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Study report on Indian agriculture with IoT

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ABSTRACT

Most of the population of our country are depends on agriculture for their survival. Agriculture plays an important role in our country economy, but since past few years production from agriculture sector is decreasing drastically. Agriculture sector saw a drastic downfall in its productivity from past few years, there are many reasons for this downfall. In this paper we will discuss about past, present and future of agriculture in our country, agricultural policies which are provided by government to improve the growth of agriculture and reasons why we are not able see the growth in agriculture. And also we will see how can we adopt automation into agriculture using various emerging technologies like IoT (Internet of Things), data mining, cloud computing and machine learning and some authors done some quality work previously on this topic we will discuss that also. Here we will see previous work done by various authors which can be useful to increase the productivity of agriculture sector.

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1. INTRODUCTION

Agriculture is an important sector in any other country, especially when it is developing country like India. Agriculture sector contributes to country's economy more than any other sector. Before independence and at the time of independence, agriculture productivity is very high when compared to the present situation of agriculture. Agriculture is the backbone of country's economy [1]. Most of population occupation is agriculture in our country. Since India is still developing country agriculture is the important sector for economic growth and also it is the only occupation on which more than 50% of population is in agriculture directly.

Agriculture offers 65 to 70 percent of the Indian economy, and therefore, it is the backbone of India. From 60.3% of agricultural land, it renders 17% of GDP and 10% of entire commodity. Agriculture support 60% of people's job. It boosts the foreign market, but farmers suffer from not perceiving required yield due to numerous causes. The computer procedures are employed to subdue crop production obstacles in predicting the yield and risks in advancement. The approaches are applied to the massive collection of agricultural raw data from which beneficial information and patterns have been obtained. More than half types of crops depend on monsoon and yield according to that. So farmers are interested in knowing the predictions. As for the growing population in India, agricultural growth is significant to meet the demand, the research on applying computer techniques is essential. The crop yield is very much influenced by factors like atmosphere temperature, rainfall and geographical topology and many others. A very exhaustive analysis is made on extensive data of the agriculture sector. To protect the crops from the natural disaster, the farmer is interested in analyzing the seasonal changes. Then the prediction about the yield from the past nearby field data can be made and which can be helped using data mining methods.

Agriculture sector also includes livestock it provides the fodder for livestock. Livestock provides quality food to human beings in the form of milk. Agriculture fulfils the food requirements of the people. It is the primary source of our national income. According to National Income Committee and CSO, it contributed 52%, 42.2%, 41.8%, and 32.4% to national income in the years 1960-1961, 1976-1977, 1981-1982, and 2001-2002 respectively. By seeing this values we can say that productivity is decreasing year by year, there are many reasons we will discuss them later.

Agriculture plays an important role in import and export i.e., international trade and foreign exchange, we can earn money by exporting our products to foreign countries, it helps to our economy, it also important in transportation. It supports road ways and railways which involves in transporting huge amount of agriculture produce factories. Agriculture has been primary source of raw materials to the many leading industries like cotton, jute textiles, sugar, tobacco, edible and non-edible oils etc., processing of fruits and vegetables, dal milling, rice husking, gur making. All these industries are depending on agriculture directly or indirectly. Agriculture also includes irrigation projects. It provides large employment opportunities in the irrigation projects and drainage system. In our country, we are facing the problem of unemployment since ages in this situation only the agriculture sector can provide more employment chances. It also main source for many state governments, many state governments getting good revenue in the form of taxes from farmers, taxes like land revenue, agriculture income tax, irrigation tax etc.

