International Journal of Advance Research in Science and Engineering
Volume No. 10, Issue No. 10, October 2021
www.ijarse.com
IJARSE
ISSN 2319 - 8354

IoT and Data-driven system for Agriculture Crop Management

Dr. R Obulakonda Reddy[1], Dr Chukka Santhaiah [2], Mr. Sama Surender Reddy[3], Dr. V Sitharamulu[4]

[1]Associate Professor of CSE, Institute of Aeronautical Engineering, Dundigal, Hyd
EMail: rkondareddy@gmail.com
[2]Associate Professor of CSE, Institute of Aeronautical Engineering, Dundigal, Hyd
EMail: chukka.santh@gmail.com
[3]Assistant Professor Of CSE, Institute of Aeronautical Engineering, Dundigal, Hyd
Email: surrender.it2008@iare.ac.in
[4]Associate Professor of CSE, Institute of Aeronautical Engineering, Dundigal, Hyd
EMail: v.sitharamulu@iare.ac.in

Abstract

IoT that is briefly abbreviated as the Internet of things plays a vital role in current technology. This works as a most effective area in every field of research. The webwork will be encapsulated with many sensor nodes and intelligent devices where statistics are communicated between source and destination with the server in the absence of human collaboration. In sensor nodes' presence, the particulars or details of the information have been imparted utilizing remote sensors. Unmistakable boundaries are assessed and gathered using the sensor hubs as these sensors are put at different spots. Between the current innovation, webworks are using significantly trendsetting innovation in each field. Here we considered a farming field where checking the areas should be possible through numerous applications in a computerized way. The notion of energy harvesting is described here as every sensor node has tight energy or power backup. Each of these nodes will be charged through solar energy, and these are utilized to monitor water management, climate monitoring, crop management, and pesticide monitoring. In this research, we have discussed a concept that uses the notion of energy harvesting in agriculture. This helps in monitoring, developing, and controlling the field automatically that increases theagricultural system's growth and productivity.

Keywords-IoT, Agriculture controlling and monitoring, sensor nodes, harvesting energy, Solar energy.

I INTRODUCTION

Some particular drivers handle all the challenges involved in IoT agriculture[1], [2]. All the data-driven and ICT facilities are pierced in the farming of large-scale industry in most of the developed countries to communicate. In some countries, as they are not that advanced, they don't know IoT'sutilisation.

Sectoral Theme

Type Nonuniformity of Sector: There are numerous types of a performer in the food system, ranging from large to small. There is no way out for the population's needs even though using many technologies, regulatory and business models that board all the needless. In a portion of the states, horticulture precision rehearses are done in beneficial cultivating massive ranchers have broadly procured that creation upgrade should be possible in quality. In agriculture, lucrative pressure, enlarged water scarcity and farm segmentation all require accurate irrigation techniques so that resources can be cut down and all the processes can be done through automation[3].Farm Measurements and capital speculation cost: In the IoT technology, to enhance crop productivity, huge capital and in-depth farms are needed and require uninterrupted investments as it requires new equipment. Enormous ranchers have planned some current and essential shrewd cultivating enterprises. These are working for a minor or restricted territory. An adjusting procedure named 365FarmNet is financially savvy. This will supply administrations dependent on size. This research aims to adopt a solution for all the farmers, especially small-scale farmers, which can be affordable with all the features and applications embedded within it[4]. Business Prototype and Business confidentiality:To design any system to automate farming, relevant business models are needed with all the necessary privacy and required data control on the system, but we need to permit other agri-food performers and farms to fabricate all the data they are manufacturing. This is a space of dispute with larger farmers as they look for utilizing all the data that is been apprehended by machines, which has been withstand by farmers' results in value and loss control, respectively. In recent times, data and set up of agriculture data alliance there was a huge fight among farmers to keep back their ownership. User and Societal affirmation:To recognize the utilization and applicability of brand new technologies, education and some of the training

aspects are required for farmers. Based upon the education degrees, some farmers are attaining interests to learn all the latest technologies, but some are disagreeing to learn new technologies. Acquiring intelligent technologies will be a challenging task for illiterate persons.

