Article

Information Development
1–13

DOI: 10.1177/0266666919864126
journals.sagepub.com/home/idv
SAGE

Farmers' use of mobile phone-based farm advisory services in Punjab, Pakistan

Nasir Abbas Khan
China Agricultural University

Gao Qijie
China Agricultural University

Selamawit Fantahun Sertse
China Agricultural University

Md Nur Nabi
China Agricultural University

Palwasha Khan
China Agricultural University

Abstract

The agriculture sector in Pakistan faces enormous challenges of lack of farm knowledge adoption due to the farmers' lack of access to the latest information. Recently various mobile phone-based farm advisory services (FAS) have been introduced as an alternative to the conventional extension methods. Despite many ICT initiatives, the performance of these projects remains unsatisfactory. The current study was designed to identify these FAS, farmers' extent of use, and factors associated with their adoption. Two hundred and forty farmers were surveyed in the rural areas of district Faisalabad, Punjab, Pakistan. Data were collected using a structured questionnaire and analysed with SPSS software. Findings revealed that 77.08% of the sampled farmers were using mobile-based FAS. Telecom and private sector FAS were reported to have the highest share of users (37.08% and 25.83% respectively). Results of the logistic regression showed that farmers' educational level, mobile use skills, mobile possession duration and the number of mobile phones in a family were found positively significant, while farmers' age and contact with extension agents were negatively significant. The findings conclude that education and digital literacy are essential for the use of mobile-based alternatives and emphasize the need for training and educating the farmers.

Keywords

farmers, mobile phones, agricultural information services, Punjab, Pakistan

Submitted: 21 April, 2019; Accepted: 10 June, 2019.

Introduction

In the current era, access to information has become crucial in every field of life. Like many other sectors, access to updated knowledge and smooth transfer of information has always been important in agriculture, but has become more needful in view of emerging global issues such as climate change and food insecurity. Farmers' access to updated farm knowledge such as innovative farm technologies and availability and market prices of various farm inputs and products has become mandatory (Aldosari et al., 2017).

Corresponding author:
Gao Qijie, College of Humanities and Development Studies (COHD), China Agriculture University Beijing.
Email: gaobjcn@163.com

Farmers' access to information determines the adoption of farm innovation and any failure in communication leads to the poor adoption of farm technologies, which ultimately results in severe losses in agriculture (Ajuka et al., 2015).

In Pakistan, one of the main reasons for low crop yields is farmers' inadequate access to updated farm knowledge (Rehman et al., 2015). This is a very alarming situation for a country like Pakistan, where the agriculture sector holds a central position in the national economy, as it generates nearly 20% of the national GDP and employs almost 50% of the country's population (Ministry of Finance, 2015). Provision of updated farm information is crucial as farming communities aim to meet the food requirements of the country's rapidly growing population. Farmers, particularly the marginalised and small growers, are needful of advisory services for their farming operations (Iqbal et al., 2016).

Generally, agricultural extension and advisory systems assist farmers with regard to various farm-related issues, but in Pakistan, the existing agricultural extension system is unable to meet the information needs of the growing population of farmers (Maqsood, 2015). A colossal asymmetry prevails, as the delivery of agricultural advisory services is biased towards the big landlords and influential farmers, while resource-poor farmers – particularly the small growers –remain underprivileged (Abid et al., 2015). In this scenario, ICT-enabled alternatives, mainly mobile phones, have emerged as a useful communication tool to help solve this information delivery challenge and bring the farmers into the mainstream (Obong et al., 2018; Javaid, 2017).

The application of ICT in agriculture initially started in developed countries and was then adopted by various developing countries, including Pakistan. During the last few years, the mobile phone, due to its affordability and user-friendly nature, has become more popular as compared to other communication tools such as landline telephones, TV and radio (Aker, 2011). The world witnessed the rapid adoption of mobile phones from around 15% in 2000 to about 76% in 2010, and more than 75% of the world's mobile phone subscribers were reportedly found in developing countries, indicating its adoption by marginalised and underdeveloped nations (Donovan, 2012). Statistics show that the planet had more than 5 billion mobile subscribers by 2017 (Okeleke et al., 2017). This trend is similar in Pakistan, as a swift rise in mobile users has been seen during the last decade,

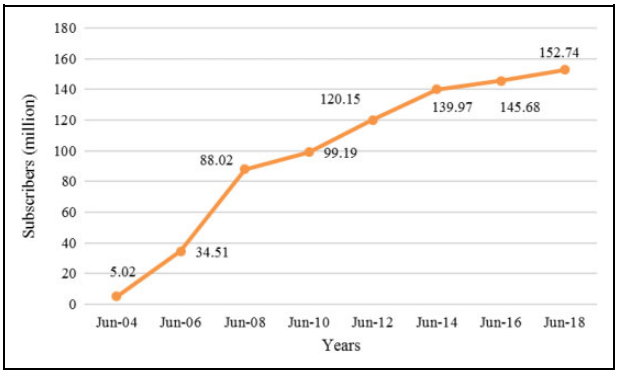

Figure 1. Statistics of mobile subscribers in Pakistan from the year 2004-2018.
Source: (Pakistan Telecommunication Authority, 2018)

and the country had reached 152 million mobile phone users by the end of July 2018 (Pakistan Telecommunication Authority, 2018) (Figure 1). This rapid growth of mobile phone coverage is considered to be one of the remedies for the communication problems in the agricultural sector of the country.

In Pakistan, many ICT-based initiatives have been taken in agricultural extension. The country started its landline agricultural helpline during 2002–2003 (Khan et al., 2010). More recently, various mobile phone-based (voice call and SMS) helplines have been started to provide timely information to farmers (Maqsood, 2015). These services are launched by the government agricultural department, private sector input suppliers, and the telecommunication sector (mobile phone network providers in the country). These services are a substitute for formal extension approaches which provide regularly updated information to farming communities. It has been found that despite various initiatives oriented towards farm knowledge transfer using ICT like mobile phones, the outcomes are not satisfactory because of poor use of these services in remote areas (Javaid, 2017; Khan et al., 2010). There is thus a need to explore the factors linked with the use of mobile phone-based farm advisory services.

