Factors affecting smallholder farmers' adoption of mobile phones for livestock and poultry marketing in Vietnam: implications for extension strategies

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Abstract. In order to promote smallholders' adoption of mobile phones for marketing, it is important to understand factors that influence their adoption. Hence, the purpose of this study was to investigate factors that affect the adoption of mobile phones for livestock and poultry marketing by smallholders in Vietnam. A two-section questionnaire was administered to 233 smallholder livestock and poultry farmers randomly selected from 573 smallholders in Phu Cat district of Vietnam. A binary logistic regression model was used to analyse the data. This study found that young smallholders who live close to an electricity base, with higher education levels, higher income, own large farms, participate in credit/training programmes, and who are members of community-based organisations, have a greater tendency to use mobile phones for livestock and poultry marketing. Subsidy and the provision of technical short course training on the use of mobile phones for smallholder livestock and poultry farmers are important extension strategies that can strengthen the adoption of mobile phones by smallholders for marketing, and this strategy should be delivered via community-based organisations.

Keywords: smallholders, adoption, livestock and poultry marketing, mobile phones, Vietnam.

Introduction

Agricultural development has been seen as an opportunity for growth in developing nations because this activity can contribute directly to economic growth (Bellon et al. 2020). Small-scale farms often dominate rural farming sectors in the developing world. For example, in the region of Sub-Saharan Africa, East Asia and the Pacific, more than 70% of farms are small-scale, and the income and employment of the majority of smallholders in these areas heavily relies on smallholder farming activities (Lowder et al. 2016). However, the smallholder farmers in developing nations, including Vietnam are encountering challenges in accessing and using knowledge, new technologies, credit and market information for maintaining and developing their livelihood (Pham 2018). Currently, 70% of the Vietnamese population are engaged in the agricultural sector and this sector contributed more than 15% to the total export earnings in 2018 (General Statistics Office of Vietnam 2019). The Vietnamese agricultural sector is preponderated by more than 10 million smallholders, providing an important proportion of the national production in 2018 (General Statistics Office of Vietnam 2019). Livestock and poultry production and marketing are important livelihood activities for many rural Vietnamese smallholder farmers (Burgos et al. 2008).

One of the key development programmes of the Government of Vietnam over the last decades has been helping smallholder farmers to gain access to markets (Tran and Dinh 2014). However, according to Pham (2018), many Vietnamese smallholders are facing numerous difficulties in accessing marketing information. The main marketing problems for the smallholder farmers are non-reliable market information, incomplete information and inappropriate information (Pham 2018). Information and Communication Technologies (ICTs) such as mobile phones, internet systems, radios, TVs and computers are important measures for lessening these marketing problems. According to Krone et al. (2016) and Bachaspati (2018), the utilisation of ICT tools such as mobile phones, radio and internet-connected computers for marketing can contribute to eliminating intermediaries, reducing transaction costs and finding suitable clients. Mapiye et al. (2020) suggest that ICTs help to strengthen communication of market information and enable producers to be constantly linked to diverse sources of market information and communication pathways. Prior studies (Mwantimwa 2017; Mapiye et al. 2020) also suggest that effective use of ICTs presents a great chance for enhancing information access for rural communities.

In developing nations, mobile phones are one of the most popular forms of ICTs used by farmers (Nyamba & Mlozi 2012; Krone et al. 2016; Hoang 2020a; Hoang 2020b). Tekin's (2011) study shows that mobile phones had assisted farmers to identify the market where they could get the best price for their produce. Mobile phones have enabled producers to concentrate and look for useful and up-to-date material such as market information and the prices of agricultural inputs from social and business networks, according to Overa (2006). The use of mobile phones can assist farmers improve their bargaining position because mobile phones help farmers to make contact with various suppliers and buyers (Krone et al. 2016).