Technical Details

The Shortage of interoperability: To arrive at a widespread simultaneousness in this space, there will be information conventions, basic structure blocks, guidelines are required by a gadget to be viable, and various norms are there in the agri-food area, so as a rancher they need to go through every one of these to adjust the framework. These standards are subsisted from data modelling and semantics, weather data, e-commerce retail stores, agri-machinery, supply chain, and much more numerous enterprise. There are many IoT standards like IEEE, ITU, onem2m, ISOBUS, and many more; these are not adapted to the new techniques and machinery. Pivotal ventures are in progress from both AgGateway and Agricultural Electronics Foundation to crush the interoperability obstructions. The principal challenge isn't the shortfall of guidelines but the divulgence of many such norms.Deficit of Connectivity:In many locations, there is a connectivity issue in the further development of IoT, as there is a poor coverage area of 3G/4G. Low power wide Area technologies have come up with real-time opportunities to overcome all those limitations like coverage issues and connectivity issues. A drawback in this technology like this can’t handle large data sets[5], [6].

Data Processing:To overcome all the limitations, this provides an ability to access all the large-scale processing power at an equitable cost to resolve all the complicated calculations. This may also remain a challenge for medium and small farmers.

Deficit transparent data governance:Pronouncement and legal frameworks are most leisurely catching up with all the latest technologies and realities. Ownership and control of farm data are still controversial. Many large industries always think of themselves as data companies and will fight against the farmers to pull out of control data to their hands and other primary actors.

Data Privacy and Security:A clear-cut form of governance issues is one issue for data security and data privacy. In some of the countries, to take up the data cloud computing services and barriers are demanded[7]. This is indicative of the broader importance of such matters of IoT adoption. Despite all these issues, there is an enlarging community of either a hi-tech or technically young literate farmer with a powerful interest in the agri-food domain. This guides the accretion of startups by conducting many hackathons. This would moderately make a

solicitation of data science, technology, and sensors in common to agri-food. Additionally, to staple the sectoral and technological issues, LSP needs to label numerous objectives specific to the agri-food sector to satisfy users by explaining the uses of IoT technologies in agriculture[8], [9].

These comprise the following:

- Enlarge yield quality/quantity and beneath production cost.
- Improve productivity and animal health or welfare.
- In the complete life cycle for food detectability and surge food realization for consumers, it enables the control and monitoring of plants and animals.
- Enhances the soil quality, reduction in the usage of other natural resources, and utilization of water.
- Ease and enhance food security and safety.
- In the complete food supply chain, guarantee that certification schemes are more effective and deceit-free.
- Prosper or authorize business models are adjusted for the IoT ecosystem, creating new business opportunities and cooperation opportunities.

II APPLICATION AREA OF IOT – BASED AGRICULTURE

Agriculture detector

To furnish a suitable environment for the development of crops with the highest production, it is challenging to monitor every crop parameter when they got affected within the stages of their development. Numerous sensors are present in both forms, like wired sensors and wireless sensors, and these are used to monitor the weather condition of the station. These sensors will store the data so that we can design a system accordingly to monitor and control the crop based on the data. Monitoring involves the below components:

Air Monitoring: Parameters like humidity, temperature, and most common parameter, namely pollutants that adapt or spoil the crop[10], [11].Soil Monitoring: In this monitoring, nutrients, pH, electric conductivity, soil moisture, and chemicals are monitored, which are commonly present in the soil, as soil plays a significant role to make the field healthy or unhealthy. A suitable quantity of nourishing should be provided to the crop. The harvest may grow healthy by delivering it, or it may get destroyed based upon the nutrients present in the field[12].

Water Monitoring: To supply the correct kind of growth in the field, the right amount of water needs to be provided to the area or rainfall so that the crops will take the nutrients.

Livestock Monitoring: Because of animal livestock, monitoring can be done using sensors put down on animals to check if there is any destruction in the field. For the successful growth of crops, we commonly use animal bi-products to get many nutrients to grow healthy from those we reach.

Irrigation Control: We can automate the irrigation process by using some automated systems with sensors are embedded. By using the data, we can control the water level in the field. When the rainwater is in the area, we can maintain the water level through an automated system by avoiding the irrigation process.

