Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

Role and Potential of Information and Communication Technologies in Agriculture for Rural Development

Aayush Shrestha
School of Electronics Engineering
VIT Vellore
Vellore, Tamil Nadu, India

Sathvik V
School of Electronics Engineering
VIT Vellore
Vellore, Tamil Nadu, India

Dr. Kubendran A
School of Social Sciences and Languages
VIT Vellore
Vellore, Tamil Nadu, India

***Abstract* – Agriculture is the primary source of income for rural people in India and is the most important sector of the Indian economy. Due to the conservative methodologies in rural farming, Indian rural farmers are now migrating towards the urban areas in search of better jobs and prospects as they do not benefit much from the conventional methods. Therefore, it becomes necessary to bring revolution in the rural farming methods through the use of Information and Communication Technology (ICT) as it provides globalization to the farmers and connects them more with potential customers and markets. A special focus has to be given to uplift the lifestyle, social status, and living standards of people which can be improved through the help of ICT tools and technologies. The Government of India has developed several initiatives in the form of ICT tools to assist in E-agriculture. ICT has the potential to address all the challenges, however, the use of these technologies in rural areas is quite slow. The proposed research paper, therefore, talks about the different tools, roles, potential, opportunities, and contribution of ICT in rural agriculture.**

Keywords - Agriculture, Information and Communication Technology, Rural Development

I. INTRODUCTION

Being a developing country, agriculture is the primary source of income in many parts of India. For a long time, Indian farmers are affected by various adverse effects like climatic changes, loss of biodiversity, natural disasters, volatile food price, inefficient supply chains, etc. Agricultural development is also facing a lot of challenges due to poverty, malnutrition, increased food demand. Sustainable agriculture is becoming more important along with environmental production. The job of farmers is more difficult as they have to make regular complex decisions on seeds selections, land usages, plants selection, the market choice for agro-based products, etc. which have an impact on the livelihoods of their families as well as society. Since the agricultural sector is facing many challenges, ICT can be used to address those challenges faced by the farmers and can altogether enhance the life of the rural community. Farmers do not gain much profit by selling their agricultural products due to the increased price of fertilizers, pesticides, and fuel price. Globalization and market fluctuations have also affected agriculture in rural India a lot. ICT not only provides market access to the farmers but also provides enormous opportunities to increase income, gives relevant and valuable insights about the crop yield using advanced and latest technologies resulting in increased production. It provides relevant information about the new ways that can be incorporated in farming, fishing, animal husbandry, etc. ICT services can help to bridge the gap between rural and urban communities by minimizing inequality, division and transforming the rural areas and the agricultural sector in those areas promoting globalization and making India competent with the other countries. The main focus of ICT is to reduce the cost, increase efficiency and productivity. The ICT technologies should be implemented in the local languages so that it would be convenient for all the farmers in different parts of rural India to use these technologies and get maximum benefits. Fig 1 shows the usage of ICT by the rural youth.

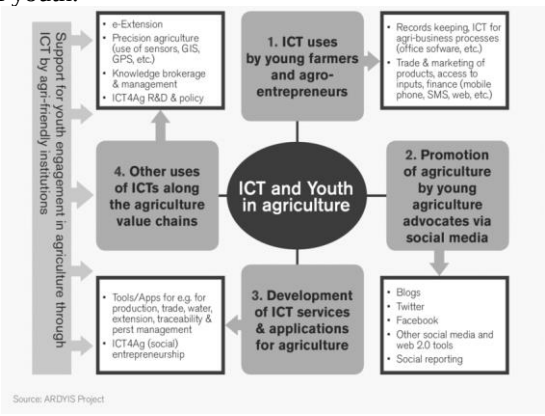

Fig 1: ICT usage for Rural Youth

II. LITERATURE SURVEY

Rural people keep migrating towards urban areas in search of better opportunities as basic infrastructure facilities in the urban areas are quite less. The goal is to use ICT to assist development in the rural areas and enhance the economy, social status, and living standards of the rural people. Agriculture plays a very important role in the economy of

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

rural areas and ICT has the potential to address the challenges using technology. This paper revolves around the role of ICT in agriculture like how it empowers the farmers, takes care of the farmer requirements, the opportunities and challenges involved, the limitations of ICT, the benefits, etc. The paper concludes with the notion that intensive training and awareness of ICT should be given to the rural community and the farmers. More emphasis should be given to the usage of ICT services, to provide relevant information to the farmer. Strong interfaces should be developed at the village level. User-friendly software, graphic interfaces, and pictorial information would encourage ICT use [1].

