

A Review of Farmers' Socioeconomic Profiles, Digital Literacy, and ICT Adoption

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Abstract: *The rapid expansion of information and communication technologies (ICTs) has transformed the agricultural information environment by providing farmers with new opportunities to access market information, weather forecasts, agricultural advisories, financial services, input information, and knowledge related to improved farming practices. However, the adoption and effective utilization of ICTs among farmers are strongly influenced by their socioeconomic characteristics and level of digital literacy. This review examines the relationship between farmers' socioeconomic profiles, digital literacy, and ICT adoption with particular reference to literature published between 2010 and 2022. The review indicates that education, income, farm size, occupational diversification, extension contact, social networks, access to infrastructure, and exposure to mass media are important factors associated with ICT accessibility and utilization.*

Keywords: Farmers, Socioeconomic Profile, Digital Literacy, Mobile Technology, Rural Development

I. INTRODUCTION

Agriculture remains highly dependent on timely access to knowledge and information. Farmers require information concerning weather conditions, seed varieties, fertilizers, pest and disease management, irrigation, government programmes, market prices, credit, insurance, and post-harvest management. Traditionally, such information has been obtained through agricultural extension workers, fellow farmers, input dealers, radio, television, newspapers, and local institutions. The development of information and communication technologies has expanded these channels by introducing mobile phones, internet services, websites, mobile applications, social media, digital advisory platforms, online markets, and electronic financial services. Ali and Kumar (2010) reported that ICT-based information services can influence farmers' decision-making across different stages of the agricultural supply chain. Their findings also indicated that socioeconomic characteristics such as education, income and landholding size were associated with farmers' decision-making capabilities.

The expansion of ICTs in agriculture, however, does not imply equal adoption among all farmers. Farmers differ considerably in education, income, age, farm size, access to infrastructure, occupational structure, social networks, extension contact, and exposure to information sources. These characteristics can influence whether a farmer has access to a digital device, understands digital information, trusts the information, and is able to convert that information into an agricultural decision. Ali (2012), in a study of 461 farmers in Uttar Pradesh, found that education, income and social category were important socioeconomic factors associated with adoption of ICT-based agricultural information. The study also reported the importance of business orientation, cropping diversification and farm characteristics in ICT information use. Thus, socioeconomic conditions form an important foundation for understanding differences in ICT adoption among farmers.

FARMERS' SOCIOECONOMIC PROFILE

The socioeconomic profile of farmers generally includes age, gender, education, family size, occupation, income, landholding, farming experience, social participation, extension contact, access to credit, mass-media exposure and membership in farmer organizations. These characteristics are important because they determine the economic and social resources available to farmers for experimenting with new technologies. Education is particularly important because it can improve the ability of farmers to read, understand, compare and evaluate agricultural information. Higher educational attainment can therefore facilitate the use of internet-based services and digital applications. Income is another important factor because smartphones, data services, computers and other digital resources involve direct and indirect costs.

Landholding size and farm orientation may also affect ICT adoption. Farmers who operate agriculture as a commercial enterprise may have stronger incentives to obtain information about prices, markets, weather, inputs and production technologies. Ali (2012) found that farmers who perceived farming as a business venture and those with diversified cropping systems were more likely to use ICT-based information. At the same time, small and marginal farmers may have substantial information needs but comparatively fewer economic resources to invest in digital technologies. The FAO literature emphasizes that small-scale farmers can face disadvantages related to infrastructure, affordability, skills and technology access (Trendov et al., 2019).

Table 1. Major Socioeconomic Characteristics Influencing ICT Adoption

Socioeconomic factor	Possible influence on ICT adoption
Age	Younger farmers may show greater familiarity with digital technologies, although older farmers can adopt ICTs when adequate training and support are available.
Education	Improves the ability to understand digital content, applications and agricultural information.
Income	Determines affordability of smartphones, internet data and digital services.
Landholding size	May influence the economic incentive to seek market, production and technological information.
Farming experience	Provides traditional knowledge but may influence willingness to experiment with new information sources.
Occupational diversification	Additional income sources can improve the ability to purchase and use ICT devices and services.
Extension contact	Encourages awareness and effective use of digital agricultural services.
Mass-media exposure	Increases familiarity with agricultural information and technology.
Social participation	Farmer groups and social networks can facilitate information sharing and technology learning.
Access to infrastructure	Connectivity, electricity and network availability are basic conditions for ICT use.