Plant Monitoring: It surrounds the plant life study very adjacently to trace the signs of damage by bugs or any recurring disease basis. Based on the damage,real action can be applied in the crop circumstances before taking necessary measures.

Fertilizer and Pesticides Control: Fertilizers and pesticides are need to be given in a specific period. This data need to be trained accordingly so that the automated system can act giving pesticides to the crop based on the input parameters by numerous sensors.

Illumination Control: To generate the correct amount of photosynthesis in plants, plants' proper amount of sunlight needs to be taken by plants, which is essential. By utilizing actuators and light sensors, ambient light can be controlled.

A. Supervised Agriculture

Greenhouse gases can provide an unnatural environment with simple control on the necessities needed for healthy crop growth. The process can be made more accessible using an automated system like an integrated IoT system by using numerous sensors to oversee the greenhouse[13].

B. Food furnish chain Tracking

In general food chain consist of the following constraints:

1. Pre- reap the production when the crop production is on the field.
2. Post-reap all the operations when the field goes through some introductory course of actions likecleaning and organizing.
3. Tight food storage.
4. shielded food transportation.

5. Processing the food.

6. Food sale.

7. Household and commerce consumption.

In each stage, we need to monitor and cut down the wastage in both the crop's quality and quantity.

D.Smart Farming

Depending upon the analysis, accuracy in agriculture can be apprehended as this comprises a bunch of technologies that include sensor networks, data analytics, and automated machinery to study asymmetric parameters and change them dynamically of the agricultural system.

III BLOCKCHAIN AND ITS EVOLUTION

In an arrangement of webworks that share vital data and uses it for additional explanation, the by and sizeable focal power will appoint the undertakings for keeping up the precision and reasonableness of the data. When a merged framework is arranged to disappointment, it could be manual for an enormous loss of essential information is required in every one of the primary applications. To crush such cataclysmic issues, it is appropriate to move solid errands to a rearranged framework. Blockchain innovation is a restricted framework that allows different frameworks to proceed with a local area duplicate of a public vault called the blockchain via a devotion convention to join a fresh out of the plastic new square into the blockchain with a strategy called mining. A simultaneousness convention to ensure soundness among various neighbourhood duplicates. Such a framework avoids a solitary mark of non-accomplishment by allowing various authority focuses with different hubs to such an extent that if an isolated corner flops, each corner associated with it will be coordinated to another intersection as long as there is no unit of the webwork. This can be additionally improvised as an administered framework with no central hubs, where every one of these hubs will, by and large, keep up the critical data. Various squares are joined to the information design of the blockchain, which is connected straightly in a successive request to create a chain, which is secured utilizing coding strategies. A square has contained a header with hash on the earlier court; the blockchain components vary, starting with one application then onto the next application[14].

A. Features of Blockchain

The following comes under the basic features of blockchain.

Decentralization: In a redistributed system, numerous trusted agencies collaborated to maintain all the blockchain data.

Persistence: Blockchain information is meddled impervious as each report is approved various occasions by various hubs and that has been duplicated in every one of the nearby duplicates of the seats if there is any adjustment in the information of the duplicates which can be expressly distinguished when the information duplicate is shifted in their substance. By not allowing the square cancellation, blockchains are made sealed.

Anonymity: The technology of blockchain permits each node to have numerous labels to ensure privacy maintenance on all the transactions.

Auditability: In the webwork, users have permitted access to every node to validate the transaction and trace all the transactions. This attribute is made possible because of the transaction validation before recording them during the procedure of mining. By permitting a user to verify the transaction process will ensure traceability, therefore non-repudiation of all the transactions can be achieved by all the nodes.

B. Challenges of Blockchain

Scalability: Once the block is attached to a blockchain and can never be detached, there will be a primary issue for the storage space. Many solutions have been studied comprises of limiting the number of transactions processed per unit time.

Privacy Leakage: The delight of publicly realistic exchanges and hence the blockchain can't ensure conditional protection. Additionally, various strategies have been created to interface every one of the clients with pen names.

*Selfish Mining:*Blockchains are permitting conspiracy from hubs if 51% of the corners are fake. This is known as a 51% attack. Such seats could join squares to the chain that will back a currency exchange that had been officially approved.

