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**NEF6002 Research Part B**

**(FINAL REPORT)**

**Impact of Internet of System/Technology in Agricultural Development in India**

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# **Abstract**

Internet of Things (IOT) is the biggest discovery which is used at huge platform in today’s time. It is utilized for interconnecting different gadgets in a framework to detect communication among various gadgets. This paper focuses the IOT in Agriculture, specifically in India. The primary aim of this paper is to focus on the technologies that are being used by the farmers, the difficulties faced by them to adopt technology and their perception on the change in the era of agriculture. In the first part of the paper conditions of farmers are specified and difficulties faced by them is using the latest technologies. Some natural difficulties faced by farmers like scarcity of water (Satyanarayana, G.V. and Mazar Uddin, S.D., 2013), overuse of natural resources can also be resolved by using IOT.Various steps are also be initiated by India to make farmers easy access to use of technology in India. Many projects in India has been started (Baruah, A. and Mohan, G.M., 2018) like world bank Invested in Pan India Project like National Agriculture Technology Project in Coordination with Indian government. The proposed methodology is qualitative research. Various comparisons are made between the technologies and applications. A survey has been conducted in India for farming related people to closely recognize the situation. At the end, Recommendations are provided on the applications and on farmers according to the age groups. So that it becomes easy for them to adopt the new practices in agriculture.

**Keywords:**

* **Internet of Things**
* **Agriculture**
* **Agriculture in India**

# **Declaration**

I, Surbhi Dhawan, hereby solemnly declare that this thesis contains no material that has been accepted for the award of any other degree or diploma in any other college, institute, or university and is the result of my own research. To the best of my knowledge, this thesis contains no material previously published or written by another person, except where references has been made in the text of the thesis.

Signature: \_\_\_\_\_\_Surbhi Dhawan\_\_\_\_\_\_\_\_\_\_\_\_\_

Name: \_\_\_\_Surbhi Dhwan\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_02-05-2020\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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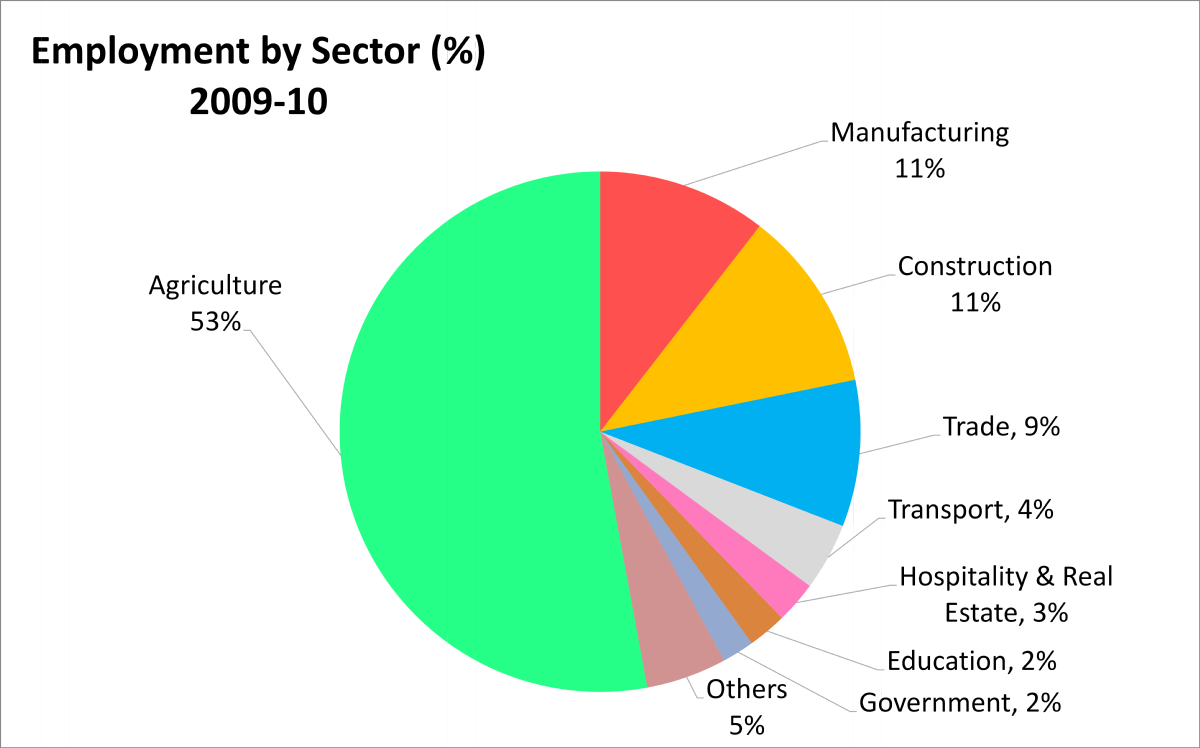
# **Glossary and List of Acronyms**

|  |  |  |
| --- | --- | --- |
| 1 | IOT | Internet Of Things |
| 2 | NASSCOM | National Association Of Software and Services Companies |
| 3 | FAQ | Frequently Asked Questions |
| 4 | ESP | English for Specific Purposes |
| 5 | US | United States |
| 6 | CMS | Central Monitoring Station |
| 7 | GPRS | General Packet Radio Service |
| 8 | GSM | Global System for Mobile |
| 9 | ANN | Artificial Neural Network |

# **Introduction**

The era of agriculture is advancing with smart agriculture and it is a vital part of any country’s economy and development. It is bread and butter to many people and of the country across the world. As agriculture area is very vast and population is increasing day by day, there is a very urgent need to keep an eye on agriculture sector. In some countries agriculture is foundation of the economy and India is one of the country among those. India employs 54.6% of population in agriculture field (Agricultural Statistics at a Glance, Ministry of Agriculture and Farmer’s Welfare, GoI, 2016).

