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IoT Technology is Benefiting Today's Modern Farming Industry

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***Abstract*--**Agriculture plays very important role in the development of agricultural country. In India about 75% of population depends upon farming and one third of the nation's capital comes from farming. Issues concerning agriculture have been always hindering the development of the country. The only solution to this problem is smart agriculture by modernizing the current conventional methods of agriculture. To improve efficiency, productivity, global market and to reduce human intervention, time and cost there is a need to divert towards new technology named Internet of Things. It is the network of devices to transmit the information without human involvement. IoT works in synergy with agriculture to obtain smart farming. This paper focuses on major role of IoT in agriculture that leads to smart farming industry.

***Keywords*--**Internet of Things, Smart Farming, Efficiency, Productivity

I. INTRODUCTION

The Internet of things (IoT) is the most efficient and important techniques for development of solutions to the problems. The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity enables these objects to collect and exchange data. IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

1.1 Internet of Things (IoT)

In Internet of things, we can represent things with natural way just like normal human being, like sensor, like car driver etc. This thing is assigned an ip address so that it can transfer data over a network. As per the report generated by Garner, at the end of 2016 there will be 30% rise in count of connected devices as compared to 2015. He further says that, this count will increase to 26 billion by 2020 [1]. "Things**,"** in the IoT sense, can refer to a wide variety of devices such as heart monitoring , biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring/field operation devices that assist fire-fighters in search and rescue operations[2]. Figure 1.1 shows that the structure of Internet of Things.

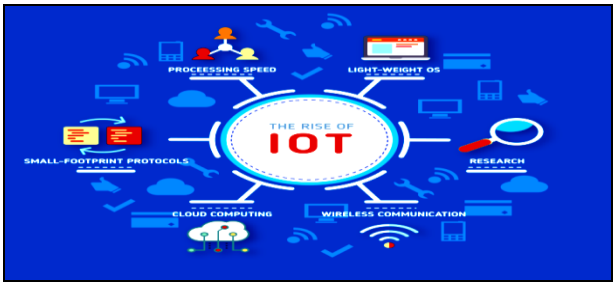

Figure 1.1 Internet of Things

1.2 Why IOT is important?

The Next Industrial Revolution which is going to change our lives in ways never imagined before, The last industrial revolution which is nothing but INTERNET the way we communicate and connect with people has changed like never before and also the Internet boom has improved our lives in many ways. Every time a Industrial Revolution happens there will be enormous changes in the economy create a whole new level of markets. Quick changes in IoT technology makes it a challenging task for the most experienced experts to anticipate the future of standardization in the field. For humanity, which is moderately clutter by nature, the IoT is an extraordinary advancement. On the other hand, for individuals who

esteem their security, the Man to Man helps in interconnecting different electronic gadgets. IOT has arrived with a highly believable promise of giving individuals few more free hours by automating few tasks and boosting productivity of businesses by making better use of data. The IoT technology is more efficient due to following reasons [3]:

1. Global Connectivity through any devices.
2. Minimum human efforts
3. Faster Access
4. Time Efficiency
5. Efficient Communication

1.3 Scope of IoT

The analyst of BCG says that by 2020 there will be over 50 billion connected devices and 6.58 devices connected per person. Anything that touches consumer industry became a buzz word. So now Internet of Things is one among. What it is – the end goals is to bring all things we use in day to day life over network and can be accessed across the world over internet. That means every objects/gadgets we use in a day to day life will have a identify over network and its information can be consumes via Laptop, Tablet and mobile and including wearable like smart watches.

1.4 IoT Industries

Environments are grouped in to there that will benefit from the IoT are Governments, Consumers and eco systems. The following table 1.1 shows the various core area of IoT in industries.