IV WIRELESS SENSOR NETWORKING FOR AGRICULTURE

Wireless sensor networks (WSN): A troupe of dispersed sensor nodes is called Wireless Sensor Networks (WSNs), which are utilized for various applications like military, environmental controlling systems, smart agriculture, weather management systems, and many more. In WSN, sensors are the major components that are dispersed in an ad-hoc

manner. Sensors are comprised of a processing system, subsystem, and communication system. Every sensor has a base system that links the Internet to share information and communicate with the system. Numerous routing algorithms are designed accordingly based on the system requirement. Every single routing protocol is distinct from another routing protocol as they have its applications and restrictions. This is based upon specific work[15]–[18].

A. Methodology

IoT is one of the most compelling sectors in research as this is playing a significant role in current technology. This is a network of connectivity into substantial gadgetry and daily things, where sensors are attached to the devices that turn into a smart device that helps collect the information from the origin and communicate with the server. WSN plays a significant role in IoT as a troupe of dispersed and committed sensors is utilised to monitor, arrange, and convey information to isolated locations using these data to be shared and communicated to the destination. Sensor nodes carry a restricted amount of energy, and batteries power this energy; when the power is lost by the sensor node, the node is equivalent to DEAD. So to overcome the energy concept, Energy Harvesting (EH) has been used[19]–[21]. EH is based upon the WSN as we need to bring out energy from numerous distinct sources like wind energy, mechanical vibration, solar energy, temperature variations, water, thermal, etc. Recently there are many advancements in the agriculture field in the management and monitor of these networks. EH has been utilized. Using solar energy, these sensor nodes are being charged. When the sensor gets fully charged, the charging process will be halted. Here, these solar panels are used to capture and are utilized to monitor crop management, pesticide monitoring, water management, and climate monitoring[22]. Using this application, there are many advantages like improving the production rate, upgrade the quality of Indian agriculture and dwindle human efforts. Farmer's conditions can be developed with the help of this system and result in polishing up labourers' lives. The latest technologies are comprised in intelligent agriculture to brush up the production ratio and production quality. In this proposed work, we utilize many energy reaping techniques to keep down the restriction of node energy, For the energy restoration we utilized some external environmental factors like solar energy. Table 1 shows the organization of solar energy and power density in distinct conditions.

Energy Harvesting Techniques	Power Density	Efficiency
Solar Energy	Direct sun: 15mW/cm^2	Highest
Solar Energy	Cloudy Day: 0.15mW/cm^2	Typical
Solar Energy	Indoor: <10μW=cm2	NA