The above image depicts the contribution of Indian population in different sectors of India. About more than 50% of Indian population is involved in agriculture sector as compared to other sectors



**Figure 1.1: ROLE OF DIFFERENT SECTOR IN INDIAN** (Wikimedia,2020)

**Keywords:**

1. **Agriculture**
2. **Internet of Things**
3. **Agriculture in India**

## **Agriculture in India**

Agriculture is a practise of science that includes farming, cultivation of soil, rearing and breeding of animals to obtain food and various other amenities from them. Farming in India is done according to suitable places that have the environment of agriculture. Farming systems in India are based on subsistence cultivation, modern agriculture and natural cultivation. India is a geographical area, so every area is considered to be different for different agricultures like some use horticulture, agroforestry, ley farming etc.

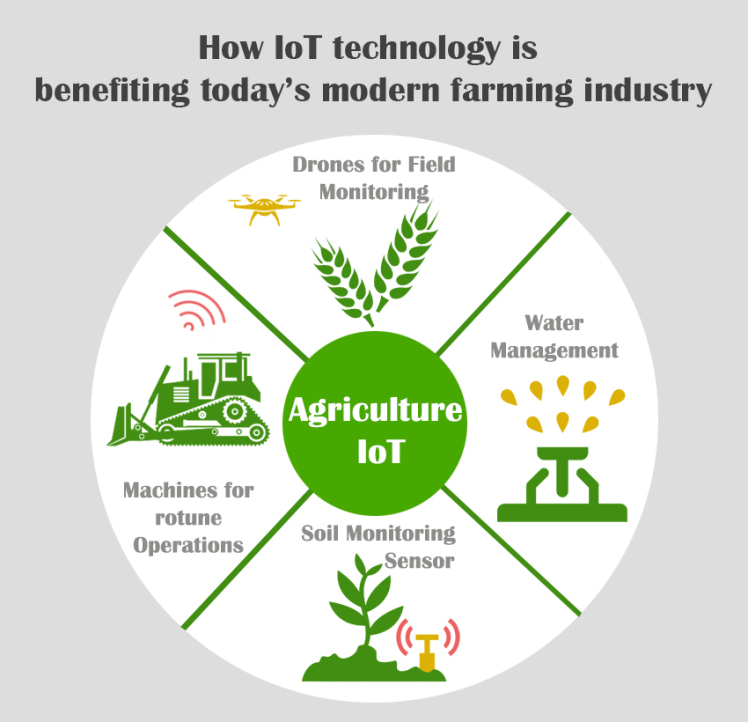
India is considered to be the second largest producer of agriculture. The crop varieties are based on different seasons. The above figure depicts the usage of Internet of things in agriculture by different ways such as moisture of soil, farming, weather conditions and quality of crops.



**Figure1.1.1: applications of IOT in agriculture**

## **Internet of Things in Agriculture**

Internet of Things or IOT are the framework that has numerous gadgets that are interrelations and gives zero inclusion of people to cooperate with one another. It is the greatest creation of innovation that is spreading generally over the world. these days IOT are utilized in brilliant homes, senior consideration, clinical and wellbeing, industrialisation and agribusiness.

In horticulture IOT has advanced a great deal. There are numerous applications made that can help in cultivating like gathering information on humidity, temperature, soil content, pest **Figure 1.2.1: Benefits of IOT in farming** (Techno FAQ, 2018)

invasion, precipitation and so on this all data can be used in computerising the cultivating systems to take significant choices on when and how is to be done as it can improve amount and nature of the creation and decreases hazard and wastage and difficult work and minimised labour.

As horticulture is significant part of each Country, more extensive number of practices come each year and develop, and a few makes gigantic benefit. In India, there are tremendous makers who follow Agriculture rehearses for little scope just as huge scope. Indian horticulture is confronting numerous needs openings and requirements. For future purposed this zone needs more thoughtfulness regarding laud. Most little scope ranchers don't know about innovation that can be utilized in horticulture and that can assist them with growing.

Many projects in India has been started (Baruah, A. and Mohan, G.M., 2018) like world bank Invested in Pan India Project like National Agriculture Technology Project in Coordination with Indian government.

Some smart agricultural products that are and would be used in India are:

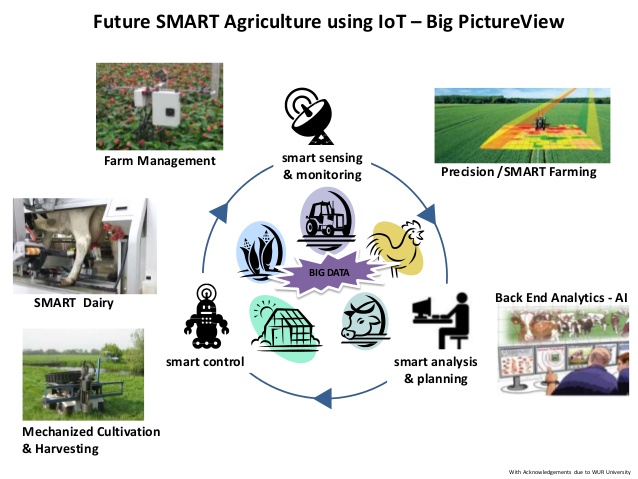
In Bengaluru, Open Source Labs are working to create a device based on IOT that is friendly to farming practices. It checks crops health, smart irrigation system, soil condition and smart livestock management. This system uses hardware’s like raspberry Pi and Arduino along with ESP.

AGNext a Punjab based company started using smart agriculture in Precision farming. It combines both Machine learning and Artificial intelligence. This created more reliable solutions to the farmers for smart farming. In India more than 40 projects are running based on IOT smart agriculture which is reported by National Association Of Software and Services Companies (NASSCOM).

Monitoring of climatic conditions: weather stations combined with smart farming sensors, located across the field collects data and sends to cloud.

Some examples of such agriculture IoT devices are [allMETEO](https://www.allmeteo.com/), [Smart Elements](https://smartelements.io/), and [Pycno](https://www.pycno.co/). For instance, [Farmapp](https://farmappweb.com/) and [Growlink](http://growlink.com/) are also IoT agriculture products offering such capabilities among others.