Research objectives

Globally, several studies have focused on mobile phone application and use in agriculture (Aker and Ksoll, 2016; Aldosari et al., 2017; Tadesse and Bahiigwa, 2015). However, in Pakistan, very little literature is found related to perception and use of ICTs (Maqsood, 2015; Javaid, 2017), and no study considered the factors related to the use and adoption

of mobile phones in the agriculture and food sector. To fill this gap, the present study aimed to consider the following research objectives:

1. to explore the various mobile phone-based farm advisory services offered in the study area.
2. to assess the farmers' use of these mobile phone-based farm advisory services.
3. to identify the determinants of farmers' use of these mobile phone-based farm advisory services.

Research methodology

Description of the study area

The study was conducted in Faisalabad district of Punjab province, which is the leading contributor to the country's agricultural GDP. Faisalabad district was selected, firstly because this district has massive production of agricultural and livestock products, and secondly because all the mobile phone-based farm advisory services available in the province are operational in this district. Faisalabad is the second largest district in the Punjab province, consisting of 6 tehsils (sub-districts/cities) with a total area of 5,856 square kilometers. The total population of the district is 7.87 million, with an overwhelming majority living in the countryside and associated with agriculture and related businesses (Pakistan Bureau of Statistics, 2017). The district contributes over 20% of Punjab's GDP, with an average annual share of $20.5 billion (Ministry of Finance, 2015).

Sampling and data collection

Faisalabad was purposively selected from the Punjab province followed by a multi-stage random sampling approach. In the first stage, the Punjab province was selected. In the second stage district, Faisalabad was selected as the main study area. In the third stage, two tehsils (sub-districts) were randomly chosen out of six tehsils of the district. In the fourth stage, four union councils (a local administrative unit of the local governance system of Pakistan) were randomly selected by choosing two from each tehsil. Only rural union councils were selected, following Pakistan village statistics (Agricultural Census Organization, 1998). In the fifth stage, eight villages were randomly chosen (two from each union council). In the final stage, a total sample of 240 respondents was generated by selecting 30 farmers from each village (using the farmers' database obtained from the district agriculture department). Figure 2 shows the sampling approach used. Data were collected through face to face interviews with the help of a structured questionnaire (see Appendix B). Data were collected in August 2018 with the help of two enumerators hired from the local university. Interviews were initially conducted in the local language and later converted into English. Data were managed and analyzed using SPSS (Statistical Package for Social Sciences) software.

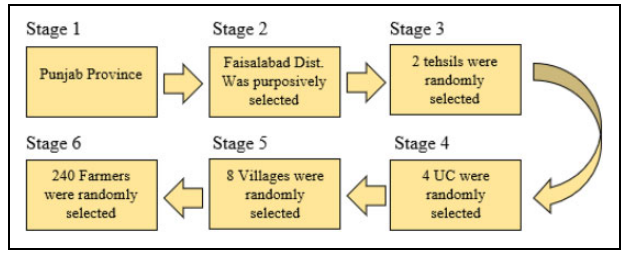

Figure 2. Sampling procedure: multi-stage sampling approach.

Empirical modeling for measuring the determinant of mobile-based FAS

Various contingent valuation models have been used to measure the adoption of technologies among farming communities. However, many studies show that these approaches are only valid when measuring the extent of adoption or use of technologies. Similarly, the commonly recognised Heckman model has also been used in similar cases but in the case of the current study, this model also appeared unsuitable as it is only applicable to non-random samples. Considering the nature of the current study, a binary logistic regression model was chosen because our dependent variable was a binary variable. In this study we assigned a numerical value 1 if the farmer was a user of any of the mobile-based FAS, otherwise we assigned a value 0.

Logit: $\left[\frac{Pi}{(1-Pi)}\right] = X_i\beta_i + \epsilon_i$

This can be expressed as:

$$Y = Xi\beta_i + \epsilon_i$$

Where:

Logit: $\left[\frac{Pi}{(1-Pi)}\right]$

P_i =The predicted probability of a particular condition occurs.

Table 1. Descriptive statistics of explanatory variables used in the model.

Variables	Description	Mean	SD	Minimum	Maximum
Dependent variable					
Use of mobile-based FAS	Dummy, 1=users, 0 non-user	0.770	0.421	0	1
Explanatory variables					
Age	Continuous (Years)	46.56	23.30	25	70
Education	Continuous (Years)	5.052	3.150	0	16
Monthly income	Continuous (PKR[a])	20445	9865	5000	100000
Farm size	Continuous (acres[b])	5.315	8.844	0.5	40
Farmers tenancy status	Dummy 1 = owner, 0= No	0.731	0.921	0	1
Farmer is household head	Dummy 1= head, 0= No	0.644	0.952	0	1
Contact with farm advisory agents	Dummy 1 = Yes, 0= No	0.466	0.683	0	1
Mobile phones in family	Continuous (Number)	2.725	1.204	1	5
Duration of mobile phone ownership	Continuous (Years)	3.431	2.143	1	8
Farmers' skills of mobile use	Dummy,1 = advance skills, 0= basic	0.288	0.515	0	1

Data Source: Field survey 2018 [a] PKR refer to Pakistani rupee here we used the average exchange rate for year 2018 (1 $ =120 PKR) when the survey was carried out. [b] Acre is a unit of land area used in Pakistan 1acre=0.40 ha.

X_i =Vector of 1×K of the independent variables (factors)

β_i = Vector K×1 of the estimated coefficient

ε_i = Error term

The explanatory variables (Xi) used in this analysis included:

X_1 = Age (Years), X_2 = Education (Years), X_3 = Farm size, X_4 = Farmers tenancy status, X_5 = Farmer is household head, X_6 = Contact with farm advisory agents, X_7 = Contact with farm advisory agents, X_8 = Mobile phones in family, X_9 = Duration of mobile phone ownership, and X_{10} = Farmers' skills of mobile use.

