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Research paper

Determinants of the adoption of mobile phones for fruit marketing by Vietnamese farmers

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ABSTRACT

Making farmers more informed about information and market opportunities is generally considered a significant way to improve their livelihood. Information Communication and Technologies (ICTs) can be important means of doing that. In order to facilitate farmers' adoption of ICTs for agricultural produce marketing, it is critical to understand factors that affect its adoption. However, few empirical studies have considered determinants of farmers' adoption of ICTs for marketing in Vietnam. This research investigates factors that shape adoption of ICT tools (mobile phones) for fruit marketing in Huong Son district, Vietnam. A random sample of 180 was drawn from a total of 325 farmers. Descriptive statistics, inferential statistics and a binary logistic regression were applied to analyse the data. The study concluded that young male farmers living far from local markets, who have high incomes and participate in training programs, have a greater tendency to adopt ICT tools (mobile phones) for fruit marketing. Demographic, socio-economic, situational and institutional characteristics of farmers should be considered when promoting farmers' adoption of ICT tools for agricultural produce marketing and when selecting marketing information strategies to deliver to small-scale farmers in developing countries.

1. Introduction

Despite the industrialization that has been occurring over the last three decades, agriculture still plays a significant role in social and economic development in developing countries. Smallholder farming dominates agricultural sectors in the developing nations. According to researchers (Lowder, Skoet, & Raney, 2016; Ye & Pan, 2016), in the developing world such as the Pacific, East Asia and Sub-Saharan Africa more than 70% of farms are small-scale, and the livelihood of the majority of the small-scale farmers in these regions heavily relies on smallholder farming activities. However, the smallholders in developing countries, such as Vietnam, are facing difficulties in accessing knowledge, skills, agricultural technology, finance and marketing information for maintaining and enhancing their livelihood (Lan, 2013; Thanh & Singh, 2006). Therefore, making the small-scale farmers in the developing countries more informed about market opportunities and more accessed knowledge, skills and new technologies is generally viewed a very significant way to develop the agricultural sector and improve the small-scale farmers' livelihood.

According to the General Statistics Office of Vietnam (GSO), most of the Vietnamese people live and work in rural areas (GSO, 2017). As such, agriculture plays an important role in the social and economic development of Vietnam (Dao & Nguyen, 2013). Facilitating agricultural development has thus been one of the Vietnamese Government's main development strategies for poverty reduction and improvement in social and economic growth. In Vietnam, the agricultural sector employed more than 70% of the labour force and contributed approximately 15% to the total export earnings in 2016 (GSO, 2017). The sector is dominated by 10.3 million smallholders, contributing a significant amount of the national agricultural production in 2016 (GSO, 2017). Fruit production and marketing are the important means of livelihood for many small-scale farmers who live in the rural areas of Vietnam (Nguyen, 2018).

Vietnam is in transition from a centrally planned to a more market-led system and this process was initiated after a comprehensive policy called the 'Doi Moi' policy was introduced in the 1980s (Cervantes-Godoy & Dewbre, 2010; Irvin, 1995). To facilitate this transition, the main agricultural development strategy of the Government of Vietnam (GOV) is to help farmers gain access to markets (Ha, Bosch, & Nguyen, 2015; Tran & Dinh, 2014). However, non-availability of timely information and non-reliable marketing information are the main marketing problems for most rural Vietnamese farmers (Pham, 2018). Information Communication and Technologies (ICTs) can be important means of reducing agricultural produce marketing problems (Alavion & Allahyari, 2012; Bachaspati, 2018; Baourakis, Kourgiantakis, & Migdalas, 2002).

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ICTs refer to technologies such as computers, mobile phones, TV, radio and internet systems that enable people to receive, process, transmit, or send information which maybe in form of voice, text and picture (Ajani, 2014; Kaware & Sain, 2015). ICTs can offer agricultural producers many chances to generate helpful networks with other producers, obtain important market information such as agricultural produce prices, and access knowledge and information. According to researchers (Alavion & Allahyari, 2012; Bachaspati, 2018; Baourakis et al., 2002), the adoption of ICTs for agricultural produce marketing significantly contributes to removing intermediaries, assists to reduce transaction costs and find potential customers. In order to facilitate the adoption of ICTs for agricultural produce marketing, its user friendliness and advantages must be demonstrated, and the ICTs must be made available to potential users (Alavion, Allahyari, Al-Rimawi, & Surujlal, 2017).

