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Sonam Pareek
Assistant Professor, Faculty of Basic and Applied Science, RNB Global University, Bikaner, Rajasthan, India

Zaiba Khan
Assistant Professor, Faculty of Basic and Applied Science, RNB Global University, Bikaner, Rajasthan, India

Dr. Ravi Kumar
Assistant Professor, Faculty of Basic and Applied Science, RNB Global University, Bikaner, Rajasthan, India

Corresponding Author:
Sonam Pareek
Assistant Professor, Faculty of Basic and Applied Science, RNB Global University, Bikaner, Rajasthan, India

Adoption and implementation of information technology in farming industry: A review

Sonam Pareek, Zaiba Khan and Dr. Ravi Kumar

Abstract
The paper aims to assess the extent of software utilization in farming industries and investigate the scope of software usage in agricultural research. The review presents a comprehensive view of how digital technology can effectively manage various farm-related activities. It examines the current state of digital technology in agriculture and identifies the factors that impact farmers' adoption of these technologies. Additionally, the study explores the advantages and challenges associated with using digital technology in agriculture and offers recommendations to promote its adoption among farmers, policymakers, and technology providers. Ultimately, the review concludes that embracing digital technology in agriculture holds potential benefits such as increased productivity, cost reduction, and enhanced sustainability.

Keywords: comprehensive, policymaker, potential, information technology, sustainability

Introduction
India plays a major role in the agriculture sector all over the world. Agriculture is the largest livelihood provider in India (~55% of India's population) (Annual Report 2022-23) [1]. India has the world's largest area under wheat, rice, and cotton and is the largest producer of milk, pulses, and spices in the world. It is the second-largest producer of fruit, vegetables, tea, farmed fish, cotton, sugarcane, wheat, rice, cotton, and sugar. India having largest agricultural land in the world which generates employment for more than half of the Indian population.

In the agricultural sector latest ideas and better technologies essentially require for enhancement of economic condition of the farmers. Farmers are the backbone of our country that is facing many problems like getting relevant information about the crop and weather details at the right time, recent development in agriculture sector, price of agriculture produce etc.

The farming industry has seen a significant transformation in recent years with the integration of information technology applications. The involvement of information technology applications represented as software programs refer to web based and mobile based applications which can be easily used by farmers. Information technology is basically the use of computer or mobile devices for storing, retrieving, transmitting, and manipulating data which is valuable to the users. In the farming industry, IT has been used to develop and implement various systems and tools that help farmers manage their farm related operations more efficiently. The use of applications such as precision agriculture, drones, sensors and farm management software has provided farmers with a new way of managing their operations. These applications have enabled farmers to monitor and manage their crops, soil and livestock more effectively, resulting in increased yields and profitability. The use of IT applications in farming industry has also led to the development of new business models, such as farm-to-table.

This paper aims to review the use of IT applications and impact on farming industry and highlight the challenges faced by farmers in adopting and implementing IT applications in the farming industry. The application of information technology by itself should be seamless and should not become a challenge to the farmers but a means of enhancing their productivity. Adoption of IT in agriculture helps policymaker for understanding the reality on the ground in more precise way which helps to develop policies that can benefit the farmers and it encompass increasing information availability, reducing dissemination costs, fostering collaboration and exchange among stakeholders, and promoting the overall growth and development of the agricultural sector. By leveraging IT solutions, the agricultural industry can benefit from improved decision-making, enhanced communication, and sustainable growth.

Literature Survey

According to Javeed *et al.,* (2020) [5] e-agriculture is a new discipline that focuses on improving agricultural and rural development through improved information and communication systems. ICT are the most natural allies for expanding the reach of the country's Agri-extension system. Despite a big, well-educated, well-trained, and well-organized agricultural extension workforce, over 60% of farmers in the country remain unreached, with no extension organization serving them. Radio and television are the primary sources of information. Approximately 45% of the world's ICT initiatives have been implemented in India, and the most information kiosks have been deployed in rural India. It was discovered that the majority of ICT initiatives in agriculture were implemented in South and Southeast Asia's socioeconomically developed states.