This paper states the role of ICT tools for the development of agriculture in rural areas of India. Some of the important tools that have been discussed include the following- eNAM which is an online trading platform for agricultural-related commodities in India, Kisan Rath Mobile App which eases farmers and traders to identify suitable transport facilities for the movement of farm produce and helped especially during the pandemic, RiceXpert which is an app that provides information about rice cultivation to farmers in immediate on insect pests, nematodes, nutrients, weeds and disease-related problems for various ecological zone, farm implements for different field and post-harvest operations, mKisan which is a SMS portal set up by the President of India for farmers that empowers all central and state government organizations in agriculture and allied sectors to give information or services to farmers concerning agricultural practices, Kisan Suvidha which was an app launched to work towards empowerment of farmers and evolution of village, Pusa Krishi which is an app with an aim to help farmers get information about the new technologies and many other initiatives have been discussed in the paper [2].

This paper was a case study on e-agriculture conducted in the Coimbatore and Tirupur districts of Tamil Nadu. These regions were selected because the paper is based on "e-velanmai" or e-agriculture which was started in July 2007 in these two districts with the help of the World Bank aided TN-IAMWARM project sponsored by the government of Tamil Nadu. The project helps to provide quality, timely, farm-specific advice with the support of ICT tools, agricultural scientists, and the needed farmers at their respective farm gates. The case studies were conducted by taking into account the real-time experience of five farmers from the two districts. The case study paved the way to find out the real-time problems that were faced by the farmers and helped to depict in what ways the problems can be overcome through the approach of e-velanmai. The documentation of the farmers' experience is depicted in the five case studies that were discussed in detail in the paper. The conclusion obtained from the paper was that there was a need to look beyond the pilot testing of ICTs to evolve proper extension efforts that harness ICTs. For this, there is a need to incorporate the ICTs into structural and functional components of the extension organizations. The recommendations for incorporating ICT in all endeavours of agriculture were also plotted down by the author in the paper [3].

The objectives of this review article are to know the concept of digital technology and its importance and to understand the digital technologies related to agriculture. The significances discussed were access to finance, forecasts on climate change, access to farming equipment and new technology, inputs for better soil fertility and soil structure, access to markets, access to information, small landholdings, and predictive analytics. Various initiatives taken by the government of India and states were also discussed in the paper. The digital technologies related to agriculture like computers and websites, broadcasting, satellite, mobile, internet and broadband, sensor networks, data storage, and analytics were also discussed in detail on how they help transform Indian agriculture. The paper concluded with the notion that a considerable number of digital efforts are being carried out by different governments for the betterment of the agricultural sector and farmers. Various digital initiatives such as Digital Green, mobile technology, e-choupal, precision farming, agricultural drones, etc. are being promoted to a larger scale to make Indian agriculture, especially in the rural areas to stand out in the global market [4].

The application of ICT in agriculture is extremely important. E-agriculture and smart farming is an emerging field focusing on the enhancement of rural and agricultural development through improved information and communication technologies. It involves the design, development, and application of innovative ways to use ICT in the rural domain with a primary focus on agriculture. This paper is a review article which states the potential of ICT in agriculture. It states that the ICT potential is divided into two ways, direct and indirect. Directly it is used as a tool that contributes directly to the productivity of agricultural production and indirectly it is used as a tool that provides information to farmers to make quality decisions for efficient management of their enterprises. To increase agricultural productivity, techniques of remote sensors with support of satellite technology, geographic information systems (GIS), agronomics, and soil science are applied. ICT supports farmers to track weather condition changes daily. Meteorological stations on fields supplied with solar energy can be connected to the computers of farmers to send information on the current temperature of air and soil, rainfall, relative humidity of the air, moisture of leaf, soil, length of the day, speed of the wind and solar radiation. The paper also talks about the various initiatives that have been taken by the Government of India like e-extension, e-choupal, Agrisnet, digital green, e-sagu, iKisan, etc. Changes in the agricultural environment that farmers face make the information not only useful but also necessary for them to stay competitive and survive in the globalized market. ICT helps the farmers in finalizing decision-making at the right time to discover the best solutions and efficient systems for water management and irrigation to harvest maximum yield [5].