Table 1. Organization of solar energy and power density in distinct conditions

Fig 2. Cost of Cultivation

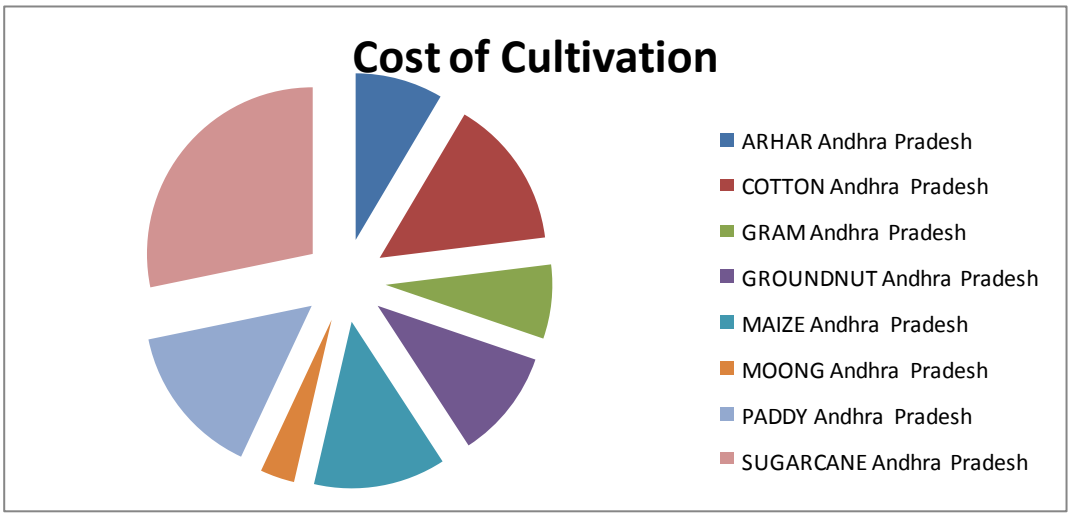

Fig. 2 clarifies the expense of the development of sensor hubs that are put at particular situations on the land to catch data like harvest the executives cycle, water supply, pesticide observing, temperature checking, and these qualities will be passed on to the passageway, the framework passes on all the accumulated data to the door so by using IoT advances rancher can get all the data from the application in one single touch and can screen every one of these boundaries in equal. In the proposed work, we have taken land and embedded all the land sensors in a distributed manner. Sensor nodes are designed so that if any movements or any difference occurred in the ground, the sensor captures it and sends an alert to the farmer. Distant nodes are proficient for small tasks for sample temperature sensors can notice all the parameters concerning temperature, water sensors could sense the prerequisite of water present in the soil, crop management sensors are designed in such a way that they can work automatically and perceive the crop which is grown based upon the data which is stored and pesticide sensors can regulate automatically the cycle of pesticide which is required for the

crops. Information detecting is done consistently by these sensors from removed sensors, and subtleties are gathered from the put-away information, and this information is passed on to the passageway. Passageways are coupling focuses between the cloud door and sensors. Data has been collected from distant sensors access points that transfers the collected data to the IoT cloud. Direct monitoring has been done as the data is analyzed and obtained automatically. The idea of energy gathering is being acquainted with conquering every one of the framework's difficulties as the sensor is battery-based gadgets the battery may lessen steadily dependent on the activity so by using the energy reaping procedure sensors are charged naturally. The sun-based collecting strategy has been utilized to assess the sensor. Free energy is generated by solar energy in a wide range. If we use this energy very accurately,the sensor lifetime can be increased proportionally. By utilizing this energy harvest method, power issues can be resolved for the sensors and results in the operational performance and effectiveness of the proposed systemIn this framework, WSN strategies are used for administering the sensors in a specific area, sensors are planned dependent on the WSN for limiting the energy, and force issues have been settled by executing energy gathering methods. Human endeavours are diminished for the rancher by using this framework. The rancher can screen consequently depending on the ready he gets and controls the farming's homestead and execution. Fig 3 represents the algorithm of the proposed system. Energy harvesting, WSN, and IoT are the leading three technologies used in this research. Fig 4 illustrates the proposed method.

The combination of all these three technologies is a powerful, deadly combo in the field of agriculture. Analysis on other related results based on Agriculture Crop Production In India collected from Kaggle.

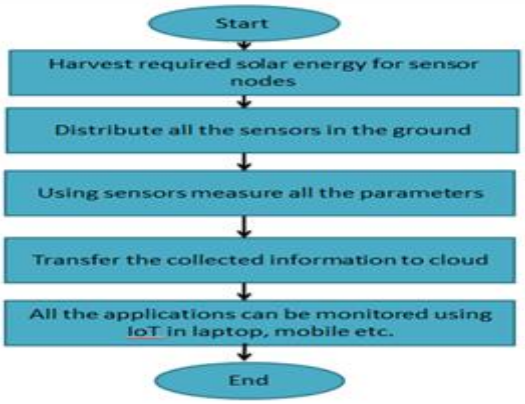

Fig 3. Algorithm of the proposed system

Mainly Andhra Pradesh crop production details are analyzed. Fig 5 represents the crop production, area, yield, and Fig 6 illustrates crop and the grown state.