Singh *et al*., (2017) [11] observed that agriculture lags behind in numerous ways, including inadequate market connectedness and disintegration, unreliable and delayed information to farmers, small land holdings, non-acceptance or limited use of improved technology, and so on. It has become critical to investigate various methods of keeping our farmers up to date on contemporary technologies and important information. The fundamental difficulty for agricultural scientists/experts is the creation and timely dissemination of better tailored technologies unique to varied agro-climatic conditions, land holding size, soil type, crop type, and related pests/diseases. The timely availability of accurate information and its effective application are critical for agriculture. Initiatives based on ICT can be launched to spread knowledge, transfer technology, buy inputs, and market products.

Dirghangi *et al.,* (2023) [2] a solar-powered smart farm monitoring system comprising IoT devices and sensors was demonstrated. They can use the Smartphone to monitor crop field conditions and efficiently take the necessary procedures based on current conditions. Their suggested system will provide farmers with useful data (information) on soil moisture, water level, humidity, and temperature, as well as the general state of the crop and field, in an easily accessible manner via real-time data transfer via IoT.

Mini *et al*., (2023) [9] proposed an IoT-based smart agriculture robotic system that is designed to sense the temperature, humidity, and moisture levels in the soil, and transmit this data to an IoT platform via the internet. The system is also equipped with wireless and manual control capabilities via a mobile application using Bluetooth, enabling farmers to control the movements of the robotic system in real-time. Compared to the complex and expensive smart agriculture systems currently on the market, their proposed system is both cost-effective and easy to use. This allows farmers to optimize resource usage and reduce waste, and take corrective measures to prevent crop loss when soil moisture falls below a predetermined threshold. The system's rechargeable lithium-ion batteries offer a cost-effective and sustainable power supply solution, especially in rural areas with limited access to reliable electricity. Overall, this system has the potential to improve crop yield and profitability while reducing resource waste and environmental damage in the agricultural sector of India.

Katode and Vyas *et al.,* (2023) [7] created a smart customized agriculture pesticide sprayer robot with multi-functionality approach using advance ARM Dule core processor. They operate that robot by using customized regional language application to help illiterate farmers and farm workers. Their system support multifunctionality like, pesticide sprayer, weed cutter, seed sowing, drip irrigation and night vision lamps.

Suryakanth *et al*., (2023) [12] introduced a versatile Agrobot system tailored for precision farming, which features a mobile robotic platform outfitted with an array of sensors, actuators, and instruments that enable it to execute numerous tasks with exceptional accuracy and efficacy. The Agrobot system is devised to function in various agricultural settings, including fields, greenhouses, and orchards, and its modularity permits customization for distinct crops and farming techniques. They introduce the creation and application of RaitaMitra, a cutting-edge Agrobot steered by an Arduino Uno microcontroller. The Agrobot, outfitted with a Bluetooth module, can be managed through an accessible Android app, crafted using the Arduino coding language, a derivative of C. RaitaMitra uses four distinct DC motors for its movement, promising superior maneuverability. The robot incorporates a weed cutter blade driven by a DC motor, offering effective control of weeds and grass. Moreover, RaitaMitra possesses a pesticide sprayer for safeguarding crops and a servo motor-controlled seed container for accurate seed placement. An exceptional attribute of this Agrobot is its soil moisture sensor that measures the water levels in the soil. When these levels dip below a set limit, the sensor triggers a relay, transmitting a message to an RF receiver that initiates a pump for targeted watering. This multifunctional approach bolsters agricultural productivity, potentially revolutionizing conventional farming methodologies.

Dhanaraju *et al*., (2022) [13] investigated the instruments and equipment utilized in applications of agriculture and anticipated obstacles experienced when integrating technology with conventional farming activities. They also look at how agricultural applications use web-based sensors and smart farming. These solutions address a variety of difficulties confronting conventional agriculture, including land appropriateness, drought mentoring, irrigation, insect management, and yield maximization. They also show the order of the primary applications, facilities, and devices for smart agriculture applications. Using modern technologies at different stages to improve efficiency and transform agriculture. Innovative technologies such as the Internet of Things (IoT) and cloud computing are expected to spur growth and kickstart the usage of robotics and artificial intelligence in agriculture.