In India, internet of things is a new age technology which is spreading day by day. It is estimated that by using IOT in agriculture it will increase the annual rate of growth by 13%.

The figure shows various areas of agriculture where farming can be used like precision farming, farm management, smart dairy, cultivation and analysis etc. and how it is used like sensors are used.

**Figure 1.2.2: Usage of IOT in various areas of agriculture** (Lawrence, 2019)

So, this research will be about impact of internet of things on agriculture especially in India and the challenges faced by Indian population to consider IOT in agriculture. As we know, in India small scale farmers still use traditional practices for agriculture despite of so many technologies in market and fails in obtaining quality crops. As an Indian citizen, I have seen many problems faced by farmers in agriculture which lead to severe problems.

Despite of many IOT technologies, only few large-scale farmers stated implementing them. As farmers needs agricultural data to make firm decisions and to fulfil instructive needs. IOT needs to spread widely. This research paper is very important for the industry practise as it has listed the present technologies and their impacts on agricultural development.

# **Literature Review and Objectives**

My research specifically is based on Indian agriculture because with advancement of technology India is also moving with it. But the agricultural practices are still traditional

Moreover, this paper focused on the impact of IOT in agriculture of India like whether it is helping the economy or not.

Throughout the years, there are many study articles that are composed by many researchers’ specialists in terms of IOT. As it is always agreed that technology is not static. And in the field of IOT there have been many technologies that got invented in market and used in the world in agriculture and in India.

The objective is also to give reviews on how IOT is affecting the agriculture: positive or negative and how to help small farmers to use this IOT.

The papers that have been discussed above are deeply studied and then reviewed. I read many papers and reviewed thirteen of them above.

**Thankachan, S. and Kirubakaran, S. (2014)** This paper’s motive is to reach out to the small scale and deprived farmers for the use of IOT, awareness about it and viewpoints on the E- Agriculture. This study used qualitative and statistical survey techniques to collect the primary data direct from the farmers and to know about the awareness. The results were not shocking yet were predictive that there was a shortage of knowledge among farmers and there is need to support them. This research paper stated the evidences of the questions which were surveyed. Farmers were asked about whether or not they are able to incur the possibility of rain falls and storms and if they were able to then How they prepared to overcome the situation. Was there any loss of output or increase of it? For improving the condition and agricultural productivity an expert agricultural advice is given. The proposed Architectural proposal is given with diagrams and pie charts are drawn to depict the information collected.

**Vasisht, D., Kapetanovic, Z., Won, J., Jin, X., Chandra, R., Sinha, S., Kapoor, A., Sudarshan, M. and Stratman, S. (2017)** This paper introduces the data driven techniques that are used in IOT to increase the productivity of crops, to manage livestock and to properly monitor the land. This paper proposed a platform named Farm Beats for data collection from various parts of fields using sensors. This research was carried out in US. Focusing on the increasing demands of food . Data driven techniques can help in increase in yield of food. The goals that have been targeted in Farm Beats are: convenience , capacity, cloud connectivity, and data freshness. Architecture involves Sensors and drones, Iot base station, IoT gateway, Services and the cloud. The algorithm is called duty Cycle which has key goals like: Variable access, energy neutrality, minimising data approach. The implementation is done based on the given details and reliable outputs were measured. This technique is reliable technique and is US based but it can be implemented in India as well. This research can be used powerfully in terms of existing applications for better results.

**Satyanarayana, G.V. and Mazaruddin, S.D. (2013)** focuses on the sensor development which can be used in agriculture. It focuses on problem of farmers when uneven distribution of rain causes damage of crops and result in loss. In this paper the authors proposed and implements a wireless sensor network connected to a node which is known as zigbee. The zigbee is connected to Central Monitoring station (CMS) through GPRS (General Packet Radio Service) or GSM (Global System for Mobile) technologies. This proposed system can help farmers in analysing the conditions of soil. In this paper the designing and implementation is also done in order to supply proofs to the situations. Overall this paper is a good paper to know about what can be the latest technologies that can be easily used to develop agriculture in India, but it lacks focus on the main point that the affordability of these equipment’s.

**Verma, N.K. and Usman, A., (2016)** discusses about the current conditions of farmers and how IOT can help them to change the total scenario of agriculture. This paper discusses about the problems farmers face while performing agricultural practices like uncertain weather conditions which can lead to destruction of soil etc. the second problem, they focused on lack of soil knowledge. The researchers proposed model for IOT smart device that could make the work of farmers easier. The proposed IOT device will help farmers to know the nature of the soil and best suited crop for that soil and the water required to grow crops and requirement of fertilizers in the crop management. Weather forecasting and theft protection are two more features that have added in this paper in local language so that farmers could easily understand the fundamentals of the IOT smart device. The proposed software has eco-friendly energy management so that it does not negatively affect the environment. This paper has clearly viewed the situation of the farmers and gave a clear proposed model for the agricultural smart device, but it is not cost effective which can be easily affordable by the small-scale farmers.

**Mwangi, M. and Kariuki, S., (2015)** discusses the condition of small holder farmers and elaborates factors that are leading to need off new technology in agriculture. Agriculture produces 2.5 billion of income (FAO,2003) to people in world. This paper has focus on small scale farmers that still use traditional practices to production. Near about 70% if maize production is by small holder farmers and they use traditional practices to grow. Due to the conditions going on in the farming industry the paper reviewed various old research papers that are influencing the adoption of new technology in agriculture. Economic, technological, household, institutional factors have been elaborated completely in order to support the context. It is a review paper which focuses on adoption and urges government and policy makers to make certain policies that may help them to adopt it easily by understanding the needs of farmers as well. This paper main focuses on small scale farmers which is really the main aim of my research and I will use this paper for further research.