The Government of Vietnam has strongly promoted the adoption of ICTs for facilitating the country's development over the last decade (Konstadakopulos, 2005; Winley & Lau, 2012). For example, the Decision No. 32/2012/QD-TTg dated July 27, 2012 of the Prime Minister approving the plan for developing national telecommunications until 2020. This decision provided many favourable conditions for Vietnamese to use ICTs. However, the adoption of ICTs by Vietnamese farmers for the marketing of agricultural produce is still very limited (VietNamNews, 2017). If we understand key factors that affect the adoption of ICTs for agricultural produce marketing by Vietnamese farmers, then it is possible to facilitate the famers' uptake of ICTs for marketing and this will help bringing about changes and development for Vietnamese farmers.

Some studies into producers' adoption of ICTs for agricultural produce marketing have been conducted in other developing countries (Alavion et al., 2017; Kante, Oboko, & Chepken, 2017; Mittal & Mehar, 2016; Senthilkumar, Chander, Pandian, & Kumar, 2013; Wyche & Steinfield, 2016). The mainstream literature indicates that the producer's adoption of ICTs for agricultural produce marketing is likely to be linked to either one or some of the following elements.

a) Producer's demographic elements such as producer's age, gender and education level (Das, 2014; Fawole & Olajide, 2012; Mittal & Mehar, 2016; Senthilkumar et al., 2013);
b) Producer's socio-economic elements such as producer's income, access to micro-credit system and farm size (Fawole & Olajide, 2012; Ogutu, Okello, & Otieno, 2014; Senthilkumar et al., 2013);
c) Producer's situational elements such as distance from producer's home to local markets and distance from producer's home to electricity base (Abebe & Mammo Cherinet, 2018; Ogutu et al., 2014); and
d) Producer's institutional elements such as producer's participation in training programs (Abebe & Mammo Cherinet, 2018; Senthilkumar et al., 2013).

However, a few studies have examined the combination of the mentioned elements about the farmers' adoption of ICTs for agricultural produce marketing. In addition, there is no research that has investigated determinants of the farmers' adoption of ICTs for fruit marketing. Moreover, the findings reported in the mainstream literature (Alavion et al., 2017; Kante et al., 2017; Mittal & Mehar, 2016; Ogutu et al., 2014; Senthilkumar et al., 2013; Wyche & Steinfield, 2016) are not consistent across the studies. For examples, Mittal and Mehar (2016) examine factors affecting the use of ICTs by Indian farmers for marketing, using a multivariate probit model and report that the farmers with a higher education level tended to use modern ICTs such as mobile phones and internet-linked computers for marketing more than those with a lower education level. The authors also found that the farmers with large farms were better modern ICTs users than those with smaller farms. Applying the same research approach as Mittal and Mehar (2016), but using a binary logistic regression, Abebe and Mammo Cherinet (2018) report that Ethiopian cereal farmers who were more educated and well-trained have a greater tendency to use ICTs for agricultural marketing than those who were not. However, they found that farm size had no effect on the use of ICTs for agricultural marketing in both traditional ICTs such as radio and modern ICTs, which is similar to the findings of Ogutu et al. (2014) who undertook a study on the use of ICTs for agricultural produce marketing by Kenyan farmers.

Senthilkumar et al. (2013) examined factors associated with utilization of ICTs by the Indian dairy farmers for marketing and found that income was negatively associated with the level of using ICTs by the dairy farmers. In contrast, Ethiopian cereal farmers with higher incomes were in a better position to use ICTs than those with lower incomes (Abebe & Mammo Cherinet, 2018). In addition, the distance from home to the nearest local markets negatively affected the adoption of ICTs for cereal marketing, whereas access to credit programs had a positive effect on the farmers' ICT adoption (Abebe & Mammo Cherinet, 2018).

Taking all these factors together, it can be seen that the adoption of ICTs by farmers for agricultural produce marketing is context-specific. Although several demographic, socio-economic, situational and institutional aspects influenced the farmer adoption of ICTs for agricultural produce marketing, the way these factors affect its adoption varies, depending on the contexts and systems in which farmers farm. Vietnamese farmers are operating in very small-scale farms and the agricultural systems in Vietnam are in the early stages of transition from a traditional to a modern agri-food system (Cadilhon, Moustier, Poole, Tam, & Fearne, 2006; Maruyama & Le, 2012). As such, Vietnamese farmer's habit to use ICTs for marketing will be very different compared to the farmers' use of ICTs for marketing in other contexts. An investigation on factors that affect Vietnamese farmer's uptake of ICTs for agricultural marketing will provide significant insights into determinants of ICT adoption by small-scale famers. Such insights will contribute significantly to the literature exploring determinants of small-scale farmers' adoption of ICTs for agricultural produce marketing as well as highlight areas that need to be considered when designing policies to enhance the farmers' uptake of ICTs for marketing in developing countries that are in the early stages of a transition from a traditional to a modern agri-food system.