Talaviya *et al*., (2020) [14] observed that researchers are focusing on observing the many applications of artificial intelligence in agriculture, such as irrigation, weeding, and spraying, using sensors and other techniques implanted in robots and drones. These technologies reduce the use of water, pesticides, and herbicides, maintain soil fertility, and aid in the effective use of labor to increase productivity and quality. They also conducted a poll to obtain a quick summary of the existing deployment of automation in agriculture, such as weeding systems using robots and drones. The numerous soil water sensing technologies, as well as two automated weeding systems, are discussed. The utilization of drones is covered, as well as the numerous methods utilized by drones for spraying and crop monitoring.

Muhammad *et al*., (2020) observed that researchers in the agricultural area have proposed various IoT-based devices that increase output while requiring less labor. They also concentrate on a thorough literature review undertaken by

researchers on IoT-based agricultural solutions. The goal of the review is to compile relevant research on IoT agricultural applications, sensors/devices, communication protocols, and network kinds. The researchers looked at 67 studies published between 2006 and 2019. The review emphasizes the increased production and higher agricultural productivity brought about by IoT-based technology. It also tackles the major issues and difficulties being researched in agriculture. Finally, it offers open concerns and difficulties for future research in the field of IoT agriculture.

Behera *et al.,* (2015) [16] studied on information communication technology (ICT) promoting retail marketing in the agriculture sector in India, IT plays a critical role in assisting farmers in making timely decisions regarding crop product diversification and market positioning for optimal revenue. The study emphasizes the necessity of educational and professional training in using IT as a tool to provide farmers with up-to-date information that is easily accessible to them. It underlines the importance of utilizing agriculture's enormous potential in the Indian economy. The study acknowledges the well-established function of information technology in agricultural development and increasing rural quality of life.IT assists farmers in India to gain access to important information on agro input crop production methods, agro-processing, market support agro-finance, and other topics.

Gap analysis

Agriculture sector is transforming with information technology and becoming technology equipped sector in India recently. Therefore, the agricultural industry (farming industry) is adopting digital technology to get exact, time-bound information, meet a farmer's demand with a quick response, and enhance the profitability of their operations.

The Internet of Things (IoT) is a trend in agriculture where data is collected, stored in the cloud, and processed to generate results and reports. It is also helping in areas such as process automation, distance control, and agrochemicals control, which are becoming increasingly important (Shetty & Smitha, 2021 and Friha, *et al*., 2021) [10, 3].

The majority of farmers lack opinions on how much technology can help them. Most of them willing to invest a small amount of money in technology. Additionally, farmers are often discouraged from investing in technology due to financial issues, but a sizable portion of them are also unsure about the kind of technology they can use in their farming businesses.

This primarily refers to the employment of robots and drones in agriculture, which is frequently accompanied with IoT and AI that is difficult for farmers to access and frequently expensive and complex. Additionally, these technologies are typically either being tested or being used on a small scale for experimentation rather than being widely accepted (Friha, *et al.,* 2021 and Mandal, *et al*., 2022) [3, 8].

There is a communication gap between technology provider and farmers due to that technology is not according to need of farmers. The majority of the information is written in English, which is difficult to use and unsuited to the demands and skills of farmers. Similar technologies also cannot be use for different cases such as different types of soil, different weather conditions, different crops etc. Low bandwidth networks can make it difficult to provide adequate service to rural areas because agricultural information requires the use of graphics intensively (Havinal, 2020 and Kasemi, 2022) [4, 6].

Conclusion

Particularly in countries that are subject to price fluctuations, climate change, and ongoing infrastructural gaps in rural areas, agriculture faces a number of present-day substantial difficulties. ICTs have a crucial role in helping farmers meet the requirement for higher food production in this scenario. ICTs can be extremely important in distributing information to farmers so they can make more informed decisions. People may learn about and practice sustainable farming via ICTs. They can also get the most recent data. In order to better understand the different distinctive paths by which ICTs might play a key role in supporting agricultural development, the aforementioned literature and case studies have been recorded in this review article in this regard.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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