According to Alavion et al. (2017), to promote the use of ICTs for agricultural product marketing, its ease of use, with advantages such as fast dissemination of information, needs to be demonstrated and the ICTs have to be made available to prospective users. The Government of Vietnam has strongly encouraged the producers' utilisation of ICTs for facilitating the country's development over the last decade. However, the unitization of ICTs by Vietnamese smallholder farmers for marketing of agricultural products is still very limited (VietNamNews 2017). To facilitate smallholder farmers' adoption of ICTs tools, such as mobile phones for marketing, it is crucial to understand what the factors are that shape its adoption.

Research into the adoption of ICTs for marketing by producers has been conducted in some countries (Senthilkumar et al. 2013; Mittal & Mehar 2016; Alavion et al. 2017). Reviewing existing literature reveals that the farmers' use of ICTs for marketing is associated with either one, or some, of the following characteristics:

- demographic characteristics of producers including: age, gender and education level (Tekin 2011; Senthilkumar et al. 2013; Mittal & Mehar 2016)
- socio-economic characteristics of producers including income, access to a micro credit system and farm size (Senthilkumar et al. 2013; Ogutu et al. 2014)
- situational characteristics of producers including: distance from the producer's home to local markets and distance from the producer's home to an electricity base (Tekin 2011; Ogutu et al. 2014; Abebe & Cherinet 2018)
- institutional characteristics of producers including: taking part in training programs (Abebe & Cherinet 2018).

However, few studies have investigated the integration of the mentioned characteristics about the smallholders' adoption of ICTs for marketing. In addition, there is scant research that has investigated smallholders' adoption of mobile phones for livestock and poultry marketing. Moreover, the findings reported in the existing ICT adoption literature (Senthilkumar et al. 2013; Ogutu et al. 2014; Mittal & Mehar 2016; Alavion et al. 2017; Hoang 2020a) are mixed. For instance, a study by Mittal & Mehar (2016) in India, used a multivariate probit model to investigate factors that shape the use of ICTs by farmers for marketing, found that the Indian farmers with a higher education level tended to utilise modern ICTs including mobile phones and internet-linked computers for marketing more than those with a lower education level, which is similar to the findings of Folitse et al. (2018) who conducted research on mobile phone adoption by farmers in Ghana. Mittal & Mehar (2016) also report that the Indian farmers who owned larger farms were better modern ICTs users than those who owned smaller farms. In contrast, Abebe & Cherinet (2018) investigated farmers' adoption of ICTs for marketing in Ethiopia and found that size of farmland had no effect on the adoption of both traditional and modern ICTs for marketing by cereal farmers, which is the same as Ogutu et al. (2014) findings who undertook a study on the farmers' adoption of ICTs for marketing in Kenya.

Abebe & Cherinet (2018) also found that Ethiopian farmers who had higher incomes were in a better position to adopt ICTs for marketing than those who had lower incomes, which contrasts with the findings of Senthilkumar et al. (2013) who found that income of Indian dairy farmers was negatively related to their level of utilising ICT tools for marketing. In addition, the distance from the producer's home to the markets negatively affected the adoption of ICTs for marketing, whereas access to credit programs had a positive effect on the producers' ICT adoption for marketing (Abebe & Cherinet, 2018). Taking all these characteristics together, it is clear that the producers' adoption of ICTs for marketing is context-dependent. Although, the socio-economic, situational and institutional characteristics of producers shaped their adoption of ICTs for marketing, the way these characteristics influence their adoption varied, depending on the contexts and marketing and production systems in which producers operated. Vietnamese livestock and poultry smallholders are operating very small-scale farms, and the Vietnamese production and marketing systems are changing from a conventional (traditional) to a modern system (Maruyama & Le 2012). As such, Vietnamese smallholders' practices to use mobile phones for marketing of agricultural produce will not be the same as the farmers' utilisation of mobile phones for marketing in other contexts. This research is designed to investigate factors that affect the adoption of mobile phones for livestock and poultry marketing by Vietnamese smallholder farmers. The research will provide useful insights as to what influenced smallholder farmers' adoption of mobile phones. Such insights will be of value for proposing policies to enhance the use of ICTs for marketing. This will help increase the uptake of ICTs by smallholder farmers and improve market access for smallholder farmers in Vietnam.