Hypothesis testing for model significance

To measure model significance, a null hypothesis technique was employed. A null hypothesis was established by supposing all values of the regression coefficient are zero against at least one value which is non-zero.

$$H_0 : \beta_i = 0$$

H_A: *at least one* $\beta_i \neq 0$

Results of the regression analysis given in Table 2 prove this model to be a good fit, as the values of Nagelkerke R Square and Cox and Snell R Square are 0.198 and 0.325, which represents the goodness of fit of this model (Blog, 2013).

Description of explanatory variables used in the model

Many studies argue that various factors are associated with the use and adoption of the mobile phone in agricultural information dissemination (Aldosari et al., 2017; Obong et al., 2018). For instance, farmers' socioeconomic characteristics like age and education are shown to be crucial in determining their behaviour regarding use of the mobile phone for accessing farm information (Ali and Kumar, 2011). Farmers of various age groups use a mobile phone for exchanging different types of agricultural information, but this trend is undoubtedly more pervasive in younger farmers, the majority of whom are educated (Rahman and Fadol, 2013). Studies also show that related characteristics of farmers' mobile use, like digital literacy and mobile phone skills, play a pivotal role in understanding its adoption and farm-related use (Koyu et al., 2018).

Considering the literature, the availability of data and the context of the study, 10 explanatory variables were selected for the current research (Table 1). These variables included farmers' socioeconomic characteristics (farmer's age, education, income, tenancy status, household head status, contact with farm advisory agents, and farm size) and mobile phone use related attributes (numbers of mobile phones in a family, duration of mobile phone ownership, and skills of mobile phone use).

Table 2. Parameters estimates of logistic regression model.

	B	S.E.	Sig.	Exp(B)	95% C.I for Exp(B) Lower	Upper
Farmers' age	−0.090	0.025	0.000	1.095	1.041	1.151
Farmers' education level	0.024	0.087	0.003	1.024	0.864	1.215
Monthly income	−0.019	0.026	0.471	0.981	0.932	1.033
Farm size	0.006	0.039	0.881	0.994	0.921	1.073
Farmers' tenancy status	0.465	0.545	0.394	1.592	0.547	4.632
Farmer is household head	−0.100	0.764	0.896	0.905	0.202	4.047
Contact with farm advisory agents	−3.025	0.704	0.000	20.597	5.180	81.902
Mobile phones in the family	0.462	0.250	0.005	1.588	0.973	2.592
Duration of mobile phone ownership	0.227	0.177	0.000	1.255	0.887	1.775
Farmers' skills of mobile use	2.933	0.968	0.002	18.775	2.815	85.218
Constant	−5.725	2.372	0.001	0.015		
Nagelkerke R Square 0.198						
Cox & Snell R Square 0.325						
−2 Log likelihood 124.585						
Hosmer and Lemeshow Test, 8.378 (sig. 0.397)						
Total number of observations 240						

Data Source: Field survey 2018

Results and discussion

Farmers use of mobile phone-based farm advisory services

Our study identified three types of mobile phone-based farm advisory services (FAS) offered to the farmers of the study area. These were:

1. public sector FAS, which include SMS and call helplines offered by government agricultural and livestock departments.
2. FAS offered by the private sector (private farm input suppliers and other helplines that provide farm assistance to the farmers in addition to selling their products).
3. FAS offered by the telecommunication sector, which includes four FAS offered by telecommunication network providers in the country. Jazz, Telenor, Ufone, and Zong are the four mobile networks providers in Pakistan, which offer their farm advisory services, locally named as *Jazz Bakhabar Kissan*, *Telenor Khushal Zamindar, Ukissan,* and *Zong Kissan Portal.* Details of these services are given in Table A1.

The findings revealed (Figure 3) that the telecommunication sector's FAS have the biggest share of subscribers (37.08%), followed by private sector FAS (25.03 %), while users of public sector FAS accounted for 18.33% of subscribers. Findings further revealed that out of 240 sampled respondents, 55 (22.92%) did not use any of the FAS. Figure 4 presents the detailed distribution of users concerning the use of FAS. The detailed statistics of respondents are presented in Table A2.

The *Jazz Bakhabar Kissan* service has the biggest share among the telecom sector's FAS. The Jazz *Bakhabar Kissan* and Telenor *Khushal Zamindar* services were reported as having more subscribers (17.50% and 16.25% respectively) than *Zong Kissan Portal* and *Ukissan* due to the higher network coverage and toll-free nature of the services.

In the public sector's FAS, the agricultural department helpline reported more users (10.83%) compared to its livestock department helpline (7.50%). In Pakistan, the public sector FAS are solely to guide farm operations and do not provide any product or input; hence farmers prefer to approach the private sector's input suppliers. The findings also indicate the inefficiency of public sector institutions and lack of interest, due to which, farmers tend to communicate with alternatives sources.

Similarly, in the private sector, 16.67% of the respondents obtained farm related information from various farm input suppliers (private enterprises), which rank second highest and are greater than the