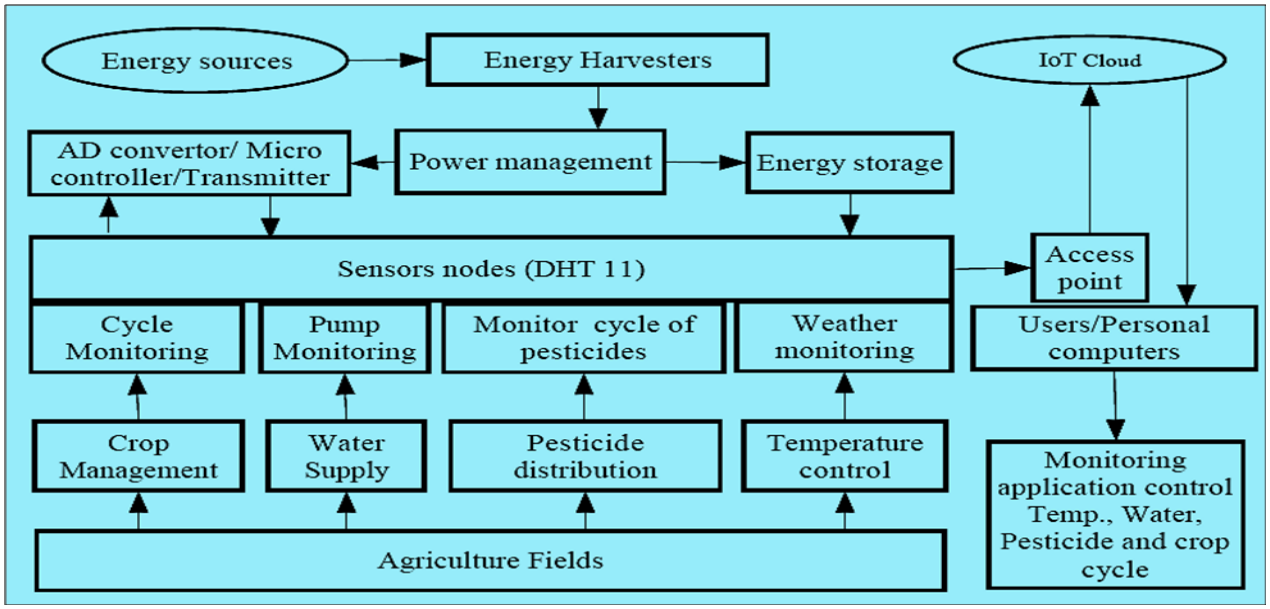

Fig 4. Proposed system

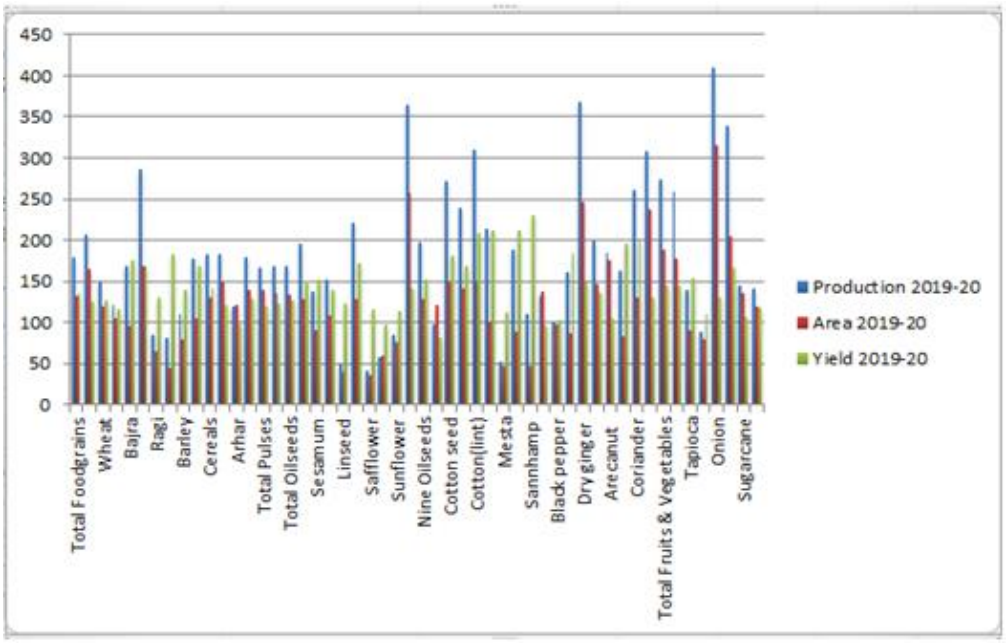

Fig 5. Crop production, area, yield

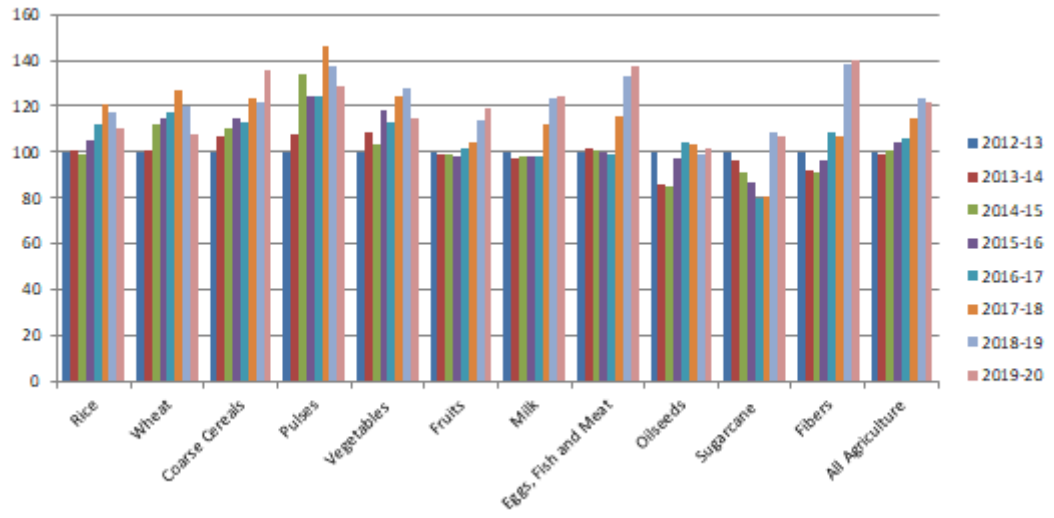

Fig 6. Crop and the grown state

VI RESULTS AND CONCLUSION

This paper represents IoT which is based upon the agriculture system that utilizes the concept of WSN. Remote sensors are placed in some particular area in a distributed pattern. Data can be sensed by every sensor, collects all the details, and conveys the details to IoT sensors by using an IoT gateway. This proposed system is beneficial compared to both old and traditional methods. With the help of this framework observing, temperature control, mugginess controlling and crop the executives, and so forth become extremely proficient as the rancher can pre-plan the undertakings which have been performed by utilizing their framework, if there happens any issue in the harvest information is sent naturally to the worker so the framework will work appropriately. Ranchers can consequently control every one of the misfortunes and improve the harvest's profitability and nature by utilizing this framework. The restricted battery issue has been overwhelmed by using this framework as we have been used an energy collecting framework to charge the batteries through sun-based energy. From the climate, we secure a lot of free energy. More victories are gotten by utilizing this proposed framework as we have been used the combo of innovations.