**Mohanraj, I., Ashokumar, K. and Naren, J. (2016)** is a recent approach towards improving agriculture in India. Authors throws light on the current scenario of agriculture in India. The current agriculture production in India is diminishing day by day due to traditional practices. The production is either getting replenished or low due to old farming techniques. This paper proposes a e-agriculture farming app framework consisting of knowledge and modules. This app will be useful for farmers to make profitable decisions in agriculture as it will include the information of whole farming cycle from start to begin. The paper also highlights the benefits of IOT in Indian agriculture which gives a think to small farmers to replace their techniques with new inventions. This paper also compares the existing apps and the developed app. This paper also focuses on how to minimise current use of natural resources and the labour cost. The first challenge identifies in this paper is to provide helpful information to farmers and timely help with ongoing process of farming cycle.

This framework involves access to all crop details, geospatial data, weather predictions etc. this model also contains a framework module for reminders, monitoring growth and profit calculator and various calamity check.

Overall, this paper is full power pack for a researcher to have help in creating a useful application for monitoring a farm, but it misses how to make farmers utilize these kinds of applications as they are not able to understand the new technologies.

**Kansara, K., Zaveri, V., Shah, S., Delwadkar, S. and Jani, K. (2015)** focuses on current situation of India. As the population of India increasing day by day. India is facing adverse situations like scarcity of water and farmers suffers due to lack of rains. This paper provides an automotive technology that irrigates the farm when required and will reduce human power and involvement. Whenever temperature and humidity vary the sensor activates and sends to micro controllers. This will be an updating to Indian farms. This paper over all views about the model for smart irrigation system which involves sensors and microcontrollers. It has various benefits like:

* simple and easy installation
* saves energy and resources
* irrigates at right time
* irrigates automatically
* time saving and low manpower involved.
* Low cost

This paper truly focuses on the current situation and acts accordingly. It is cost effective for farmers and easy to use.

discusses about different types of soil present in India and different weathers. This paper focus on the problems like current farmers face like instant rains, wrong weather forecast, and lack of knowledge of soil and crops suitable to that soil. The problems are proposed with the solutions like using centralised data server which is compatible for farmers even in rural areas.

This paper aims on the current conditions and proposed a solution to create a visual alert for farmers in their own language to get notified and care the crops from theft protection.

**Mankar, A.B. and Burange, M.S. (2014)** This paper deals with the solutions of difficulties in collecting data during field monitoring. So, to overcome this data mining is used. As we know data mining is also establishing and implementing day by day. It is also helping many of the sectors to develop. In this paper, data mining techniques were implemented and monitors in order to know the progress of the crop yield with the existing data used. Some more techniques like GPS for monitoring the land is used and reviews are given based on the inputs and outputs and results got in return. This paper fully supports the implementation of the data mining process in agriculture as gives a broader view to deal with the problems related to agriculture.

**Dahikar, S.S., Rode, S.V. and Deshmukh, P. (2015)** this paper covers the conditions of soil that changes time by time and gives a proposed model for sensing the soil and knowing the suitable crop for it. Artificial neural networks have been used to know the condition of the soil as these tools are more predictive and effective. The method that is used is called crop prediction in which soil is sensed by sensors through various parameters of soil in the field and know the suitable crop for it. Parameters that include for soil are nitrogen, oxygen, potassium, phosphate, temperature, rain fall and depth. In this paper, Artificial Neural Network is used that is commonly called ANN. After implementation, and deep study of paper it can be conclude that the system gives reliable result after using ANN test. This proposes that we can sense the soil by various parameter quantity and know which crop is suitable for that soil. Also, by knowing the deficiency of the soil we can suggest the best fertilizer that can be used in order to increase the quality and quantity of crop. This setup can be truly used by farmers that have bad financial conditions and cannot afford lab test for soil. So, overall this paper highlights the major problem faced by the farmers and a possible solution to it. Also, this proposal is useful for small scale farmers and this can improve the yield of crops thereby increasing the income of farmers that can help the farmers to resist or come out from debt conditions. This research was carried out in Maharashtra, India and it can be a possible good research if implemented across India. This software can be modified for various features like crop disease detection and prevention, care for single crop and micronutrients essential for the soil and crop for better yield.

Overall , I found this paper the most interesting and knowledgeable for my future research and these techniques can be used in India as well.

**Channe, H., Kothari, S. and Kadam, D. (2015)** This paper demands on the adoption of the new technologies specially in India using precision agriculture. This paper proposed a multi visionary model by using Mobile computing, sensor, cloud computing, and internet of things, Big data Analysis. Agriculture related people like vendors and suppliers and farmers need to register as a member in Agro cloud through a mobile application. Agro cloud storage will be having data related to farmers, crops, marketing, governmental schemes and policies and current climatic and weather conditions. The conditions of soil will be senses repetitively and will be sent to agro cloud using internet of things. Big data analysis will help to know the crop yield, total production, current stock, best suitable crop and market analysis. This model can be an eye opening for people as it will give best results in terms of farming. Sensors will be used to sense the different parameters of soil and weather conditions to keep the people updated about the crops. This model will help in controlling the total cost and crop production.

**Jaiganesh, S., Gunaseelan, K. and Ellappan, V. (2017)** discusses about the latest technologies that can be best use in agriculture like GPS system, sensors that can sense the land and various other technologies that can help in increasing yield of crops with better quality and quantity. This paper appreciates the benefits cloud computing has given to us to keep the data safe. The cloud that is used for cloud is agriculture cloud that is prepared of MAD cloud design. The authors are combining the IOT with cloud computing to make its best use. They also write about the benefits provided by IoT in agriculture like improvement of use of natural resources , cost reduction, earth protection etc. According to Gunaseelan, sensors play a very important role in the agriculture farms. When sensors, database, cloud computing, Big Data, GPS and Iot combines it can make best use and gives best results. Overall, this paper is very complex paper that discusses every aspect of the present technology, but this paper can be understood by converting in simple language. This paper throws light on the benefits of IOT in agriculture and how all the technologies can combine to make a better system for agriculture. This paper also gives the methods of cost reduction of technologies that can be used. I can follow this paper for my further research.

