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Agro-Based Mobile Apps Adoption among Bangladeshi Farmers at the 'Hamlet' of Bangladesh – A Case Study of Chandpura Village of Barisal

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ABSTRACT

Farmers in Bangladesh are gradually adopting and using ICT-based agricultural applications. This study attempted to identify the factors influencing the use of agro-based mobile applications by farmers in Chandpura village of Barisal district. The study examined farmers' access to ICT in terms of smartphone ownership, internet access, their ICT use behaviour for agriculture, and their knowledge and use of agro-based mobile applications. The research was conducted following the principles of qualitative methods in case studies. For data collection and analysis, in-depth interviews, semi-structured questionnaires, and narrative data analysis were utilised. The results showed that farmers were primarily influenced by personal factors such as need, age, education, and satisfaction. The youth were more receptive to innovations because they were more educated and adaptable. In addition, technological factors, such as access to a device and the internet, digital knowledge, ease of use, and a support network, played a significant role in this regard. While the study helped us understand the significance of ICT technology for the continued development of the agricultural sector, market and weather information were neglected in agro apps for small villages where disease, market, and weather information took precedence. Before implementing any technology, it is crucial to conduct research on the population and their specific needs. The implication is that the study helped us comprehend the significance of ICT technology for the advancement of the agriculture sector, even in small villages, and how implementing an ICT-based "agricultural advisory service" supported and benefited farmers.

Keywords: *Agro-based mobile apps, farmers, agriculture, information and communication technology (ICT), smartphone and internet.*

INTRODUCTION

Agriculture is the main source of livelihood for most of the rural population in Bangladesh (Hossain & Paul, 2019). It is the largest employment sector in Bangladesh. As of 2018, the sector employed 45.33% of the total labour force (Byron, 2023) and comprised 12.46% (Manik, 2023) of the country's GDP. For 164 million people, the country's cultivated land is 22.3 million acres, which is 69 per cent of the total land area (Xu et al., 2020). This limited cultivable land fails to produce adequate crops for the huge population. In addition, loss of arable land, population growth, climate change, lack of proper management, scarcity of quality seeds, insufficient credit support for farmers, and unfair pricing of produce have largely contributed to the decline of agricultural productivity (Rezvi, 2018).

The government, local non-government organisations, and international development organisations have been working for a long time to reduce such barriers. Scientists are researching better crops, while the government is offering loans at low-interest rates. Also, foreign and upgraded technologies are being used in agriculture. Alongside this, different government and non-government bodies are training farmers (Miah et al., 2020). Among those, mobile apps are one of the remarkable initiatives that are being implemented for the advancement of agriculture. The government, with its concept and philosophy of "Digital Bangladesh," implies the broad use of computers and the effective and useful use of technology in terms of implementing the promises in education, health, job placement, and poverty reduction (Biswas & Roy, 2020; Chowhan & Ghosh, 2020; Huq et al., 2017).

The main goal is for Bangladesh to become a middle-income country where poverty will be completely eradicated (Karim & Nessa, 2022; Kisinger & Matsui, 2021) The government initiated a programme named "Access to Information in Bangladesh, or a2i, which is supported by UNDP and USAID and operated from the Prime Minister's Office. Through the initiative, the government has established around 5,000 Union Digital Centres, which act like one-stop service centres for rural people. They are getting different types of services from these centres, such as support with birth and death registrations, mobile banking, employment information, computer training, video conferencing, online university examinations, getting public exam results, etc.

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(Biswas & Roy, 2020). With a vision to build an ICT-based society by 2021, The National ICT Policy 2009 (Ministry of Post Telecom and ICT, Govt. of Bangladesh) identifies agriculture as a thriving sector. ICT-enabled services can be applied and utilised in the sector to increase productivity, facilitate market linkages, develop farmers' databases, establish agriculture information centres, and address climate change issues, among others (Chowhan & Ghosh, 2020; Khan Tithi et al., 2021). The policy also emphasises the need for e-agriculture. The National Agriculture Extension Policy 2015 identified ICT as an enabler for the development of the agricultural sector and specified scopes of integration of ICT at various levels (Billah et al., 2021; Biswas & Roy, 2020).

