

Role of Socioeconomic Profiles, Digital Literacy, and ICT Adoption in Agriculture

Laxmi Priya¹ and Dr. Hirdesh Kumar²

¹Research Scholar, Department of Agriculture

²Assistant Professor, Department of Agriculture
Vikrant University, Gwalior, M.P, India

Abstract: *The increasing integration of information and communication technologies into agriculture has created new opportunities for improving farm decision-making, access to information, market participation, productivity, and rural livelihoods. However, the benefits of agricultural digitalization are not distributed equally among farmers because ICT adoption is strongly influenced by socioeconomic characteristics and digital literacy. The present research paper examines the role of socioeconomic profiles, digital literacy, and ICT adoption in agriculture during the period 2010–2022. The study follows a descriptive and analytical approach based primarily on secondary sources, including research articles, agricultural studies, and institutional reports. Evidence indicates that education, income, age, landholding size, farming experience, access to training, and social networks influence farmers' ability and willingness to use ICT-based agricultural services.*

Keywords: Socioeconomic Profile, Digital Literacy, Digital Agriculture

I. INTRODUCTION

Agriculture is increasingly becoming an information-intensive sector in which farmers require timely and reliable information about weather, crop varieties, agricultural practices, input prices, market conditions, pest management, government schemes, financial services, and post-harvest opportunities. Information and communication technologies have expanded the mechanisms through which such information can be delivered to rural communities. Mobile phones, the Internet, computers, social media, SMS services, digital advisory platforms, agricultural applications, and online marketplaces have gradually become important components of modern agricultural information systems.

Ali and Kumar (2011), in their study of the e-Choupal initiative in India, demonstrated that ICT-based information delivery could improve farmers' decision-making across different stages of the agricultural supply chain. Their findings also showed that education, income, social category, and landholding size influenced farmers' decision-making capabilities, highlighting the importance of socioeconomic characteristics in determining the usefulness of ICT interventions.

The expansion of ICT in agriculture, however, does not automatically result in equal adoption. Farmers differ substantially in their ability to access, understand, evaluate, and apply digital information. Socioeconomic characteristics such as age, education, income, farm size, farming experience, gender, access to training, and social networks can influence both technological access and actual utilization. A systematic review of digital agricultural technology adoption identified socioeconomic characteristics including age, gender, education, income, farming experience, health status, and cooperative membership as important factors considered in adoption studies. Thus, the digital transformation of agriculture is closely related to the social and economic conditions of farming households.

Digital literacy represents another important dimension of agricultural ICT adoption. Digital literacy extends beyond simply possessing a mobile phone or having Internet connectivity. It involves the ability to operate digital devices, search for information, evaluate its reliability, communicate digitally, use applications, and apply information to practical agricultural decisions. Research among smallholder farmers in South Africa found that ICT literacy was

positively associated with educational level and negatively associated with age and years of farming experience. These findings indicate that access to technology and the capacity to use it effectively are separate but interconnected issues.

NEED OF THE STUDY

The need for studying socioeconomic profiles, digital literacy, and ICT adoption arises from the growing importance of digital technologies in agricultural development. Digital agricultural services can potentially reduce information gaps between farmers, agricultural experts, markets, financial institutions, and government agencies. Nevertheless, the availability of digital technologies does not guarantee their effective utilization. Farmers with limited education, lower income, inadequate digital skills, poor connectivity, limited access to devices, or insufficient training may remain excluded from the benefits of digital agriculture. Evidence from digital extension research in low- and middle-income countries indicates that women, less educated farmers, and less wealthy farmers can face greater difficulties in using digital extension tools because of device access, electricity, network availability, digital illiteracy, language, cost, and lack of awareness. Consequently, understanding the relationship between socioeconomic conditions and digital literacy is necessary for designing inclusive agricultural ICT programs.

RESEARCH METHODOLOGY

The present study follows a descriptive and analytical research design based on secondary information published between 2010 and 2022. Research articles, agricultural studies, institutional reports, and literature concerning ICT, digital literacy, socioeconomic characteristics, and agricultural technology adoption were examined. The analysis focuses on three interconnected dimensions: socioeconomic profile, digital literacy, and ICT adoption. The socioeconomic dimension includes variables such as age, education, income, landholding, farming experience, gender, and access to training. Digital literacy is considered in terms of farmers' ability to operate digital devices, access agricultural information, use Internet-based services, communicate digitally, and interpret information. ICT adoption includes the use of mobile phones, Internet services, social media, SMS, agricultural applications, digital extension services, and other technology-based information systems.