**Rajeswari, S., Suthendran, K. and Rajakumar, K. (2017)** This paper combines the use of IOT and Big data together in terms of agriculture to make it more feasible. It improves agricultural activities by applying these techniques. It discusses about the various applications in digital world like monitoring the crops and soil, choosing the correct fertilizer, automated irrigation support, live management of livestock and preventing crop diseases. Big data is used to analyse the type of fertilizer to be used correctly. This paper involves the analysation of fertilizer by using big data, monitoring crops and stock. The aim of this paper is to reduce the agricultural cost and to increase the production. This paper proposed a model algorithm that is used for monitoring the crop production and decides the future crop for specific nutrients and requirements of fertilizer. This will help in future storage and crop reduction.

This paper is a good paper as it gives an idea of combining Big Data , mobile computing, sensors, cloud computing and different techniques. It is the recent approach for the smart agriculture.

**Karim, F. and Karim, F. (2017)** discusses the main problem that is scarcity of water. More of water is used in agriculture and is a serious problem for everyone. To this problem, real time observations are necessary for weather conditions. This paper proposes a prototype model using IOT wireless sensor network and cloud which can be used in precision farming.

in this paper author presented a system which alerts when water is overused. It involves steps how to create It and implementation of it. This paper can give benefit to the farmers but overall this paper is not so effective in terms of research because it does not focus on real problems faced by farmers. I did not gain knowledge after reading this paper. The steps involve are basic and research is not so powerful to change the scenario of agriculture.

**Deichmann, U., Goyal, A. and Mishra, D., 2016** The paper says about the change brought by mobile and internet technology. According to World Bank report, this paper gives a proposal of a brief framework of recent communication and internet technologies and their benefits. These technologies not only effect the production but also raises the economic factor, reduces manpower and cost. This paper gives a brief review on already presented papers and also focusses on how the technologies are giving impact on small areas in developing country like India. No doubt the technologies have given many benefits to every sector of the occupation, but main problems arises when barriers occur to adoption of these technologies among farmers. This paper is based on the already published report by world development report team and development research group in 2017. According to authors, more than 70% of people have access to mobile phones. This paper reviews how internet is spreading and how It can be used widely in agriculture. It can also help the people of rural areas to develop more and cross barriers of adoption of IOT in agriculture.

**Jamaluddin, N., 2013** This paper explains the pattern for delay in adoption of IOT in agriculture. This paper research conducts a survey in the area of Tamil Nadu to find the level on which the technology is developed in Agriculture. The objective of this paper is to study the profile of farmers, obstacles in using IOT and impact of not using IOT in agriculture. This paper brings a model which will be useful for introducing IOT in agriculture. The drawback for this paper is that it has not been used or produced to the usage for further use.

**Jaiganesh, S., Gunaseelan, K. and Ellappan, V., 2017** This Paper describes the part and role IOT plays in Agriculture. Technologies like sensors, GPS, that help to increase grown of output and trading which can help to grow income benefit farming. This paper is based on review which is done by applying a cloud construct application and results were calculated. the paper is divided into segments and includes information about Shrewd cultivation by IOT, review on IOT and farming IOT and cloud computing framework, Big Data in Agriculture. .The drawback for this paper is that it just reviews the technologies but does not help farmers to gain knowledge.

# **Research Problems**

Agriculture is very important part of India and it also depends on the natural elements (Vaghjiani, K., 2012) even today. Any variance or negligence in any of the natural element give bad impact on the crop yield and production. Since Internet and Technology is excelling in the field of agriculture as well and technology is not static. Every day a new technology is. discovered. We also know the literacy rate of India is very low that is 74.04% (Pathania, R., 2020.). So, adoption of technology in agriculture is quite slow. The rural areas and areas where farming and agriculture is on peak are not deprived of invention or technologies, but they lack knowledge. Moreover, due to low literacy rate of India farmers don’t believe in modern practices. They still believe in traditional practices in farming.

The equipment’s and the sensors that are used in agriculture are quite expensive. Even if they are affordable, they need maintenance throughout, which cannot be affordable by most of the farmers.

These technologies are only used by the large firms that are either private or under government. So, the following challenges that have been listed are real and need to be more focused on and that are:

* So, first challenge is lack of awareness among farmers (Mwangi, M. and Kariuki, S., 2015)in context to usage of technology in farming and their applicability.
* Second, due to low literacy rate farmers are not dependent on technology. They be afraid of upgrading it as they have reliability issues ( Mohanraj, I., Ashokumar, K. and Naren, J. , 2016).
* Most of the farmers find these IOT’s expensive. Some gadgets need updating according to farmers which are costly.
* In India, due to lack of supporting infrastructure these IOT techniques are not so known.
* The sensors that are used in the agriculture are expensive and not affordable by small scale farmers.

These are the barriers faced Indian farmers to adopt the technology in agriculture. This research carried out by knowing the perceptions of farmers through surveys and focused on their problems. Also, recommendations are provided at the end stage of the research study.

So, the main focused questions to be solved till the end of the research are:

* How can we make farmers aware of the latest IOT(Dahikar, S.S., Rode, S.V. and Deshmukh, P., 2015) they can use in agriculture to increase productivity?
* What kind of easy to use interface that are available can be used in local language (Sangtrash, H.M. and Hiremath, A.S. 2017)by the farmers?
* How can we make the available technology cost effective for farmers to afford?

# **Research Methodology**

Research is a process of collecting information and data on specific topic or product in order to make it effective or to take any decision based on it. This research is based on qualitative approach to obtain solutions to the research gaps. The basic aim of this research is to know the Impact of Internet of things on the agriculture particularly in India. This research is review based and journals, articles are selected based on keywords, and year of the publications. After that the journal and papers will be separated based on themes. For example, Survey papers and review papers are separated.

The focus of research remain on the impact of IOT on agriculture and to collect the data for my proposed research problems, it is very important to understand the tools and techniques used in agriculture. So, data is separated in two types: Primary data and Secondary data. Primary data is collected based on real observations and techniques which will be used in implementations in part b and real information was collected. Data was collected through surveys.

