









ADOPTION OF MOBILE-BASED INFORMATION SYSTEM AMONG SUGARCANE FARMERS IN INDIA

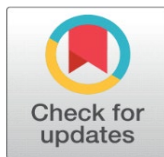
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ABSTRACT

Across the global South, smallholder farmers face problems accessing information that limits their ability to participate fully in rural development. Mobile-based information systems can act as a catalyst for the digital inclusion of farmers and can improve their social, economic, and informational capacities. The study applied the Socio-technical system theory to analyse the adoption of information systems among farmers for their digital inclusion. The study adopted a descriptive research design, and the multi-stage purposive sampling was used for collecting data from 320 smallholder farmers in the region. Result highlights that the socio-economic characteristics of farmers are correlated with the adoption of information systems among farmers. In addition, they face challenges such as affordability, digital literacy and trust in adopting the information system. Finally, the findings of study have significant implications for researchers studying the relationship between society and technology and for policymakers designing digital policies related to the digital inclusion of rural communities.

Keywords: Digital Inclusion, Smallholder Farmers, Digital Divide, Socio-Economic Impact, Sustainability, Information System, India



1. INTRODUCTION

In recent years, there has been a substantial increase in the spread of information systems across societies. According to the World Bank Group's Findex report (2025), approximately 4.88 billion people use smartphones globally,

which is 60.42% of the total population. In the Indian context, according to IAMAI and Kantar report (2025), India has over 900 million internet users, and 55% of the users are from rural areas. Information and communication technology has become easy to access and cost-effective, specifically in rural regions (Kusumaningsih, 2023). Information and communication technologies are acting as catalyst for improving the socio-economic status of smallholder farmers (Glendening and Ficarelli, 2012). The usage of information systems plays a significant role in providing information related to the market, pesticides, fertilisers, weather, etc. (Yamada and Gummert, 2015). Farmers can access information related to climate change impact that helps farmers to take decisions for their daily practices (Muriithi, Bett, and Ogaleh, 2009). Information systems empower farmers to overcome challenges such as inaccurate market information, measures to crop pest control, etc. Previous studies find that spending one hour on accessing online information tends to a 0.71% increase in agrarian productivity (Obayelu et al., 2023). Using mobile phones among farmers enhance the rural livelihoods (Mdoda and Mdiya, 2022).

In recent times, India has witnessed a substantial increase in mobile phone applications that aims to digital inclusion of smallholder farmers. However, as the previous studies suggested, despite having the potential of technology, this does not mean the automated adoption of technology by the rural community. Hence, the design and implementation of a pro-farmer information system (mobile phone apps) is essential to digitally empower the smallholder farmers. To do so, it is crucial to understand the usage of mobile apps among the smallholder sugarcane farmers. So far, no study has been conducted in India to understand the adoption of the information systems among the smallholder sugarcane farmers. The present study focuses on Indian smallholder farmers.

To analyse the impact of adoption of information systems on smallholder farmers, the study utilised a descriptive research design. A semi-structured questionnaire was used to collect the primary data from 320 sugarcane farmers in the sugarcane belt of Uttar Pradesh, India. The present study uses socio-technical systems theory as a theoretical lens to understand the adoption of information systems among smallholder sugarcane farmers. The study provides a significant contribution to existing literature on ICT and development by providing empirical insights into the adoption of information systems among smallholder farmers. Theoretically, it contributes by extending the application of the STS framework in the rural community. Practically, the study's findings provide directions to the government organisation and policy makers to consider the region's social structure before introducing any digital intervention. Additionally, the study also highlights the implications for future researchers, such as longitudinal studies to understand the evolving behaviours of farmers for adopting the information system and intersectional studies to understand the adoption of the information system among women and marginalised groups.

The subsequent research article is organised as follows: The next section come up with the theoretical underpinning of the study, Section 3 outlines details about the material and method applied for the study, the subsequent Section provides the data analysis and results of the study, and, Section 5 illustrates an in-depth discussion on the results. Section 6 states the theoretical and practical implications of the study, accompanied by limitations and future researchers of the study. Finally, section 7 presents the concluding remarks.