This study is designed to examine determinants of the adoption of ICTs for fruit marketing by Vietnamese farmers. The rest of this paper is organized as follows. The next section provides a brief research area and methodology. After that, selected results of the study are reported. In the next section, discussion of the key results of the study is provided. The final section is about conclusions and implications.

2. Research area and methodology

2.1. Research area and description

This study is conducted in Huong Son district. It is a rural highland district in Ha Tinh province, which is located in Central Vietnam (Fig. 1), and agriculture is a key contributor to its economy. The district comprises 1101 km^2 (110,100 ha). The agricultural sector made up more than 50% of the gross output of the district in 2018 (Ha Tinh Statistical Office, 2018). About 77% of the population live in rural areas and are engaged in agricultural activities (Ha Tinh Statistical Office, 2018). Promoting the development of the agricultural sector is, thus, an important component of the social and economic development plan for the district (Huong Son District People's Committee, 2018). The agricultural sector in the district comprises cropping, livestock and forestry activities, but fruit crops such as citrus fruit are the most important contributors to agricultural activity and, hence, a focus for the development in the district. In 2018, the gross output of fruit crops contributed to more than 80% of the total gross output from crops (Ha Tinh Statistical Office, 2018). The main fruit crops in the district include Orange Chanh, Orange Duong, Mandarin and Lemon.

2.2. Sample, instrumentation and data collection

This study applied a cross-sectional survey research design (De Vaus, 2014). In order to determine a standard sample size for this

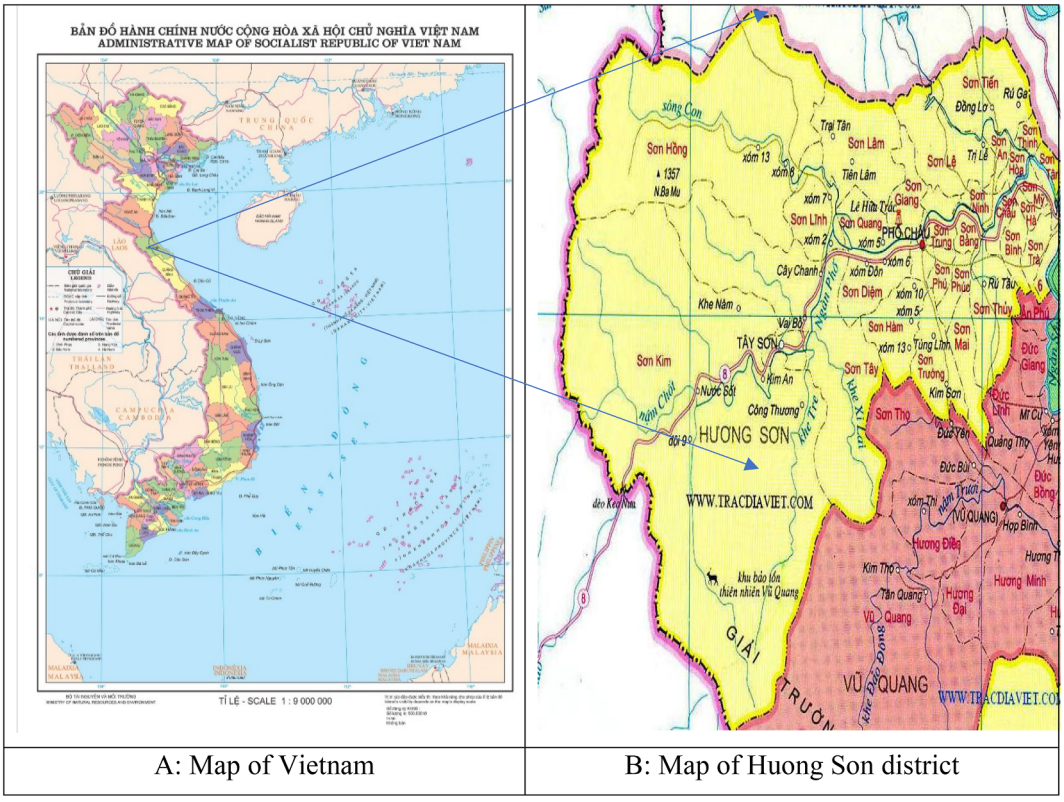

Fig. 1. The study region: A is Vietnam and B is Huong Son district.

research, a random sampling technique was used to select sample households and a formula provided by De Vaus (2014) was applied to determine the required maximum number of respondents at an 5% level of precision. Finally, a sample of 180 fruit farmers were randomly selected from a total population of 325 fruit farmers who mainly produced and marketed fruit in the Huong Son district, Ha Tinh province of Vietnam. The total population of 325 fruit farmers is in the list of fruit households of the district, which is obtained from the office of Huong Son District People's Committee.