Study region and methodology

Study region

This research was conducted in Phu Cat district of Vietnam. The Phu Cat district comprises 681 km^2 (68,071 ha) and, in 2019, its population was 193,262. The agricultural sector is a key contributor to the district's economy (Binh Dinh Statistical Office 2019). About 90% of the district's inhabitants reside in rural regions and participate in farming activities (Binh Dinh Statistical Office 2019). Facilitating agricultural development is, thus, a key area of the social and economic development plan for the Phu Cat district (Phu Cat District People's Committee 2019). Agriculture in Phu Cat district consists of cropping, livestock/poultry, forestry and fishery activities. However, livestock and poultry are the important contributors to the district economy and, hence, central areas for the agricultural development in Phu Cat district. The recent official statistics show that livestock and poultry accounted for 67% of the total gross output from agriculture in 2018 (Binh Dinh Statistical Office 2019). The main livestock and poultry in the Phu Cat district include beef cattle, pig, chicken, duck and buffalo.

Sample, instrumentation and data collection

This research utilised a cross-sectional survey research design (De Vaus 2014). To obtain a standard sample size for this study, a technique of random sampling was applied to choose participants and a sample size formula suggested by De Vaus (2014) was employed to determine the needed number of participants at a 5% precision level. Accordingly, a statistical sample size of 233 smallholder livestock and poultry farmers were randomly chosen from a population of 573 smallholder livestock and poultry farmers who farmed livestock and poultry in the Phu Cat district of Vietnam. The total population of 537 smallholder livestock and poultry farmers is in the household list of the district, which was obtained from the Phu Cat District People's Committee Office.

A two-section standardized questionnaire was created to gather data. The first section contained statements on: (1) types of livestock and poultry farmed and marketed, prices of selling the livestock and poultry produce; (2) sources of livestock and poultry marketing information; (3) ICTs use by smallholders for marketing; (4) the extent of use of ICTs for livestock and poultry marketing. The extent of use of ICTs was measured on a five-point Likert scale, which ranged from "never use" to "very often use"; and (5) constraints to ICTs use. The second section collected socio-economic information such as age, gender, education level and income. The questionnaire was pre-tested with nine smallholders and it was evaluated by a group of experts from a university for face and content validity. Five experienced enumerators were employed to administer the questionnaires in the study region. The survey was conducted from March to May 2020.

Data analysis

Data were coded and analysed in SPSS version 20. Descriptive statistics including frequency, percentages, means and standard deviations were used. Inferential statistics including Chi squares test and T-test were applied to identify the relationships between independent variables associated with the adoption of mobile phones for livestock and poultry marketing. A model of binary logistic regression was employed to examine the effect of the exploratory variables on the dependent variable (Agresti & Finlay 2009). The binary regression analysis was chosen because this type of analysis helps to predict a discrete outcome of the dichotomous dependent variable from either dichotomous, continuous or discrete independent variables (Agresti & Finlay 2009). The exploratory variables were theoretically chosen from the relevant literature (Senthilkumar et al. 2013; Mittal & Mehar, 2016; Alavion et al. 2017; Abebe & Cherinet 2018) and based on the important characteristics of smallholder farmers in the study area.

The dependent variable used in this research is a dummy variable, which assigns a value of 1 for mobile phone user and 0 otherwise. The basic form of the binary regression model (Agresti & Finlay 2009; De Vaus 2014) utilised in this research is presented as follows:

$$\text{Ln}\left[\frac{Pi}{1-\text{Pi}}\right] = \beta o + \beta 1 X 1 + \beta 2 X 2 + \beta 3 X 3 + \cdots \beta n X n.$$

Where:

Pi is the likelihood that the smallholder is a mobile phone user.
1− Pi is the likelihood that the smallholder is a non-mobile phone user.
β_0 = is an intercept.
β_1, β_2... βn are slopes of the equation in the logistic regression model.
X_1, X_2... Xn are vectors of relevant smallholder characteristics.

