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An Overview on Internet of things (IoT) as a Technological boon for Sustained Agriculture Farming

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Abstract **– In the burgeoning population there is a huge scarcity of food. Hence, to fulfill this demand and to gain high productivity, the farmers and agricultural companies moving towards the new technologies which provide accuracy, time saving, cost effectiveness and less human interference. One of the techniques named IoT is very much in trend to obtain smart farming. It is the collection of devices which transfer the data on the basis of networks, sensors and computer systems. It can play a big role in enhancing crop productivity with less physical work. This article describes the application of IoT in different sectors of Agriculture.**

Keywords **– IoT, Sensors, Smart Agriculture, Productivity, Farmers, etc.**

I. INTRODUCTION

IoT for smart farming relates agriculture sector based object's networking to a self-configuration and self sustaining system, without the indulgence of man-kind and supports smart farming. The geometrics use including RS, GPS and GIS, Cloud computing and Sensor technology benefits agriculture sector, on economic and ecofriendly basis. However, to apply IoT in agriculture, various diversified domains must be integrated for the monitoring and management of agricultural supply chain in systematic, collaborative and structured manner. IoT has super power to carry out the immense connectivity of agricultural based objects in intelligent and sensory manner through current technological trends using Nanotechnology, WSN, Embedded systems. Before more than ten years, IoT was implemented by U.S Wal-Mart and their Department of defense regulated RFID tags for the inventory control provided by their contractors making it as one of the breakthrough in field of IoT [23].

The growing demand of food, enforced the government of different developing and developed countries to give a good thought and the hand in hand collaboration of modern technologies with conventional farming.

The previous studies predicted that in order to fulfil the huge demand of the growing global population there will be immense requirement need to enhance the food production by 70% more till 2050 [22]. This could only be satisfied by the collaboration of technology with conventional agriculture. In technology internet of things i.e. IoT could serve as a dynamic weapon, without human intervention, to meet the production requirements in agriculture.

IoT has the ability to transform the world and it is the key source of technology which is utilized in every domain like road safety, railway management, smart cities and water resource management, etc. It involves the use of RFID, wireless and other sensors with Internet stack inbuilt into the device. It includes sensors, networks, and storage device and computer system which enable us to sense, data collection and management.

In the eon of climate change and extreme weather conditions the world is facing food loss and there is a need to produce food for the satisfaction and maintenance of economy of the developing country like India. Therefore, mechanization must be implemented in the farming to overcome these issues. Smart farming based on IoT techniques will enable growers and farmers to reduce the surplus and improve the productivity of crops.

In IoT based smart farming system the crop is monitored through the sensors (temperature, humidity, moisture, etc.) and automatic irrigation system as previously studied [2, 26]. The farmers can monitor their field from anywhere. This IoT based smart farming is highly efficient when compared with the conventional farming.

The application of IoT is not only to increase the productivity of the crops but it could also be utilized in different trends like agro related information's to the farmers via mobile messaging service. It provides data related to soil quality at each zone like amount of nitrogen, phosphorous and potash present in the soil. It can also provide the information regarding moisture in the soil which helps to do irrigation whenever is required avoiding wastage of water.

Overall IoT based smart farming provides lots of benefits to the farmers and to the final users. In the nutshell, the IoT technology could serves as one of the most efficient technology collaborator to agriculture sector by reducing human intervention and so the efforts with intense and fast global access and connectivity in short duration of time making an effortless communication across the world.

Now let's have a discussion on major application of IoT based smart farming to accelerate the new green revolution in the agriculture.

II. WATER MANAGEMENT WITH IOT

Water is the need for everyone and to avoid wastage of water the IoT based smart farming is matched with Web Map Service (WMS) and Sensor Observation Service (SOS) provides the information of the requirements of

water. It analyzes crop water necessity and utilizes water source. Under drought conditions, it can easily handle the water management with the help of smart sensors which are capable of notifying the moisture level in the field and can supply the water in the field whenever is required. To avoid the wastage of water in the field monitoring is done with the help of remote sensing. This ability can be additionally intensified if the real-time sensor data can trigger action in the meter by switching it off or on. The meter can be automatically switched on or off depending on the need of irrigation and level of the water resource as previously suggested [22]. Besides, smart sensors can categorize the defects in the irrigation system and can respond reducing of water without effective supervision. The sensors are also quick in finding the faults and will promptly respond to help saving water. The enhanced automated system using mobile phone or wireless PDA facilitates precise monitoring through intelligent networking with the sensors. The process of water saving is performed using embedded control technology that indirectly improves agricultural water use efficiency with low cost input [27]. Internet of Things - Wetting front detector technology (IoT-WFT) provide real time wetting front information in soil for water management in more precise and efficient way to meet the demands of farmer. This system proves to be more suitable as it consists of low costing with high throughput [20]. The Wireless sensor network (WSN) and Linux combination provide web interface so that the farmer as an end user can control and monitor system through remote and facilitate him with automatic farm irrigation. This system is managed by current use of ZigBee wireless communication protocol where soil and humidity is collected as database, monitored and analyzed through web browser. This technology drastically reduces the water consumption and support uniform distribution of water to the crops, throughout the field [18]. For the development of agriculture, crop's health maintenance is one of the important factors. An automated system, developed by Martins *et. al*, primarily attains temperature and humidity data and analyze it using programmable logic controller that supply optimized water amount at the most suitable time, only according to the requirement. Further, this information or process is floated on webpage, so the users can manage and monitor the water irrigation system accordingly [16].