REFERENCES

[1] I. Mat, M. R. M. Kassim, A. N. Harun, and I. M. Yusoff, "Smart agriculture using internet of things," in *2018 IEEE Conference on Open Systems (ICOS)*, 2018, pp. 54–59.

[2] C. Brewster, I. Roussaki, N. Kalatzis, K. Doolin, and K. Ellis, "IoT in agriculture: Designing a Europe-

wide large-scale pilot," *IEEE Commun. Mag.*, vol. 55, no. 9, pp. 26–33, 2017.

[3] G. Seeja, O. Reddy, K. V. R. Kumar, S. Mounika, and Others, "Internet of Things and Robotic Applications in the Industrial Automation Process," in *Innov. Ind. Internet Things Smart Fact.*, IGI Global, 2021, pp. 50–64.

[4] L. Ruiz-Garcia, L. Lunadei, P. Barreiro, and I. Robla, "A review of wireless sensor technologies and applications in agriculture and food industry: state of the art and current trends," *sensors*, vol. 9, no. 6, pp. 4728–4750, 2009.

[5] T. Wark *et al.*, "Transforming agriculture through pervasive wireless sensor networks," *IEEE Pervasive Comput.*, vol. 6, no. 2, pp. 50–57, 2007.

[6] X. Yu, P. Wu, W. Han, and Z. Zhang, "A survey on wireless sensor network infrastructure for agriculture," *Comput. Stand. \& Interfaces*, vol. 35, no. 1, pp. 59–64, 2013.