A two-part structured questionnaire was developed to collect data. The first part comprised statements on: (1) types of fruit produced and marketed and prices of selling the fruit; (2) sources of fruit marketing information; (3) farmer ICTs' use for marketing; and (4) challenges when using ICTs. The second part gathered demographic, socio-economic, situational and institutional information. The questionnaire was reviewed by a panel of experts for face and content validity. Two trained enumerators were hired to manage the questionnaires in the field. The survey was conducted in 2018.

2.3. Data analysis

Data were analysed by using SPSS version 20. Descriptive statistics such as frequency percentages, means and standard deviations were used. Inferential statistics such as Chi squares test for dummy variables by ICT use and T-test for continuous variables were applied to identify the relationships between independent variables associated with the adoption of ICT for fruit marketing. Multicollinearity among the variables was checked. A binary logistic regression model was used to determine the effect of the independent variables on the dependent variable (Agresti & Finlay, 2009). The binary regression analysis is suitable for predicting discrete outcome of dichotomous dependent variable from independent variables that are dichotomous, continuous, discrete or an integration of these types of variables (Abebe & Mammo Cherinet, 2018; Agresti & Finlay, 2009; Southavilay, Nanseki, & Takeuchi, 2012). The dependent variable is a dummy variable which takes a value of 1 for ICT user and 0 otherwise. The independent variables were mindfully selected from the literature (Alavion et al., 2017; Kante et al., 2017; Mittal & Mehar, 2016; Senthilkumar et al., 2013; Wyche & Steinfield, 2016) and based on the main characteristics of smallholders in the study region.

The functional form of the binary regression (logistic) model (Agresti & Finlay, 2009; Field, 2013) is briefly described as follows:

$$\mathrm{Ln}\left[\frac{Pi}{1-\mathrm{Pi}}\right] = \beta o + \beta 1X1 + \beta 2X2 + \beta 3X3 + \cdots \beta nXn.$$

Where:

- Pi is the probability of the respondent being an ICT user.
- $1 - Pi$ is the probability of the respondent being a non-ICT user.
- β_0 = is an intercept.
- β_1, β_2... βn are slopes of the equation in the model.

Table 1 describes the characteristics of hypothesised dependent and independent variables in the adoption of ICT tools (mobile phones) for fruit marketing. Among ten independent variables, four variables were dummy, and the other six variables were continuous.

3. Results

3.1. Socio-demographic characteristics of the surveyed farmers

Table 2 describes socio-demographic characteristics of the surveyed farmers. The age of the surveyed farmers was ranged from 25 to 65 years or older. A high proportion of the surveyed farmers (31.7%) were aged between 45 and 54 (36.47%), followed by aged between 25 and 34 (26.1%), aged between 35 and 44 (25.0%) and aged between 55 and 64 (16.1%). About 58% of the farmers were male and the remaining 43% were female. The surveyed farmers' education levels as

Table 1
Hypothesized variables in the use of ICTs for fruit marketing.

Variables	Explanation	Category	Measurement
Dependent variables			
ICT users	Use of ICTs for fruit marketing	Dummy	1 = User; 0 = Non-user
Independent variables			
AGE	Age of farmers	Continuous	Years[1]
EDULEV	Level of education of farmers	Continuous	Years[2]
DISTMAR	Distance from local markets	Continuous	Kilometres
DISTELEC	Distance from electricity base	Continuous	Kilometres
FARMSIZ	Farm size	Continuous	Sao[3]
INCOME	Total annual income	Continuous	VND[4]
GENDER	Gender of farmers	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 CBO[5]	Dummy	1 = yes; 0 = no

[1] 1 = 18–24 years old; 2 = 25–34 years old; 3 = 35–44 years old; 4 = 45–54 years old; 5 = 55–64 years old; 6 = 65 years old or older.
[2] 1 = did not go to school; 2 = primary school; 3 = junior high school; 4 = senior high school; 5 = technical training; 6 = college degree; 7 = university degree; 8 = postgraduate; 9 = others.
[3] One hectare equals to 20 sao.
[4] VND is Vietnamese dong. About 23.000 VND = 1 USD.
[5] Community-based organisations (CBOs).

Table 2
Main characteristics of farmers (N = 180).

