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Role of ICT in bridging the knowledge gap in rural agriculture

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Abstract
Information and Communication Technology (ICT) encompasses a wide range of tools, including mobile applications, internet-based platforms and communication systems, which address critical challenges faced by farmers, such as inadequate market access, poor training, and climate resilience. Information and Communication Technology (ICT) plays a crucial role in transforming agriculture into a more productive, sustainable, and efficient sector. ICT tools, including mobile applications, internet platforms, and communication systems, enable real-time access to information, enhance decision-making, and promote sustainable agricultural practices. Therefore current study is based upon the importance of ICT tools in agriculture by highlighting the successful ICT initiatives in India, such as AGRISNET, AGMARKNET, e-NAM, and e-Sagu, as well as mobile apps like Kisan Suvidha and Pusa Krishi, Kisan 2.0 etc. which provide essential insights into weather, crop management, and market prices. Mobile applications such as Kisan Suvidha, Pusa Krishi, and Farm-o-Pedia provide actionable insights on weather forecasts, crop health, and market prices, empowering farmers with data-driven decision-making. Despite its advantages, ICT adoption faces barriers like infrastructure gaps, high costs, and limited digital literacy. Addressing these challenges is critical to maximizing the potential of ICT in Indian agriculture, ensuring equitable and sustainable growth.

Keywords: Agricultural productivity, e-agriculture, ICT, rural development, sustainable farming system

Introduction

Information and Communication Technology (ICT) is a broad term that refers to the various technologies used to capture, store, process and communicate information. In agriculture, ICT encompasses a wide range of tools that include digital systems like computers, mobile phones, satellite communications and internet-based applications, as well as traditional methods like radio and television broadcasting. One of the most significant contributions of ICT is access to real-time information. Farmers can obtain critical data on weather forecasts, soil conditions, pest infestations, and crop management techniques through mobile apps, SMS services, and online platforms. This timely access helps in making informed decisions, leading to increased productivity and reduced losses.

The primary goal of applying ICT in agriculture is to enhance the efficiency and effectiveness of farming practices through better access to information. ICT is a powerful tool that provides farmers with real-time access to vital data such as weather forecasts, soil conditions, market prices and pest control measures. It empowers farmers by improving their decision-making ability, enhancing farm management and promoting sustainable agricultural practices. Information and Communication Technology (ICT) plays a pivotal role in modern society, driving innovation, improving efficiency, and fostering global connectivity.

It is essential in education, healthcare, business, and governance, enabling instant communication, streamlined operations, and access to vast information resources. ICT facilitates remote learning, e-commerce, telemedicine, and digital inclusion, significantly contributing to economic and social development. However, its implementation comes with challenges. The digital divide, characterized by unequal access to technology, limits opportunities for disadvantaged communities. Cyber security threats, data privacy concerns, and the rapid pace of technological obsolescence also pose significant risks. Additionally, reliance on ICT can lead to environmental issues such as electronic waste and energy consumption. Overcoming these challenges requires equitable access, robust security measures, and sustainable practices to ensure ICT's benefits are maximized while minimizing its downsides (Nehra *et al*., 2018; Sharma *et al*. 2019 & Sharma *et al*., 2017) [8, 12, 13].

Methodology

To extract relevant literature on different roles of ICT in agriculture, abstracts and citations were traced through a search using the different documents online as well as offline. This paper mainly depends on the secondary data

derived from different published reports, journals and book etc. Information elicited from these sources was synthesized towards addressing the set objectives of this review manuscript. Finally, all the related information was compiled to prepare this article.

Results and Discussion

Tools of ICT in agriculture

1. **Informative tool:** Informative tools are the applications that provide large amounts of information in various formats such as text, graphics, sound, or video. Examples of informative tools are internet, network drive, internet systems, homepage etc.
2. **Situating tool:** Situating tool is a system that lay the students in the environment where it involves a context and the occurrence of a situation. Example of situating tools includes CD-ROM.
3. **Constructive tool:** Constructive tool is a general-purpose tool that can be used to manipulate information, construct their own knowledge or visualize students understanding. Examples of constructive tools are MS Word, PowerPoint, Adobe Photoshop.
4. **Communicative tool:** Communicative tools are system that easy communication between teachers and students or between students outside the physical barrier classroom. Examples of communicative tools include e-mail, SMS etc.
5. **Collaborative tool:** Collaborative tools of ICT are commonly focused on real time projects. The developments of new collaborative tools make online collaborative projects draw a realistic option for a distributed group work. Examples of collaborative tools include discussion boards (Singh *et al*., 2014) [10].