DIGITAL LITERACY AMONG FARMERS

Digital literacy refers to the ability to access, understand, evaluate, create and communicate information using digital technologies. In agriculture, digital literacy goes beyond the simple ability to operate a mobile phone. A digitally literate farmer should be able to search for relevant agricultural information, identify reliable sources, use digital applications, communicate through online platforms, interpret digital recommendations, protect personal information and apply useful information to farm decisions. Therefore, digital literacy represents an important link between technological availability and actual agricultural benefits.

The FAO's 2019 assessment of digital technologies in agriculture identified digital skills as an important enabling condition for digital transformation. The report also highlighted differences between rural and urban populations in digital skills and emphasized that affordability, connectivity, education and supportive policies are necessary for effective digital adoption (Trendov et al., 2019). In the Indian context, digital agriculture has considerable potential, but

continued investment in digital literacy and farmer training remains necessary. FAO's 2022 work on India similarly emphasized the need for capacity building because many farmers were not yet fully comfortable with digital technologies.

Digital literacy also influences the quality of information use. A farmer may possess a smartphone and internet connection but still have difficulty searching for trustworthy information, understanding technical agricultural terminology or using a particular application. Consequently, measuring ICT adoption only through ownership of devices may provide an incomplete picture. Effective digital participation requires both access and competence.

ICT ADOPTION IN AGRICULTURE

ICT adoption in agriculture includes the use of mobile phones, SMS, internet, social media, agricultural websites, mobile applications, digital extension platforms, online marketplaces, digital payment systems, GPS-enabled technologies, remote sensing and precision agriculture technologies. During the 2010–2022 period, mobile phones became particularly important because they provided a relatively accessible channel for farmers to communicate with extension personnel, traders, input suppliers and other farmers.

Ali and Kumar (2010) demonstrated the role of ICT-based information in agricultural decision-making, while Ali (2012) examined the determinants of ICT information adoption among Indian farmers. These studies suggest that adoption is not determined by technology alone; farmer characteristics and farming conditions are also relevant. Later literature expanded the focus from basic ICT access toward digital agriculture services, including digital advisory and extension systems. A systematic scoping review by Fabregas, Kremer and Schilbach (2019), together with subsequent reviews, indicates that digital agricultural services can improve access to information and knowledge, although the effects depend on the characteristics of the users and the design of the services.

By 2022, the literature had increasingly emphasized mobile technologies and digital agricultural services. A systematic review of mobile phone technology adoption among farmers identified substantial heterogeneity in adoption patterns and noted that the determinants of adoption were not uniform across contexts (Aparo et al., 2022). Similarly, a global scoping review of digital agriculture services found that a large proportion of studies focused on digital advisory and extension services and reported outcomes such as changes in farming practices and increased knowledge (Steinke et al., 2022).

Table 2. Common ICT Tools Used in Agriculture

ICT tool	Major agricultural uses
Mobile phone	Communication with extension workers, traders and other farmers
SMS	Weather, crop advisory, pest and disease alerts
Smartphone	Agricultural applications, internet, digital payments and market information
Internet	Search for agricultural information, government schemes and technical knowledge
Social media	Peer communication, farmer groups and information sharing
Mobile applications	Crop advisory, weather, market and farm-management services
Digital marketplaces	Price discovery and market linkage
Online extension	Remote advisory and training
GPS/GIS	Farm mapping and precision agriculture
Remote sensing	Crop monitoring and resource management
Digital financial services	Payments, credit and financial transactions

RELATIONSHIP BETWEEN SOCIOECONOMIC PROFILE AND ICT ADOPTION

The relationship between socioeconomic characteristics and ICT adoption has been documented in several studies. Education is consistently identified as an important factor because digitally mediated agricultural information requires a minimum level of comprehension and confidence. Income affects the ability to acquire digital devices and pay for

connectivity. Extension contact provides an additional pathway through which farmers become aware of ICT-based services. Mass-media exposure can similarly increase awareness of digital agricultural resources.

A study by Anand, Prakash and Singh (2022) in Bihar reported that occupational diversification, education, annual income, farming system or allied agricultural activities, mass-media exposure and extension contact were positively and significantly associated with accessibility to ICT tools. Their regression analysis indicated that the selected farmer characteristics explained a substantial proportion of variation in ICT accessibility. Chandra et al. (2022) also examined socioeconomic factors and ICT utilization among farmers in Uttar Pradesh and reported a strong relationship between selected socioeconomic variables and ICT utilization.