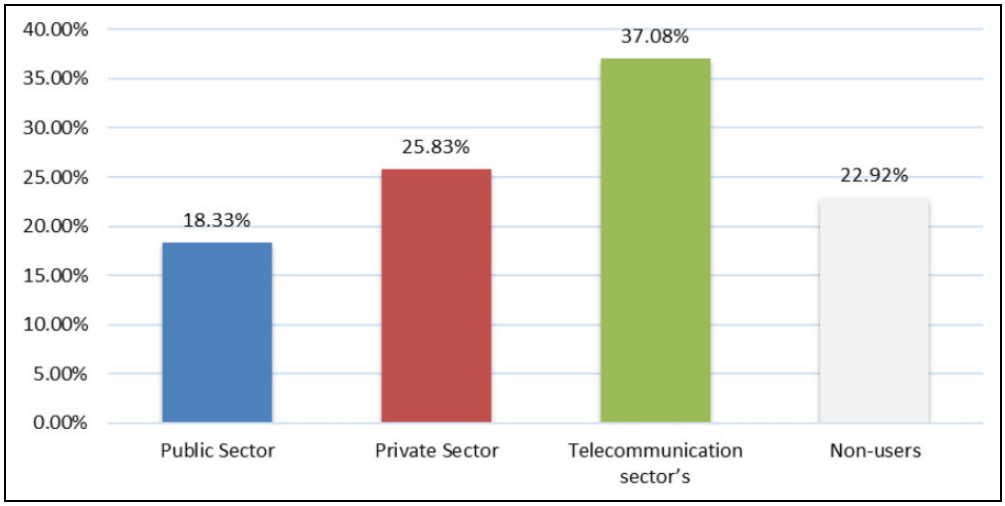

Figure 3. Sector-wise distribution of users of mobile-based FAS.
(The sum is higher than 100% because a farmer can use more than one advisory service simultaneously N = 240).
Data Source: Field survey 2018

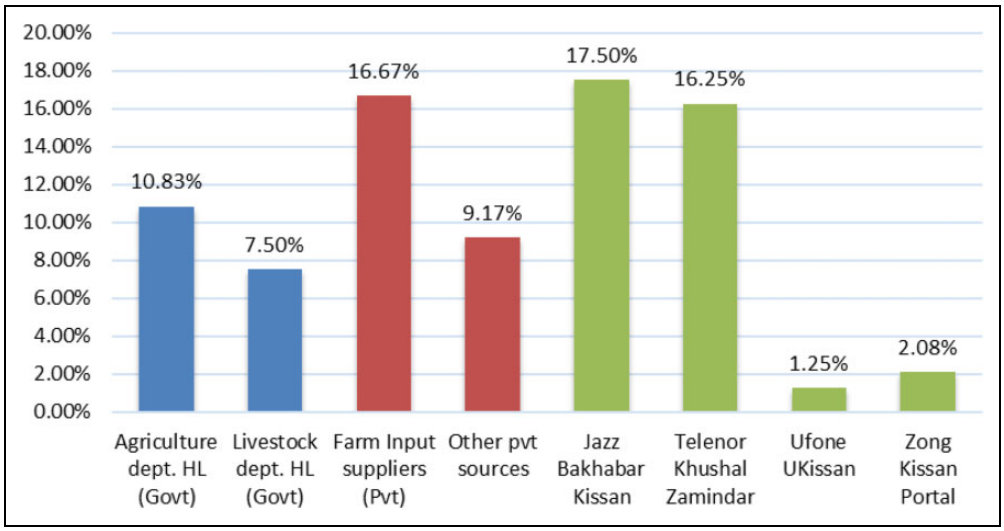

Figure 4. Distribution of users of various mobile-based FAS (N=240).
Data Source: Field survey 2018

public sector FAS. The other private sources, which include private helplines of various farming organizations, accounted for 9.17%. These findings indicate the efficiency of the private sector in terms of assisting the farming communities and meeting their information needs. These results are in line with a study conducted in India, which also found that farmers prefer to contact private companies and input suppliers because they provide products and inputs in addition to advisory services (Verma et al., 2014).

Our study also attempted to identify the type of service used by the farmers, such as voice or SMS (short message service). The FAS mentioned above are delivered to the farmers through a short-recorded voice (IVR) or an SMS-based content. The type of service used determines the farmers' behaviour and convenience and the effectiveness of a particular service. Findings (Figure 5) show that farmers mainly used voice-based FAS in the private sector and telecommunication sector (nearly 70% on average), while

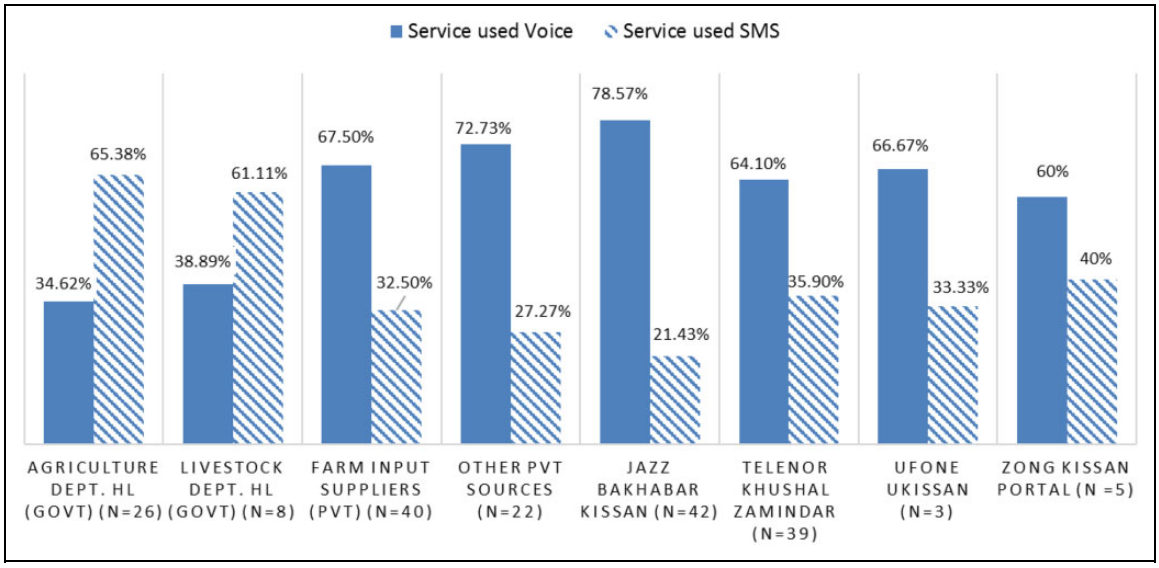

Figure 5. Distribution of users according to the type of service used.
Data Source: Field survey 2018

as regards the public sector FAS, farmers mostly indicated the use of SMS-based service. The Punjab Directorate of Agriculture (Information) stated that the government agricultural department's FAS are provided solely through SMS. No voice call or IVR-based content is delivered; instead farmers are required to call the agricultural helpline themselves (Directorate of Agriculture (Information) (2017). Despite the fact that the public sector departments do not provide voice-based content on a regular basis, more than one third of users dialed their call helplines. This shows the farmers preferences in using voice-based service in order to obtain farm information.

