussed various modern farming methods like aeroponics, aquaponics and hydroponics along with their advantages and uses. We have discussed various cultures in modern farming and their uses which boost the yield of crops as well as prove helpful to the farmers in their tasks.

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