Farmers' characteristics		Value[1]
Age (years)	25–34	47 (26.1)
	35–44	45 (25.0)
	45–54	57 (31.7)
	55–64	29 (16.1)
	65 or older	2 (1.1)
Gender	Male	103 (57.2)
	Female	77 (42.8)
Education level	Did not go to school	17 (9.4)
	Primary school	56 (31.1)
	Junior high school	79 (43.9)
	Senior high school	28 (15.6)
Income/year	1–30 VND million	15 (8.3)
	31–45 VND million	9 (5.0)
	46–60 VND million	1 (0.6)
	61–75 VND million	57 (31.7)
	76–85 VND million	83 (46.1)
	86–95 VND million	1 (0.6)
	96–105 VND million	9 (5.0)
	106 VND million or higher	5 (2.8)
Farm size (sao)	Average farm size	4.1 (range 1–7)
Distance from local markets (km)	Average distance	6.6 (range 1–10)
Distance from electricity base (km)	Average distance	5.2 (range 3–6)
Training course participation	Yes	90 (50)
	No	90 (50)
Credit program participation	Yes	65 (36.1)
	No	115 (63.9)
CBO participation	Yes	58 (32.2)
	No	112 (67.8)

[1] : Values in parenthesis are percentages and without parenthesis are numbers.

did not go to school, primary school, junior high school and senior high school were 9.4%, 31.1%, 43.9% and 15.6% respectively. A high proportion of the farmers had income from 76 to 85 VND million (46.1%), followed by income from 61 to 75 VND million (31.7%). The average size (area) of farmland owned by a farmer was 4.1 sao and ranged from 1 to 7 sao ("sao" is a common unit of area in Vietnam and one "sao" equals to 500 m^2). The farm size distribution for a farmer is shown in Fig. 2. A high percentage of farmers had a farm size of 4 sao (26.6%),

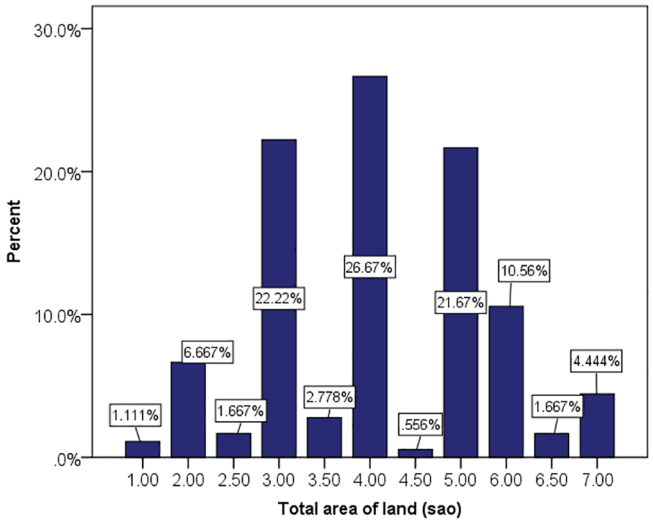

Fig. 2. Area of land distribution of farmers in the study region.

followed by 3 sao (22.2%) and 5 sao (21.6%). The percentage of the farmers participated in training courses (50%) was equal to those who did not take part (50%). The proportion of farmers who took part in credit programs (36.1%) was less than those who did not participate (63.9%). Similarly, the proportion of the farmers who was a member of CBOs (32.2%) was less than those who did not take part in this type of community-based organisation (67.8%).

3.2. Types of fruit produced and marketed by farmers

Table 3 describes main types of fruit produced and marketed by farmers in the study region. In general, farmers in this region produced and marketed a number of fruits including: Orange Bu, Mandarin, Lemon, Orange Duong and Orange Chanh. In particular, Orange Bu was the most popular fruit that was produced and marketed by all farmers in the study region. Lemon, Orange Chanh and Orange Duong were produced and marketed by a number of farmers, which accounted for 16%, 15.5% and 12.8% respectively. In contrast, only a small number of farmers (5%) produced and marketed Mandarin.

3.3. Sources of fruit market information

Table 4 reports farmers' sources of fruit marketing information. Overall, Vietnamese fruit farmers in the study region sought fruit marketing information from multiple sources including: neighbours/friends, other producers, preferred collectors/traders, mobile phone, local markets and TV. In particular, the main farmers' source was from neighbours/friends (99.4%), followed by from other producers (98.9%). Seventy-five and approximately sixty-four percent of farmers reported getting fruit marketing information through preferred collectors/traders and mobile phones, respectively. Farmers also sought fruit marketing information from local markets, which accounted for 50.6%

Table 3
Main types of fruits produced and marketed by famers.