Table 1 shows the characteristics of hypothesised dependent and exploratory variables in the adoption of mobile phones for livestock and poultry marketing. There were four dummy variables and six continuous variables.

Table 1. Hypothesized variables in the use of mobile phones for marketing

Variables	Explanation	Category	Measurement
Dependent variables			
Mobile phone users	Use of mobile phones for livestock and poultry marketing	Dummy	1 = User; 0 = Non-user
Independent variables			
AGE	Age of smallholders	Continuous	Years
EDULEV	Level of education of smallholders	Continuous	Years
DISTMAR	Distance from local markets	Continuous	m
DISTELEC	Distance from electricity base	Continuous	m
FARMSIZ	Farm size	Continuous	m^2
INCOME	Total annual income	Continuous	VND[a]
GENDER	Gender of smallholders	Dummy	1=male; 0= female
CREDITPA	Participation in credit programs	Dummy	1 = yes; 0 = no
TRAINPA	Participation in training programs	Dummy	1 = yes; 0 = no
CBOPA	Participation in CBOs[b]	Dummy	1 = yes; 0 = no

[a]: VND is Vietnamese dong. About 22,000 VND = 1 USD.
[b]: Community-based organisations (CBOs).

Results

Main characteristics of the livestock and poultry smallholders

Table 2 describes main characteristics of the livestock and poultry smallholders in the study region. Overall, the majority of the smallholders in this region were middle-aged. In particular, a large proportion of the smallholders were aged between 45-54 (39%), followed by those aged between 35-44 (25%), aged between 55-64 (17%) and aged between 25-34 (10%). About 53% of the respondents were female and 47% of the respondents were male. The majority of the smallholders' education level was in 'junior high school' (66%). In contrast, only about 10% of the smallholders graduated 'senior high school' and approximately 7% of the smallholders obtained 'certificate/technical training'.

A large percentage of the smallholders had an annual income from 46-60 VND million (36%), followed by annual income from 31 to 45 VND million (28%) and annual income from one to 30 VND million (18%). The average area of farmland owned by a smallholder in the study region was 2,650 m^2 (0.265 ha). The percentage of the smallholders who took part in technical training programmes conducted in the study region was 44%, while the percentage of those who did not take part in these programmes was 56%. The percentage of the smallholders who participated in rural credit programs operated in the study region (46%) was less than those who did not participate in these programmes (56%). In contrast, the percentage of the smallholders who were members of community-based organisations such as farmers' union, women's union and cooperatives (87%) was much greater than those who did not participate in these types of CBOs (13%).

Type of livestock and poultry produced and marketed by the smallholders

Table 3 presents types of livestock and poultry farmed and marketed by the smallholders. Overall, the smallholders participating in this research farmed and marketed several livestock and poultry including: chicken, beef cattle, pig, buffalo, goose and duck. A majority of smallholders produced and marketed chicken (74%), followed by beef cattle (55%) and pig (51%). However, only a small proportion of smallholders farmed and marketed buffalo, goose and duck, accounting for about 7%, 7% and 5% respectively.

Sources of market information

Table 4 describes sources of market information used by the smallholders in the study region. In general, the smallholders in this region sought livestock and poultry market information from a large number of sources including: neighbours, other farmers, preferred collectors, local markets, mobile phones, TV, women's union, internet and Facebook. The main smallholders' source of livestock and poultry market information was from neighbours (98%), followed by other farmers (80%), preferred collectors (60%), local markets (58%) and mobile phones (56%). About 11% of the smallholders reported getting market information through TV, which was about one fifth,

compared to livestock and poultry market information sought from mobile phones. In contrast, a small number of the smallholders reported looking for livestock and poultry market information through the farmers' union (7%), women's union (7%), internet (5%) and Facebook (3%).