2. THEORETICAL FRAMEWORK

The present study applied the socio-technical system theory to analyse adoption of the of information among the smallholder farmers. The STS provides a extensive lens to understand how social and technical components interact in organisations and community settings to achieve sustainable outcomes. The theory emerged in the mid-20th century study the British coal mine. This framework illustrates the relationship between the two interconnected components: the social and technological subsystems (Bostrom et al., 2009). It emphasises that neither technology nor social component alone can decide the desired outcomes (Clegg, 2000). Various studies have used this framework to evaluate the relationship between the social and technical components among various disciplines from different dimensions. For instance, Meesala & Brunori (2025) demonstrate how supportive socio-technical networks can reinforce the agroecological practices using technology.

Although other theoretical frameworks could be applied to examine the adoption of information systems among smallholder farmers but STS theory provides a comprehensive lens for analysing the adoption of mobile- based information systems on farmers for their digital inclusion. Hence, the STS theory is suitable for analysing the relationship between the information system and digital inclusion of smallholder farmers, where digital inclusion not only depends on technology adoption but also on alignment between the information system, the tool used by farmers and their social

characteristics. By applying this framework, this study goes beyond just the measurement of technology usage; instead, it evaluates the underlying socio-technical factors that impact adoption of information systems among the farmers.

3. MATERIALS AND METHODS

3.1. STUDY AREA

The present study was conducted in the state of Uttar Pradesh, India, which is the sixth largest geographical region in India. Uttar Pradesh is India's most populous state (Moinuddin, 2017). Within the vast state, a region lies in Western Uttar Pradesh, often called the sugarcane belt of Uttar Pradesh. According to the Indian Sugar & Bio-energy Manufacturers Association (ISMA), this region contributes nearly 17% of India's sugar production. Therefore, this region is also known as the Sugar Bowl of India. The maximum number of people in this region is engaged in agricultural activities. They produced multiple crops, but sugarcane is the region's leading crop. According to the 2011 census, the region's literacy rate is 65-69%. A considerable proportion of the region's farmers are expected to be literate and can also use smartphones and the internet for agricultural-related activities.

3.2. SAMPLING PROCEDURE

The study was conducted among smallholder farmers who use mobile phones. A multistage purposive sampling technique was used to select the research participants. In the first step, the sugarcane belt of Uttar Pradesh is selected based on its literacy level. Afterwards, the top four districts (Meerut, Saharanpur, Bijnor, and Muzaffarnagar) were selected. The second stage includes the purposive selection of 2 Blocks from each district. In the final stage, two villages were selected from each block, and in total, 16 villages were chosen. The participants were randomly selected from these villages.

The study's sample size was decided using optimal design sample size determination software; 320 participants were selected for data collection. In all, 256 (80%) participants were chosen who use mobile phones and 64 (20%) were chosen who do not use mobile phones. Since categorising data is crucial to evaluating the impact of adoption of information systems for digital inclusion of smallholder farmers, it provides a comprehensive lens to compare the impact of usage and non-usage of mobile phones.

3.3. DATA COLLECTION

The present study uses a descriptive research design for data collection. The study's main aim is to analyse the adoption of information systems among smallholder farmers for their digital inclusion. This research design helps find an association between the usage of mobile phones applications and digital inclusion of farmers. For this, we adapted a semi-structured questionnaire from Mdoda et. al (2023). The research tool was previously used to analyse the impact of the information system in Eastern Cape Province, South Africa. The findings of the study have shown that the socio-economic factors are interrelated with the adoption of mobile phone (Mdoda et. Al., 2023).

The data was collected between 10th May 2025 and 25th July 2025 using a semi-structured questionnaire through face-to-face interviews. The reliability and validity of questionnaire was tested by conducted a pilot study. The information gathered through the research tool collected data on such as the demographic data, socio-economic conditions of the smallholder farmers, access to information system, usage of mobile phone apps (YouTube, Facebook, agricultural related apps) for agricultural purpose such as tracking the sugarcane supply tickets and payment, pest control measures, selection of variety of seeds and forming farmer groups for sharing the information and problems faced by farmers such as the affordability of mobile phone, operational difficulty, trust issue etc. in accessing and using the information system for agricultural information.