In the telecom sector, FAS are based on both voice and SMS services, and farmers preferred the voice-based service, which is delivered in their local language (Jazz, 2018; Global System for Mobile Association, 2017). These findings indicate that the user's choice of service type is based on convenience and other associated factors such as literacy and mobile phone operating skills. Farmers in the study area lack these attributes because most of them attained only primary level of education and had basic mobile use skills (basic skills referred to voice calls only) (Table 1). Hence most farmers preferred voice-based content as compared to SMS, which requires a higher level of education and mobile phone use skills. The detailed statistics are presented in Table A3.

Descriptive statistics of farmers' socioeconomic and mobile related characteristics

The average age of the farmers was 46.56 years, which shows that most of them belonged to the middle and old age groups. The majority of farmers had a low level of education, as the mean of their years of schooling was 5.05 years. These findings are supported by similar studies showing that most farmers in developing countries belong to the middle and old age groups with low education level (Roy et al., 2018; Rahman and Fadol, 2013). Regarding farmers' land ownership and household status, the means for these two variables were 0.731 and 0.644 respectively, which shows that most of the farmers owned their land, while more than half of the respondents were head of the farm household. The majority of the farmers had possessed a mobile phone for more than 3 years (mean 3.43) and the average numbers of mobile phones in a family was 2.72. Parallel with the findings of Tadesse and Bahiigwa (2015), our study further revealed that farmers had very basic (mean 0.288) mobile phone use skills which were limited to voice calls. The detailed statistics of explanatory variables are given in Table 1.

Determinants of farmers' use of mobile-based farm advisory services

The study further identified the factors that influence the farmers' use of mobile phone-based FAS. Logistic

regression was employed to measure the impacts of explanatory variables on farmer's mobile phone use for accessing FAS. The parameter estimates of the regression model are given in Table 2 in which coefficients show the direction of the effect of the explanatory variables on farmers' use of mobile-based FAS. For instance, the positive value of coefficient shows a positive relation, and a negative sign represents the case otherwise.

According to Table 2, the factors which have been found positively significant with farmers use of mobile-based FAS included farmers' educational level, farmers' skills of mobile use, mobile phone possession duration, and number of mobile phones in a family, while farmers' age and formal contact with extension agents were reported as negatively significant.

Farmers' age

Age is another pivotal attribute which has a crucial role in farmers' behaviour regarding various decisions. A farmers' age represents his experience and knowledge and understanding of the social system and the community. According to the results of this study, farmers' age was highly significant (0.000) in relation to the use of mobile-based FAS. The negative value of the coefficient indicates a decrease in the use of mobile phone-based FAS with the increase in farmers' age. These findings illustrate that older farmers have a lesser tendency (1.095 times) of using mobile phone-based FAS compared to the younger farmers. It is argued that farmers' age can also indirectly affect the use of the mobile phone for FAS, as old farmers lack operational skills, education and interest in ICT of the modern age like cellular phones, and hence do not prefer their use over conventional information sources. Roy et al. (2018) found in his study in India that the old farmers are very strict in following their traditional beliefs and indigenous knowledge system and do not rely on the new ICT.

Farmers education level

Education is considered an essential factor in the farmers' use of ICT for accessing farm information. Many studies have reported that farmers' education level plays a pertinent role in their use of modern technologies like a mobile phone (Gichuki and Mulu-Mutuku, 2018; Saroj et al., 2017). In the current study, farmers' years of schooling was shown to have a significant relationship with the use of mobile phone-based FAS at 0.003 significance level. According to the parameter estimates of logistic regression model (Table 1), the positive value of coefficient indicates a positive correlation of education with the use of FAS, which means farmers with higher educational level have a 1.024 times greater tendency to use the mobile phone for agriculture-related purposes. These findings are parallel with another study which showed that educated farmers have more knowledge about the services and useful information sources, and hence have a higher rate of mobile phone adoption and use for farming matters (Obong et al., 2018). It can be concluded that farmers' educational level determines the use of the mobile phone for accessing farm advisory services.

Number of mobile phones in a family

Our study identified that the total number of mobile phones in a family was positively significant in relation to the farmers' use of mobile-based FAS (sig. level 0.005). A farmer having a higher number of mobile phones in the household has 1.588 times more tendency to use the mobile phone for farming purposes. This might be due to the fact that a higher number of mobile phones in a farm household enables family members to have a bigger communication circle. Moreover, individuals' mobile phone use skills are more developed when there is more than one mobile phone user in a farm family, because the other family members can create a better learning environment for those who lack mobile operational skills (Obong et al., 2018). We can conclude that the number of mobile phones in a farm family also shapes the farmers' use of mobile-based FAS.

Duration of mobile phone ownership

Duration of mobile phone ownership has also been reported with a significant positive relationship (0.000). This indicates that farmers who have owned a mobile phone for a longer duration have 1.225 times higher inclination towards farm-related uses as compared to those who have owned a phone for a shorter duration. This might be because farmers using the mobile phone for a prolonged duration have more understanding regarding mobile operations and have developed a big circle of useful contacts and helplines which can lead towards the increased use of the mobile phone for accessing agricultural information. These findings show that mobile phone ownership, which in the case of the current study is very low (3.431 years), could also emerge as a potential challenge regarding the adoption of mobile-based FAS.