No.	Type of fruits	Responses		Percent of Cases
		N	Percent	
1	Orange Bu	180	66.9	100.0
2	Mandarin	9	3.3	5.0
3	Lemon	29	10.8	16.1
4	Orange Duong	23	8.6	12.8
5	Orange Chanh	28	10.4	15.6

NB: frequencies reflect multiple responses; N = 180.

Table 4
Sources of fruit market information.

No.	Sources	Responses		Percent of Cases (%)
		Frequency	Percent (%)	
1	Neighbours/friends	179	24.7	99.4
2	Other producers	178	24.5	98.9
3	Preferred collectors/ traders	135	18.6	75.0
4	Mobile phone	115	15.8	63.9
5	Local markets	91	12.5	50.6
6	TV	26	3.6	14.4

NB: frequencies reflect multiple responses; N = 180.

which was about half compared to fruit marketing information sought from neighbours/friends and from other producers. Only a small number of farmers (14.4%) reported seeking fruit marketing information from TV.

3.4. The use of ICTs for fruit marketing

Table 5 presents the distribution of respondents by ICT tools used for fruit marketing. Overall, farmers participating in this study used mobile phones as the key ICT tool to seek fruit market information from different information sources. Our analysis results showed that 115 of the respondents used a mobile phone, and the remaining 65 did not use this ICT tool. The respondents who used a mobile phone for getting marketing information in this study were considered as ICT users. In contrast, the farmers who did not use a mobile phone were regarded as non-ICT users. Accordingly, 63.9% and 36.1% of the respondents were found to be ICT users and non-ICT users, respectively (Table 5).

The chi-square test results in Table 6 revealed that there was a statistically significant difference between ICT users and non-users (mobile phone users and non-users) with regard to gender, credit program participation and training program participation at less than 1% ($p > 0.01$). The T-test results in Table 7 showed age, education level, distance from home to nearest local markets, farm size and income were statistically significant at less than 1% (p *less than 0*.01).

3.5. Farmers price for fruit

Table 8 shows variation in producer prices when marketing fruit between ICT users and non-ICT users. It can be seen that farmers using ICTs were selling their fruit produce at a higher price than those who did not use ICTs to do so. Importantly, T-test results in Table 8 show a statistically significant difference in the average price per one kg of Orange Bu, Lemon and Orange Duong at a significance level of less than 1% ($p > 0.01$).

3.6. Logistic regression model output for ICT use for fruit marketing

Table 9 describes an estimation of logistic regression model output for ICT use (mobile phone) for fruit marketing. Overall, demographic, socio-economic, situational and institutional characteristics of farmers affected their adoption of ICTs for fruit marketing. Among the ten independent variables analysed, six variables were found to be statistically significant and affecting the respondents' adoption of ICT for fruit marketing. In particular, age of respondents (AGE), credit program participation (CREDIPA) and training program participation (TRAINPA) were found to be statistically significant at less than 5% (0.05). Distance from home to the nearest local markets (DISMA), income of respondents (INCOME) and gender of respondents (GENDER) were found to be statistically significant at less than 1% (0.01).

Table 10 shows challenges in using ICT tools (mobile phones) for fruit marketing by farmers in the study region. It can be seen that the main challenges that impede the adoption of ICTs by Vietnamese farmers for fruit marketing in the study region were (1) high cost of using mobile phones (84.4%), followed by lack of knowledge/skills to use applications on mobile phones (63.1%). Mobile phone network problems and not knowing how to use mobile phones were somewhat challenges for farmers when using ICTs (mobile phones) for fruit marketing, and accounted for 3.4% and 2.2% respectively.

Table 5
Distributions of respondents by ICT use for fruit marketing.

No.	ICT tools	Number of respondents	Percentage (%)
1	Mobile phone users	115	63.9
2	Non-mobile phone users	65	36.1
3	Total	180	100.0

Table 6
Distribution of dummy variables by ICT use for fruit marketing.

Variables		Total		Mobile phone users		Non-mobile phone users		Chi-squares test
		N	%	N	%	N	%	
Gender	Female	77	42.8	29	16.1	48	26.7	40.118**[1]
	Male	103	57.2	86	47.8	17	9.4	
Credit participation	No	115	63.9	65	36.1	50	27.8	7.492**
	Yes	65	36.1	50	27.8	15	8.3	
Training participation	No	90	50.0	37	20.6	53	29.4	40.479**
	Yes	90	50.0	78	43.3	12	6.7	
CBO participation	No	122	67.8	76	42.2	46	25.6	0.417[NS2]
	Yes	58	32.2	39	21.7	19	10.6	

[1]** indicate significant at ≤0.01 level.
[2]NS indicates non-significant.

Table 7
Distribution of continuous variables by ICT use for fruit marketing.