The paper [6] discusses the implementation of an application that would be useful for farmers. The app would contain the details of all the different types of crops that the farmer can harvest and also the best efficient way in which he can get the yield. All this information would be provided in regional

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

audio so that it would be easier for them to understand. It would be extremely useful for farmers in India as they can get the information in multiple languages within a few key presses. The project discussed has been divided into different stages or modules including the implantation stage, cloud implementation, farmer registration, e-farming process implementation, etc. The current and the future challenges of the app included content, capacity development, access and participation, partnerships, identifying the right mix of technologies, economic and social sustainability, etc.

Oscar project [7] mainly aims for the improvement in the agricultural productivity with the help of ICT mainly in IGP (India, Pakistan, Bangladesh) region which has very high agricultural productivity and also called as Bread basket. The project chose to focus on the aspects of weed identification and control them, since weeds are considered to be the one of the most detrimental factors hampering productivity. Its main aim was to basically develop an application to solve the problem which would be highly flexible in terms of language or names of species and methods of identification as this region is very diverse. This application uses sketches and images of flowers seeds and roots of different weeds which helps in identifying the weed easily. It is basically a decision support system and also many interviews and group discussions were conducted with the farmers to understand how the application is received on the other end. In the context of rural regions, the Oscar project was very effective in identifying the weed problems but major concern of the farmers was to get the required agricultural products for the weed control at appropriate time and cost. The ICT services used here in this paper had resulted in better identification.

In this case study [8], a survey had been conducted with a set of questions to the 1990 (1170 ICT & 820 Non-ICT) farmers from a population comprises farmers all over the country, by the help of interviews and group discussions. The main goal of this research article was to draw a thin line between the productivity gain of two different farmer groups (i.e.., Farmers using ICT and not using ICT). This research was conducted with the farmers from (65.63%) ICT area and (69.94%) from non-ICT area. In the research they had collected the agricultural data of two consecutive years (2012 & 2014) through recall method and they implemented Difference in Differences model to estimate the impact of ICTs on the production aspects of food crops. To have a better Reliability for internal consistency they had followed Cronbach's (1970) Alpha Coefficient. All the findings were visualised using graphs to have a clear understanding and to figure out the differences easily. The results of the research were then graphically visualised using DiD (Difference in Differences model) method. According to this method, the production data of different crops (Boro Rice, Potato, Wheat, Maize, Pulses) had been graphically visualised and from all these graphs it could be inferred that the production of different food crops from the ICT service area had increased more than the increase of maize production in non-ICT area. By reading the research article one can come to a conclusion that there is a need to make ICT usage 100% in agriculture as it not only significantly increases the productivity but also cuts down the investment.

III. POTENTIAL OF ICT IN AGRICULTURE

The ICT in agriculture has its potential in two different ways- direct and indirect. The direct potential of ICT is when it is used as a tool contributing directly to the productivity of the crop yield while indirectly also it can be used where it provides information to the farmers for making quality decisions in the efficient management of their enterprises which otherwise is very mediocre. Direct contribution involves precise farming in the developed countries where there is the intensive use of ICT and its contribution directly to productivity and crop yield. In order to increase productivity, satellite technologies with remote sensors, geographic information systems (GIS), agronomics, and soil sciences are applied. ICT helps the farmers to track and monitor the weather conditions on a regular basis. Meteorological stations on fields supplied with solar energy can be connected to the computers of farmers in order to send information on current temperature, humidity conditions of the air and soil, rainfall, moisture of soil, length of the day, speed of the wind, solar radiation, amount of sunlight, etc. All these technologies are required for precise farming and result in increased quality of the crop yield.