These findings demonstrate that ICT adoption should not be treated as an isolated technological phenomenon. Farmers with better educational opportunities, higher income, stronger institutional connections and greater exposure to information sources may have more opportunities to adopt digital tools. However, the relationship is not necessarily linear. Even farmers with access to technology may not use it effectively if applications are difficult to operate, information is not available in local languages, or farmers do not perceive sufficient benefits.

Table 3. Socioeconomic Factors and Expected Relationship with ICT Adoption

Factor	Relationship generally reported in literature	Explanation
Education	Positive	Improves comprehension and digital skills
Income	Positive	Improves affordability of devices and connectivity
Extension contact	Positive	Increases awareness and training opportunities
Mass-media exposure	Positive	Builds information-seeking behaviour
Occupational diversification	Positive	May increase financial capacity and information needs
Social participation	Generally positive	Facilitates peer learning and information exchange
Farm commercialization	Positive	Creates greater demand for market and production information
Age	Mixed	Digital familiarity may vary, but training can reduce age-related barriers
Farm size	Mixed/Context dependent	Larger commercial operations may have stronger incentives, but small farmers may also have high information needs
Gender	Context dependent	Differences may arise from access, social norms, income and digital opportunities

MAJOR BARRIERS TO DIGITAL LITERACY AND ICT ADOPTION

Despite the potential benefits of ICTs, farmers face several barriers. The first is inadequate digital infrastructure. Poor internet connectivity, weak mobile networks, electricity problems and limited availability of digital services can restrict use, particularly in remote rural areas. The second barrier is affordability. Even when smartphones are relatively widespread, recurring expenditure on data, device replacement and digital services can affect sustained usage.

The third major barrier is inadequate digital literacy. Farmers may know how to make calls or use basic messaging services but may not possess the skills required for online searches, agricultural applications, digital payments or verification of information. The fourth barrier is language and content relevance. Agricultural information is more useful when it is available in local languages and adapted to local crops, climatic conditions and farming practices. The fifth barrier is trust. Farmers may hesitate to act on information received from unfamiliar digital sources, especially when the information concerns costly decisions related to seeds, pesticides, fertilizers or markets.

The FAO (2019) identified affordability, connectivity, education, digital skills and supportive policies as important conditions for digital agricultural transformation. The literature also indicates that smallholder farmers may experience greater constraints because many digital agricultural solutions are developed around commercial or large-scale farming

models. Consequently, digital transformation can potentially reproduce existing socioeconomic inequalities unless accessibility and inclusion are deliberately incorporated into programme design.

ICTS AND AGRICULTURAL EXTENSION

ICTs should not necessarily replace conventional agricultural extension; rather, they can complement face-to-face extension. Extension workers can use mobile communication, digital platforms and social media to distribute timely information to large numbers of farmers. Farmers can also use digital platforms to ask questions, obtain recommendations and share field-level experiences. Digital extension is particularly useful when agricultural information needs to be delivered quickly, such as weather warnings, pest outbreaks, market-price changes and disease alerts.

The literature reviewed up to 2022 shows that digital advisory and extension services constitute one of the major areas of digital agriculture research. Steinke et al. (2022) found that many digital agriculture studies focused on advisory and extension services and reported outcomes related to increased knowledge and changes in agricultural practices. Nevertheless, digital extension effectiveness depends on the quality, credibility, timeliness and contextual relevance of information. Therefore, integration between digital systems and local extension institutions remains important.

II. CONCLUSION

The review of literature from 2010 to 2022 demonstrates that farmers' socioeconomic profiles, digital literacy and ICT adoption are closely interconnected dimensions of contemporary agricultural development. Education, income, occupational diversification, extension contact, mass-media exposure, social participation and farming characteristics can influence farmers' ability and willingness to access ICT-based agricultural information. At the same time, digital literacy determines whether farmers can move beyond simple device ownership toward meaningful use of digital services. ICTs provide important opportunities for improving agricultural information access, extension, market participation, financial inclusion and decision-making, but their benefits are constrained by connectivity problems, affordability, inadequate digital skills, language barriers, limited awareness and unequal access. The evidence therefore suggests that digital transformation in agriculture should be approached as a socioeconomic and institutional process rather than simply as a technological intervention. Policies and agricultural programmes should combine affordable connectivity with digital literacy training, locally relevant content, trusted extension support and farmer-oriented digital platforms. Particular attention should be given to small and resource-constrained farmers so that digital agriculture contributes to inclusive rural development rather than widening existing inequalities.

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