Reasons for agriculture: There are many reasons, we will discuss few here. First reason is most of the rural area people are moving to urban areas. Most of the farmers are unaware of government policies and subsidies. Negligence of government, government is mostly concentrating on industrials and not providing sufficient subsidies and policies except some of the state governments. Overall country wide if we consider agriculture sector is not getting efficient attention. Nowadays technology is everywhere, but we are still at initial stage in adopting technologies into agriculture sector. Farmers are still using manual methods to detect the crop disease, crop monitoring and other activities it takes much time, sometimes predictions based on these manual methods will fail and it leads to loss. Price policies most of the time price provided by government to the product will against to farmers, subsidies and government invests less on agriculture. Water is the main resource for agriculture so government should provide proper irrigation and water management. Land issues also one of the reasons for low profit; some of the farmers do not have the land for harvesting. We can adopt land leasing technique and solve this problem [2].

Government policies: Indian is mostly focusing on sugarcane production and horticulture. Government policies are: Ministry of agriculture is suddenly giving importance to the horticulture, 2012-2013 is declared as "Year of Horticulture". Indian government is allowing 1 million tons of sugar export to help sugar mills. Ministry of Agriculture to extent the subsidies on loans for crop for agriculture mechanization. Government giving priority to food gain production and decided to end the technological missions for cotton and jute. Government buys the crop products from the farmers at a price called as minimum support price (MSP). The process is goes like this farmers will sell products to the middleman and from middleman it will go to the government. This year government is planning to send MSP directly to the farmer but middleman are creating issue and not agreeing to this.

National Crop Insurance Scheme (NCIP) aims to provide insurance and financial support to the farmers in the event of crops failures as a calamities, pests and diseases. Integrated Scheme on Agriculture Cooperation (ISAC) aims to provide financial assistance for the activities like agro-processing, computerization of cooperatives, marketing of food grains, input supply etc. Integrated Scheme on Agriculture Census, Economics and Statistics (ISACES) this scheme aims to collect data of operational holdings in country to provide aggregates for basic agricultural characteristics for use as the bench mark for inter-census estimates.

In India population is growing incredibly and agriculture growth is decreasing every year it will affect our economy, statistics are show in Table 1. Agriculture was good at the time of independence and some years after it saw its downfall at that time "Green revolution" was happened in mid-1960's from green revolution to 2001 we saw a good growth in agriculture, but after 2001 again it facing low time in its growth. Even though we are achieving sufficient growth rate that can enough for our country population that's not enough we have to achieve more growth. We need to work for it.

Table 1. Population growth and production growth

	1950-1966	1966-1996	1996-2014	2014-2018
Growth rate of population	2.03%	2.18%	1.51%	1.50%
Growth rate of production	2.10%	2.97%	1.90%	1.75%

2. IoT IN AGRICULTURE

As we mentioned earlier, farmers are still using manual methods for crop monitoring, disease detection and other activities, there are some disadvantages when we use manual methods, like they take time, we need to present there in the farm, they fail to detect exact situation. We can use technology in efficient way to get accurate results and to save our time. Now we will see technology in agriculture, there are many technologies but nowadays all prefer use IoT for agriculture related work, sometimes IoT solely handles the project and sometimes IoT with any other technologies which can be useful and compatible. With help of technology we can monitor the crop from anywhere and we can provide water to field from remote location, crop detection can also be done without being on field.

Now we will discuss how technology can be used. IoT related sensors can be used to sense the weather situations, pH value of any solution, we can monitor the moisture percentage by using soil moisture sensor, water level sensor, PIR (private infrared) sensor, temperature sensor, humidity sensor, pH sensor, and Zigbee, XBee protocols we will use. Microcontrollers like aurdino, Raspberry Pi minicomputer will be used, we will use camera modules also. Data mining and machine learning algorithms also used sometimes we will use image processing techniques to. Data mining algorithms used to disease detection, crop classification, to find factors that affecting crop productivity, to provide advisory system. Machine learning algorithms used to extract the data, understanding what is the problem and generates some rules based on that rules algorithm will work and solve the problem. When data is in the form of images at that image processing can be used. Sensors will generate huge sensed data cloud is used to store the data.