3.4. DATA ANALYSIS

For the data analysis, we used SPSS 26.0 for descriptive statistical analysis, including frequencies, percentages, distribution, and emerging trends from the collected data. Subsequently, we applied logistic regression analysis to find the factors that impact the usage of mobile phone applications among smallholder farmers.

The study used the logistic regression to measure the impact of adoption the Information system on smallholder farmers in Uttar Pradesh, India. This model represents the relation between the independent variable and the dichotomic dependent variable (G Tripepi et al., 2008). In addition, Chauke et al. (2013) state that logistic regression is used to measure the probable relations for all of the independent variables used in the study.

Moreover, explanatory variables differ in the extent of level of impact on the information system used by sugarcane farmers. The comparative impact of a given explanatory quantitative variable on adopting the information system for farmers productivity is measured by examining the adoption elasticity (Mdoda et al., 2023). Therefore, the logistics regression model is the most suited because other regression models do not provide such an in-depth analysis of the situation. The variables were tested for multicollinearity, which was assumed to impact the usage of the information system for farmers' productivity.

In the context of our study, the participants are categorised into two categories: those not using mobile phones and those using mobile phones. Thus, the regression analysis consists two different substitutes. The study applies a binomial logistic model, 1 when farmers make use of the mobile phone; 0 when farmers do not use the mobile phone

Additionally, in the present study, two categories are used: non-use of mobile phones and usage of mobile phones. The binary logit regression demonstrates $Y=1$ to demonstrate the usage of a mobile phone, and $Y=0$ for demonstrating the non-usage of a mobile phone. As assert by Wooldridge (2009), the presupposition that X is indicate as a pathway for persuasive characteristics (Wooldridge ,2009), while p is the probability that $Y=1$, this binary probability relationship can be measured in mathematical operations as follows:

$$P(Y=1) = \frac{\exp\beta X}{1+\exp\beta X} \quad (1)$$

$$P(Y = 0) = 1 - \frac{\exp\beta X}{1+\exp\beta X} = \frac{\exp\beta X}{1+\exp\beta X} \quad (2)$$

Here, equation no. 2 is the weaker response level, which indicate the probability that farmers use mobile phones. This possibility is estimated by employing the logistic regression analysis. Hence, the computation calculus demonstrates the logistic alteration results with the probability ratio, as explained below:

$$[\theta(x)] = \log = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \dots \beta_n X_n \quad (3)$$

The following are the descriptions of the above characters used in mathematical representation:

$$\log \text{it} [\theta(x)] = \log \frac{\theta(x)}{1-\theta(x)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \dots \beta_n X_n \quad (4)$$

The following are the description of above characters used in mathematical representation:

θ =logistic change of the probability ratio=the intercept span of model;

β = explanatory variables;

X_i = predictor variables.

The preceding operations were feasible within the SPSS. In relation to Equation (3), the analysis used the maximum probability estimation method to obtain the odds ratios.

Accordingly, the logistic regression analysis applied in this study stated as below:

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \dots \dots \dots U_n \quad (5)$$

Here, the characteristic used of used mathematical symbols as follows:

Y_1 is the dependent on variable distinct as the usage of mobile phones by farmer = 1 and 0 for otherwise

α = constant

β = slope of expandatory variables

U_n = correction error term.

Table 1

Table 1 Description of Variables			
Code	Variables	Description	Type
Y	<i>Uses a mobile phone for agricultural information</i>	1 = uses a mobile phone to obtain agricultural information, 0 = Otherwise	Binary (dummy)
X_1	<i>Gender</i>	1 = Male, 0 = Otherwise	Binary (dummy)
X_2	<i>Age</i>	Respondent's age in completed years	Continuous (scale)
X_3	<i>Years spent in school</i>	Formal education in years completed	Continuous (scale)
X_4	<i>Family size</i>	Number of household members (persons)	Continuous (scale)
X_5	<i>Farming experience</i>	Years engaged in farming (years)	Continuous (scale)
X_6	<i>Monthly household income</i>	Total household income per month (₹)	Continuous (scale)
X_7	<i>Member of farm organisation</i>	1 = Yes (member of farm organisation), 0 = No (Otherwise)	Binary (dummy)
X_8	<i>Access to rural credit</i>	1 = Yes (access to rural credit), 0 = No (Otherwise)	Binary (dummy)
X_9	<i>Farming as the main income source</i>	1 = Yes (main income source), 0 = No (Otherwise)	Binary (dummy)
X_{10}	<i>Knowledge of information systems</i>	1 = Yes (can use mobile phone for daily use purposes), 0 = No (Otherwise)	Binary (dummy)