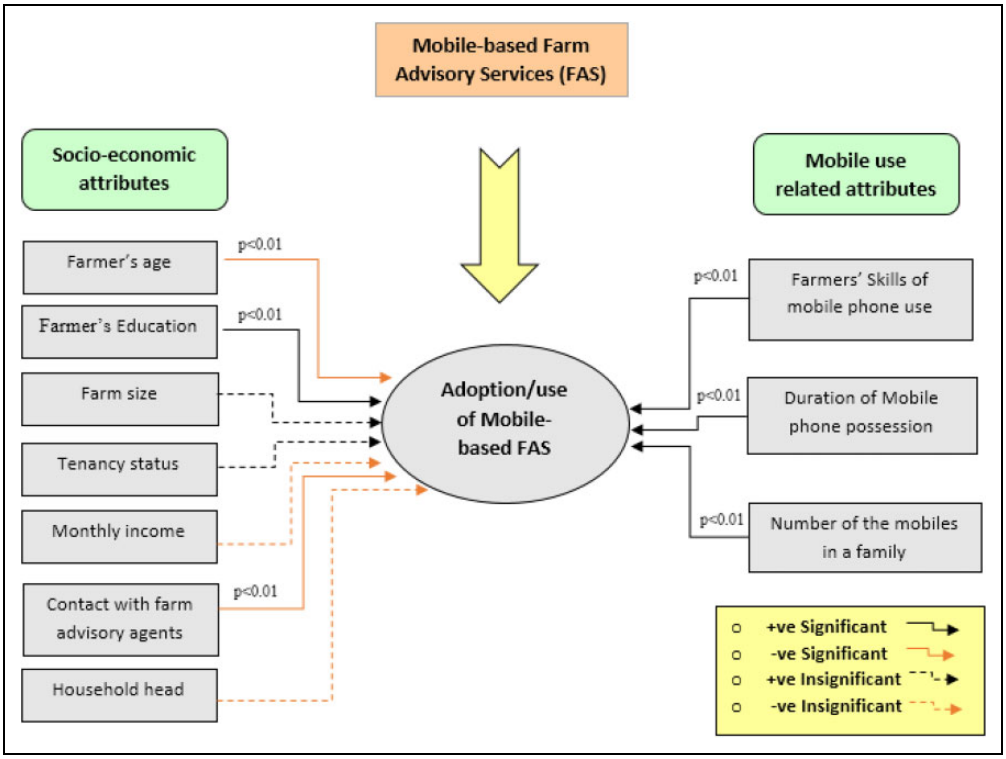

Figure 6. Schematic framework of farmers' use/adoption process of Mobile-based FAS (based on field Data analysis).

Farmers' skills in mobile phone use

In our study, we defined mobile phone skills as 'basic' if farmers had skills limited to voice calls only, while 'advanced skills' refers to the use of smartphone, SMS services, and Internet-based mobile services. The findings show that the farmers' skills in various mobile phone operations have a significant positive relationship with the use of mobile phone-based FAS at 0.002 level of significance. This shows that farmers who have advanced skills in mobile phone operations, like, SMS, and use of Internet-based mobile applications, have a greater tendency (18.775 times) to use mobile phone-enabled FAS. Similar findings have been reported in another study which showed that farmers with higher levels of digital literacy have a higher tendency to use mobile phones for farm information (Roy et al., 2018). This study also concludes that farmers' use of mobile phone-based FAS services is determined by their mobile operating skills.

Farmers contact with extension agents

Findings of the current study have also shown that farmers' contact with agricultural extension agents (farm advisory personnel) has a significant negative relationship with the use of mobile-based FAS (sig. level 0.000). Regression results indicate that a farmer having regular formal meetings with or visits from agriculture extension agent has 20 times less tendency to use mobile-based FAS. This shows that when farmers do not have access to formal extension and advisory services, they tend to rely on mobile phone-based information services as a substitute. It is argued that farmers only try to obtain information from other sources if the formal extension and advisory services do not meet their information needs (Aker and Ksoll, 2016).

Schematic framework of farmers' use/adoption process of mobile-based FAS

The process of farmers' use or adoption of mobile phone-based FAS is illustrated in the schematic framework shown at Figure 6, which is based on the analysis of the field data. This framework serves as a useful tool to understand the use or adoption process of mobile phone-based farm advisory services offered to farmers in the study area (Figure 4). The various socio-economic and mobile phone-related attributes of the farmers (Table 1) are illustrated with respect to their effect on the use of mobile-based FAS. In

Figure 6, the smooth black line indicates a significant positive relationship between certain independent variables and use of mobile-based FAS, while the black dotted lines represent an insignificant positive relationship. Similarly, the smooth orange lines indicate a significant negative relationship, while the orange dotted lines show an insignificant negative relationship between the dependent and independent variables.

Conclusions and implications

To meet the information needs of farming communities, various mobile-based FAS have been started in Pakistan since the start of the current decade. These services provide farm assistance to the farming communities regarding various agronomic operations, livestock, market updates, and other farm-related matters. Although many ICT initiatives have been taken in agricultural extension in Pakistan, their performance has remained questionnable. The current study focused on identifying farmers' use of the mobile-based FAS offered in the study area and analysing the factors associated with their use.

The findings revealed that more than three quarters of the sampled farmers indicated that they used various mobile-based FAS (77.08%). Detailed statistics of all FAS revealed that the private sector's input suppliers and the telecom sector's *Jazz Bakhabar Kissan* holds the highest share of users, while the public sector's agricultural department and livestock department helplines had the lowest share of total users. The lower use of the public sector's FAS shows certain problems with their delivered content and indicates the lack of interest from these institutions in the provision of updated and needs-specific information. This study findings urges the concerned authorities to consider the adoption of a contemporary mode of e-extension equipped with the latest information based on the farmers' actual requirements.

This study further found that the majority of the farmers preferred voice-based content compared to the SMS-based information, because voice content was provided in their local languages. The farmers' low educational level and lack of mobile use skills could also be a reason for less use of SMS-based information, as most of the farmers might not be able to read SMS. These findings suggest that Punjab government's agricultural and livestock departments should provide voice-based content as most of the farmers are illiterate.