With the emergence and rapid spread of mobile technology and connectivity even in rural areas, both the Bangladesh government and non-government organisations (NGOs) have come forward with mobile-based applications providing advice and suggestions to help farmers with cultivation, pest controls, weather forecasts, and other related issues (Das et al., 2017). Due to the massive number of farm families and the shortage of adequate manpower, many farmers who want help are, in a way forced to seek assistance from people who are not experts. This results in farmers either being misguided or exploited and eventually losing faith in technology (Biswas et al., 2021; Huq et al., 2017). To address the problem, the government and NGOs are aiding farmers. In January 2017, the flagship Aspire to Innovate (a2i) programme of the Prime Minister's Office and the Department of Agricultural Extension (DAE) under the Ministry of Agriculture of Bangladesh launched three agriculture extension mobile apps: Krishoker Digital Thikana [Digital Address of Farmers], Krishoker Janala [Farmers' Window], and Pesticide Prescriber (Correspondent, 2017; Rahab, 2021). The spread of mobile apps and making farmers rely on technology to get timely help to boost their production could be a remarkable achievement for the government in accomplishing its goal of establishing a digital Bangladesh (Ahmed et al., 2015; Kashem et al., 2013). It is important to understand what areas of personal, socio-demographic, technological, and economic interaction influence farmers to adopt or not to adopt mobile apps in their agricultural production. A farmer tends to place little or no value on new production methods or techniques that do not fall in line with their previous experiences (Rashid et al., 2016; Shams et al., 2021). This study intends to explore the farmers' usage of an ICT-based mobile app, "Farmer Query System (FQS)," for their production in the village named "Chandpura" of the Barisal Sadar Upazila of Barisal district of Bangladesh (Bangladesh National Portal, 2023). The study analysed whether the farmers are ready to adopt and use ICT-based mobile apps in their agricultural productions from the farmers' perspective.

BACKGROUND

The study area is Chandpura which is one of the villages in Barisal Sadar Upazila of Bangladesh with a population of around 2500. Agriculture is the main livelihood with mainly cultivating paddy, mung bean and vegetables. There are around 5000 acres of arable land in the village Bangladesh National Portal, 2023). The farmers use e-agriculture services, especially agro-based mobile apps – the "Farmer Query System (FQS)". FQS app was first introduced among the farmers in 2014, through a USAID funded project named USAID Agricultural Extension Support Activity (AESA/Ag-extension Project), on a limited scale (Ahsan & Sadek, 2015; Rabbani, 2020). During the study period around 25 farmers were using the app and among them, 16 farmers were the respondents of this study. All the respondents were male farmers. A detailed profile of the village is provided in Table 1.

Table 1: Profile of Chandpura Village

Total Population	2500 = Male: 900 + Female: 1200 + Youth: 400
Literacy Rate	45%
Educational Institutions	School: 2, College: 1, University: 0
Language	Bengali
Religion	Muslim: 2200, Hindu: 300
Major profession	Farmers: 400, Public- Private Job: 300, Business: 200
Total farmers	Subsistence Farmers: 150, Commercial Farmers: 250
Major Crops Cultivate	Paddy, Mung Bean, Chili, Vegetables
Electricity	Yes
Access to Smart phone	300 Farmers
Access to Internet	300 Farmers (Farmers can access internet from Union Digital Centre of Chandpura)
Agricultural Land	5000 Acre
Measurement of Land	Acre, Bigha
Weather	Tropical wet and dry

LITERATURE REVIEW

In recent years, information and communication technology has become one of the primary tools to be used by farmers for controlling key production factors such as land, labour, capital, or soil (Daum, 2019; Daum et al., 2022). Therefore, several studies have been done on the use of ICT-based services, more specifically mobile phone grounded technology in agriculture and how it is impacting farmers worldwide (Ahmed et al., 2015; Ayim et al., 2022; Gavai et al., 2018; Hanson & Heeks, 2020). Farmers need a variety of ICT service for pest control, post harvesting, irrigation, water management, marketing, and weather forecasting (Gavai et al., 2018).

In order to determine whether to adopt or try a farming innovation, one must have the information and rational skills to comprehend the innovation's added values (Abdullahi et al., 2021; Olum et al., 2020; Thar et al., 2021). Such knowledge has a positive impact on farmers' decisions to adopt mobile phone technology (Krell et al., 2021; Ma et al., 2020). While basic phone activities like voice call can be performed by someone with little to no education, operating smartphones with numerous features require a better level of education.

Besides education, key aspects influencing farmers' adoption of mobile phone applications included age, gender, perceived cost, perceived cost-benefit, performance and effort expectations, attitude, skills, and knowledge. In developing nations, major hurdles preventing farmers from adopting mobile phone technology include price of phone, poor infrastructure, and high cost of airtime, complexity of phone operation language barriers. The influence of mobile phone ownership and adaptation on farmers' use of agro-based mobile apps or services varies from country to country. Kenya is at the forefront of ICT use and mobile phone ownership compared to other countries in the region. Therefore they do not have much concern regarding use of mobile application for climate and agriculture information (Anh et al., 2019).

Meanwhile using foreign languages in a local context runs the risk of being misinterpreted and misapplied (Misaki et al., 2018; Zvobgo et al., 2023). Therefore, mobile phone companies and related bodies must give ethical and linguistic considerations a high priority in the initial design stage. To promote the acceptance and scalability of mobile phone usage in agriculture, Misaki et al. (2018) recommend including local languages pertinent to the cultural setting in the mobile phone technology design process.