2.1. Sensors used in agricultural IoT

2.1.1. Soil moisture sensor

Soil moisture sensor in Figure 1 is used to measure the volumetric water content in soil. It senses the moisture content based on soil properties like, resistance, dielectric constant, interaction with neutrons, and based on environmental factors like soil type, temperature, and electrical conductivity. This has two probes which are inserted in to field when current passes through probes based on resistivity moisture percentage will be measured [3, 4].

2.1.2. Temperature sensor

Temperature sensor basically used to measure the hotness or coldness of an object. This sensor is more accurate than thermistor which are initially used to measure temperature. This sensor will not get heated easily; it has 3 terminals input, output, and ground. There are many types of Temperature sensors. We will use LM-35 IC as shown in Figure 2.

2.1.3. PIR sensor

All the objects with temperature above absolute zero temperature emit heat energy in the form radiation. PIR (private infrared) sensor as shown in Figure 3 is used to detect infrared radiation emitted or reflected from an object. It is used to detect the movement of people, animals, and any other object. When any obstacle passes in the field, temperature at the point will raise from room temperature. Sensor converts it into voltage and triggers the detection.

2.1.4. Water level sensor

This sensor in Figure 4 is used to detect the level of water or any fluids. It has a sensing probe which senses the surface level of nearly any fluid includes water, salt water and oils. This sensor will not get damaged easily, it interfaces with Aurdino easily. It has two buttons, one records minimum fluid level, and other records the maximum fluid level. Level will be measured based on voltage.

2.1.5. pH sensor

The pH sensor in Figure 5 used to measure the pH value of the solution. pH value is measured 0-14, 0-6 is acidic, 7 is neutral, 8-14 is non-acidic or basic. It is measures the pH value based on hydrogen ion concentration, which is measured by pH electrode. The response time is less than 2 minutes. Temperature range is around 60^0 c input range voltage is 5 V and output range is 414.12 µV.

2.1.6. Temperature and humidity sensor

The DHT11 is a basic, ultra low cost digital temperature and humidity sensor in Figure 6. This sensor made of two parts a capacitive humidity sensor and a thermistor. Humidity sensor senses, measures and reports both moisture and air temperature. Temperature range is 0°C-50°C, humidity range is 20%-90%. These sensors are mostly used in IoT along with these there are many other sensors but we will use these sensors frequently.

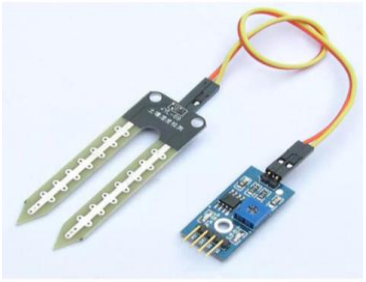

Figure 1. Soil moisture sensor

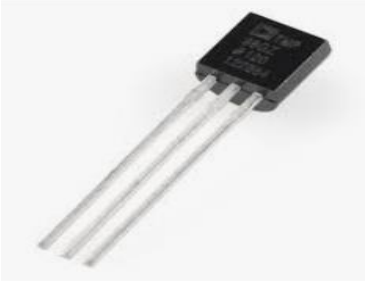

Figure 2. Temperature sensor

Figure 3. PIR sensor

Figure 4. Water level sensor

Figure 5. pH sensor

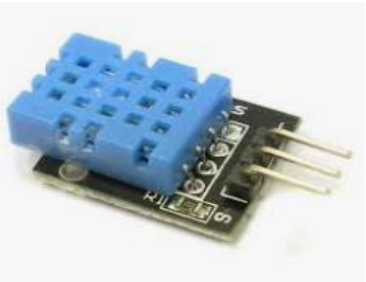

Figure 6. Temperature and humidity sensor

2.2. Hardware also consists of two main things microcontrollers Aurdino and Raspberry Pi

2.2.1. Aurdino

Aurdino is single board microcontroller which is mainly used for building various kinds of digital devices, the block diagram shown in Figure 7. It can also control and interface with various electronic components such as sensors, actuators and many more. It has its own static RAM and stores data at flash memory and EEPROM. It uses programming languages like C, C++, and java.