4. RESULTS

4.1. SOCIO-ECONOMIC STATUS OF SMALLHOLDER FARMERS

This section provides a comprehensive summary of the socio-economic profile of smallholder farmers who use mobile phones. The findings highlight that the majority (80%) of the studied farmers are using information system for one or another agricultural-related activity. These findings align with those of Tambo et al. (2019), who found that ownership and access to mobiles are important developing a rural region (Tambo et al., 2019). The majority (92%) of the smallholder farmers were male, while the rest (8%) were female farmers. The findings are consistent with Chikaire et al. (2017) and Onyeneke et al. (2022) that farming is male-dominated because of land ownership and head of the family. The farmers engaged in sugarcane farming are the majority of the mature age group (35-60). These findings align with Jabri (2011) and Sikundla et al. (2018), who state that farming is mainly practised by the elderly, which has a substantial effect on the sustainability of agriculture (Sikundla et al., 2018). Moreover, the majority of farmers are married, with having an average household size of 4 persons. This is consistent with Nwafor et al. (2020), who found that married farmers were very important, which assists in decreasing the need to hire labour for field-related activities (Nwafor et al., 2020).

Additionally, Smallholder sugarcane farmers in the region are literate and majority of them spend the 6th -12th in schools (primary and secondary education), these inputs aligned with Mdoda and Obi (2019), Onyeneke et al. (2022), and Luqman et al. (2019), that literate farmers can easily understand and adopt the information systems for their daily agrarian activities.

4.2. USAGE OF MOBILE PHONE APPS AMONG SMALLHOLDER SUGARCANE FARMERS

The findings indicate that YouTube emerged as the dominant mobile phone app among farmers for agricultural-related activities. 62% of the participants found it to be a primary source for accessing agricultural-related information, as shown in Table 2. The platform's popularity can be analysed as the ease of using the app, which provides audio-video content in the local language, so they can easily understand the application of information. The findings are consistent with earlier studies that state the usefulness of video-based learning in agriculture (Razaque, 2013; Masuka, et al., 2016).

Moreover, besides YouTube, one-fifth of the farmers' mobile users also use WhatsApp to share and gather information about agricultural activities. WhatsApp acts as a communication channel for farmers. In contrast, only 12%

of the participants' mobile phone applications related to agriculture, such as e-Nam, e-Ganna app, Krishify, Agrostar, etc. At the same time, these applications provide information related to market price, weather conditions, use of pesticides, etc. Farmers also use the Facebook platform, but its usage is minimal.

Table 2

Table 2 Extent to which farmers use mobile phone apps to access agrarian information		
Categories	Frequency	Percentage (%)
YouTube	160	62
WhatsApp	50	20
Agricultural Apps	30	12
Facebook	16	6

Agricultural apps include mKisan, e-NAM, e-Ganna etc. Note: single response-each user reports the one main app they use; percentages are over N=256.

Source: Field Survey, 2025

4.3. FREQUENCY OF INFORMATION SYSTEMS USED BY SMALLHOLDER FARMERS

Besides the preference for using mobile apps to disseminate agricultural information, the frequency of use provides further understanding of the study. As shown in Table 3, about 60% of farmers use mobile apps daily for information related to agriculture. Additionally, 25% of farmers use these apps one to three times a week, while 11% of participants use them weekly. Only 5 % of users use two to three times a month. These findings are aligned with previous literature that show some farmers regularly use information and communication technologies, while some use them occasionally; it varies according to information need and literacy level (Caine et al., 2015; Andika et al., 2025).