Our study has also analysed certain socio-economic and mobile use-related factors which were closely linked with the use of mobile phone-based FAS. For example, farmers' educational level is one of the determinants which positively influence farmers' use of FAS. A higher education level among the farmers leads to the greater adoption and use of mobile-based FAS. In the current study, where farmers' average years of schooling are critically low, this could be a major constraint in the use of mobile-based FAS. Similarly, farmers' age has been reported to indicate a decrease in the use of mobile-based FAS among the older farmers. These findings highlight the significance of education and awareness regarding the use of mobile-based FAS among the illiterate, older, and middle-aged farmers. Based on these findings, policy makers and practitioners in the field of ICT-enabled agricultural extension services should consider farmers' socio-economic traits prior to adopting alternatives like mobile phones for farm information dissemination.

The farmers' mobile phone-related characteristics, such as their mobile operating skills, duration of mobile phone ownership and total numbers of mobile phones in a family, have been found positively significant in relation to the use of mobile-based FAS. These findings highlight the importance of digital literacy in the application of mobile phone-enabled solutions in agricultural extension, and point to the need for the training of farmers in the study area, as the majority of the farmers lack mobile related skills. The provincial government should integrate public and private sector institutions in advisory provision and jointly launch training campaigns and workshops for the farming communities. This will improve the compatibility of delivered content with farmers' actual information needs, and hence increase the practical feasibility of these mobile-based FAS.

Acknowledgements

We are incredibly thankful to the College of Humanities and Development Studies (COHD) China Agriculture University (CAU) Beijing, China, for the support in completing this work. We further extend our thanks to the District Agriculture Department Faisalabad-Pakistan for their cooperation during the field survey.

ORCID iD

Nasir Abbas Khan https://orcid.org/0000-0002-6079-715X

References

Abid M, Scheffran J, Schneider UA, et al. (2015) Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab Province, Pakistan. *Earth System Dynamics* 6: 225–243.

Agricultural Census Organization (1998) Pakistan Mouza statistics., Statistics Division, Agricultural Census Organization, Islamabad, Pakistan.

Ajuka PN, Anyiro CO and Ijioma JC (2015) Awareness, access and use of information and communication technologies by agricultural extension personnel in Abia State, Nigeria. *Nigerian Agricultural Journal* 46: 7–15.

Aker JC. (2011) Dial 'A' for agriculture: a review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics* 42: 631–647.

Aker JC and Ksoll C (2016) Can mobile phones improve agricultural outcomes? Evidence from a randomised experiment in Niger. *Food Policy* 60: 44–51.

Aldosari FO, Al-Sakran MS, Alkhubizi HFN, et al. (2017) Use of cell phones by the farmers as an extension tool to practice sustainable agriculture and achieve food security in the Kingdom of Saudi Arabia. *Journal of Experimental Biology and Agricultural Sciences* 5: S91–S98.

Ali J and Kumar S (2011) Information and communication technologies (ICTs) and farmers' decision-making across the agricultural supply chain. *International Journal of Information Management* 31: 149–159.

Blog TM (2013) Regression analysis: how do I interpret R-squared and assess the goodness-of-fit? Available at: http://blog.minitab.com/blog/adventures-in-statistics-2/regression-analysis-how-do-i-interpret-r-squared-and-assess-the-goodness-of-fit.

Directorate of Agriculture (Information) (2017) Government of Punjab. *Electronic Media*. Directorate of Agriculture (Information) Punjab.

Donovan KP (2012) Mobile money, more freedom? The impact of M-PESA's network power on development as freedom. *International Journal of Communication* 6: 2647–2669.

Gichuki CN and Mulu-Mutuku M (2018) Determinants of awareness and adoption of mobile money technologies: Evidence from women micro-entrepreneurs in Kenya. *Womens Studies International Forum* 67: 18–22.

Global System for Mobile Association (2017) Khushaal Zamindar: a mobile agriculture service by Telenor Pakistan. GSMA Head Office Floor 2 The Walbrook Building 25 Walbrook London EC4N 8AF United Kingdom. Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/07/Khushaal-Zamindar-A-mobile-agriculture-service-by-Telenor-Pakistan.pdf.

Iqbal M, Imam MF, Amir R, et al. (2016) Assessing training needs of farmers In Pakistan: A case of Farmer Field Schools (Fruit And Vegetable Project) In Tehsil Rawalpindi. *Journal of Global Innovation in Agriculture and Social Scieces* 4: 204–206.

Javaid U (2017) Role of mass media in promoting agricultural information among farmers of District Nankana. *Pakistan Journal of Agricultural Sciences* 54: 711–715.

Jazz (2018) Jazz Bakhabar Kissan. Available at: https://www.jazz.com.pk/prepaid/bakhabar-kissan/.

Khan GA, Muhammad S, Chaudhry KM, et al. (2010) Present status and future preferences of electronic media as agricultural information sources by the farmers. *Pakistan Journal of Agricultural Sciences* 47: 166–172.

Koyu B, Singh RJ, Kalai K, et al. (2018) e-Readiness of farmers in agricultural extension system: a case of Ri-Bhoi district, Meghalaya, India. *Plant Archives* 18: 117–120.

Maqsood L (2015) *Use of mobile technology among rural women in Pakistan for agricultural extension information*. Michigan State University. Telecommunication, Information Studies and Media.

Ministry of Finance (2015) *Pakistan economic survey* 2015–16. pp. 5–8.

Obong R, Mugonola B and Phillips DP (2018) Determinants of mobile phones usage in sweet potato vine business in Gulu district northern Uganda. *African Journal of Agricultural Research* 13: 1071–1079.

Okeleke K, Rogers M and Pedros X (2017) *The mobile economy 2017*. London: GSMA Intelligence. Available at: https://www.gsmaintelligence.com/research/2017/02/the-mobile-economy-2017/612/.

Pakistan Bureau of Statistics (2017) Province wise results of population census. Pakistan Population Census 2017. Available at: http://www.pbs.gov.pk/sites/default/files/PAKISTAN%20TEHSIL%20WISE%20FOR%20WEB%20CENSUS_2017.pdf.