Inadequate internet access and digital literacy are the major obstructions to the use of agricultural apps (Thar et al., 2021). To use mobile applications without hurdles, farmers must have strong network coverage, which will ensure a stable internet connection (Ahmed et al., 2015; Michels et al., 2020). The foremost factors affecting acceptance when it comes to agricultural apps are still the basic ones, including efficacy and usability (Schulz et al., 2022).

Although multiple costs associated with mobile phone technology, including purchase of smart phone, credit, data, and financial transaction fees, repair, and accessory replacement have a negative impact on farmers' adoption of mobile phone technology, as farmers use such technology for the benefit they receive. As stated by Omar et al. (2021) farmers in Sarawak used a gain-oriented strategy that stimulated them to utilize mobile applications despite potential expenses since they presumed higher values. Furthermore, it is assumed that farmers' perceptions of costs and advantages are influenced by their experience using mobile phone technology.

A study found that mobile devices escalated farmers' earnings by accelerating access to markets with better prices. Developments are being made through ICT for agriculture initiatives when prior interventions have concentrated on expanding market access and providing climate information (Hanson & Heeks, 2020). However there was no significant difference between the use of agricultural mobile applications in relation to crop income or off farm revenue and gender (Thar et al., 2021).

Despite having good intentions to apply new technology in agriculture, many farmers who lack prior knowledge of the available assorted mobile phone-based service are unable to use them and reap their benefits (Kabirigi et al., 2023; Misaki et al., 2018). Therefore, it is important to provide proper information at the right time to increase adoption of agro-based digital technology (Fielke et al., 2020). Timely, accurate, relevant, consistent, and reliable sources are required for information provided to farmers to encourage adoption of new services (Olum et al., 2020). Making better informed decisions, expanding productivity, accessing crucial information when required, and time savings were the leading five factors of using mobile app mentioned by Schulz et al. (2022).

In Kwekwe, Zimbabwe, farmers agree that ease of use may affect ICT investment in commercial agriculture. However, there is a low level of adoption of ICT in commercial agriculture in Kwekwe. For ICT adoption in commercial agriculture training, government policy and awareness campaigns are the three major components that the author found crucial (Gavai et al., 2018). Some studies claimed that due to lower degree of digital literacy, small farmers may not benefit from digital agriculture as compared to large, wealthy farmers. Large and rich farmers may also be able to gain more from the usage of such instruments owing to their lack of resource limitations. The use of agricultural mobile applications is more likely to be used by better mechanized farmers (Thar et al., 2021). Awareness campaigns can be run by telecoms, mobile app creators, and the agricultural department as prospective approaches to proceed adult education and enhance farmers' competence through specific instruction in the use of mobile applications.

The younger generation, more educated farmers, and farmers who produce specialized crops should be given priority while promoting campaigns on agro-based mobile apps (Thar et al., 2021). Younger farmers demonstrated a greater inclination to use agriculture based mobile apps or their phones for agricultural motives. They tend to be more radical and innovative when it comes to new technologies as they anticipate the advantages from utilizing innovation with long-term benefits (Chellappan & Sudha, 2015; Kabirigi et al., 2023; Olum et al., 2020). Therefore, youth contribution is critical for effective agricultural digitalization and the potential diffusion of digital skills to older farmers (Kabirigi et al., 2023).

The success of a rural e-service varies on a number of aspects, including the development and delivery of the facility in accordance with the information requirements of the target audience, the use of adaptable technologies that are simple to use within a given infrastructure, the accessibility of facilities at rational prices, and effective awareness-raising with the particular community (Islam & Grönlund, 2010). It is crucial for all stakeholders of the mobile phone business and the agricultural sector to consider farmers' opinions of ease of use into account. Application developers should consider making mobile applications that are suitable for farmers with limited literacy levels and simple to learn and operate them (Kabbiri et al., 2018).

Studies found social influence has a positive impact on farmers' intentions to adopt mobile phone technology (Kamrath et al., 2019; Olum et al., 2020; Victor et al., 2021). If farmers' family members or fellow farmers supported and employed mobile phone technology and other advances, most farmers would follow them. Furthermore, it was determined that self-efficacy in their capacity to exert control over tasks positively influenced farmers' intents to use MPT (Landmann et al., 2021). It indicates the need for designed training and skilling programs that fill farmers' mobile use needs and increase their confidence. The importance of credibility and quality of the source of the information and delivering the content is also vital, as stressed by Ayim et al. (2022)

The success of a rural e-service varies on several aspects, including the development and delivery of the facility in accord with the information requirements of the target audience, the use of adaptable technologies that are simple to use within a given infrastructure, the accessibility of facilities at rational prices, and effective awareness-raising with the particular community. In addition to the development of well-designed and functional services, achieving adoption might also require existing advertising campaigns, support from regional authorities, or cooperation with farmers' organizations.