Table 1.1 IoT Industries

Agriculture	Insurance	Banks
Manufacturing	Logistics	Utilities
Transportation	Defense	Infrastructure
Food Services	Connected Home	Oil, gas, and mining
Hospitality	Healthcare	Smart Building

Section I mainly deals with the overview of Internet of Things (IoT). This section gives brief introduction of Internet of Things, IoT Importance, Scope of IoT and core area of IoT industries. Section II contains IoT working mechanism, IoT sensors and agriculture sensors are used to farming. Section III contains research area of Agriculture, Smart agriculture and smart agriculture solution benefits. Section IV contains Applications of IoT in agriculture. Section V gives conclusion of IoT technology is more benefits in modern farming industry

II. HOW DOES IoT WORKS?

Device with build in sensor connected to IoT platform, Which consolidate data from the different devices and applies analytics to share the most valuable information with applications to address specific needs. Which can be interrelated computing devices, mechanical machines, objects, animal, people that are provided with unique identifiers and the ability to transfer data over a network by Artificial intelligence.

Internet, things, Internet of things, Internet of Everything.These is more than just keywords; IoT (Internet of Things) is a technology concept. Similar to the way in which Internet has changed the way we work and communicate by connecting us (humans) through World Wide Web, IoT aims to take this connectivity to next level by connecting various devices to the internet facilitating human-machine, machine-machine interactions also.

The visionaries have also realized that this IoT ecosystem has business applications in areas of Home Automation, Automotive, Factory/assembly line automation, Retail, Medical/Preventive healthcare and more. Now that we all understand the IoT concept, it would be worthwhile to deep dive in order to get familiar with the building blocks of IoT [4]. Figure 2.1 shows that the working functionality of IoT.

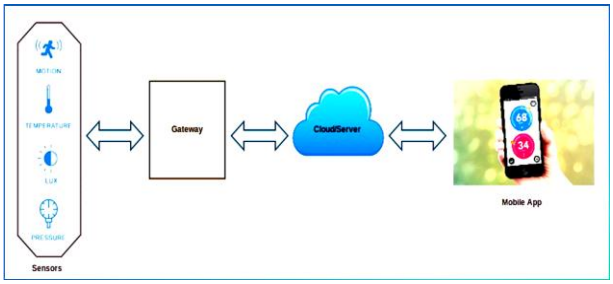

Figure 2.1 Working Mechanism of IoT

a) **Sensors & Sensor technology**: They will sniff a wide variety of information ranging from Location, Weather/Environment conditions, Grid parameters, Movement on assembly lines, Jet engine maintenance data to Health essentials of a patient.

b) **IoT Gateways**: IoT Gateways, as the name rightly suggests, are the gateways to internet for all the things/devices that we want to interact with. Gateways help to bridge the internal network of sensor nodes with the external Internet or World Wide Web. They do this by collecting the data from sensor nodes & transmitting it to the internet infrastructure. IoT Gateway development defines the success of an IoT implementation. The Gateway design can be a customized or a turnkey solution depending on the application.

c) **Cloud/server infrastructure & Big Data**: The data transmitted through gateway is stored & processed securely within the cloud infrastructure using Big Data analytics engine. This processed data is then used to perform intelligent actions that make all our devices 'Smart Devices'.

d) **End-user Mobile apps**: The intuitive mobile apps will help end users to control & monitor their devices (ranging from room thermostat to jet engines & assembly lines) from remote locations. These apps push the important information on your hand-held devices & help to send commands to your Smart Devices.

2.1 IoT sensors

IoT sensors are capable of providing farmers with information about crop yields, rainfall, pest infestation, and soil nutrition are invaluable to production and offer precise data which can be used to improve farming techniques over time. Internet of things, with its real-time, accurate and shared characteristics, will bring great changes to the agricultural supply chain and provide a critical technology for establishing a smooth flow of agricultural logistics [5].

2.1.1 Agricultural Sensors

A number of sensing technologies are used in precision agriculture, providing data that helps farmers monitor and optimize crops, as well as adapt to changing environmental factors including [6].The table 2.1 shows the various types of agricultural sensors and its important uses in farming industry.