Table 2: Characteristics of the smallholders

Smallholders' characteristics		Value[c]
Age (years)	18-24	9 (3.9)
	25-34	23 (9.9)
	35-44	58 (24.9)
	45-54	90 (38.6)
	55-64	39 (16.7)
	65 or older	14 (6.0)
Gender	Male	111 (47.6)
	Female	122 (52.4)
Education level	Did not go to school	20 (8.6)
	Primary school	20 (8.6)
	Junior high school	154 (66.1)
	Senior high school	23 (9.9)
	Certificate/technical training	16 (6.8)
Income/year (VND million)	1-30	42 (18.0)
	31-45	64 (27.5)
	46-60	78 (35.5)
	61-75	28 (12.0)
	More than 75	21 (9.0)
Farm size (m^2)	Average farm size	2,650.9 (range: 700.0 - 5,500.0)
Participation in training programs	Yes	103 (44.2)
	No	130 (55.8)
Participation in credit program	Yes	106 (45.5)
	No	127 (54.5)
Participation in CBOs	Yes	203 (87.1)
	No	30 (12.9)

[c] : Values in parenthesis are percentages and without parenthesis are numbers

Table 3: Types of livestock/poultry marketed by smallholders

Name of produce	Responses		Percent of Cases (%)
	Frequency	Percent (%)	
Chicken	173	37.2	74.2
Beef cattle	128	27.5	54.9
Pig	119	25.6	51.1
Buffalo	17	3.7	7.3
Goose	16	3.4	6.9
Duck	12	2.6	5.2

frequencies reflect multiple responses; *N* = 233

Table 4. Sources of market information

Sources	Responses		Percent of Cases (%)
	Frequency	Percent (%)	
Neighbours	228	25.6	98.3
Other farmers	185	20.7	79.7
Preferred collectors	139	15.6	59.9
Local markets	135	15.1	58.2
Mobile phones	129	14.5	55.4
TV	25	2.8	10.8
Farmers' union	17	1.9	7.3
Women's union	17	1.9	7.3
Internet	11	1.2	4.7
Facebook	6	0.7	2.6

frequencies reflect multiple responses; *N* = 233

The use of mobile phones for livestock and poultry marketing

Table 5 shows distributions of the smallholders by mobile phone use for livestock and poultry marketing in the study region. It was found that 129 smallholders used mobile phones for livestock and poultry marketing, while 104 smallholders did not use mobile phones for doing so. The smallholders who utilised a mobile phone for seeking livestock and poultry market information in this study were considered as mobile phone users. In contrast, the smallholders who did not use a mobile phone were treated as non-mobile phone users. Accordingly, about 55% and 45% of the smallholders were found to be mobile phone users and non-mobile phone users, respectively (Table 5).

Table 5. Distributions of smallholders by mobile phone use for marketing

ICT tools	Number of respondents	Percentage (%)
Mobile phone users	129	55.4
Non-mobile phone users	104	44.6
Total	233	100.0

Extent of use of mobile phones for marketing

Table 6 outlines the extent of smallholders' use of mobile phones for livestock and poultry for marketing. It can be seen that a number of the smallholders taking part in this study frequently used mobile phones for their livestock and poultry marketing. In particular, about 34% (80) and about 17% (38) of the smallholders reported using mobile phones for livestock and poultry marketing as "often" and "very often" respectively. In contrast, about 45% of smallholders reported not using mobile phones to market livestock and poultry produce.