Farmers are familiar with basic phone operation techniques and have a positive attitude towards mobile phone applications. Mobile apps have helped to facilitate speedy information transfer, access to current information on improved farming activities, monitor market situations effectively. Service provider and other stakeholders should consider critical needs first, such as dissemination of weather or climate and market information that Abdullahi et al. (2021) mentioned. Findings from Thar et al. (2021) also showed that farmers are less likely to use apps further from the market.

ANALYTICAL MODEL

This study's theoretical framework was derived from "Diffusion of Innovations" and "Uses and Gratifications" theories. The Diffusion of Innovations Theory, developed by E. M. Rogers in 1962, describes how, over time, an idea or product gains momentum and diffuses (or spreads) throughout a particular population or social system (Rogers, Singhal, & Quinlan, 2019). Rogers

discussed three major components of his theory. Initially, he proposed that innovation, channel, social system, and time, impact the propagation of a new idea. Second, the theory's process includes five sequential steps - knowledge, persuasion, decision, implementation, and confirmation. The five adopter categories are innovators, early adopters, early majority, late majority, and laggards (Miranda et al., 2016).

While Uses and Gratifications Theory is a method for comprehending why and how people actively seek out specific media to fulfil specific needs. This theory emphasised cognitive, affective, personal integrative, social integration, and tension-free needs (Ruggiero, 2000; Katz, E., Blumler & Gurevitch, 1973). Table 2 demonstrates how these needs of farmers were met by the Farmer Query System (FQS), such as access to relevant and timely information and user satisfaction with its services. Also discussed was the role of FQS in boosting farmers' confidence, credibility, social connections, and reducing their stress levels.

Table 2: Farmers' needs gratified by Farmer Query System (FQS)

Need Type	Description	Farmer Query System
• Cognitive	Acquiring information	The information FQS providing for agricultural needs
• Affective	Pleasant	The benefit of using FQS – quick response, less expensive
• Personal Integration	Enhancing credibility and confidence	Farmers self-credibility and confident increase because of easy access of information
• Social Integration	Enhance connection	Enhancing connection with agriculture experts, NGOs
• Tension Release Needs	Quick access of information	Farmers tension has released because of easy access of information within short period of time

The conceptual framework (Figure 1) was constructed using the two theories. It demonstrates that farmers' decisions to adapt or reject any idea or innovation are influenced by their environment and needs.

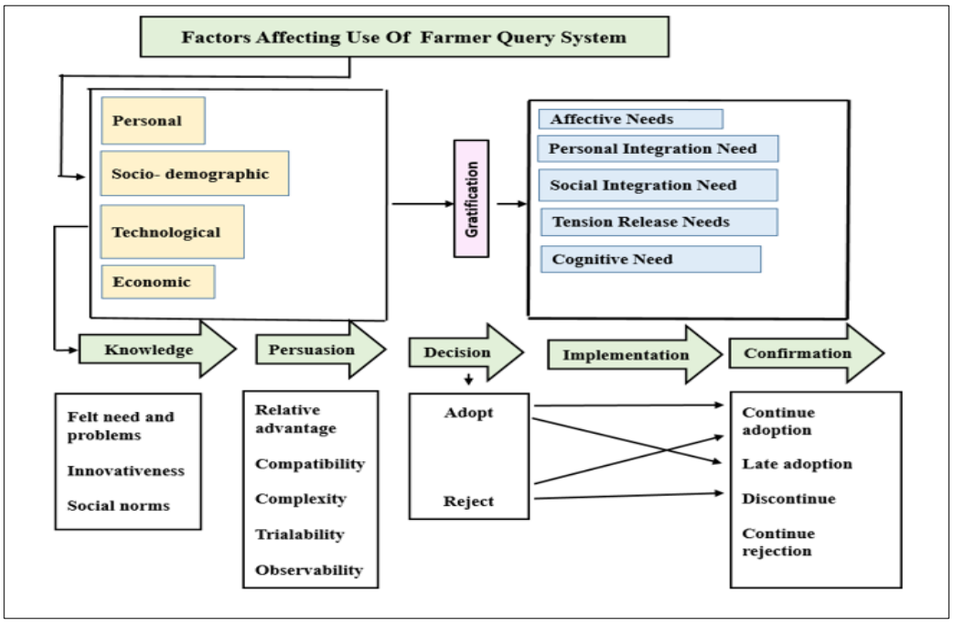

Figure 1: Conceptual framework

MATERIALS AND METHODS

The study used qualitative methods to collect data from the field, in which participants shared their personal experiences or problems directly related to the issue under investigation (Leavy, 2020). This intimate and personal information was gathered by speaking directly with respondents and observing how they behaved and acted in their context (Alam, 2020). In contrast, the study used numbers or terms such as "majority" or "minority" to describe sample characteristics (number of participants and behavioural patterns). The use of numbers in qualitative research needs to be more transparent in terms of data analysis and enhancing the quality of the research by adding precision to statements (Runeson, 2018).