SOCIOECONOMIC PROFILE AND ICT ADOPTION IN AGRICULTURE

Farmers' socioeconomic profiles play an important role in determining their access to and utilization of ICT. Education is particularly important because farmers with higher educational attainment may have greater ability to understand digital interfaces, search for information, interpret technical recommendations, and evaluate alternative sources. Ali and Kumar (2011) demonstrated that education, income, social category, and landholding size were significant factors associated with the decision-making benefits obtained from ICT-based agricultural information in India.

Income also influences ICT adoption because digital technologies require financial resources for purchasing smartphones, computers, data packages, electricity, and sometimes subscription-based agricultural services. Farmers with greater economic resources may be better positioned to experiment with new technologies and absorb the risks associated with adoption. Conversely, low-income farmers may prioritize basic livelihood expenditures over digital devices and Internet services. FAO's 2022 assessment of agricultural digitalization noted that access to digital and automation solutions remained limited for many small-scale producers in low- and lower-middle-income countries.

Age represents another important socioeconomic characteristic. Younger farmers are often more familiar with smartphones, Internet services, and social media, whereas older farmers may require additional training and support. However, age should not be treated as an absolute barrier because older farmers can also adopt ICT when technologies are affordable, understandable, relevant, and supported through training.

Landholding size and farming scale may also influence ICT adoption. Larger farms can potentially generate greater economic returns from precision agriculture, digital farm-management systems, and online market services. Smallholders, on the other hand, may benefit substantially from relatively inexpensive technologies such as mobile phones, SMS, WhatsApp groups, voice services, and digital advisory systems. Therefore, ICT interventions need to be

adapted to different categories of farmers rather than assuming that a single technological model will work equally for everyone.

Table 1. Major Socioeconomic Factors Influencing Agricultural ICT Adoption

Socioeconomic factor	Possible influence on ICT adoption	Major implication
Education	Improves ability to understand and use digital information	Digital training becomes more effective
Age	May influence familiarity with digital devices	Older farmers may require additional support
Income	Determines ability to purchase devices and data	Affordability is important
Landholding size	Can influence investment capacity and expected returns	Different technologies may suit different farm sizes
Farming experience	Provides agricultural knowledge but may not always correspond to digital skills	Traditional knowledge and digital knowledge should be integrated
Gender	Can affect access to devices, training and information in some contexts	Gender-inclusive programs are required
Social networks	Facilitate information sharing and technology learning	Peer-to-peer learning can encourage adoption
Training	Improves knowledge and confidence	Practical training can reduce adoption barriers
Cooperative membership	Can improve access to information and collective resources	Institutions can support digital inclusion

ROLE OF DIGITAL LITERACY IN AGRICULTURE

Digital literacy is increasingly recognized as a fundamental capability for successful agricultural digitalization. A farmer may own a smartphone but still be unable to search for reliable agricultural information, download an application, interpret weather information, compare market prices, or communicate effectively with extension personnel. Consequently, digital literacy should be distinguished from simple technological access.

The 2021 study of smallholder farmers' ICT literacy demonstrated that educational level had a positive association with ICT literacy, whereas age and years of farming experience showed negative associations with ICT literacy. This finding indicates that education and training can play an important role in strengthening farmers' digital capabilities.

Digital literacy also influences farmers' capacity to evaluate the quality and credibility of online information. Agriculture involves decisions that can have direct financial consequences, and therefore farmers need to distinguish reliable agricultural recommendations from misleading or inappropriate information. Digital extension research in South Asia and other regions identified distrust, unfamiliar language, poor usability, digital illiteracy, and information irrelevance among the factors limiting effective use of digital extension tools.

Digital literacy can also improve farmers' interaction with markets. Through mobile phones and Internet services, farmers can obtain information about commodity prices, contact buyers, access financial services, and communicate with other farmers. In Pakistan, research published in 2022 found an association between mobile-phone/Internet use and agricultural income, emphasizing the economic relevance of digital connectivity.