Table 6: Extent of smallholders' use of mobile phones for marketing

Extent of use ICTs (mobile phones)	Frequency	Percentage (%)
Never	104	44.6
Rarely	4	1.7
Sometimes	7	3.0
Often	80	34.3
Very often	38	16.3
Total	233	100.0

Relationships between smallholders' characteristics and mobile phone use

Tables 7 and 8 report relationships between smallholders' characteristics and mobile phone use for livestock and poultry marketing in the study region. Generally, the use of mobile phones for livestock and poultry marketing was statistically associated with several characteristics of the smallholders. In particular, the chi-square test results in Table 7 showed that the use of mobile phones for livestock and poultry marketing by the smallholders was statistically associated with their gender and training program participation at less than 1% ($p<0.01$) and with their credit program participation at less than 5% ($p<0.05$). Similarly, the t-test results in Table 8 revealed that the smallholders' age, education level, distance from their home to electricity base, their farm size and income were statistically significant at less than 1% ($p<0.01$).

Table 7. Distribution of dummy variables by mobile phone use for marketing

Variables		Total		Mobile phone users		Non-mobile phone users		Chi-squares test
		N	%	N	%	N	%	
Gender	Female	112	52.4	56	24	66	28.3	9.28 ***d
	Male	111	47.6	73	31.3	38	16.3	(0.002)
Credit Participation	No	127	54.5	61	26.2	66	28.3	6.07 **e
	Yes	106	45.5	68	29.2	38	16.3	(0.014)
Training Participation	No	130	55.8	58	24.9	72	30.9	13.75 ***
	Yes	103	44.2	71	30.5	31	13.7	(0.000)
CBO Participation	No	25	10.7	10	4.3	15	6.4	2.67 NS f
	Yes	208	89.3	119	51.1	89	38.2	(0.102)

[d] : significant at ≤ 0.01
[e] : significant at ≤ 0.05
[f] : non-significant.

Table 8: Distribution of continuous variables by mobile phone use for marketing

Variables	Mobile phone users		Non-mobile phone users		t-test
	Mean	Std. Dev.	Mean	Std. Dev.	
Age	3.46	1.19	4.04	1.01	-4.02 ***d (0.000)
Level of education	3.24	0.84	2.68	0.95	4.65 *** (0.000)
Distance from local markets (m)	1,973.25	873.43	2,089.42	751.55	-1.07 NS f (0.284)
Distance from electricity base (m)	392.48	255.45	493.46	273.61	-2.90 *** (0.004)
Farm size (m²)	2,831.93	1,208.18	2,426.53	1,149.15	2.60 *** (0.01)
Income	3.94	1.04	3.31	1.23	4.14 *** (0.000)

d : significant at ≤ 0.01
f : non-significant.

Price of livestock and poultry marketed by the smallholders

Table 9 describes variation in prices of livestock and poultry when marketing them between mobile phone users and non-mobile phone users. It is clear that smallholders who used mobile phones were marketing their livestock and poultry produce at a higher price than those who did not use mobile phones to do so. In particular, t-test results in Table 9 showed a statistically significant difference in the average price per one kg of chicken and pig at a significance level of less than 1% ($p<0.01$); beef cattle at a significance level of less than 5% ($p<0.05$); and duck and goose at a significance level of less than 10% ($p<0.1$).

Table 9. Variation in prices among smallholders (VND)

Produce	Average price in VND/kg			t-test
	Mobile phone users	Non-mobile phone users	Mean difference	
Chicken	75,376.34	73,308.64	2,067.70	3.78 *** d (0.000)
Duck	40,166.66	39,666.66	500.00	1.86 * g (0.092)
Pig	40,445.94	38,444.44	2,001.50	5.17 *** (0.000)
Beef cattle	100,057.14	94,385.96	5,671.17	2.17 **e (0.031)
Goose	61,000.00	59,333.33	1,666.66	1.79 * (0.095)
Buffalo	76,333.33	72,000.00	4,333.33	1.13 NS f (0.274)

d : significant at ≤ 0.01
e : significant at ≤ 0.05
g : significant at ≤ 0.1
f : non-significant.