Secondary data is the data that will be collected by reading and reviewing several journals. Deep study is involved in this subject to know every basic knowledge about applications that are used in agriculture and how they are implemented.

The secondary data was collected in part A by keywords and recent year of publications and theme on which research is carried out. This research makes use of existing research papers, journals, articles, internet blogs etc.

After gathering information, I used Pictures to depict my information in diagram form to easily understood by reader.

The primary data is collected through surveys. The survey is done across India through software called survey monkey. Survey is a tool that is used to know the perspective of people for a specific problem and to frame their answers in way that the problems can be solved.

The survey was conducted among 100-120 people through software called Survey Monkey. The similar research has been done in TranzNzoia County, Kenya in 2013 (Namisiko, P. and Aballo, M., 2013)

My research has four stages which is to be followed:

* Propose
* Prepare
* Analyse
* Recommendations and Conclusion

1. **Propose**

Based on the analysation of data the research problems that were proposed in Part A . In this stage I deeply looked upon the conditions of the people related to the agricultural field and tried to find out possible solutions for it.

The research problems that are proposed in this research are:

* So, first challenge is lack of awareness among farmers (Mwangi, M. and Kariuki, S., 2015)in context to usage of technology in farming and their applicability.
* Second, due to low literacy rate farmers are not dependent on technology. They be afraid of upgrading it as they have reliability issues (Mohanraj, I., Ashokumar, K. and Naren, J. , 2016).
* Most of the farmers find these IOT’s expensive. Some gadgets need updating according to farmers which are costly.
* In India, due to lack of supporting infrastructure these IOT techniques are not so known.
* The sensors that are used in the agriculture are expensive and not affordable by small scale farmers.

1. **Prepare**

In this stage I went through some journals, articles and blogs and will prepare what kind of things to be analysed during my research.

Based on the knowledge gathered from reading articles, I analysed the problems by face to face interviews with the people who belong to this field. The template was prepared based on the understanding and knowledge.

In this part, I will carry forward my research by following questions and based on this I will make a conclusion. Also, I will go through more articles and journals which will be based on latest technologies or applications that are used in agriculture and will make comparison and come out with good technologies that can be used in India.

The questionnaire created with set of some questions that are related to the field of agriculture. This will help me to know the perspective of people belong to this field by different age groups.

The set of interview questions that will be included are:

# **Questionnaire**

***General Questions***

1. What age group you belong to? (In years)
2. 15-20
3. 21-25
4. 26-30
5. 31-35
6. 36-40
7. 40-50
8. 50 or above
9. For what reason you use agricultural practice.
10. Home gardening
11. family business
12. employed job
13. As a hobby
14. How many years of experience do you have in Indian Agricultural industry?
15. 0-5 years
16. 6-10 years
17. 10-15 years
18. 16-20 years
19. Most part of India depends on agriculture.
20. Strongly agree
21. agree
22. neutral
23. disagree
24. strongly disagree
25. Is technology developing in agriculture of India?
26. Strongly agree
27. agree
28. neutral
29. disagree
30. strongly disagree
31. Is there any quality and quantity increase in grown crops?
32. Yes
33. No
34. Is the technology affordable by small scale farmers?
35. Yes
36. No
37. Is technology easy to use for farmers?
38. Strongly agree
39. agree
40. neutral
41. disagree
42. strongly disagree
43. Does Government provide loans to support E-agriculture?
44. Yes
45. No
46. Is it easy to adopt technology in agriculture by small scale farmers?
47. Strongly agree
48. agree
49. neutral
50. disagree
51. strongly disagree

***Knowledge Questions***

1. Do you use technology in agriculture?
2. Yes
3. sometimes
4. no
5. Do you have knowledge to use sensor in agriculture?
6. Yes
7. No
8. Do you use any software for remote sensing for data analysis?
9. Yes
10. No
11. Do you think it encourages small famers to increase their yield?
12. Yes No
13. Do you think small scale farmers need more attention to introduce technology?
14. Yes
15. No
16. What barriers do you think farmers face, which prevent them from benefitting through technology? (choose any 3)
17. Access to digital media and technology is too restrictive.
18. Not enough content/ resources available.
19. The cost is too high.
20. The digital technology available are not too reliable.
21. Farmers don’t have necessary skills
22. Lack of equipment’s.
23. Other
24. Are you able to incur unusual high rainfall events such as storm or heavy pouring which can affect the crops?
25. Yes
26. No
27. sometimes
28. Whether you were able to reduce the output loss or increase output with storm?
29. Yes
30. No
31. only once
32. more than once
33. never
34. Do you know a mobile phone can also be used to receive regular information ?
35. Yes
36. no
37. Do you think technology in agriculture has reduced the risk faced by traditional practices?
38. Yes
39. No
40. Neutral
41. According to you, what are the consequences do you think farmers are currently facing for not using technology?
42. production and management efficiency loss
43. Competitiveness loss
44. Unable to get timely information
45. Unable to use innovations in technology
46. What are the consequences do you think for extension of not utilizing technology?
47. Loss of Persistence, credibility and certainty
48. Away from daily information and innovation
49. Lack of service
50. Loss of quality and quantity
51. **Analysation**

In this stage all the I started analysing the data. All the surveys are studied properly and focused on the problems resulting the use of IOT.

Also, some more research papers that are related to the applications that already exist in market are reviewed and compared. As market already has applications available, I reviewed them and create a comparison and study and clarify which will best used for the same purpose

The research gap focuses on development are following questions:

* How can we make farmers aware of the latest IOT(Dahikar, S.S., Rode, S.V. and Deshmukh, P., 2015) they can use in agriculture to increase productivity?
* What kind of easy to use interface that are available can be used in local language (Sangtrash, H.M. and Hiremath, A.S. 2017)by the farmers?
* How can we make the available technology cost effective for farmers to afford?

This is the final stage of the research in which I tested the results and compare with the existing applications that are being used nowadays.