Changes in the agricultural environment that farmers face make the information useful and it becomes necessary for them to stay competitive and survive in globalized markets. However, efforts on providing ICT will be wasteful if they do not know how to use ICT effectively. Therefore, minimum computer literacy is very important for the farmers to utilize ICT in the best possible way. ICT would have the potential of making Indian farmers globalized. Through the internet, they can track the prices and communicate with farmers around the world as often as they want to. They can exchange ideas, ask questions and get answers for specific themes. Specific importance is when receiving feedback and suggestions from agronomists and researchers on the cultivation of crops and animals. ICT influences on reduction of the gap that presently exists between agricultural researchers and farmers. The reduction would definitely help the farmers leading to highly developed agriculture having an enormous contribution to the national economy and society

ICT empowers the farmers

ICT provides information on the market trends and prices which helps the farmers to negotiate prices, protect their food security and livelihoods. The following areas where ICT can be applied are-

Agricultural Advisory: ICT provides weather forecasts, crop-specific advisory according to the stage in the crop cycle, and price information which empowers the farmers and prepares them to gain maximum profit from the available resources.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

Agricultural marketing: ICT tools and technologies enable farmers to manage their supply chains and control production. ICT platforms assist in making better decisions regarding transportation and logistics, price and location, supply and demand, and cheaper access to inputs.

The ICT platforms also facilitate financial transactions, capturing data about crop loss and damage assessment which would help in getting insurance claims for the farmers.

ICT provides a means for exchanging vital information between the farmers and the service providers. Farmers always need services like credit, savings, transfer and payment facilities, insurance claims to achieve economic growth. The ICT has the potential to provide more diverse, financial facilities and lower business and transaction costs.

The GIS system helps in effective land management and uses land resources effectively.

ICT technologies using machine learning and artificial intelligence can help in the early detection of plant and crop diseases.

Irrigation Management: ICT helps in analysing the moisture content of the soil using various humidity sensors that can be installed in the fields for that purpose. The farmers can better irrigate their crops by having this information and it also leads to lesser wastage of water.

Fig 2 shows the role and potential of ICT technologies in transforming the agricultural sector.