Factors affecting the adoption of mobile phones for marketing

Table 10 presents logistic regression model output for mobile phone use for livestock and poultry marketing. Generally, the characteristics of smallholders influenced their adoption of mobile phones for livestock and poultry marketing. Among the ten exploratory variables analysed, eight variables were found to be statistically significant and influencing the smallholders' adoption of mobile phones for livestock and poultry marketing. In particular, age of smallholders (AGE), distance from smallholders' home to the electricity base (DISELEC), farm size (FARMSIZ), income of smallholders (INCOME), participation in credit programs (CREDIPA), and participation in training programs (TRAINPA) were found to be statistically significant at less than 5% (0.05). Smallholders' education level (EDULEV) and community based-organisation participation (CBOPA) were found to be statistically significant at less than 1% (0.01).

Table 10: Logistic regression model output for mobile phone use for marketing

Variables	Coefficient	Std. Err.	*p value*
AGE	-0.393**	0.162	0.015
EDULEV	0.708***	0.211	0.001
DISTMAR	0.000[NS]	0.000	0.269
DISTELEC	-0.002**	0.001	0.023
FARMSIZ	0.000**	0.000	0.030
INCOME	0.320**	0.161	0.047
GENDER	0.546[NS]	0.368	0.138
CREDITPA	0.870**	0.345	0.012
TRAINPA	0.748**	0.349	0.032
CBOPA	1.402***	0.516	0.007
Constant	*-3.644***	*1.313*	*0.005*

N = 233
LR chi square (10) = 88.04***
Prob>chi-square =0.000
Model correction 80%.

Constraints to the use of mobile phones for livestock and poultry marketing

Table 11 reveals constraints to mobile phone use for livestock and poultry marketing by the smallholders in the study area. Generally, the key constraints that hinder the adoption of mobile phones by smallholders for livestock and poultry marketing in the study area were (1) 'high cost of using mobile phones' (64%), followed by 'lack of knowledge/skills to use applications on mobile phones' (55%). 'Mobile phone network problems' and 'not knowing how to use mobile phones' were the other main constraints to smallholders when using mobile phones for livestock and poultry marketing, and accounted for about 34%.

Table 11. Constraints to the use of mobile phones for marketing

Type of constraints	Responses		Cases
	No.	(%)	(%)
High cost of using mobile phone	150	30.7	64.4
Lack of knowledge and skill in using applications on mobile phones	129	26.4	55.4
Mobile phone network problems	80	16.4	34.3
Do not know how to use mobile phones	80	16.4	34.3
Poor quality battery	43	8.8	18.5
Unable to buy mobile phones	6	1.2	2.6

Discussion

Our analysis results show that the adoption of mobile phones for livestock and poultry marketing by smallholders was positively and significantly associated with their CBO participation. This means that the smallholders who are members of CBOs, have a greater tendency to adopt mobile phones for marketing. In the mainstream literature (Senthilkumar et al. 2013; Ogutu et al. 2014; Mittal & Mehar 2016; Alavion et al. 2017; Folitse et al. 2018), nothing has been written about the importance and impact of smallholders' CBO participation on their adoption of mobile phones for marketing of livestock and poultry. Agricultural extension programs designed to assist smallholder farmers adopt ICTs for marketing should consider smallholder farmers' participation in existing CBOs. Developing and sustaining the CBOs such as farmers' union, womens' union and agricultural cooperatives for rural smallholder farmers and promoting smallholders' use of ICTs via these organisations could be the good extension strategy to foster the adoption of mobile phones for marketing by smallholder farmers.

Adoption of mobile phones for livestock and poultry marketing by smallholders was positively and significantly associated with their participation in credit programmes, and participation in training programmes, a finding not reported in previous studies. The results suggest that the smallholders who participate in credit/training programmes have a greater tendency to adopt mobile phones for marketing of livestock and poultry. One possible reason is that in rural Vietnamese communities, smallholders who participate in credit programmes and training courses often have more human and financial resources and this can lead to being in a better position to adopt mobile phones for marketing of livestock and poultry. The Government of Vietnam must pay more attention to training smallholder farmers through both informal and formal education systems.