Table 3

Table 3 Frequency of information systems usage among farmers		
Categories	Frequency	(%)
Daily	152	59
1-3 times a week	64	25
Weekly	28	11
2-3 times a Month	11	5

4.4. MAIN PURPOSE OF INFORMATION SYSTEMS USAGE AMONG SMALLHOLDER FARMERS

As shown in Table 4, they often rely on mobile phone applications for various agricultural Purposes for many types of support. The most common purpose (71%) for using mobile apps is to check weather forecast services. The findings show the importance of weather-related information for supporting the sugarcane crop due to the unpredictability of the weather. Along with weather forecasting, 68% of the farmers use mobile apps to track sugarcane supply tickets and payment from sugar mills. The data highlights the importance of digital technologies in the sugarcane value chain and establish transparency and accountability in the sugarcane supply chain.

Moreover, 63% of the farmers use these apps for pest control and fertiliser recommendations, ranked third for usage. Other than this, 50% of the farmers use mobile apps for livestock management, which highlights the role of digital technologies in their everyday activities. The information system is least used for farmer group coordination (37%), digital payments and online purchase (32%), and expert consultation (25%), while far fewer farmers used photo-based diagnosis and record-keeping (10%). Similar findings were also observed from previous studies (Mdoda, et al., 2023; Shanthi et al., 2016).

Table 4

Table 4 Purposes for which mobile phones are used in farming			
Purposes	Frequency	Percentage (%)	Rank
Weather forecasts	182	71	1
Tracking cane- supply tickets and payment of sugarcane	174	68	2
Fertilizer and pest control recommendations	162	63	3

Crop & livestock management	128	50	4
Seed/variety selection & availability information	102	40	5
Farmer group coordination	95	37	6
Digital payments & input purchases (UPI/online orders)	82	32	7
Extension/KVK advisories & expert consultation	64	25	8
Photo-based diagnosis & simple record-keeping	26	10	9

Multiple response; percentages are calculated on mobile-phone users only (N = 256), so column totals need not sum to 100.

4.5. ADVANTAGES OF USING INFORMATION SYSTEM FOR SMALLHOLDER FARMERS

In today's era, there is a substantial increase in demand for agrarian sustainability due to increased urbanisation and population growth, which traditional farming methods may not provide (Hemathilake et al., 2022). Hence Information and communication technology is playing a crucial role in agrarian sustainability, which will help achieve the Sustainable Development Goals, specifically the 1st and 2nd (Jones et al., 2017).

Table 5 shows the advantages of smallholder farmers using information system for agricultural-related activities. 73% of the farmers take advantage of mobile apps for optimised fertiliser and pesticide use. The findings indicate that the information system helps farmers to make precise and cost-effective decisions related to their crops. Similarly, 68% of the farmers availed the benefits of tracking cane-supply tickets and payments, which enhance transparency and efficiency in the sugarcane value chain.

Additionally, more than half of the participants learn about the high-yielding variety seeds, and half admitted that the information system improved their crops and livestock practices. Similarly, nearly half of the mobile app users acknowledge that access to general agriculture news benefits them in their day-to-day activities. The farmers also get other benefits, such as reducing transaction costs through digital payments and online services (39%) and access to agricultural extension- expert advice via KVKs (35%).

Table 5

Table 5 Benefits experienced from using mobile phones		
Benefits	Frequency	Percentage (%)
Optimized fertilizer/pesticide use	186	73
Payment Status and cane- supply ticket tracking	174	68
Access to HYV/region-fit varieties	143	56
Improved crop/livestock practices	128	50
General agricultural news	118	46
Reduced time/transaction costs (UPI/online)	101	39
Faster expert help (KVK)	90	35

Note: (multiple response; users only, N = 256)

4.6. CHALLENGES FACED BY FARMERS IN USING MOBILE PHONE APPLICATION

Along with benefits, farmers also face significant challenges in using the mobile phone application, as shown in Table 6. The most common problem was the affordability of the mobile phone and internet data; 62% of participants reported affordability as a significant challenge. The findings of study are aligned with the previous literature, which state that the affordability of digital devices and data plans remains a global challenge in rural digitalisation (OECD, 2021).