Variables	Mobile phone users		Non-mobile phone users		*t*-test
	Mean	Std. Dev.	Mean	Std. Dev.	
Age	3.043	0.985	4.061	0.916	−6.824**
Level of education	2.860	0.825	2.292	0.785	4.515**
Distance from local markets	7.852	1.812	4.584	2.621	8.917**
Distance from electricity base	5.261	0.828	5.123	0.927	1.027[NS]
Farm size	4.678	1.232	3.292	0.979	8.286**
Income	5.904	1.051	4.446	1.677	6.341**

Table 8
Variation in producer prices among farmers (VND).

Fruits	Average price in VND/kg			t-value
	Users	Non-users	Mean difference	
Orange Bu	30,773.9	28,861.5	1912.3	9.724**
Mandarin	15,928.5	15,666.6	261.9	1.144[NS]
Lemon	12,076.9	10,200.0	1876.9	10.947**
Orange Duong	21,916.6	20,600.0	1316.6	4.267**
Orange Chanh	21,294.1	20,772.7	521.3	2.008[NS]

Note:
**: indicate significant at ≤ 0.01 level. NS: indicates non-significant.

4. Discussion

This research is designed to investigate determinants of the adoption of ICTs for fruit marketing by Vietnamese small-scale farmers. A

Table 9
Estimation of logistic regression model output for ICT use for fruit marketing.

Variables	Coefficient	Std. Err.	P *value*
AGE	−0.614*[1]	0.292	0.036
EDULEV	−0.493	0.391	0.207
DISTMA	0.440**	0.152	0.004
DISTELE	0.172	0.348	0.621
FARMSI	0.456	0.261	0.081
INCOME	1.560**	0.391	0.000
GENDER	1.720**	0.621	0.006
CREDITPA	−2.034*	0.801	0.011
TRAINPA	1.431*	0.687	0.037
CBOPA	0.150	0.616	0.807
Constant	−10.499**	3.537	0.003

Note: *Number of observations = 180.*
*LR chi square (10) = 140.91**.*
Prob > chi-square = 0.000.
– Log likelihood = 94.546.
Nagelkerke R Square 0.744.
Model correct prediction: 90.6%.
[1]:* indicates significant at ≤0.05 level.

Table 10
Challenges in using mobile phone for fruit marketing.

Challenges in using ICTs (mobile phone)	Responses		Percent of Cases (%)
	Frequency	Percent (%)	
High cost of using mobile phones	151	55.1	84.4
Lack of knowledge using app. on mobile phones	113	41.2	63.1
Mobile phone network problems	6	2.2	3.4
Do not know how to use mobile phones	4	1.5	2.2

NB: frequencies reflect multiple responses; N = 180.

binary logistic regression model is used to examine key factors that affect the Vietnamese farmers' adoption of ICTs for fruit marketing. This is believed to be the first study which has examined factors that influence small-scale farmers' adoption of ICTs for fruit marketing in a developing country that is in the early stages of a transition from a traditional to a modern agri-food system, using quantitative methods. The research results show that the characteristics of fruit farmers varied, reflecting a diverse context of fruit production and marketing system in the study region. Our analysis shows that small-scale farmers do not produce and market a single type of fruit, but a number of fruits including: Orange Bu, Mandarin, Lemon, Orange Duong and Orange Chanh. The results from this research show that Vietnamese small-scale farmers seek fruit marketing information from several sources which may be complementary to each other. This means that one type of marketing information such as fruit prices may be best available from one information source such as preferred collectors while other marketing information can be best obtained from other producers in the village. This also suggests that any single source of information does not meet all information needs of the farmer for fruit marketing. The results from this research is generally consistent with the findings reported in the literature (Alavion et al., 2017; Das, 2014; Mittal & Mehar, 2016), that farmers did not rely on a single source of information for marketing agricultural produce, but used diverse information sources.

Our analysis results revealed that the adoption of ICT tools (mobile phones) for fruit marketing was negatively associated with age of farmers and this association was statistically significant. This means that younger Vietnamese farmers are in a better position to adopt mobile phones for fruit marketing than older Vietnamese farmers. Basically, the results of this study support Abebe and Mammo Cherinet (2018) findings that the adoption of ICTs by Ethiopian farmers for cereal marketing was negatively affected by the age of the farmers, but it was not statistically significant. For any development programs and strategies that aim to promote Vietnamese small-scale farmers' adoption of ICTs for fruit marketing, the age of the farmers should be taken into account.