Role of ICT in agriculture

To adopt modern agricultural technologies and enhance production in a sustainable manner ICTs can be efficiently used for collecting and sharing timely and accurate news on weather, inputs, markets, and prices by feeding information into research and development initiatives. Application of ICT in agriculture i.e. e-agriculture promotes a multi-stakeholder, people-centric, cross-sectoral platform that will bring together all stakeholders, especially farmers and enable them to access timely and relevant information, exchange opinions, experiences, good practices and resources related to agriculture. It allows easy access to ICTs including cell phones, radio, TV etc. for information dissemination. This will also promote the integration of technology with multimedia, knowledge and culture. The urgent needs of ICT in e-agriculture are as follows;

Collecting, storing, maintaining data and information to provide farmers with real time information related to integrated crop management, input availability, dosage, irrigation, soil quality, fish culturing, livestock, poultry etc. at the community level. Strengthening the existing information channels and develops new ones for a demand-driven, decentralized and localized extension program with proper management and efficient delivery. Fostering market access with necessary information and training to promote, support and enhance rural farm and non-farm enterprises locally and internationally. Build the capacity of farmers and extension workers through distance learning and by using local and relevant multimedia content and other means of ICTs. Organize or unite farmers nationally to enable exchange of knowledge, information and to ensure their collective voice participation in policy formulation. ICT tools also help to recognize and promote women's role in agriculture (Chowhan and Ghosh, 2020, Devi and Sharma 2022 & Sharma *et al*., 2023) [2, 3, 11].

ICT initiatives for agriculture and rural development

Agrisnet: It is a comprehensive web portal to broadcast relevant information to farmers, which was initiated and funded by the Ministry of Agriculture, Government of India. The AGRISNET serves farming community by disseminating information and providing services through use of Information & Communication Technology (ICT). It has following goals; providing information to the farmers on quality of the inputs and its availability, disseminating information of various government schemes and recommending fertilizers after soil testing and providing information on latest technologies for increasing productivity in agriculture.

Agmarknet: Agricultural Marketing Information Network (AGMARKNET) was commenced in March, 2000 by Ministry of Agriculture, Government of India with the aim of empowering decision-making ability of the farmers regarding selling of their produce. This portal was developed to pace up the agricultural marketing system through broadcasting information about influx of agricultural commodities in the market and their prices to producers, consumers, traders, and policy makers transparently and quickly.

Kisan Call Centre (KCC): KCCs were commenced on January 21, 2004 by the Department of Agricultural and Co-operation with the main intend of endowing extension services to the farming community in the local languages. The queries of farmers are tackled by agricultural graduates on help line, toll free number in their local language. The agricultural scientists also visit the field in person to get an idea about complex agricultural problems to resolve them.

E-Chaupal: e-*Choupal* launched in June 2000 in which village internet kiosks managed by farmers called *sanchalaks* themselves, agricultural enable the community access ready information in their local language on the weather & market prices, disseminate knowledge on scientific farm practices & risk management, facilitate the sale of farm inputs and purchase farm produce from the farmers' doorsteps (decision information-based).

E-NAM: e-NAM (National Agriculture Market) was introduced on April 14, 2016. The e-NAM portal connects the existing APMC (Agriculture Produce Marketing Committee) to unify all national agricultural markets. This includes commodity arrivals, quality & prices, buy & sell offers, provision to respond to trade offers, and electronic payment settlement directly into farmers' accounts, among other services.

E-*sagu*: The *e-Sagu* system was developed in 2004 and provides customized solution to the farmer's problems and

advise them from sowing to harvesting. Farmers send their farm condition in the form of digital photographs and videos, which were analyzed by the agricultural scientists and experts. The expert advice is conveyed to the concerned farmer within short time. The queries of illiterate farmers are dealt with the help of educated coordinators at village level.

E-Arik: The e-Arik project was initiated in 2007 and it aims to disseminate climate smart agricultural practices and to achieve food security. It is an integrated platform to enhance the accessibility of agricultural information and technology in north-eastern India. It delivers agricultural specialist advice on crop cultivation, crop management and marketing. Farmers can also obtain information direct from the portal but field workers help farmers to access ICT based information or to consult with other agricultural experts.