1. **Recommendations and Conclusion**

In this stage, I created a research paper that includes focused problem, literature reviews, interview analysation comparisons on latest technologies. To afford this expensive technology will find some better ways by reading existing rules of agriculture in India by government.

Also, the recommendations are provided for different age groups to tackle with the problems faced by using the IOT in agriculture.

Then the shortcomings are identified and better solutions to the problems are suggested.

# **Research Significance**

IOT assumes a worthy role in every field like science, medical, health, smart home, smart agriculture and many more. It helps farmers to increase the productivity of crops by increasing quality and quantity of crops and making the right use of natural resources. My research paper highlight all the present technologies used in agriculture and their impact on Indian market. It also highlights the research problems and their future directions and possible ways to solve the research problems. This research will be a very good reference for future researchers, academies and practitioners to get to know about perceptions of Indian farmers and to know the possible recommendations or solutions to the problems faced by them.

This paper includes survey questionaries’ which will be conducted across India through Survey Monkey and will help us to know the perception of the Indian farmers about smart agriculture and by deep study of surveys and various research papers, I provided solutions and recommendations to the problem they are facing today.

Future researchers will think about this scenario and this research can go beyond and find out ways to flourish the Indian agriculture and India is second largest producer of Agriculture.

# **Data Collection**

Survey was performed through survey monkey. A set of 21 Questions was created which is mentioned in research methodology. The survey was published on 21st April and sent to people related to farming field in India. A total of 105 responses are collected and based on that data analysation is performed. Some of the results of key questions are displayed below.

Q Is the technology affordable by small scale farmers?

0%

Answered: 105

Skipped: 0

Yes

No

20

%

40

%

60

%

80

%

100

%

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| Yes | 45.65% |  |
| No | 54.35% |  |
| TOTAL | 105 |  |

Q Is it easy to adopt technology in agriculture by small scale farmers?

0%

Answered: 105

Skipped: 0

Strongly

Agree

Neither

Disagree

Strongly

20

%

40

%

60

%

80

%

100

%

agree agree nor disagree

disagree

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| Strongly agree | 10.87% |
| Agree | 43.48% |
| Neither agree nor disagree | 21.74% |
| Disagree | 23.91% |
| Strongly disagree | 0.00% |
| TOTAL | 105 |

Q Do you use any software for remote sensing for data analysis?

0%

Answered: 105

Skipped: 0

Yes

No

20

%

40

%

60

%

80

%

100

%

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| Yes | 36.96% |
| No | 63.04% |
| TOTAL | 105 |

Q What barriers do you think farmers face, which prevent them from benefitting through technology? (choose any 3)

Answered: 105

Skipped: 0

20

%

40

%

60

%

80

%

100

%

0%

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Access to  digital media ... | Not enough content/ resource... | The cost is too high | The  digital  technology  y... | Farmers don’t have n... | Lack of equipment  ’s. | Other (please specify) |

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| Access to digital media and technology is too restrictive. | 47.83% |
| Not enough content/ resources available. | 67.39% |
| The cost is too high | 65.22% |
| The digital technology available are not too reliable. | 39.13% |
| Farmers don’t have necessary skills | 56.52% |
| Lack of equipment’s. | 21.74% |
| Other (please specify) | 2.17% |
| Total Respondents: 105 |  |  |

Q Do you know a mobile phone can also be used to receive regular information ?

Answered: 105 Skipped: 0

|  |  |  |  |  |
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|  |  |  |  |  |

100%

80%

60%

40%

20%

0%

Yes No

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| Yes | 69.57% |
| No | 30.43% |
| TOTAL |  | 105 |

Q According to you, what are the consequences do you think farmers are currently facing for not using technology?

Answered: 105

Skipped: 0

20

%

40

%

60

%

80

%

100

%

0%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| production and management efficiency... | Competitiveness ss loss | Unable to get timely information | Unable to use innovations in technology | Other (please specify) |

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| production and management efficiency loss | 19.57% |
| Competitiveness loss | 32.61% |
| Unable to get timely information | 28.26% |
| Unable to use innovations in technology | 17.39% |
| Other (please specify) | 2.17% |
| TOTAL | 105 |  |

Q What are the consequences do you think for the extension of not utilizing technology?

Answered: 105

Skipped: 0

20

%

40

%

60

%

80

%

100

%

0%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Loss of Persistence, credibility and certainty | Away from daily information and... | Lack of service | Loss of quality and quantity | Other (please specify) |

|  |  |  |
| --- | --- | --- |
| **ANSWER CHOICES** | **RESPONSES** |  |
| Loss of Persistence, credibility and certainty | 30.43% |
| Away from daily information and innovation | 43.48% |
| Lack of service | 13.04% |
| Loss of quality and quantity | 13.04% |
| Other (please specify) | 0.00% |
| TOTAL | 105 |  |

# **Analysation of Data**

## **Result Of Survey**

According to the survey, 41.30% of the people in agriculture field work a farmer, and 24% opt it as a Home Gardening routine and has 0 to 10 years of experience in this field. 98% of the people agree that most part of India depends on agriculture.74 % people feel technology is developing in India but more than 50 % feel that it’s not affordable and it’s not easy to adopt technology by small scale farmers. 60% of people who are under 25 age feel that technology is easy to use. They also agree that technology helps to increase quality and quantity of crops and government also supports in providing loans. 78% farmers use technology like mobiles in farming but only 50% have knowledge of sensors in agriculture and 65 % are not aware of data analysation using remote sensing. They believe that farmers are encouraged to use technology to increase yield but 85% people they need extra attention to use this technology. Most people believe that the barriers farmers face, which prevent them from benefitting through technology are : Not enough content/ resources available, The cost is too high, Farmers don’t have necessary skills. 79% people were able to incur unusual rainfall or weather conditions and out of them only 65% of them were able to cope up with the output loss.

70% are aware of that they can use the mobile phone as an application to agriculture. 85% feel that they agree agriculture has reduced the risk faced by traditional practices. According to survey, consequences that farmers face of not using technology are competitive loss and unable to get timely information. The consequences for the extension of not utilizing technology Loss of Persistence, credibility and certainty and also Away from daily information and innovation.