Pakistan Telecommunication Authority. (2018) *Annual Report 2017-18*. PTA Headquarters, F-5/1, Islamabad. Available at: https://www.pta.gov.pk/en/telecom-indicators.

Rahman AMA and Fadol IO (2013) Influence of socioeconomic characteristics on purposes for which mobile phone was used by small scale farmers in the Gezira State, Sudan. *International Journal of Agricultural Science, Research and Technology in Extension and Education Systems* 3: 181–184.

Rehman A, Jingdong L, Shahzad B, et al. (2015) Economic perspectives of major field crops of Pakistan: An empirical study. *Pacific Science Review B: Humanities and Social Sciences* 1: 145–158.

Roy ML, Nirmal C, Anirban M, et al. (2018) Extent of use of ICT tools by hill farmers and associated social factors. *Indian Research Journal of Extension Education* 18: 27–31.

Saroj K, Nishi S and Raman J (2017) Socio-personal factors with impact assessment of mobile based advisory services in Haryana *Annals of Agri-Bio Research* 22: 299–302.

Tadesse G and Bahiigwa G (2015) Mobile phones and farmers' marketing decisions in Ethiopia. *World Development* 68: 296–307.

Verma SR, Sharma FL, Singh N, et al. (2014) Constraints and obstacles perceived by extension personnel in application of information and communication technology in agriculture. *Agriculture Update* 9: 279–287.

About the Authors

All the authors may be contacted at: College of Humanities and Development Studies (COHD), China Agriculture University, No.17 Qing Hua Dong Lu, Haidian District, Beijing 100083 P.R. China.

Nasir Abbas Khan
Phone No: 008613031180702. Email: nasirkhanpk@cau.edu.cn; nasirkhanpk@outlook.com

Gao Qijie
Email: gaobjcn@163.com

Selamawit Fantahun Sertse
Email: fantahun1999@gmail.com

Md Nur Nabi
Email: nurnabicau@cau.edu.cn

Palwasha Khan
Email: palwashakhanfsd@gmail.com

Appendix A

Table A1. Sector wise description of mobile-based FAS.

Service providing sector	Service name	Service type
Public sector	Govt. Agriculture Department helpline	Call & SMS helpline
	Govt. Livestock Department helpline	Call & SMS helpline
Private sector	Private companies (input suppliers)	various helplines & sales officers contacts
	Other private sources	Private helplines of farming solutions of various organizations
Telecommunication sector	Jazz Bakhabar Kissan (The Well Aware Farmer)	Robocall & SMS
	Telenor Khushal Zamindar (The Prosperous Farmer)	Robocall & SMS
	Ufone Ukissan (Ufone's Farmer service)	Robocall & SMS
	Zong Kissan portal (Zong's Farmer portal)	Robocall & SMS

Jazz, Telenor, Ufone and Zong are the four mobile networks providers in Pakistan. The meanings of local names (Urdu language) are given in parenthesis.

Table A2. Sector wise share of mobile-based FAS.

Service provider	Frequency	%
Public Sector	44	18.33
Private Sector	62	25.83
Telecom sector	89	37.08
Non-users	55	22.92

(The sum is higher than 100% because a farmer can use more than one advisory service simultaneously N=240).

Table A3. Detailed distributions of users with respect to service type used.

	Subscribers/ users		Service type used			
			Voice		SMS	
Service name	F	(%)	(F)	(%)	(F)	%
Agriculture Dept. HL (Govt)	26	10.83	9	34.62	17	65.38
Livestock Dept. HL (Govt)	18	7.50	7	38.89	11	61.11
Farm input suppliers (Pvt)	40	16.67	27	67.50	13	32.50
Other private sources	22	9.17	16	72.73	6	27.27
Jazz Bakhabar Kissan	42	17.50	33	78.57	9	21.43
Telenor Khushal Zamindar	39	16.25	25	64.10	14	35.90
Ufone UKissan	3	1.25	2	66.67	1	33.33
Zong Kissan Portal	5	2.08	3	60.00	2	40.00

Appendix B

Questionnaire

N.B. The origial questionaire was in Urdu.

GENERAL INFORMATION

Sr. #	Question	Response
1.	City (Tehsil) (to which subdistrict district do you belong)	
2.	UC (Union Council) (to which UC do you belong)	
3.	Village ID	
4.	Date of Survey	
5.	Enumerator Name	

A. The Demographic Characteristics of Respondents

1. Name _____

1. Age _____
2. Years of schooling _____
3. Family income (annual) _____
4. Family Source of income _____
   a) Farming b) Farming + labor
   c) Farming + other business
5. Are you the household head?
   a) Yes b) No
6. Land holding _____Acres
7. Do you own this land?
   a) Yes b) No
8. Family size _____Members

B. Basic Information regarding Mobile phone

9. Do you have cellular phone access?
   a) Yes b) No?
10. Type of cellular Phone
    a) Smart Phone b) GSM or simple Phone
11. Do you have internet access?
    a) Yes b) No
12. Type of Internet
    a) 2G b) 3G c) 4G
13. How long you have been using mobile phone? _____
14. How many mobile phones does your family have?
    a) 1 **b)** 2 **c)** 3 **d)** More than 4
15. Please indicate your mobile operating skills?
    a) only voice calls
    b) SMS and internet-based application use
16. Do you use any mobile phone-based agriculture information service/ source?
    a) Yes b) No

C. Farmers use of various agricultural information sources

Agricultural information service	Yes	No	preferred service (Voice or SMS)
Govt. Agriculture Department Helplines 0800-15000 & 0800-29000			
Livestock department helpline 0800-78685			
Pvt. Agri. Companies (Farm Input suppliers)			
Pvt. Helplines			
Jazz Bakhabar Kissan Helpline 03030300000			
Telenor Khushal Zamindar Helpline 7272			
Ukissan Helpline700 (By Ufone)			
Zong Kissan portal Helpline 700 (By Zong)			
Warid Kissan Line Helpline 2444			

D. Please give us the suggestions for effective utilization of mobile phone-based FAS?