Table 2.1 Agricultural Sensors

Sensor Type	Uses
Location Sensors	Use signals from GPS satellites to determine latitude, longitude, and altitude to within feet. Three satellites minimum are required to triangulate a position. Precise positioning is the cornerstone of precision agriculture.
Optical Sensors	Use light to measure soil properties. The sensors measure different frequencies of light reflectance in near-infrared, mid-infrared, and polarized light spectrums. Sensors can be placed on vehicles or aerial platforms such as drones or even satellites. Soil reflectance and plant color data are just two variables from optical sensors that can be aggregated and processed. Optical sensors have been developed to determine clay, organic matter, and moisture content of the soil
Electrochemical Sensors	Provide key information required in precision agriculture: pH and soil nutrient levels. Sensor electrodes work by detecting specific ions in the soil. Currently, sensors mounted to specially designed "sleds" help gather, process, and map soil chemical data.
Mechanical Sensors	Measure soil compaction or "mechanical resistance." The sensors use a probe that penetrates the soil and records resistive forces through use of load cells or strain gauges. A similar form of this technology is used on large tractors to predict pulling requirements for ground engaging equipment. Tensiometers, like Honeywell FSG15N1A, detect the force used by the roots in water absorption and are very useful for irrigation interventions
Dielectric Soil Moisture Sensors	Assess moisture levels by measuring the dielectric constant (an electrical property that changes depending on the amount of moisture present) in the soil
Airflow Sensors	Measure soil air permeability. Measurements can be made at singular locations or dynamically while in motion. The desired output is the pressure required to push a predetermined amount of air into the ground at a prescribed depth. Various types of soil properties, including compaction, structure, soil type, and moisture level, produce unique identifying signatures
Agricultural Weather Stations	Self-contained units that are placed at various locations throughout growing fields. These stations have a combination of sensors appropriate for the local crops and climate. Information such as air temperature, soil temperature at a various depths, rainfall, leaf wetness, chlorophyll, wind speed, dew point temperature, wind direction, relative humidity, solar radiation, and atmospheric pressure are measured and recorded at predetermined intervals. This data is compiled and sent wirelessly to a central data logger at programmed intervals. Their portability and decreasing prices make weather stations attractive for farms of all sizes

III. AGRICULTURE

Agriculture is the process of producing food, feed, fiber and many other desired products by the cultivation of certain plants and the raising of domesticated animals. Other agricultural production goods include timber, fertilizers, animal hides, leather, industrial chemicals (starch, sugar, alcohols and resins), fibers (cotton, wool, hemp, silk and

flax), fuels (methane from biomass, ethanol, biodiesel), cut flowers, ornamental and nursery plants, tropical fish and birds for the pet trade, and both legal and illegal drugs (biopharmaceuticals, tobacco, marijuana, opium, cocaine) [7]. The ever-growing global population would touch around 9.6 billion by 2050. So, to feed this immense population, the agriculture industry needs to embrace IoT. The demand for more food has to meet overcoming challenges such as, rising climate change, extreme weather conditions and environmental impact that results from intensive farming practices [8].

Figure 3.1 IoT of Agriculture

From the figure 3.1 shows that agriculture of IoT in farming. Smart farming through the use of IoT technologies will help farmers to reduce generated wastes and enhance productivity. That can come from the quantity of fertilizer that has been utilized to the number of journeys the farm vehicles have made. So, smart farming is basically a hi-tech system of growing food that is clean and is sustainable for the masses. It is the induction as well as the application of modern ICT (Information and Communication Technologies) into agriculture.

3.1 Smart Agriculture

There are many reasons to implement a smart agriculture solution into commercial and local farming. In a world where the internet of things is accelerating adoption of data gathering and automation, an important industry such as agriculture can surely benefit. From the figure 3.2 represent sample example of smart agriculture solution in modern farming industry.