The second major challenge emerged as difficulty using mobile phone applications for agricultural purposes. Similar problems have also been noted in previous studies across Asia and Africa, where digital literacy remains a significant constraint for the adoption of information and communication technology (Ilavarasan and Kar, 2022).

Additionally, a significant number of sugarcane farmers are afraid of misinformation, and they have low trust in the information system. The findings indicate that usage of information systems is not only associated with the availability and affordability of mobile phones, but trust in information systems is a primary concern due to scams associated with online systems (Addo et al., 2022). Moreover, about one-fourth of the farmers also face the constraint of the costs of

maintenance of mobile phones, which shows that farmers also face financial constraints in sustaining the usage of information system in rural areas.

Table 6

Table 6 Challenges faced by smallholder sugarcane farmers in adopting the information systems			
Problems	Frequency	(%)	Rank
Affordability of smartphone and internet data	158	62	1
Difficulty in using mobile phone	136	53	2
Misinformation / low trust in online information	95	37	3
Privacy / scam concerns	89	35	4
Repair/maintenance cost	72	28	5

Note: Multiple response; percentages are based on users (N=256) and do not sum to 100

4.7. ECONOMETRIC ESTIMATION TO IDENTIFY THE FACTORS THAT IMPACT THE USAGE OF INFORMATION SYSTEM

The present study applies the logit regression model to test the factors that impact the usage of information systems by smallholder sugarcane farmers in the sugarcane belt of Uttar Pradesh, India. Table 7 represents the result of logistic regression analysis that presents the logit model's acceptable goodness of fit. The R², which is 68% indicate that the reliant variable used in the model explains the variation and probability of adopting the information system among smallholder farmers. The likelihood ratio (138.569) and p-value (0.000) indicate that this model fits well. This table shows that the estimates of eight explanatory variables are statistically significant at the 10% or below: Age, Years spent in school, Family size, Farming experience, Monthly household income, Member of farm organisation, Access to rural credit, Knowledge of information system for daily use purpose. The sign of the coefficients and the marginal effect show the influence of the explanatory variable on the probability of using the information system.

As per the findings, there is a negative correlation between the age of the farmers and the usage of information system for agrarian purposes. The farmers' age is statistically significant at 5% level. Previous studies also find similar results; older farmers face difficulty in using these digital tools due to low literacy level (Asif et al., 2017; Mdoda et al., 2023). This highlight that farmers of this age are 14% less likely to adopt mobile phone apps for information related to agriculture. Additionally, there is a positive correlation between the years spent in school and the adoption of information systems, which is also statistically significant at 1% level. The results are aligned with previous studies that state that more educated farmers have a higher chance of adopting the information system (Giua et al., 2021; Michels et al., 2020).

Moreover, the positive correlation between family size and the usage of information systems, which is statistically significant at a 1% level, indicates that the greater the family size, the greater the number of information systems users for agricultural purposes. The negative sign of correlation between the farming experience and the adoption of information systems, which is statistically significant at 5%, highlights that the higher the experience in farming, the less likely it is to adopt the information system for agricultural purposes. The findings are aligned with the previous study, which found that farmers' experience influences their decision to adopt the information system in Nigeria (Akinola, 2017).

The positive and significant (1%) sign of estimates of the variable Monthly household income indicates that the higher the monthly household income of the farmers, the greater the chance of adopting the information system. In other words, it implies that households with greater monthly income are 20% more likely to adopt the information system. It can be assumed that a family with more household income can spend more on non-food items and enhance their farm productivity. The Variable Member of farm organisation shows a positive and statistically significant sign of estimates, indicating that farmers who are members of the farm organisation are 22% more likely to adopt the information system for agricultural purposes. The findings aligned with other studies (Barnes et al., 2019; Shang et al., 2021).

Moreover, the positive correlation between the Access to rural credit and the adoption of information systems, which is statistically significant at 5% level, shows that farmers who have access to credit are more likely to use the information systems. In the end, variable knowledge of information system for daily use purposes is positively correlated with the adoption of information systems. This indicates that farmers who are familiar with mobile phone applications

for agrarian purposes are more likely to adopt information systems. In summary, the socio-economic profile of farmers, such as age, income, and farm size, impact the usage of the information system for agricultural activities. The findings highlight that the socio-economic status of farmers is correlated with the adoption of information systems in agrarian community.