Due to the small sample size pool, the study employed purposive sampling. Among the various types of purposive sampling methods, the study utilised maximum variation sampling, which examines the research subject from all available angles in order to achieve a deeper

comprehension (Mayan, 2023). The study conducted sixteen in-depth interviews with subsistence and commercial farmers utilising agro-based mobile applications. The in-depth interview respondents were categorised as R1 to R16. Participants/farmers in the study cultivate one to five bighas of land (one bigha = 0.3306 acres; five bighas = 1.6529 acres). This study also included three key informant interviews (KIIs) with the local Agriculture Official, representative of Union Digital Centre (UDC) and project personnel. KII involves gathering information directly from a person with extensive knowledge or experience on a topic of interest to the researcher (Sakyi et al., 2020).

FINDINGS

The findings from the research were twofold. The first was how a farmer's socio-demographic, personal, technological, and economic circumstances influenced his adoption of innovation, particularly mobile applications such as FQS. And how a farmer gradually realised the app's value and begin using it to his advantage. These two factors also played a significant role in the adoption and implementation of new innovations by farmers.

As shown in Table 3, socio-demographic factors aided farmers in their use of FQS. Through formal and informal networks, they learned about FQS and its agricultural benefits.

Consequently, they were encouraged to use the application. Neighbours and relatives are informal networks, while agriculture officers, NGO employees, and other organisations are formal networks. Farmers from both groups learned how the app worked and how efficient it was. These formal and informal networks play a vital role in the decision of farmers to adopt or reject FQS.

The Diffusion of Innovation Theory focuses on the role that interpersonal communication plays in the adaptation of new things by a social group. Farmers developed their convictions about FQS based on information obtained from agriculture officials and other sources.

The second stage of the Diffusion of Innovations Theory for the adaptation or rejection of any new idea or service is their persuasion (Rogers et al., 2019). Therefore, the app owner must ensure that information and service providers have adequate knowledge of the app and deliver messages to farmers effectively. Otherwise, farmers might develop a negative perception or misunderstanding of any newly introduced agricultural product or service.

Table 3: Sources that helped farmers to learn about FQS

Categories	**Farmers**
Agriculture Officer	0
Neighbour	10 (Majority)
NGO workers and other organizations	6 (Minority)
Relatives	0

Workers from NGOs and other organisations (the partners of the USAID-funded project that implemented the FQS) organised community-based programmes and educated farmers on the benefits of the FQS. Some farmers become interested in FQS after observing their neighbours' positive experiences with the app. Officials from FQS concurred that rapid response, low usage costs, and direct access to experts are the primary factors that motivate farmers to utilise the apps. Prior to using the FQS app, farmers obtained agriculture-related information from multiple sources, including family, fellow farmers and neighbours, agriculture officials, the media, and non-governmental organisation (NGO) employees. One farmer (R8) added that,

> "Before using the apps, for simple problem I used to take help from neighbouring farmers, we often share information and help each other. If the problem becomes serious, we communicate with the Sub Assistant Agriculture Officer (SAAO)" (Respondent R8)

As illustrated in table 4, most of the farmers were between 16 and 45 years old, and they primarily cultivated paddy, mung bean, chilli, and vegetables. There was no incidence of illiteracy among the participating farmers. All farmers were given the opportunity to complete either primary or secondary education. Since the majority of farmers belong to extended families, they receive support from family members during planting and harvesting seasons. The study found no significant differences in income between subsistence and commercial farmers. Subsistence

farmers are farmers who grow food crops to meet their own and their family's needs. Commercial farmers grow food crops to sell at market or to corporations.

Table 4: Profile of respondent farmers (R1-R16)

• Total Number of Farmers	Subsistence Farmer: 8 people Commercial Farmer: 8 people
• Gender	Male: 16 Female: 0
• Age	16 – 30 years: 9 31 – 45 years: 3 Above 46 years: 4
• Family Members	1 – 4 Family Members: 3 5 – 8 Family Members: 13
• Religion	Muslim: 12 Hindu: 4
• Education Level	Up to class 5: 6 Up to high school: 10
• Type of Land	Own Land: 11 Rented/ Leased Land: 5
• Years of engagement in agriculture	1 – 10 years: 3 11 – 20 years: 6 21 – 30 years: 3 31 – 40 years: 4
• Types of Cultivations	Paddy, Mung Bean, Chili, Vegetables
• Monthly income (USD)	45 – 90: 0 91 – 136: 10 137 – 181: 6
• Access to Electricity	Yes: 16

Connectivity in this study illustrates two significant technological factors – internet and mobile access – that encourage app users to utilise FQS. Table 5 shows that all of the farmers who participated in the in-depth interviews having smart phones and internet access is a promising sign. They all use mobile data to access the internet because Wi-Fi is not readily available in rural areas. However, their knowledge of the internet and its services is limited. Social support regarding the utilisation of technology played a crucial role for FQS users. Obtaining FQS assistance from family or neighbours, for instance, if a farmer is experiencing issues with internet connectivity or smartphone functionality.