III. IoT IN SOIL MANAGEMENT

Management of soil before the cultivation of crop is very much important. For that IoT is used to monitor the various factors like soil pH, humidity, temperature, moisture and presence of nutrients in the soil. Earlier all these parameters were taken conventionally means farmer manually taking all the measurements and observe them at various intervals. The nodes send the data to the main server, which collect all the data, analyzed, then displayed and can also send the information in the mobile. This application gives information related to soil stress, depth of irrigation, daily water consumption rate and total water used. A studies conducted by Kansara *et. al*, reported a technology where automatic irrigation system is proposed to reduce human intervention. The temperature and humidity of the surrounding is regulated by the microcontroller that eventually increases or decreases power consumption, minimizes time and possibilities of human error [8]. The real time monitoring of soil's humidity and nutrient content is performed through ZigBee technology, decision support technology, artificial intelligence. This system helps the farmers and growers to improve their crops in more precise and scientific manner for the irrigation. It contributes in low labor cost with reduction of pollution [24]. Furthermore, a system using low cost CC3200 sensor Launchpad, cloud computing, mobile computing and IoT is developed for the monitoring of soil's pH, moisture and temperature [17]. Recently, smart irrigation system using 'Arduino' for the optimization of soil moisture and temperature is also developed [13].

IV. CROP MONITORING THROUGH IoT

All the crops need monitoring throughout its life cycle from sowing to harvesting. For that there is requirement of manpower to monitor all the things. Wireless sensor system collects all the data and is transmitted to the system of agriculturist that starts curative activities as previously reported [15]. For real time monitoring of crops precision agriculture is one of the very handy practices of IoT in the agriculture sector and various organizations taking benefits of this technique everywhere in the world. Today agricultural drones are also used to monitor the crops and to enhance the agricultural practices. The most important aids of using drones includes health of the crop health, integrated GIS mapping, easy to use, save time and are increased the productivity of the crops. 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. The climatic conditions severely affects the growth of crops but the application of IoT through Intellisense, pervasive computing and identification technology with ubiquitous networking support, small scale environmental study of crops. By use of such IoT techniques, the meteorological and soil information is acquired through large number of nodes and made accessible to the farmers through internet facility. [28]. Abiotic factors such as light, temperature and humidity influencing crop field are monitored by the use of sensors. The another IoT technique, optimize crop growth influencing factors, using wireless transmission aids transmission of acquired data from sensor to webserver database using JSON encoding. Through this automated system, farmers get an access to monitor water problem scarcity anywhere and periodically. This studies proposed an automated system which is 92% efficient than conventional method of irrigation [19].

V. IoT IN LIVESTOCK MONITORING

Farmers with very huge farms can take the benefit of this wireless IoT application to collect and store the location and health of their cattle. This information supports the farmers to identify the disease and they can separate those diseased animals to prevent the spread of disease. It also reduces the cost of labor and can easily find the 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. Wireless sensor networking (WSN) is one of the wireless communication devices, for the sensing, processing and communication over large distances. But, they need a replacement or over recharging their batteries and this acts as the drawback for using them in Livestock monitoring. Wireless power transfer (WPT) serves as solution where Wireless service network (WSN) and near field communication (NFC) functions hand in hand to monitor health of livestock [10]. In the recent studies, IoT based Live monitoring system (LMS), with help of UID a smart tag for the livestock and smart card for the user is designed. These sensors are implemented in wearable collar designed with QR code for the livestock and it simultaneously reads, process and display information through the wireless technology [9]. The environment has significant role in health, growth and prevention of disease in livestock. The breeding environment, data acquisition by MCU program trial application for reading and sensing is performed on livestock [7]. A complex integrated sensor device is designed to monitor, control and reduce the odor in livestock facility area for their better health conditions [5t is a farming that is used to increase the yield of different vegetables and fruits, etc. by giving pooled environment conditions. Cloud computing will not only help in updating the farmers with the latest techniques of farming but also aid in tracking the top to bottom process from the production to marketing as well with special focus of supply chains in agriculture sector reported by Satpute *et al.,* and Channe *et al* [21, 4]. For this, a smart greenhouse can be designed with the support of IoT where the monitoring and controlling of environment can be done with the help of different sensors by eliminating the need for physical intrusion.