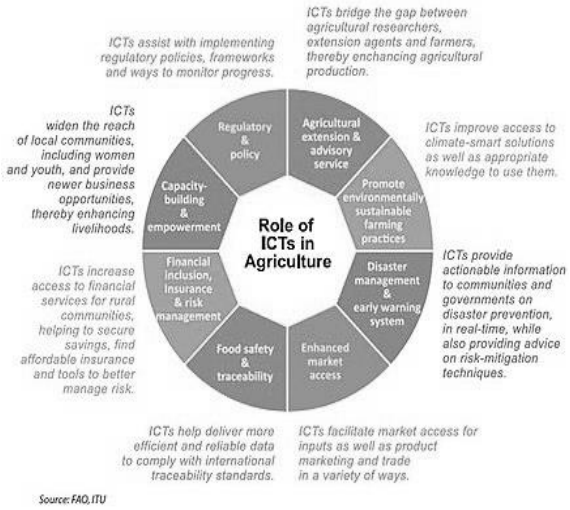

Fig 2: Role and Potential of ICT

IV. ICT IMPLEMENTATION

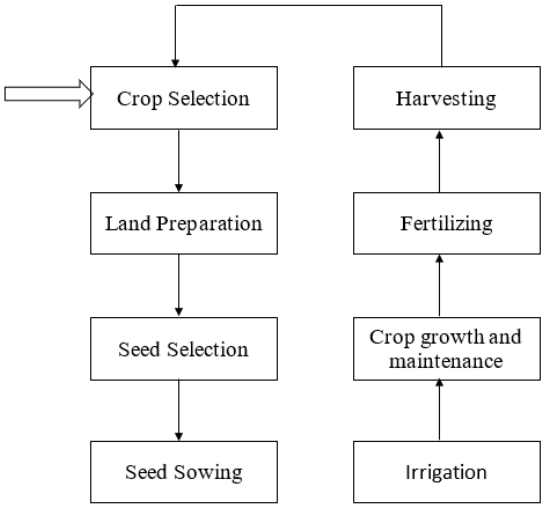

Fig 3: Steps in agriculture

The above steps shown in Fig 3 can be further simplified into three steps:
• Sowing the seeds • Maintaining and taking care of the crops while they grow • Harvesting the crops when they are ready. Taking care of crops is the most important job that a farmer has to do. It determines the quality of the crop that grows. The job includes:
1) Irrigation is the application of controlled amounts of water to the plants at needed intervals. Water is generally taken from irrigation canals or rivers by the farmers and is manually given to the crops or in some cases waiting for the rain to do the job. The farmers need to maintain the appropriate soil moisture content throughout the year. If the appropriate amount is not maintained it can be harmful for the plans. Farmers mostly rely on the little knowledge they gain from the experience or by manually looking at the crops. This leads to mistakes and damaging of the crops. During draughts maintaining the water supply is very crucial.
2) Fertilizing: Maintaining the quality of soil with the required amount of minerals is important for a healthy crop growth. Farmers in India manually add fertilizers. Often times the quality of the fertilizers is not good or the farmers add less to save money. This result in bad crop growth.
3) Protecting the crops: Many times, stray animals damage or eat the crops. The farmers need to be alert and prevent such incidents from happening. Most farmers use's attached bells on the fences to alert them but that is a very primitive way and can be easily bypassed by animals.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

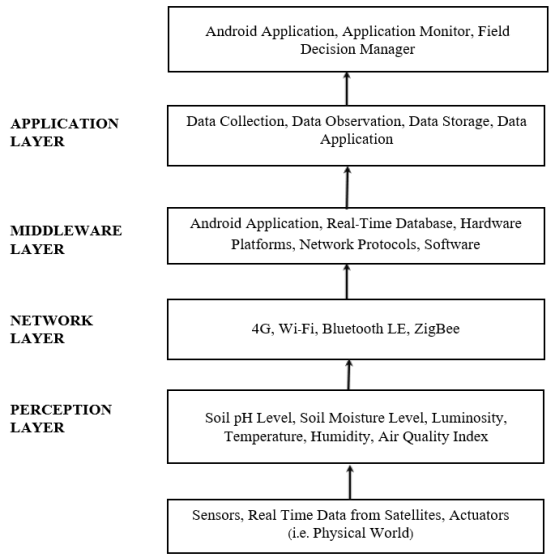

Fig 4: Flowchart for the different IoT layers required in agriculture

Fig 4 shows the ICT implementation using different IoT layers that can be used in Agricultural development.
The main idea here is to make use of widely used android based smart-phones to help farmers in agriculture, primarily horticulture, by providing software that can help the farmers to pick crops which they can cultivate, understand the market demand and prices of various crops in the market and suggest methods which can give them maximum yield. This will help the farmers by providing them an e-market where they can sell the goods and thus make this app a perfect tool for farmers by providing them this information in various languages so that they can choose their language of choice and as most Indian farmers are not much educated, this feature can make this software reach more deeply and can cause greater impact.

The software can be built using an angular framework which is very dynamic and provides a lot of options for customization. Applications that are developed using angular frameworks are fast and efficient and can be used across different languages. These frameworks use code splitting and code generation that will enhance the performance of the app. Visual studio can be used as the Integrated Development Environment (IDE) as it is developed by Microsoft and extensively used across the world, for web and mobile-based app development. It comes along with the code editor and debugger and has a code profiler which is helpful for GUI-based applications and even integration with git becomes easier by using visual studio. SQL (structured query language) can be used to create and manage a relational database management system that plays a crucial role in maintaining data for the application. This helps to avoid the exhausting process of searching for any record in the database as we can get the data using a single command. Data handling and modifications become much easier when we use this instead of old APIs like VSAM and ISAM. These tools can be used to create a dynamic mobile-based application that will be very interactive and user-friendly.

The implementation of this task will be divided into stages as shown in Fig 5. These stages are Cloud Implementation, Customer Registration process, Farmer Registration, and E-Farming Process Implementation. These stages are crucial for the application and some of the major challenges that can be faced include bad network coverage in rural areas that needs improvement, huge government backup funding, most of the farmers should be taught about how to use this application properly and this application must be very user friendly. E-Agriculture has not been properly implemented because of a lack of information and awareness about this technology among young farmers. So, the government should organize seminars and workshops among these people to spread the knowledge and make them aware of the potential benefits and merits of ICT. These steps can cause a huge development in the farming sector and agriculture, especially in India.