Monitoring and collecting data for soil moisture, air temperature, air humidity and sunlight intensity across multiple fields will improve efficiency of water usage and crop yield of large and local farms. As the world population increases, farming and food production will have to increase with it. Low cost sensors, data insights and IoT Platforms will enable this increase in efficiency and production.

Figure 3.2 Smart Agriculture Solution

3.2 Smart Agriculture Solution Benefits

The following table 3.1 shows that some important benefits of implementing a smart agriculture solution of modern farming industry [9].

Table 3.1 Benefiting Today's Modern Farming Industry

S.No	Focused on	Meaning
1	Increased Production	Optimized crop treatment such as accurate planting, watering, pesticide application and harvesting directly affects production rates.
2	Water Conservation	Weather predictions and soil moisture sensors allow for water use only when and where needed
3	Real-Time Data and Production Insight	Farmers can visualize production levels, soil moisture, sunlight intensity and more in real time and remotely to accelerate decision making process.
4	Lowered Operation Costs	Automating processes in planting, treatment and harvesting can reduce resource consumption, human error and overall cost.
5	Increased Quality of Production	Analyzing production quality and results in correlation to treatment can teach farmers to adjust processes to increase quality of the product
6	Accurate Farm and Field Evaluation	Accurately tracking production rates by field over time allows for detailed predicting of future crop yield and value of a farm.
7	Improved Livestock Farming	Sensors and machines can be used to detect reproduction and health events earlier in animals. Geofencing location tracking can also improve livestock monitoring and management.
8	Reduced Environmental Footprint	All conservation efforts such as water usage and increased production per land unit directly affect the environmental footprint positively.
9	Remote Monitoring	Local and commercial farmers can monitor multiple fields in multiple locations around the globe from an

		internet connection. Decisions can be made in real-time and from anywhere
10	Equipment Monitoring	Farming equipment can be monitored and maintained according to production rates, labor effectiveness and failure prediction.

IV. APPLICATIONS OF IoT AGRICULTURE

Agriculture plays a vital role in manufacturing and for livelihood. So, in this Internet of Things Applications in Agriculture, we are going to look applications of IoT in agriculture area [10]. The figure 4.1 shows the various types of agricultural applications of IoT in modern farming industry.

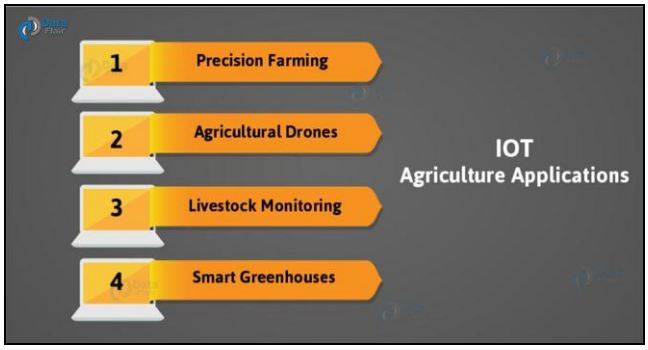

Figure 4.1 IoT Agriculture Applications

4.1 Precision Farming

Also known as precision agriculture, precision farming can be thought of as anything that makes the farming practice more controlled and accurate when it comes to raising livestock and growing of crops. In this approach of farm management, a key component is the use of IT and various items like sensors, control systems, robotics, autonomous vehicles, automated hardware, variable rate technology, and so on.

the adoption of access to high-speed internet, mobile devices, and reliable, low-cost satellites (for imagery and positioning) by the manufacturer are few key technologies characterizing the precision agriculture trend.

Precision agriculture is one of the most famous applications of IoT in the agricultural sector and numerous organizations are leveraging this technique around the world. Crop Metrics is a precision agriculture organization focused on ultra-modern agronomic solutions while specializing in the management of precision irrigation.