2.2.2. Raspberry Pi

It is a credit card sized minicomputer. It is a series of small single board computers, the block diagram shown in Figure 8. There are many generations of Raspberry Pi. Each generation has its own specifications. Latest version is Raspberry Pi module 3. It has on-board WI-FI/Bluetooth support. Processor speed is more than any other microcontroller. It is uses programming language python.

Figure 7. Aurdino microcontroller

Figure 8. Raspberry Pi microcontroller

3. RELATED WORK

Harneet kaur [5] discussed about how we can achieve inclusive growth in agriculture and GDP (Gross Domestic Productivity), talked about past achievements and future challenges, structural transformation of the Indian economy and major drivers of it, and key issues and strategies to achieve sustainable growth as soon as possible. In this paper also mentioned about issues like climate change, equity

in agriculture, and policies such as price policies, land issues, subsidies and investment in agriculture, irrigation and water management, credit, and role of agriculture growth. How agriculture sector plays a primary role in Indian economy.

N. Kiruthika [6] investigated about the investments and returns related to Indian agriculture. Also talks about role agriculture in national income. Done research on public sector investments and returns, private industries investments and return and success rate of both the sectors. When compared to public sector private industries developed more in less time. In this paper [6] also discussed about public-private partnership (PPP) through we can see more development in agriculture within very less time. Himani [7] this paper analyzing the agriculture in India, it talks about India's position in world producing the agricultural products, agriculture importance in our country, and also explained about challenges, priorities and government policies.

Ansari and Shazia [8] Adoption of sustainable agriculture practices, it is explains the behavioral approach, Reasoned Action Approach/Theory of Planned Behavior (RAA/TSPB). According to RAA/TPB approach based on some factors we will suggest which one is the best crop to farm on a particular field. Factors considered in this framework are farmer's characteristics, farm characteristics, contextual factors, information, relative advantage, complexity, compatibility, observability, and trailability.

Veenadhari and Bharat Mishra [9] it's a review paper, in this paper they just described that where we can apply data mining and machine learning algorithms on agriculture. K-means algorithm used to classify crops and soil. ID3 algorithm used to provide advisory system to tomato growers. Decision tree induction algorithm used to disease detection and explained about OLAP (Online Analytical Processing). Ravisankar and Siddardha [10] data mining techniques used to classification of agriculture data but accuracy is lower when compared to big data techniques. In this they proposed a big data technique Hadoop cloud-based analytics map reduction techniques for data analysis. Big data provides advantages over data mining. Simple linear regression and decision tree algorithms are used.

Data mining algorithms which are used to extract the important and information from huge information, there are two steps classification and clustering. Various algorithms are used to various purposes. For the classification ID3, J48, LMT, KNN algorithms are used and for clustering EM and K-means algorithms are used. These algorithms tested with huge agriculture data [11]. Machine learning is an emerging technology in this a software workbench called WEKA (Waikato Environment for Knowledge Analysis). We have to learn about Machine learning, in this technology there are many methods, characterizing the problem this done in two steps one is defining types of data, second one quality of data there are seven levels of quality. AQ11 algorithm is explained. How can machine learning used in agriculture with the help example explained by using WEKA [12].

Manjula and Narsimha [13] proposed a framework called as eXtensible Crop Yield Prediction Framework (XCYPF). It is flexible and dynamic framework which can be used to find any crop's crop yield prediction. It takes different kind of input and provides a single and appropriate output. This framework helps in making strategic decisions. S. Surai and R. kundu [14] proposed a smart agriculture monitoring system with the help of soil moisture sensor. Soil moisture sensor used to measure the moisture percentage of soil and based on that percentage system will take decision whether soil need water or not, If there exist need of water it automatically switch ON the pump.