Table 2. Dimensions of Digital Literacy among Farmers

Dimension	Meaning in agriculture	Example
Basic device literacy	Ability to operate digital devices	Using a smartphone
Information literacy	Ability to search and interpret information	Searching crop-management information
Communication literacy	Ability to communicate digitally	WhatsApp/voice communication with experts

Application literacy	Ability to use agricultural apps	Weather or crop advisory applications
Evaluation literacy	Ability to assess information reliability	Comparing information from different sources
Market literacy	Ability to access digital markets	Checking prices and contacting buyers
Financial literacy	Ability to use digital financial services	Digital payments and banking
Problem-solving literacy	Ability to use technology for farm problems	Identifying pest or weather-related solutions

ICT ADOPTION IN AGRICULTURAL ACTIVITIES

ICT adoption has increasingly transformed several agricultural activities. The most basic application is communication. Mobile phones enable farmers to communicate with extension workers, input suppliers, traders, fellow farmers, and family members. Internet-based services extend this capacity by allowing farmers to search for information and access specialized agricultural resources.

Digital extension services have become another important application. A 2022 global review of digital agriculture services in low- and middle-income countries found that research was particularly concentrated on digital advisory and extension services, with reported outcomes including increased knowledge and changes in agricultural practices. Digital extension may include SMS, phone calls, social-media groups, mobile applications, online videos, and other information platforms.

ICT is also relevant to agricultural technology adoption. Evidence from 1,449 Chinese farm households indicated that Internet use significantly increased the adoption of new crop varieties, water-saving irrigation, and straw-returning technology. This demonstrates that ICT can function not only as an information channel but also as an enabling mechanism for technological change in agricultural production.

Table 3. Major ICT Applications in Agriculture

ICT application	Agricultural function	Potential benefit
Mobile phones	Communication and information	Rapid access to advice
Internet	Information searching	Wider knowledge access
SMS	Weather and advisory alerts	Timely information
Social media	Farmer-to-farmer communication	Knowledge sharing
Mobile applications	Crop and farm management	Specialized advice
Digital extension	Expert communication	Improved agricultural knowledge
Online markets	Buyer-seller communication	Market access
Digital payments	Financial transactions	Convenient financial services
Weather services	Weather forecasting	Better farm planning
Video-based extension	Demonstration of practices	Practical learning

RELATIONSHIP BETWEEN SOCIOECONOMIC PROFILE, DIGITAL LITERACY AND ICT ADOPTION

Socioeconomic characteristics, digital literacy, and ICT adoption should not be considered independent variables. They interact with one another to determine farmers' actual participation in digital agriculture. Education can improve digital literacy, while income can increase access to devices and connectivity. Digital literacy can then increase the probability that farmers will actually use ICT services effectively. Similarly, social networks can facilitate learning and encourage farmers to experiment with technologies.

The relationship can therefore be conceptualized as:

Socioeconomic Profile → Digital Access → Digital Literacy → ICT Adoption → Agricultural Outcomes

However, the relationship is not necessarily linear. For example, a farmer may have sufficient income to purchase a smartphone but lack the skills to use agricultural applications. Similarly, a digitally literate farmer may not adopt online

agricultural services if Internet connectivity is poor or if the information is unavailable in a familiar language. Research on digital extension tools identified device accessibility, electricity, mobile networks, digital literacy, language, usability, relevance, and trust as interconnected barriers to use.

II. CONCLUSION

The study demonstrates that the role of ICT in agriculture cannot be separated from the socioeconomic and educational characteristics of farmers. Between 2010 and 2022, agricultural ICT evolved from relatively basic information and communication applications toward Internet-based extension, smartphone services, digital marketplaces, and technology-enabled farm management. Evidence indicates that education, income, age, landholding, farming experience, training, and social networks influence farmers' ability to access and utilize ICT. Digital literacy is particularly important because effective digital agriculture requires more than device ownership; farmers must be capable of searching, evaluating, interpreting, and applying digital information.

Research from India showed that socioeconomic characteristics influenced the decision-making benefits obtained through ICT, while subsequent research demonstrated associations between education, age, farming experience, ICT literacy, Internet use, and agricultural technology adoption. The evidence therefore supports a multidimensional understanding of agricultural digitalization in which infrastructure, socioeconomic capacity, digital literacy, institutional support, and relevant content operate together. Inclusive agricultural digitalization requires policies that address both the technological and human dimensions of adoption, particularly for small and resource-constrained farmers.

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