The district and provincial agricultural office, regional extension centres and other development agents need to provide training and orientation to smallholder farmers on how to obtain marketing information through using of ICT tools.

Adoption of mobile phones for livestock and poultry marketing was also negatively and significantly associated with age of smallholders and the distance from smallholders' homes to an electricity base, which means that younger smallholders who live close to an electricity base tend to use mobile phones for livestock and poultry marketing more than older ones who live far from an electricity base. A previous study by Abebe & Cherinet (2018) found that the adoption of ICT tools by Ethiopian farmers for cereal marketing was negatively affected by the age of the farmers, but it was not statistically significant, which is supported by this research.

It was found that the use of mobile phones for livestock and poultry marketing was positively and significantly associated with their education level. This means that smallholders who are at a higher education level are in a better position to adopt mobile phones for marketing of livestock and poultry. The findings from this study are generally consistent with findings reported in the literature (Mittal & Mehar 2016; Alavion et al. 2017; Abebe & Cherinet 2018), that farmers who are well-trained tended to be ICT adopters.

The results from this study indicate that smallholders in the study area look for market information of livestock and poultry from a wide range of information sources including: neighbours/friends, other producers, preferred collectors, local markets, mobile phones, TV, mobile phones, women's union, internet and Facebook. This suggests that market information for one type of produce such as beef cattle can be best gained from one source, such as other producers, while market information of other produce, such as chicken, may be best available from the local market. This also suggests that any single source of information may not meet all market information needs of the smallholder livestock and poultry farmers.

The results from this study also indicate that major constraints such as 'high cost of using mobile phones' and 'lack of knowledge/skills to use applications on mobile phones' are hindering the smallholder livestock and poultry to adopt mobile phones for marketing. Other constraints to the adoption of mobile phones for marketing include (1) 'mobile phone network problems' and (2) 'not knowing how to use mobile phones'. Subsidy and the provision of short course technical training on the use of mobile phones for smallholder livestock and poultry farmers are important extension strategies that could strengthen the adoption of mobile phones by smallholders for marketing. This strategy should be delivered via CBOs. This research needs to be replicated in other regions of Vietnam to better understand factors affecting the ICT adoption for marketing by smallholder farmers. The results gained will help to develop a national strategy for delivering development programs such as enhancing market access for Vietnamese smallholder farmers.

Conclusions and implications

In order to facilitate the smallholders' adoption of ICTs for marketing, it is important to understand factors that influence its adoption. This study is designed to determine factors that affect the adoption of mobile phones for livestock and poultry marketing by the Vietnamese smallholders. Based on the results of this study, it is concluded that younger smallholder farmers with higher education levels who live close to an electricity base, have higher income, own large farms, participate in credit/training programmes, and who are members of CBOs, have a greater tendency to adopt mobile phones for marketing of livestock and poultry. Extension strategies such as, improving marketing access for rural smallholder farmers through using of ICTs should create favourable conditions for smallholder farmers to access rural credit services and take part in agricultural cooperatives or interest groups. These are significant policies that need to be put in place to foster smallholder farmers to adopt ICTs for marketing.

The 'high cost of using mobile phones' and 'lack of knowledge/skills to use applications on mobile phones' are major constraints which are hindering the smallholder livestock and poultry to adopt mobile phones for marketing. Other constraints to the adoption of mobile phones for marketing include (1) 'mobile phone network problems' and (2) 'not knowing how to use mobile phones'. Enhancing infrastructure systems including electrical supply systems and basic literacy about the utilisation of ICTs are important. Financial credit should also be provided to smallholder farmers.

Results of this study should be shared with agricultural extension officers and policy makers to identify the suitable strategies for delivering market information to smallholder farmers, including developing agricultural extension programmes/strategies which shape agricultural development for the country. Extension strategies designed to promote smallholder farmers' adoption of mobile phones for marketing in developing countries should collaborate with existing CBOs and focus on young smallholder farmers with higher education levels.

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