This study found that the use of ICTs (mobile phones) for fruit marketing was positively and significantly associated with the distance from farmers' homes to the nearest local markets. This suggests that farmers who live far from local markets tend to be mobile phone adopters for fruit marketing. In the mainstream literature (Alavion et al., 2017; Kante et al., 2017; Mittal & Mehar, 2016; Ogutu et al., 2014; Senthilkumar et al., 2013), little has been written about the importance and impact of distance from farmers' homes to the nearest local markets on their ICT adoption for fruit marketing. In the developing countries such as Vietnam where the traditional market system for fruit consisting of a diverse types of markets including official markets (formal markets), unofficial markets (informal markets), street vendors and small independent stores (shops) (Moustier, Figuié, Dao, & Nguyen, 2009), infrastructure development in rural areas including the distance from farmers' homes to the nearest markets substantially influence their decisions in relation to ICT adoption as evidenced in this study.

The present study found that the adoption of ICTs (mobile phones) for marketing was positively and significantly associated with income, gender and training program participation, which means that Vietnamese male farmers who had high income and participated in training course programs were in a better position to use ICTs for marketing than female farmers who had lower income and did not participate in such programs. This can be explained as follows; in rural Vietnamese communities, men often have more freedom to move about to get agricultural information and this may likely affect their adoption of ICTs (mobile phones) for marketing. In addition, Vietnamese farmers who have high income and participate in training courses often have more human and financial resources and this can lead to being in a better position to adopt ICTs (mobile phones) for marketing. The characteristics of farmers' gender, income and training course participation should be considered when promoting farmers' adoption of ICT tools for fruit marketing and when selecting marketing information strategies to deliver to fruit farmers in Vietnam.

It was, however, found that the adoption of ICTs for fruit marketing was negatively and significantly associated with farmers' credit program participation, which is not consistent with the findings by Abebe and Mammo Cherinet (2018), who reported that access to credit use was positively associated with the use of ICTs for cereal marketing by Ethiopian farmers. This research illustrates how the specific production and marketing system context and the stages in technological transition to a modern agri-food system in Vietnam shaped Vietnamese small-scale farmers' decision in relation to ICT adoption for fruit marketing.

5. Conclusions and implications

The small-scale farmers in developing countries, such as Vietnam, are facing difficulties in accessing knowledge, skills, agricultural technology, finance and marketing information for maintaining and enhancing their livelihood. ICTs enable small-scale farmers in developing countries to access timely and reliable agricultural market information, so as to make viable decisions. This paper has investigated the factors that may influence farmer's adoption of ICTs (mobile phones) for fruit marketing. A binary logistic regression model was used, and the results show that younger male farmers who had higher income are in a better position to use ICTs (mobile phones) than older female farmers with lower income. Farmers who live far from local markets tend to be ICT users compared to those who live close to one. Farmers who participated in training programs are better ICT users than those who did not take part in them. However, farmers who did not participate in credit programs tended to be ICT users compared to those who took part in this program. The high cost of using mobile phones and lack of

knowledge/skills to use applications on mobile phones are hindering farmers to adopt ICTs (mobile phones) for fruit marketing. Financial support and the provision of training courses on the use of ICTs for fruit farmers are some of strategies that can facilitate the farmers to adopt ICTs (mobile phones) for marketing.

This research should be replicated in other areas of Vietnam to better understand factors shaping the adoption of ICTs for agricultural produce marketing by small-scale farmers. Such an understanding will help to develop a national strategy for delivering development programs such as improving market access for rural Vietnamese farmers. Findings of this study should be shared with local communication officers and extension educators to identify the most appropriate strategies for delivering marketing information for fruit farmers. A combination of demographic, socio-economic, situational and institutional characteristics of farmers and farms should be taken into account when promoting farmers' adoption of ICT tools for agricultural produce marketing and when selecting marketing information strategies to deliver to small-scale farmers in developing countries.

It is acknowledged that this study has limitations. The study has provided an important understanding of determinants of small-scale farmers' adoption of ICTs (mobile phones) for fruit marketing. However, the data of this study was focused on only citrus fruits. There is need for more study in order to generalize these findings. Extending this study beyond the Huong Son district and other types of fruit would be also very interesting. In addition, the research design used in this study was cross-sectional. It only measured farmers' perceptions at a single point in time. Clearly, farmer's perceptions change over time as the farmers obtain practical experience. For anyone interested in predicting ICT adoption by small-scale farmers over time, this change has implications. Thus, more effort to evaluate validity of the findings from this study is required. The present study focuses on fruit. Further research could be conducted to assess determinants of farmers' ICT adoption with other agricultural produce including livestock and fishery. Different contexts could help to capture full insights into farmers' ICT adoption for marketing.

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Conflicts of interest

The author declares no conflict of interest.

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