Table 5: Level of access of smartphone and internet

• Total Farmers	16 = Subsistence Farmer: 8 + Commercial Farmer: 8
• Respondents' Categories of Using Smartphones	Farmer has smartphones: 16 Farmer does not have smartphones: 0
• Respondents' Family Members Using Smartphone	Family members using smartphones: 12 Family members are not using smartphones: 4
• Respondents' Preferred Method of Troubleshooting	Seek help from family and neighbours: 16 Visit local service centres: 16
• Method of using internet	Mobile data: 16 Wi-Fi: 0
• Use of mobile internet per month	3-4 GB: 13 Other: 3
• Internet connectivity of family members	Not connected: 6 Connected: 10

It revealed that farmers are using the app because it matched their beliefs, needs, and personalities, and made them happy. Utilising a new technology requires a focus on applications and satisfaction. According to the Uses and Gratification Theory, certain variables play a crucial role in a person's use of and satisfaction with a new technology. The variables are whether the individual is receiving the information he desires and whether he is satisfied with the information (Katz et al., 1973). Table 6 demonstrates that disease, insects, and market information are the most important factors required by all subsistence and commercial farmers utilising FQS. In addition, seven of the eleven agricultural information priorities identified by farmers are met by FQS. Even though market and weather information are, respectively, the highest and second-highest priorities for all farmers, FQS does not provide this data.

Market information, particularly the knowledge of product prices in various regions, enables farmers to determine whether the price offered by local merchants is reasonable or not. According to farmer (R1):

> "A thorough understanding of the market can reduce farmers' reliance on middlemen and enable them to demand the appropriate price for their goods." (Respondent R1)

> Farmer (R16) added: "We often encounter middlemen who take advantage of us by offering lower prices for our produce, as we are disconnected from the wider market. The lack of access to real-time updates on product prices hinder our ability to bargain efficiently. Regardless of our persisted and dedicated efforts in agriculture, it is frustrating that brokers often take benefit." (Respondent R16)

Table 6: Priority of agricultural information among the farmers

Agricultural Information Needed	**Priority of information needs**			**Received information through FQS**
	Top	Medium	Low	
• Seed implantation and production	4	8	4	Yes
• Diseases and insect	16			Yes
• Modern cultivation and technology	2	6	8	Yes
• Manure and fertilizer management	3	6	7	Yes
• Weather		16		No
• Soil and water conservation		6	10	Yes
• Irrigation	3	8	5	Yes
• Crop collection and storage	6	6	4	Yes
• Market information	16	×	×	No
• Nutritional value			16	No

Table 7 explains the level of satisfaction of the respondent farmers (R1-R16) on FQS, whether they were satisfied through the FQS. Farmers stated that the app is simple to use. Where "easy to use" indicates that the application is simpler to learn, use, comprehend, or deal with. Initially, it was quite difficult for farmers to comprehend and operate the app; however, after receiving training on how to use it, farmers gradually became adept at using it. Similar overview received from respondent (R4):

> "When I began to use the app, it was quite difficult for me to operate and understand. But NGO workers gave us training on how to use it. Gradually I learned and now it is not difficult at all to use the app. It's quite simple and straightforward." (Respondent R4)

Table 7: Farmers' opinions on FQS app

Categories	**Farmers**
Beneficial	16
Not beneficial	0
Easy to use	11
Not easy to use	5
Get faster feedback/ agricultural solutions	16
Get accurate, complete and concise information	16
User-friendly	16
App less expensive/ Cost-effective	16

Table 8 implies that, after beginning to use the FQS app, the majority of farmers reported that crop quality improved. This positive change has been brought about by prompt problem identification, immediate solutions, and efficient use of time. They all agreed that FQS made this change possible. However, farmer R13 did not experience any change in his crop's quality.

> "Sometime recommended medicine by FQS experts doesn't work well. Also, I don't always get recommended medicine in the local market. Therefore, the quality of my crops did not change after implementing FQS." (Respondent R13)

13 farmers (R1-R7, R9-R11, R14-R16) reported that their income from farming had increased after using the app, while the remaining participants (R8, R12, and R13) reported that FQS had no effect on their income level. After using the FQS app, most farmers (R2-R7, R9-R11, R14-R16) reported an increase in profit margin. The 2020 profit margin is disclosed in table 9. Farmers who regularly used the app saw an increase in their profit margin, whereas farmers who did not regularly use the app did not observe an increase in income or improvement in crop quality.