Snowber Mushtaq [15] esigned a system with the aim of combining IoT and image processing technologies for developing a smart agriculture based system. In this system there are four modules they are, data collection module here data from various sensors will collected in the form of images and text format. Second module is Gateway module acts as a connector for connecting various sensors and cameras by wireless communication. Third module is cloud server data storage module, in this module data is collected, compared and analyzed for decision making. in last module that is web and mobile application decision will send to the user through this module.

N. Suma [16] proposed a smart agriculture monitoring system to detect the risk i.e., animal detection and to provide proper irrigation from remote location, by noting various environment properties and soil properties continuously. Nageshwar Rao and N. Sridhar [17] proposed a smart crop field monitoring and automatic irrigation system. A Raspberry Pi and cloud based IoT system will monitor the real time data come from the crop field. Mainly focuses on moisture variations correlate with temperature changes data by smart sensors and controls irrigation system. M. Jagadesh [18] proposed a wireless sensor network based agricultural monitoring system which helps farmers to monitor the various changes in the agriculture field. It is a single system with multiple applications. Data is collected from various sensors and stored in the Raspberry Pi using Zigbee.

4. COMPARATIVE TABLE

Comparison of various approaches in literature is tabulated in Table 2.

Table 2. Comparative table

Author/ Parameters	Niketa Gandhi [19] (TIAR 2017)	Niketa Gandhi [20] (JCSSE 2016)	Niketa Gandhi [21] (ICACCI 2016)	Niketa Gandhi [22] (TIAR 2016)	A. k. Tripathy [23] (2011 IEE)	Ratchapum Jaikla. [24]	A.K. Marippam [25]
Objective	Extracting knowledge for predicting rice crop yield	Predicting rice crop yield for Kharif	Predicting rice crop yield for Kharif	Rice yield prediction using neural networks	Understand relationship between disease (BNV)/pest(t hrills and weather parameters of groundnut crop	Is to Check whether the location is appropriate for rice or not, Reducing risk investments, crop yield prediction	Rice yield prediction
Software	WEKA	WEKA	WEKA	WEKA	XLminer	DSSAT4 using crop simulation model	Crop simulation model
Parameters	Precipitation, soil type, min, avg, max temperature, Area, production, yield	Precipitation, min, avg, max temperature, Reference crop evapotranspiration, Area, production, yield	Precipitation, min, avg, max temperature, Reference crop evapotranspiration, Area, production, yield	Precipitation, Area, yield, Production, Temperature, reference crop evapotransipiration	Temperature, relative humidity, rainfall, sunshine hour, leaf wetness, evapotranspiration	Day, Weather data- solar radiation, max, min temperature, precipitation	Soil PH, temperature, sunshine, rainfall, land, fertilizer, paddy, pest, post harvest
Methods	J48, LADTree, IBk , LWL classifications are used	Support vector machine(SVM), Sequential minimal optimization(SMO)	BayeNet and NaiveBayes algorithms	Multilayer perceptron technique	Gaussian naive bayes, Regression mining technique, EM algorithm, Rapid association rule mining algorithm	Support vector Machine (SVM)	ZeroR classifier algorithm.
Advantages	J48, LADTree are more accurate	-	BayeNet is more accurate	ANN techniques are more accurate than data mining techniques	CWK model is more accurate prediction method	This model error is in acceptable range	-
Disadvantages	LWL is least effective	Lowest accuracy and worst quality	NaiveBaye lowest accuracy	-	-	-	
Crop Type	Rice	Rice	Rice	Rice	Groundnut	Rice	Rice

5. CONCLUSION

Agriculture is the backbone of our country. In this paper we discussed about the importance of agriculture and challenges faced to improve the agriculture growth. Issues and priorities related to agriculture. Government policies of agriculture and technologies used in agriculture and we are tried to provide some the previous work related to agriculture. Hopefully, this paper will help you for better understand of agriculture and technologies used in agriculture which can also be called as digital green revolution.

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