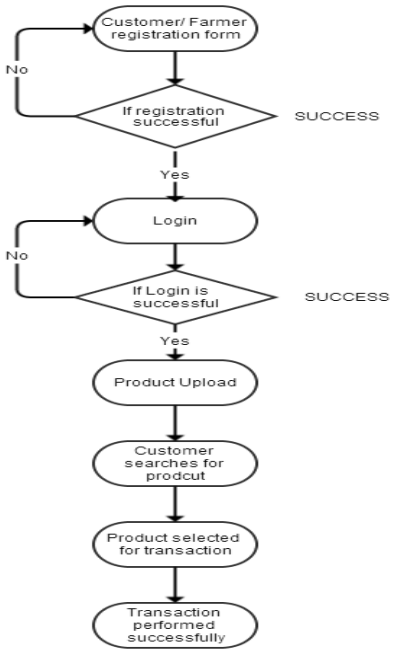

Fig 5: E-Farming Process (web application or app interface)

Agricultural infrastructure plays a crucial role in rural development. For the last couple of decades, rural people have migrated to urban areas in search of better opportunities. The economy, social status, and the lifestyle of the rural people must be given a special focus to promote rural development. The objective is to use ICT in assisting rural activities and improve rural standards to enable rural development. Agriculture is the primary component of the nations' development and economy. But the improvements are still disappointing and uneven. ICT has the potential to address these kinds of challenges and can enhance the living standard of the rural community, but the use of these technologies in rural areas and agriculture is very slow.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

V. ROLE OF ICT TOOLS

1. The farmers can get all the knowledge that is required regarding marketing, sales, crop yield, weather conditions, etc. easily using these tools.
2. It acts as a decision support system for the farmers thus aiding in proper decision making
3. ICT tools enable the widening of the marketing horizon for the farmers and also directly to the customers or other users for maximum profit.
4. ICT technologies help in strengthening farming communities through wide networking and also promote globalization for the farmers. There can also be collaborations with several NGOs, private sectors, and various other institutes.

Some ICT Tools:

1.eNAM

The National Agriculture Market called the eNAM is an online trading platform for agriculture and related products in India. It helps in better price discovery and provides enormous facilities for improving the existing market system. The products range from about 90 commodities including vegetables, fruits, and staple food grains which are all available for trade. This platform basically provides uniformity among the agricultural market by making the procedures smoother. It removes any information that causes an imbalance between the buyers and the sellers and also enhances real-time price discovery that is based on the actual demand and supply which is helpful for both customers and farmers.

2.Kisan Rath Mobile App

Transportation plays a major role in the agricultural market. This app mainly helps the farmers and traders to identify suitable transport facilities for the movement of the farm produce and was launched during the current pandemic situation. The app facilitates a constant supply chain between farmers, inter and intrastate buyers, and traders. It also helps to reduce wastage and contributes to the better pricing of the products that are perishable. The app is developed by the National Informatics Centre (NIC) and helps the primary and secondary transportation of farmland and horticulture produce.

3.RiceXpert

This is a web-based application that was developed by ICAR-National Rice Research Institute (NRRI). It provides relevant information to the farmers regarding rice cultivation. Information regarding insects, pests, nutrients, weed, nematodes, and disease-related problems for various ecological zones. This application enables the smooth flow of information from the farmers to the farm scientist and the farmers can use this as a diagnostic tool in their rice fields and customize queries for the quick solution of their problems.

4.mKisan

This is an SMS portal set up by the President of India to give information or services to farmers concerning agricultural practices. Interactive Voice Response System (IVRS) and Pull SMS are value-added services that have enabled farmers and other stakeholders to not only receive broadcast messages but also to get web-based services on their mobiles without having internet facilities. The portal acts as two-way communication between farmers and the government as it not only provides information and services to the farmers but also helps them to raise queries using the Pull SMS feature. This is a centralized portal wherein the farmers can get different modes of information in their local languages.

5. Kisan Suvidha

This app was launched for the empowerment of farmers and the evolution of the village. It has a user-friendly interface and provides information on current weather, and also forecasts for the next few days, market prices of commodities-related agriculture in the nearest market, knowledge for fertilizers, seeds, machinery, etc. It is also available in many languages which makes it more accessible all over India especially in rural areas.

6. Pusa Krishi

The app was launched by the Union Agriculture Minister of India in 2016 to help farmers to get information about technologies developed by IARI, which would help in increasing returns to farmers. The app also provides information related to new varieties of crops developed by ICAR, resource-conserving cultivation practices as well as farm machinery, and its implementation would help in increasing returns to farmers.