Table 8: Quality of crops and increase of income after using FQS app

Categories	Farmers
• Quality of crops	Got better quality of crops: 15
	Got same quality of crops: 1
• Level of income	There was increase in income: 13
	There was no increase in income: 3

Table 9: Profit margins of farmers after using the FQS app

Categories	Farmers
No big difference of profit margin – before and after the use of FQS app	4
Received around 30% increase in the profit margin	6
Received around 50% increase in the profit margin	3
Received around 65% increase in the profit margin	2
Received around 75% increase in the profit margin	1

Farmers can immediately get useful insights into crop production and pest control with the help of FQS, which is a great source of agricultural information. With the help of this app, farmers can make informed decisions to boost their farming practices. The ICT Complementation Manager of the USAID project M.A.H Sumon reported that:

> "Farmers do not have to spend money and time by going to agricultural officer. They can get the right information at the right time from an expert. This has reduced the cost of traveling and improved the production efficiency of farming communities living in remote areas." (M.A.H Sumon)

The Agriculture Extension Officer (AEO) of the Barisal Sadar Upazila Mahfuzur Rahman emphasizes farmers' digital knowledge, equipping them with tools and techniques that enable high precision. He added that:

> "If farmers enter the industry with digital expertise, the app will be even more beneficial because they will have a greater understanding of the digital platform." (Mahfuzur Rahman, AEO, Barisal Sadar).

However, he also believed that mobile applications are not entirely capable of meeting the needs of farmers. Few farmers have smartphones, and they do not know how to properly use smartphones or the internet. Also, many have not yet utilised mobile applications, which have their own limitations. These applications only offer agriculture-related solutions; they lack other required data such as market information, weather updates, or the most recent information on production technology or medicines, etc.

DISCUSSION

According to the respondent farmers, personal, socio-demographic, technological, and economic interactions influence their adoption of mobile applications. As the FQS app met their emergency information needs related to crop disease, the respondent farmers believe it will help them improve their crop production. The app is simple to use and provides instant access to data. And so, respondents are content with the facilities and services they are receiving.

However, Chandpura village is situated in Barisal, which is one of the natural disaster-prone regions in Bangladesh. This region is affected by monsoon floods, cyclones, and storms throughout the year (Jagnoor et al., 2019; Xenarios et al., 2016). Information on weather, therefore, is vital for farmers but the app is not providing them with the service. This corroborated the findings of Abdullahi et al. (2021), who reported weather information has not

been distributed via mobile phone apps. Simultaneously, all year-round farmers work hard to produce crops but due to less connection with the market, village farmers are being deprived of fair prices. Middlemen buy their crop paying a minimum price and sell those at a much higher rate (Isalm, 2021). Excluding FQS, there are no digital services for farmers of the village to get timely market information. Daily weather forecasts and market updates are essential for farmers' survival and development.

Implementation of new digital services such as mobile apps requires a prior study on the target population's needs. From these needs, service providers should specify the most important requirements and based on those they should provide innovative services. Much like the present study, Schulz et al. (2022) found that adapting to an app, users should be offered more effective ways to do what they have done in the past and implementation of new methods or information which no user has used before. FQS lacks some services that respondent farmers sought but farmers could not compare it with other apps as they did not have any experience in using them. Therefore, it brought easy satisfaction among the respondent farmers.

In this study, farmers' personalities, attitudes, and willingness to adopt new innovations played significant roles in using FQS. Age, income, and education, the three socio-demographic factors had a significant impact on farmers' utilization of FQS. It was observed that most farmers using the app were young and part of the prime working group. They were educated and had a higher income than non-user farmers. They were willing to adopt this new technology and quickly master the app's interface. Similar outcomes came from Krell et al. (2021) and Baruah et al. (2023), they demonstrated that education made it easier for individuals to attain the required skills to effectively use ICT tools. However, Krell et al. (2021) did not find a positive correlation between age and farmers' adaptation of mobile service.

Farmers' capability to comprehend the usefulness and easy accessibility of mobile is influenced by extensive social interactions between fellow farmers and neighbours. This result is in line with Victor, Nic and Xiaomeng, (2021). The study found no correlation between the adoption of FQS and the religion of farmers. The app's content did not contradict their beliefs.