The products and services of Crop Metrics include VRI optimization, soil moisture probes, virtual optimizer PRO, and so on. VRI (Variable Rate Irrigation) optimization maximizes profitability on irrigated crop fields with topography or soil variability, improve yields, and increases water use efficiency.

The soil moisture probe technology provides complete in-season local agronomy support, and recommendations to optimize water use efficiency. The virtual optimizer PRO combines various technologies for water management into one central, cloud based, and powerful location designed for consultants and growers to take advantage of the benefits in precision irrigation via a simplified interface.

4.2 Agricultural Drones

Technology has changed over time and agricultural drones are a very good example of this. Today, agriculture is one of the major industries to incorporate drones. Drones are being used in agriculture in order to enhance various agricultural practices. The ways ground-based and aerial based drones are being used in agriculture are crop health assessment, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis.

The major benefits of using drones include crop health imaging, integrated GIS mapping, ease of use, saves time, and the potential to increase yields. With strategy and planning based on real-time data collection and processing, the drone technology will give a high-tech makeover to the agriculture industry.

Precision Hawk is an organization that uses drones for gathering valuable data via a series of sensors that are used for imaging, mapping, and surveying of agricultural land. These drones perform in-flight monitoring and observations.

The farmers enter the details of what field to survey, and select an altitude or ground resolution .From the drone data, we can draw insights regarding plant health indices, plant counting and yield prediction, plant height measurement, canopy cover mapping, field water ponsing mapping, scouting reports, stockpile measuring, chlorophyll measurement, nitrogen content in wheat, drainage mapping, weed pressure mapping, and so on. The drone collects multispectral, thermal, and visual imagery during the flight and then lands in the same location it took off.

4.3 Livestock Monitoring

Large farm owners can utilize wireless IoT applications to collect data regarding the location, well-being, and health of

their cattle. This information helps them in identifying animals that are sick so they can be separated from the herd, thereby preventing the spread of disease. It also lowers labor costs as ranchers can locate their cattle with the help of IoT based sensors .JMB North America is an organization that offers cow monitoring solutions to cattle producers. One of the solutions helps the cattle owners observe cows that are pregnant and about to give birth. From the heifer, a sensor powered by battery is expelled when its water breaks. This sends information to the herd manager or the rancher. In the time that is spent with heifers that are giving birth, the sensor enables farmers to be more focused.

4.4 Smart Greenhouses

Greenhouse farming is a methodology that helps in enhancing the yield of vegetables, fruits, crops etc. Greenhouses control the environmental parameters through manual intervention or a proportional control mechanism. As manual intervention results in production loss, energy loss, and labor cost, these methods are less effective. A smart greenhouse can be designed with the help of IoT; this design intelligently monitors as well as controls the climate, eliminating the need for manual intervention. For controlling the environment in a smart greenhouse, different sensors that measure the environmental parameters according to the plant requirement are used. We can create a cloud server for remotely accessing the system when it is connected using IoT.

V. CONCLUSION

Thus, in the IoT technology is more benefits in modern farming industry, because agriculture and agricultural applications are making it possible for ranchers and farmers to collect meaningful data. Large landowners and small farmers must understand the potential of IoT market for agriculture by installing smart technologies to increase competitiveness and sustainability in their productions. The demand for growing population can be successfully met if the ranchers as well as small farmers implement agricultural IoT solutions in a successful manner.

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Dr.R.Shankar born in 1973 completed PG degree in the year 1998 and Ph.D from Bharathiar University, Coimbatore, India in 2018. He is guiding students towards M.Phil programme in the areas like Network Security and Cryptography and Routing and Data Mining. He has published 13 papers in International Journals and more than 7 conferences National and International level. He has over 20 years 6 months in teaching experience in the field of higher education. Presently he is working as Assistant Professor in computer science Department at Chikkanna Government Arts College, Tirupur. His research interests specialized in Speech Quality in VoIP, Video Streaming and Big Data.

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