Table 7

Table 7 Determinants influencing the usage of information systems			
Variables	Coefficient	Std. error	dy/dx
Constant	-1.950	0.673	—
Age	-0.267**	0.586	-0.143
Years spent in school	0.778***	0.023	0.177
Family size	0.681***	0.068	0.15
Farming experience	-0.163**	0.545	-0.200
Monthly household income	0.115***	0.383	0.205
Member of farm organisation	0.275**	0.145	0.224
Access to rural credit	0.248**	0.425	0.212
Knowledge of information system for	0.805***	0.791	0.19

Note: Statistically significant at *** at 1% level; ** at 5% level; 10% level.

5. DISCUSSION

The findings of data analysis are presented in Tables 2 to 7. The study uses socio-technical system theory to study the impact of adopting an information system. The present study examines the extent to which smallholder farmers are using mobile phone applications, what factors impact the adoption of information system, and what benefits they are getting by using these apps for agricultural purposes. Subsequently, what are the challenges they face in adopting the information system in agrarian community.

The results indicate that mobile phone applications have been found to play a crucial role in supporting the smallholder farmers. The findings of the study highlight that the farmers prefer to use platforms such as YouTube and WhatsApp over the specified agricultural apps. This shows that the effectiveness of using the information system depends on how well the information system fits with the social conditions of farmers. Technology alone cannot provide the desired results unless it fits with the social conditions of the users (Bostrom et al., 2009 and Clegg, 2000). Farmers are inclined toward those platforms that are socially embodied and easy to operate. For example, they prefer to use YouTube because of the audiovisual feature of the app, which helps them understand the content with low literacy levels. Previous studies also find a similar pattern, where farmers preferred to use familiar and easy-to-operate digital platforms. (Kolapo and Didunyemi, 2024). The results emphasise including the social subsystem while designing the technology for a specific target group (rural population).

Furthermore, the logistic regression analysis results provide a deeper understanding by showing that socio-economic characteristics such as farmers' income, education, family size, farmers' organisational membership, and access to credit significantly impact the likelihood of adopting the information system for daily use purposes. The findings show that the availability of digital technology does not solely shape the usage of digital technology, but social and economic factors also shape the adoption and usage of information systems. Farmers with high income and better education are more likely to use the information system for agrarian productivity. In contrast, elder people were less likely to adopt the information system; this might be due to low literacy level and a generational gap. Previous studies also find that the socio-economic conditions of the farmers impact the adoption and usage information system for agrarian purpose (Mdoda et al., 2023 and Landmann et al., 2021).

Additionally, sugarcane farmers reported the advantages of using mobile phone apps in deciding which fertiliser and pesticide they should use; they also learned about the timely supply of sugarcane tickets and the payment status. The findings show that information systems have contributed to informational capacities of the farmers. However, the benefits do not arise mainly from adopting the information system; it also rely on how the design of the information system is embedded in the region's social structure. For instance, the majority of mobile app farmers use weather forecasting services because they believe in the accuracy of the information. Similar results were also found in previous

studies. Ahmadi et al. (2025) found that digital technologies helped in knowledge transfer most when the technology was embedded in the social and institutional structure of the region (Ahmadi et al., 2025).

Despite the benefits, the sugarcane farmers also face several challenges, such as the affordability of mobile phones and internet data, operational difficulty, lack of trust in information system and the cost of repairing mobile phones. Previous studies also identified the challenges in the adoption of digital technology, such as economic constraints, lack of digital technical knowledge, trust, and lack of digital infrastructure (Dibbern et al., 2024 & Haider. Sundin 2025). Therefore, the result highlights that the challenges faced by farmers are not mainly associated with the availability of technology, but they are associated with the social structure- income inequalities, low digital literacy, etc.

The findings from the study demonstrate that digitalisation of agricultural practices is not solely a technical process but more of a socio-technical phenomenon. Information and communication technologies succeed when they connect with the social and institutional structures of rural areas.