Another important factor will be when agricultural products are affected by disease, a quick response is obvious. But in rural areas it is hard to access quick information or support from traditional sources (agriculture officer, Upazila agriculture office). Mobile technology or apps like FQS can provide faster solutions in comparison to traditional methods. Despite the additional costs associated with the use of mobile apps, farmers acknowledged the benefits in terms of saving money and time and perceived it would benefit them in the long run. These findings corroborate that of Omar et al. (2022) who reported, even with the potential costs, farmers used a gain-oriented strategy that encouraged the use of mobile applications since they assumed higher values. Mobile companies will also have to come forward to assist farmers. Due to the availability of electricity in Chandpura village, they can offer internet packages to farmers. Additionally, the Union Digital Centre offers free internet services. Therefore, access to the internet has become much easier for village farmers. Thus, technological factors influenced financially stable farmers' and their families' use of FQS.

These days smartphones are no longer associated with high prices, but they are still somewhat expensive for villagers. Due to that, small farmers remained unable to utilize ICT services in agriculture. The cost of ICT services impedes their ability to get agricultural information. The app's future usage largely depended on its accessibility and service cost. Similar outcome was noticed in Ahmed et al. (2015), Michels et al. (2020), and Thar et al. (2021) studies, where adequate internet access, technical facilities and digital literacy are highly emphasized. Despite having smartphones, internet access, and education, the study found that elderly farmers did not believe FQS was necessary for them. They believed that traditional agricultural practices would suffice to meet their needs. Therefore, app developers must think beyond the current information the app provides.

Technophobia was one of the reasons why many farmers in the study area were reluctant to use the application. In addition, many farmers are unaware of FQS, and those who were aware lacked adequate knowledge. Dissemination of information and awareness building is important for the adaptation of digital technology among farmers (Abdullahi et al., 2021; Girma & Kelil, 2021). In such instances, to inform farmers about the app, the authorities must raise FQS awareness among farmers. It is essential for the diffusion of any innovation that users have knowledge of the innovation, farmers will be better able to decide if they will be persuaded to

use the app if they have knowledge of FQS. They will understand if the application is relevant to them, if there is an advantage to using it, if it is comparable to other agricultural information services, and if it is simple to use. Based on these arguments, the farmers were able to make decisions.

In general, commercial farmers are more open to innovation than subsistence farmers, who are more traditional and produce for their own consumption (Llewellyn & Brown, 2020). The socio-economic context of farmers showed that digital agriculture is mainly favourable to large, rich farmers. This can be due to small farmers' low level of digital literacy. Large and wealthy farmers be able to draw more benefits from the use of such tools (Gavai et al., 2018). This finding is not in line with the current study. The number of subsistence farmers in the village who use FQS is greater than the number of commercial farmers. Subsistence farmers receive less assistance from formal social networks (agriculture officers, NGO), and are more dependent on FQS than commercial farmers. There was little variation/difference in the adoption tendency of FQS between the two groups.

Farming and agriculture are the backbones of Bangladeshi society. According to the Food and Agriculture Organization (FAO), small-scale farmers produce about 80 percent of the food in developing countries, making them critical to global food security. The app owner must ensure that information and service providers have adequate knowledge of the app and deliver messages to farmers effectively. Otherwise, farmers might develop a negative perception or misunderstanding of any newly introduced agricultural product or service. This is consistent with Ayisi Nyarko and Kozári (2021) which suggested that agricultural extension professionals should receive intensive ICT training to better integrate ICT into extension advisory services.

CONCLUSIONS

The 2009 National ICT Policy recognises agriculture as a thriving industry. In addition, the government and private organisations have launched numerous initiatives, such as mobile application development, to boost the sector. To increase the use and number of users of agro-based mobile apps, the government, app providers, and private organisations should place greater emphasis on farmers' needs, socio-demographics, economic development, and the ease with which they can adopt the technology. Through this study, it was determined that farmers' need for information was the most influential factor in their decision to use FQS.

Therefore, it is necessary to prioritise the collective needs of farmers in specific regions and to concentrate on their needs. It is believed that youth participation is essential for familiarising farmers with the application. They have an extensive social network and can quickly adapt to the app. They can also help farmers access the application. In addition, two factors must be considered - whether farmers have access to smartphones and the internet, and whether their locale can provide technological support to user farmers. Government and private organisations have developed numerous agriculture-related applications to assist farmers. However, they must also focus on how to make the apps better and more user-friendly by providing accurate and up-to-date information.

IMPLICATIONS OF STUDY

In the context of the village, the findings will assist the union digital centre and other bodies of the village in caring more about farmers' needs relating to mobile phone issues, internet connectivity, and the use of ICT, as well as facilitating training and boosting the digital literacy of young farmers. The study outlined the advantages of implementing an ICT-based agricultural advisory service for farmers and the agricultural sector as a whole.

In general, this paper highlighted the repercussions of using mobile apps in agriculture, which helped us comprehend the significance of ICT technology for advancing the agriculture sector even in small villages. The study's findings will aid government and private organisations in developing techniques to increase the adoption of mobile apps for farming practices

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