E-*Velalnmai*: The *e-Velanmai* project was initiated in 2013 in Tamil Nadu. Meaning of "*Velanmai*" in Tamil is Agriculture is a combination of personal and ICT based, demand driven, participatory and sustainable extension approach to provide appropriate and timely agro advisory services by scientists to the registered farmers using ICT tools (Internet, Tablet, Mobile Phone etc.) on need and regular basis (Dutta and Anand, 2023) [4].

Mobile apps used for agriculture in India

***Kisan Suvidha*:** This app was launched in 2016 and provides information on current weather, forecast for the next five days, market prices of commodities/crops in the nearest town, knowledge on fertilizers, seeds, machinery, etc. The option to use the app in different languages makes it more widely accessible.

Upaj: This app was launched in 2021 and is a cutting-edge farming application that revolutionizes agriculture by addressing the challenges faced by farmers. It simplifies farming by offering precise crop advice which includes exclusive farming tips, accurate weather forecasts, latest agricultural news and expert insights, comprehensive agronomy solutions including crop safety, smart satellite mapping, pest management, soil testing, and affordable crop insurance.

Farm-o-pedia: Developed by CDAC (Centre for Development of Advanced Computing), Mumbai on 27 Feb, 2014. The application is a multilingual Android application targeted for rural Gujarat. The main functionalities of the app are to get crop wise information, check weather in particular area and get suitable crops as per soil and season.

***Bhuvan* hailstorm:** A mobile app has been developed on 15 Jan, 2016 by CDAC, Mumbai to capture crop loss happened due to hailstorm. This mobile app is able to capture following parameters: Photograph of field, name of crop, date of sowing, and date of likely harvesting. This captured data will automatically be plotted to Bhuvan Portal and analysis can be done easily.

Pusa Krishi: This app was launched in 2016. It aims to help farmers to get information about technologies developed by Indian Agriculture Research Institute (IARI), which will help in increasing returns to farmers. The app also provides information related to new varieties of crops developed by Indian Council of Agriculture Research (ICAR).

IFFCO *Kisan*: This app was launched in 2015 and is managed by IFFCO Kisan. Its aim is to help Indian farmers make informed decisions through customized information related to their needs. The user can access a variety of informative modules including agricultural advisory, weather, market prices, agriculture information library in the form of text, imagery, audio and videos in the selected language.

***Kisaan* 2.0**: This app was launched in February 2019. KISAAN 2.0 (Krishi Integrated Solution for Agri Apps Navigation) is envisaged to help e-agriculture and to drive smart phone-based agriculture in India. It has been developed with an aim to make farming convenient for Indian farmer. KISAAN 2.0 app provides a single interface in multiple Indian languages for Indian farmers to access agricultural knowledge about crops, horticulture, livestock, fisheries, natural resource management, agricultural engineering, agricultural education and agricultural extension (Ibrahim *et al*., 2020) [5].

India's position in ICT use

- Second biggest software exporter globally.
- 45% of the world ICT projects implemented in India
- There were 751.5 million internet users in India till January 2024.
- India's internet penetration rate stood at 52.4 percent of the total population at the start of 2024 (Saravanan R, 2020) [9].
- There were 1.12 billion cellular mobile connections in India at the start of 2024.
- Mobile connections in India were equivalent to 78 percent of the total population in January 2024.
- There were 462.0 million social media users in January 2024, equating to 32.2 percent of the total population (Anonymous, 2024) [1].

Benefits of ICT in Agriculture

Saves Money: The use of modern technology in agriculture helps farmers to save money. Farmers can work much more quickly, efficiently, and with less effort with the aid of contemporary technologies. Modern technology makes it simple and inexpensive to complete tasks that previously needed many people and a lot of time.

Productivity is increased: The productivity of farmers can be easily increased by a number of contemporary technical tools and machinery. To boost production, agriculture uses tractors, robotic lettuce harvesters, automatic in-row weeders, carrot harvesters, and separators, among many other modern devices.

Modern technology simplifies transportation: With modern technology, transportation becomes very simple for farmers. They can move the crops from one location to another with ease using tractors and trucks.

Modern technology lessens farmers' efforts: The major goal of modern technology is to make it easier for individuals to work by minimizing their labour-intensive activities. The agricultural efforts of farmers are significantly reduced by modern technologies.