# **Proposed Framework**

Since most of the experienced people know how to use mobile phones as a device that can be best used for timely information regarding agricultural practices. There are many application available in India that can be used as good information source but after seeing the downloads of the applications they are very less than they are expected. The government must update information to information systems and application managers should keep it updated and over the internet the application can be downloaded on mobile phones and update farmers . These application are on top in India to use. The proposed framework which should be used to use these application is as follows:

**Explanation:**

Step 1 : The government schemes and expert information about the farming related techniques should be added in the information systems.

Step 2 : This information should be updated on the databases which will be accessed through internet by various means like websites, applications, live supports etc.

Step 3 : Since application in a mobile device is a easy medium which can be used by people, so over the mobile devices applications are developed. There are various applications available that are used in India but in very few downloads are there.

Step 4 : Over the mobile devices applications are installed and can be easily used by the farmers.

D

Information System

Internet

Mobile Devices

Application

**Figure : A proposed Framework**

The application must be able to perform various functions and should have listed features:

**Daily and Seasonal Alerts**

Temperature

Humidity

Rainfall

Wind Velocity

Pesticides and information related to seasonal crops

**Other Information**

News

Government services

Mandi prices

Best pesticides

Government schemes

Agricultural advices

**Features**

Easy to use interface

Small in memory

farming input/output

government service on an online platform

Available in different languages

Agricultural advice

Mandi prices

Weather forecast

farming retail and fulfilment service

live chat for helpline

**Figure: Features for available applications**

After going through several articles from scholar and surfing various websites, My research stopped when the eye was put on various applications that are already available in market that posses these features but when the availability was checked, only 500K or near about people use these applications and when I focused on the features of these applications, I found out that they can very easily guide the farmers to install and use the technology in agriculture, as it is available in local language, it can be easily interpreted, videos are provided. So, overall there are many facilities available for farmers to use it, but they are not aware about it. Further I am going to discuss some applications that can help farmers to excel and how to make them aware about them.

Application can play an important role over every technology because sensors, controllers are installed by experts only, but their maintenance and usage is done by farmers itself. Farmers can easily install the applications and get help from them.

Before discussing the applications, I would discuss the initiative took by Reliance Company which made internet so affordable for every inch of society. We Can say that five years ago, smart phones were not affordable by everyone. And if we could find easy solutions by then, it would be very difficult for us. To access these applications smartphone is essential thing to have. The Reliance company in India launched a scheme of Jio Internet which has reduced the price of internet consumption by $3 per gigabyte and very cheap access to 4G network. Moreover, not only internet but affordable smartphones under 50$ i.e. under Rs 1500 which is very affordable for lower class people to use.

The various Applications over the internet which has features are:

1. **Plantix :** This application was released in 2015 and with android operating system developed by PEAT Gmbh considered to be crop advisory application. It helps in diagnose of any disease of plant or pest disease, and deficiencies in crops and their solutions and treatments. There is live support as well where farmers can interact with scientist or crop experts which can help in any related issues to crops or farming and updates weather reports. This app is considered to minimise the effects of plant disease and pest and can control the overall yield of crops. It allows famers to upload the pictures related to problems and get solutions. Plantix use neural system innovation. Besides, it helps in giving recommendations and solutions. As farmers can upload their images on daily basis which help’s database to get updated daily. It also calculates the amount of fertilizer needed and available in 14 local languages. The application currently and updating regularly. Till date it has higher number of downloads.
2. **Agri App :** It is a mobile based android Application that provide information about production and protection of crops, smart farming and various services like live support. It provides an online market for retail services. It has features such as ICT, Big Data, e- commerce and best practice to bring technology in agriculture. Some of highlighted features are: buy crop solutions, complete information from start till end about sowing of crop, crop calendar, chat with expert, weather updates, and videos help. It is available in local languages and has 500K downloads.
3. **Farm Bee** : It is also mobile based application that provides information about solutions or nutrients required for crops, weed and pest management solutions, has an online market (mandi) and helps farmers to connect with traders across the country. A farmer can choose from 450 crop varieties, 1300 markets, 3500 weather locations and available in 10 Languages
4. **Kisan Yojana :** It is mobile based application and dedicated to farmers. It is good option for farmers to fill the gap between knowledge and information. This application has information about Government schemes according to states that can help farmers. Since its government-based applications but still its not updated and does not have features that others application do have.

# **Future Work**

This framework mentioned above can be used for future applications can give results as farmers want. The applications framework can be coded and can provide results. For example: If a farmer uploads a video or image of pest infecting the crops, Live support people who are experts can give solutions and related medicines that can help to overcome the problem. Similarly, it will provide regular weather updates with rainfall and storm warnings so that farmers can easily protect their crops and reduce the loss of output. Also, to remember while creating application, as most of farmers does not have high configuration mobiles, so the application should support low configuration mobiles such as low in memory and RAM.

# **Recommendations and Conclusion**

IOT is introduced in agriculture to increase quality and quantity of crop and reduce cost. But seeing the overall scenario in India the cost of introducing IOT is very high which is not very much affordable by small scale farmers. Here are few recommendations that can be considered for IOT in to reach out to farmers in agriculture:

* For people under age 25 who find easy to use technology can help old experienced people to use technological practices.
* Like Live support in application, Government can arrange free classes to teach the usage of applications, sensors etc.
* Since very low downloads of available applications, Marketing need to be done to provide awareness to the farmers about applications.
* Biotechnology products should be available at affordable prices.
* Various educational institutions that have students in agriculture field can help small holders to gain knowledge and provide practice to them by live support.
* Government has to play important role in providing policies to support small farmers.
* The proposed framework can help farmers to use technology through applications.
* A smart work is needed to provide smart assistance.

It highlights the introduction to keywords and their basic knowledge. After it displays how IOT is emerging in agriculture. In the next sections, research papers have been highlighted. The research problems are basic but severe because that problems are making deprived of using new technologies in agriculture.

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