We can create a cloud server for remotely accessing the system when it is connected using IoT. This eliminates the requirement of continuous monitoring in the greenhouse. Inside the greenhouse, the cloud server also enables data processing and applies a control action. We can also monitor the water conservation with the help of sending SMS alert to the farmer with an online portal. This design provides cost-effective and optimal solutions to the farmers with minimal manual intervention.

The light intensity in green house is regulated by IoT technique that optimizes crop growth by the wireless transmission of acquired data from sensor to webserver database through JSON encoding [19].

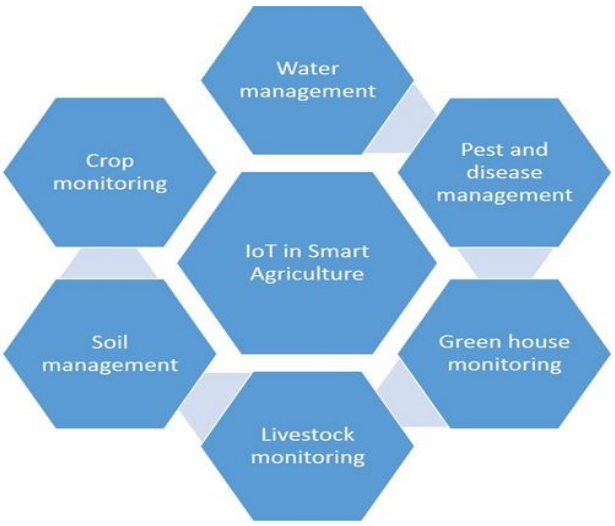
VI. PEST AND DISEASE MANAGEMENT AND IoT

The severe diseases caused by pest and pathogen are one of the major threat to the crop's production. This eventually targets at heavy loss of economy to the farmers as well as the economy. Through IoT in agriculture it is possible to monitor and detect several diseases in the seasonal crop through smart phones, wireless sensors, RFID chips and drones. These IoT tools would further, transfer information to the user's gadget and the farmers will be prepared with their safety measures to combat the microbial diseases and pest infestation problems through sprays using technology [12].

This approach may help in regulating the dose of pesticides and controlling disease problem in the beginning of the infections in future. At the same time, the health of soil, parameters such as moisture content, rainfall, temperature and weather fluctuations parameters could support to obtain a clear view of crop problems by the agri-experts for the sowing of seeds, as suggested Chui *et al*. [11].

They can use IoT for the collection of information about the pest infestation and disease infection using WSN and simultaneously monitor and spread the information for the application pesticides in the fields. This may indirectly help in reduced cost production with enhancement of crop yield, it's sales and over all increased profitability, previously reported [6, 14]. IPM promotes the healthy growth of crop with the natural pest control methodologies. The farmer can access the required information, create personal, self-defense plan with variable weather conditions and could obtain information about treatments through IoT middleware enabled mobile driven and distributed complex event processing solutions [3]. IoT based three levels and three systems provide access to agriculture information to farmer for monitoring and collection of pest and disease information through sensors, data processing and data mining [23]. A real system for the monitoring of environmental factors through data mining, information fusion and Apriori algorithm has been proposed for detection plant disease and insect pest invasion [25]. Recent concept of IoT in IPM is construction of IPM ontology which serves as web ontology language document. It helps in long term prevention of pest via automated ontology method [1]. IoT support reduction of insecticides and fungicides. It correlates among pest and weather data managed by weather stations. This system makes disease and pest information available to farmers for taking controlled measures to protect their crops [6].

VII. CONCLUSION



The Internet of things (IoT) and its derived wide range of techniques support farmers in development and remodeling of the agricultural field to be more sustainable and precised for combating the new upcoming challenges. This technology aids farming and makes it better and more sustainable through faster access of the information of the effective parameters. It connects the users through and devices with efficient communication at global platform in short duration without any human intervention. IoT helps in collection of the information obtained from abiotic factors like soil pH, fertility, humidity and temperature, water level detection in fields, crop growth and its online monitoring, pest - disease detection. IoT supports agriculture and farmers to get connected to his fields at global level and without any time bound. IoT technology empowers farmers well informed and equipped with the current conditions of his agricultural farms, its requirements and prepare for preventive measures. IOT technology leverages smart farming with enhanced productivity and low cost inputs over traditional farming. Conclusively as summarized below in the given figure, IoT not only supports farmers and agriculture through minimized efforts and less time investment with low risks but also contributes in various agricultural sectors such as, water management, pest and disease management, green house monitoring, livestock monitoring, soil management and crop monitoring.

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