Improving access to information: ICT can help to make a wide range of information and resources available to farmers and extension workers, such as weather forecasts, market prices, and best practices for crop management.

Agricultural databases: ICTs can be used to create and manage databases of information, such as weather data, soil maps, and crop yield records. These databases can be accessed by farmers, extension agents, and researchers to help inform their decision making.

Video and multimedia content: ICTs like smartphones and tablets can be used to create and share video and multimedia content, such as instructional videos, podcasts, and webinars, which can provide farmers with access to information in an engaging and accessible format.

SMS and mobile apps: ICTs can also be used to send information directly to farmers' mobile phones through SMS or mobile apps, which can provide them with timely and relevant information in areas with limited internet connectivity.

Enhancing communication and collaboration: ICT tools, such as mobile phones and social media platforms, can facilitate communication and collaboration among extension workers, farmers, and other stakeholders. This can help to improve the sharing of knowledge and expertise and facilitate the adoption of new technologies and practices.

Supporting distance education and training: ICT can be used to deliver extension services remotely, using platforms such as online courses, webinars, and video conferencing. This can be particularly useful in areas where extension workers are scarce or hard to reach (Javeed *et al*., 2020) [6].

Obstacles to ICT expansion in agriculture

Farmer's lack of education: Since most farmers lack formal education, it can be quite challenging for them to comprehend how contemporary technology is used in farming.

Reduce soil fertility: The soil fertility is decreased by the overuse technologies in the fields. Technology in agriculture decreasing soil fertility is one of its major drawbacks. The soil in the fields is damaged and becomes less fertile due to the excessive use of technology. While pesticides and fertilizers might speed up output, they also gradually degrade soil fertility.

High Cost of Maintenance: One of the drawbacks of agricultural technology is its expensive maintenance requirements. As farmers cannot afford the high maintenance costs of current technical machines and devices, maintaining technology is particularly challenging for them.

Environment-related harm: The majority of technology tools and gadgets cause climate pollution that is extremely detrimental to us. Tractors, trucks, and other large machinery that are used excessively release hazardous chemical gases and carbon dioxide into the air, which pollutes and harms both people and other living things.

Infrastructure Deficiencies in Rural Areas: Poor development of ICT infrastructure, such as lack of reliable internet connectivity, inadequate electricity supply, and insufficient mobile network coverage in rural areas, limits the accessibility and usability of ICT tools for farmers.

Limited Availability of Localized Content: ICT applications in agriculture frequently lack region-specific, customized, and real-time data on weather, soil conditions, pest control, and market prices, reducing their relevance and effectiveness for local farmers.

Weak Policy Support and Institutional Frameworks: Absence of well-defined policies promoting ICT in agriculture, inadequate funding, and lack of collaboration between governments, private sectors, and research institutions hamper the widespread adoption of ICT solutions.

Data Privacy and Security Concerns: Farmers may hesitate to use ICT tools due to concerns about the misuse of personal or farm-related data by corporations or other stakeholders, hindering adoption rates.

Gender and Social Inequalities: Women and socially marginalized groups in rural areas often face restricted access to ICT tools due to gender biases, limited mobility, and unequal opportunities, widening the digital divide in agriculture (Mahant *et al*. 2012) [7].

Conclusion

ICT plays a crucial role in providing accurate and timely agricultural information, which improves food production, productivity and market pricing for farmers. Overcoming obstacles and expanding ICT use can greatly benefit the agricultural sector in India. ICT can improve farm management and farming technologies by efficient farm management. ICT can help in better marketing exposure and pricing and reduction of agricultural risks and enhanced income. ICT are going to play greater role in private sector such as agribusiness, market information and market intelligence. It is enabling farmers to make better decisions about future crops and commodities. It is important that accurate information reaches the farmers at the right time. ICT enhances productivity, improves efficiency, and empowers farmers by providing timely access to information, tools, and resources. From precision farming and weather forecasting to market access and supply chain management, ICT bridges the gap between rural farmers and global agricultural advancements. It promotes sustainable practices, increases resilience to climate change, and ensures better decision-making. ICT is a critical enabler in modern agriculture, fostering innovation and inclusivity. By integrating technology into farming practices, we can address food security challenges, boost rural development,

and create a more sustainable and equitable agricultural ecosystem. However, for ICT to achieve its full potential, there must be continued investment in infrastructure, capacity-building, and equitable access to technology, particularly for small-scale and marginalized farmers.

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