Finally, the findings are significant within the global debates for achieving the Sustainable Development Goals (SDGs) through digitalisation, However, the present study demonstrates that digital inclusion cannot be assumed. Inclusion of smallholder farmers in the digital ecosystem requires diminishing income inequalities, gender inequalities, and skills inequalities..

6. IMPLICATIONS OF THE STUDY

The present study significantly enhances our understanding of adoption of information systems among smallholder farmers for their digital inclusion

However, the existing literature on adopting digital technology for agriculture is limited to analyse the impact of hardware technology on agricultural productivity. Limited studies considered the social aspect of ICT for agrarian productivity. By applying the socio-technical system framework, we provide a new dimension to understand how considering the social and technical aspects is crucial for successfully implementing information and communication technologies for rural digital inclusion. The study's findings have substantial implications for researchers studying the relationship between society and technology and for practitioners designing digital policies for achieving the Sustainable Development Goals.

6.1. THEORETICAL IMPLICATIONS OF THE STUDY

The present study provides several significant contributions to the academic literature on ICT and sustainable development, this case provides a extensive understanding of the relation between the social and technological components. It demonstrates that social structure of the region shapes the adoption of technology in particular region. The study makes an important contribution by expanding the socio-technical system theory and applying it to understanding the adoption of information system among smallholder farmers. The findings confirm the principles of the STS theory by showing that farmers are more likely to use information system apps when aligned with their social structure. The study contributes to the extension of STS theory to the agrarian community. It demonstrates that the success of the adoption of digital technologies depends on the socio-economic conditions of the region.

6.2. PRACTICAL IMPLICATIONS

The present study provides valuable insights for policymakers, organisations, and technology developers committed to achieve digital inclusion in rural areas. The findings suggest that the interventions should not be solely focused on introducing the digital platforms but also on creating the favourable socio-economic conditions that help in making these digital platforms accessible and valuable. In addition, the governments and policy makers should focus on bridging the digital divide by providing hands on session to the farmers. Finally, the technology developers should also consider the social structure before designing the technology for a specific target group, for their better inclusion in digital spaces.

6.3. LIMITATIONS AND FUTURE RESEARCH SUGGESTIONS

The present case has several limitations. Firstly, it uses the cross-sectional data, which analyses farmers' behaviours at a single time. Longitudinal studies could provide insights into how smallholder farmers' mobile phone usage patterns

emerged over time. Secondly, the study focused on sugarcane farmers only, which limits its generalisability to other crops. Future researchers can focus on a comparative study of different crops within different geographical regions. Third, the present study used the socio-technical systems (STS) theoretical lens to understand the relation between the social and technical subsystems. The study did not consider the role of women in shaping the usage of the information system. Future researchers can apply an intersectional approach to analyse how gender and social identity interact with information and communication technologies in rural areas, specifically in the farmer community. Finally, by following these directions, future work can build on this study to provide a comprehensive understanding of how socio-technical systems shape the role of digital technologies in improving the livelihood of agrarian community by their digital inclusion.

7. CONCLUSION

In recent years, international organisations and governments worldwide have been focusing on adopting information and communication technologies to promote sustainable development. ICTs have the potential to reduce inequalities and empower marginalised groups. The present study analysed the impact of adopting an information system on smallholder farmers by applying the STS theoretical lens. The findings show that both social and technical subsystems shape the adoption of information systems. The socio-economic conditions of the farmers play a substantial role in adopting the information system.

The study emphasizes the need for governments and practitioners to promote the adoption of ICTs among smallholder farmers through measures such as providing subsidies on internet data and programmes for improving digital literacy. The study also provides the future research agenda for researchers that includes: (a) longitudinal analysis to understand the adoption of ICTs over a period of time, (b) intersectional analysis to understand how gender and social identity interact with digital technologies, specifically in rural contexts, and (c) comparative analysis of different geographical regions. The study's findings indicate the need for interdisciplinary research to achieve the sustainable digital inclusion of marginalised groups and achieve sustainable development goals.

CONFLICT OF INTERESTS

None.

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