[7] K. V. R. Kumar, K. D. Kumar, R. K. Poluru, S. M. Basha, and M. P. K. Reddy, "Internet of things and fog computing applications in intelligent transportation systems," in *Archit. Secur. Issues Fog Comput. Appl.*, IGI Global, 2020, pp. 131–150.

[8] M. S. Mekala and P. Viswanathan, "A Survey: Smart agriculture IoT with cloud computing," in *2017 international conference on microelectronic devices, circuits and systems (ICMDCS)*, 2017, pp. 1–7.

[9] S. R. Prathibha, A. Hongal, and M. P. Jyothi, "IoT based monitoring system in smart agriculture," in *2017 international conference on recent advances in electronics and communication technology (ICRAECT)*, 2017, pp. 81–84.

[10] D. Shinghal, A. Noor, N. Srivastava, R. Singh, and others, "Intelligent humidity sensor for-wireless sensor network agricultural application," *Int. J. Wirel. \& Mob. Networks*, vol. 3, no. 1, pp. 118–128, 2011.

[11] A. Z. Abbasi, N. Islam, Z. A. Shaikh, and others, "A review of wireless sensors and networks' applications in agriculture," *Comput. Stand. \& Interfaces*, vol. 36, no. 2, pp. 263–270, 2014.

[12] F. Shah and W. Wu, "Soil and crop management strategies to ensure higher crop productivity within sustainable environments," *Sustainability*, vol. 11, no. 5, p. 1485, 2019.

[13] S. D. Bhogaraju, K. V. R. Kumar, P. Anjaiah, J. H. Shaik, and Others, "Advanced Predictive Analytics for Control of Industrial Automation Process," in *Innov. Ind. Internet Things Smart Fact.*, IGI Global, 2021, pp. 33–49.

[14] A. Vangala, A. K. Das, N. Kumar, and M. Alazab, "Smart secure sensing for IoT-based agriculture: Blockchain perspective," *IEEE Sens. J.*, 2020.

[15] M. Saxena and S. Dutta, "Improved the efficiency of IoT in agriculture by introduction optimum energy harvesting in WSN," in *2020 International Conference on Innovative Trends in Information Technology (ICITIIT)*, 2020, pp. 1–5.

[16] F. K. Shaikh and S. Zeadally, "Energy harvesting in wireless sensor networks: A comprehensive review," *Renew. Sustain. Energy Rev.*, vol. 55, pp. 1041–1054, 2016.

[17] W. K. G. Seah, Z. A. Eu, and H.-P. Tan, "Wireless sensor networks powered by ambient energy harvesting (WSN-HEAP)-Survey and challenges," in *2009 1st International Conference on Wireless Communication, Vehicular Technology, Information Theory and Aerospace \& Electronic Systems Technology*, 2009, pp. 1–5.

[18] X. Lu and S.-H. Yang, "Thermal energy harvesting for WSNs," in *2010 IEEE International Conference on Systems, Man and Cybernetics*, 2010, pp. 3045–3052.

[19] T. Ruan, Z. J. Chew, and M. Zhu, "Energy-aware approaches for energy harvesting powered wireless sensor nodes," *IEEE Sens. J.*, vol. 17, no. 7, pp. 2165–2173, 2017.

[20] W. B. Stine and R. W. Harrigan, "Solar energy fundamentals and design," 1985.

[21] V. Raghunathan, A. Kansal, J. Hsu, J. Friedman, and M. Srivastava, "Design considerations for solar energy harvesting wireless embedded systems," in *IPSN 2005. Fourth International Symposium on Information Processing in Sensor Networks, 2005.*, 2005, pp. 457–462.

[22] K. V RajeshKumar, B. Ramesh, and Others, "Energy management in an automated solar powered irrigation system," in *2013 Int. Conf. Inf. Commun. Embed. Syst.*, 2013, pp. 1136–1140.

[33] M Rudra Kumar, et all., "Design of High Security Smart Health Care Monitoring System using IoT," International Journal of Emerging Trends in Engineering Research, Volume 8, Issue 6, PP. 2259-2265, June 2020.