7. Crop Insurance Mobile App

This app helps the farmers to calculate their insurance premium on crops and provides relevant information on company contacts and cut-off dates for their crop and location. It can also be used to get details of the normal sum insured, extended sum insured, and premium details of any crops in the notified area. It also has a web portal catering to all stakeholders, including farmers, states, insurance companies, and banks.

8. Kisan Call Centres

The prime intent behind these call centres was of endowing extension services to farmers in their local languages.

Fig 7 shows the role of ICT tools in agriculture.

Fig 7: Role of ICT Tools

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

VI. ICT BENEFITS IN AGRICULTURE

1. Agricultural markets become efficient and transparent
2. Connects the rural farmers to the urban areas and global markets
3. Improves services and governance for the rural poor
4. Improves land and natural resource management
5. Support to increase rural economy
6. Improved efficiency, productivity, and sustainability
7. Strengthen farmer capabilities and representation
8. Minimizes social isolation
9. Open up new business opportunities
10. Provides weather information beforehand
11. Improved standard of living
12. Better and cheaper access to finance.

VII. ICT LIMITATIONS IN AGRICULTURE

1. **Lack of Awareness:** Rural people are unaware of the latest technological trends in the industries
2. **Coordination:** Collective and coordinated mechanism is required between the agency, stakeholders, and government to develop a system for agricultural improvement.
3. **Easiness of system:** Most of the contents are delivered in English and not in the local languages of the farmers which is not easy to use
4. **Connectivity:** Lack of reliable internet connectivity and internet access are costlier
5. **Bandwidth:** Low bandwidth can limit effective service
6. Difficult location and irregular electric supply to the rural areas
7. Illiterate farmers and stubborn conservative mindsets
8. Agricultural income primarily depends upon the seasonal variation.

VIII. CONCLUSION

Economic and social changes are essential in the rural and agricultural sectors. Features and facilities of ICT have the potential to provide information necessary to buy, produce, exchange, and sell the product. Rural communities and farmers should be given training and awareness of ICT services and their endless benefits. Greater emphasis should be given to the practical usage of ICT services and to impart relevant information to the farmers and rural people. Interactive and strong interfaces should be developed at the village level comprising user-friendly software, graphic interfaces, and pictorial information and data to encourage ICT use by rural communities. Farmers need to be educated and upskilled to effectively use the services provided by ICT.

Strategies, policies, and proper plans of action for the implementation and use of the ICT framework in agriculture need to be formulated. Single institutions' small initiatives alone cannot successfully implement ICT in agriculture and rural areas because agriculture is an enormous sector especially in a country like India. Hence collaborative plans, schemes, and joint initiation by various stakeholders are crucial for the success of ICT in the agriculture sector and rural areas.

IX. REFERENCES

[1] Ramanna Havinal, “The Role and Potential of Information Technology in Agricultural Development”, published in IJERT, Vol 9, Issue 07, July 2020
[2] Girijesh Yadav, “Use of Some Important ICT Tools in Renovating Agriculture”, published in Biotica International Journal, 2021, Vol 3:3
[3] P Anbarasan, “A Case Study Analysis on E-agriculture (e-velanmai): An ICT based Technology Transfer Model in Agriculture in Tamil Nadu State, India”, published in International Journal of Current Microbiology and Applied Sciences, Volume 10, Number 01, 2021
[4] Ashok Kumar, “Transforming Indian Agriculture with Digital Technologies”, Review Article, AJAEES
[5] Insha Javeed, “Role of Information and Communication Technology in agriculture”, published in International Journal of Current Microbiology and Applied Sciences, Special Issue 11: 2028-2017
[6] Samer D.M, “E-Farming: A breakthrough for Farmers”, published in IJERT, Vol 9, Issue 07, July 2020
[7] D Balasubramaniam, “ICT and Agriculture in India”, published in NETCOM, 23-3/4, 2009
[8] Susmita Das, “The Impact of ICTs on Agricultural Production in Bangladesh: A study with Food Crops”, published in SAARC Journal of Agriculture, 2016
[9] Muhammed Ali, “Factors Influencing Behavioural Intention of Farmers to use ICT for Agricultural Risk Management in Malaysia”, published in Pakistan Journal of Agricultural Research, 2020
[10] Saurav Verma, “An Internet of Things Architecture for Smart Agriculture”, presented at 2018 IEEE Conference