Factors Affecting Farmers' Uses of Information Sources in Vietnam

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Abstract

Every information source has advantages and disadvantages for delivering certain types of information. However information sources have generally been recognized as tools that improve the efficiency and effectiveness of agriculture as collecting and distributing agricultural information is difficult, time-consuming, and expensive. The purpose of this study is to identify factors that explain the variation among farmers in their use of information sources based on household (farm)-level data. The results show that household income, farm size, household size, educational attainment, and off-farm jobs are the most important factors influencing the use of media and personal information sources. The implications of these results are introducing and encouraging more off-farm jobs for farmers. As such, the provincial government and extension agents are recommended to work more effectively to enhance and help farmers diversifying crops and applying technologies. It is also important to improve the quantity and quality of extension services. The results also suggest that adjusting policies for reducing the gap among districts are needed, and farmers' education should focus on training for agricultural knowledge, social activities, governmental policies, as well as, using informational sources, such as the Internet, computers, etc.

Keywords

information sources, agricultural information, agricultural ICT, ivprobit, Vietnam

Introduction

An information source is an originator of facts or knowledge that can inform individuals. There are many types of information sources because there are numerous types of questions. Consequently, information sources can be primary, secondary, or tertiary sources, and they can be classified as observations, people, documents, etc.

Information sources are very important in agricultural activities because agriculture strongly relates to socio-economic development, food and securities issues, increasing yields, improving product quality, and reducing costs. As such, information is necessary to both the inputs and outputs of agricultural activities

(Kaaya 1999). Farmers can better decide and realize greater profits when they have good data, analysis of marketing strategies, and detailed information on costs (Milovanović 2014).

Numerous studies have investigated the use and adoption of information and communication technologies (ICT) in agriculture (Foltz and Makus 1996, Ford and Babb 1989, Gloy and Whipker 2000, Kaaya 1999, Milovanović 2014, Ortmann et al. 1993, Patrick et al. 1993). Some of these studies cover mostly rural and remote areas (Adamides et al. 2013, Madden and Coble-Neal 2003, Michailidis et al. 2011, Ramirez 2001). However, most of them are conducted in developed countries, such as the US, Australia, and Canada or in countries such as Cyprus, Tanzania, Serbia, and Greece. Furthermore, they focus on analyzing factors that influence the adoption and use of personal computers and the Internet by farmers unfamiliar with farming in Vietnam, particularly in rural and remote areas.

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This study employs data from surveys conducted in Son La Province in northwest Vietnam. Son La is considered the largest cultivated area and biggest producer of maize in Vietnam. However, it is distant from the capital and more rural than any other region in Vietnam (Minot et al. 2006).

The Son La geography consists mostly of hills and mountains, the transportation system is poorly developed, and poverty is relatively high (58.7%), compared to the 2012 national average of 17.2% (GSO 2012). The inhabitants are mostly members of ethnic groups that tend to have a low educational attainment and that lack access to modern technologies (Linh et al. 2015c).

As previously mentioned, information sources have an important role in all socio-economic activities, including agriculture, and are recognized as a tools to improve efficiency and effectiveness in agricultural production. However, studies have not been conducted place in Vietnam on the importance of information sources in agriculture or the determinants of information source use by Vietnamese farmers. Consequently, this study identifies the factors that explain variation among farmers in their use of information sources. The results are helpful for farmers, policy makers, extension agents, and researchers. The following section briefly explains the study's methodology. Subsequently, the data and variables are described, the results are presented and discussed. Finally, the implications and conclusions are drawn.

Methodology

Farmers at the study site were asked whether and how often they use information sources. A respondent's decision to use an information source was provided by an indicator, where 1 would mean "yes" and 0, "no". Since the indicator is the outcome variable, a binary regression model was used to examine the farms' and farmers' characteristics that influenced their use of information sources (Adamides et al. 2013, Gloy and Akridge 2000, Hoag et al. 1999).

The binary model is written as follows:

$$D = I(\beta X_i + \varepsilon \geq 0) \quad (1)$$

where D is an observed binary variable, the dependent variable to be explained, $\beta_{i,s}$ are the parameters to be estimated, X_i is the vector of the independent variable, and ε is the unexplained random component (error term). This type of specification is known as a threshold crossing model, and special cases of the threshold crossing model are logit and probit models, with logistic or normal error term, respectively.

However, binary choice models often deal with estimation problems when one or more regressors are endogenous or

mis-measured. For example, if treatment is not randomly assigned and outcomes are binary, the endogeneity of treatment effects will be occurred. Literature suggests certain approaches to solve this problem, such as the linear probability model (LPM) with instruments, maximum likelihood estimation (MLE), control function based estimation, and special regressor methods. Each of these estimators have advantages and disadvantages, but of these drawbacks are rarely acknowledged or recognized. However, all of this estimators requires a set of strong instrument variables (Lewbel et al. 2012). For our study, we chose MLE using the ivprobit model (probit model with continuous endogenous regressors) to solve the endogeneity problem if it appears after trying to compare with other methods.

Assume that some elements of X_i in the binary model (1) are endogenous or mismeasured, and they may correlate with the error term (ε). Let X_i^e and X_i^0 denote the vectors of endogenous and exogenous regressors. Let Z be a vector of instrument variables. Generally, Z can include all of the elements of X_i^0 . Let $G(X_i^e, Z, \epsilon) = 0$ show the relationship between X_i^e and Z , where G is a function containing many elements of the vector X_i^e and ϵ is a vector of errors.

Hence, the threshold model is

$$D = I(\beta^e X_i^e + \beta^0 X_i^0 + \varepsilon \geq 0) \quad (2)$$

$$X_i^e = G(X_i^e, Z, \epsilon)$$

This model can be implemented using MLE. Maximum likelihood allows endogenous regressors in X^e only to be continuous only, and can not be used with discrete endogenous regressors (Lewbel et al. 2012, StataCorp 2013).

Data and Variables

The data were derived from face-to-face interviews with 360 randomly sampled respondents from 12 villages in three districts in Son La province, Vietnam. The survey was conducted between February and March 2014, and collected valuable information on various aspects of respondents' lives, such as household composition and characteristics, farm characteristics, crop production and cropping systems, information sources used, etc.

Information sources used by the respondents

Previous studies suggest that farmers use many information sources (Ford and Babb 1989, Tatlidil et al. 2008, Gloy et al. 2000, Ortmann et al. 1993, Patrick et al. 1993). However, this survey received limited responses on the information sources used because of the methodology and status of the respondents.

Following Gloy et al. (2000) and Tatlidil et al. (2008), and considering the reality of information sources farmers use, and the difficulty in collecting data, we define all dependent variables. Five information sources (i.e., print materials, radio, television, mobile phones, and the Internet) were categorized as media sources and three others (i.e., extension services, visited an agricultural model, and agricultural group membership) were categorized as personal sources.

Table 1 summarizes the eight measures of information source use in the study. Most of these dependent variables were collected by asking the frequency of accessing information sources. Printed materials include books, magazines, news, brochures, which can be read by buying, borrowing or going to the Commune Cultural Post Office (CCPO). Most households in the study area own television, some families having more than one. The number of radios that farmers own is small because most of the communes have a linked loudspeaker system. However, farmers use these mass media for entertainment, and news, and programs on television or radio lack agricultural information. Around 99% of respondents have their own mobile phone but they only use them to communicate with each other for social activities.

Although most of the respondents have mobile phones, only around 1% of them have Internet connectivity. This lack of access is because smart-phones and Internet services that use 3G technologies are too expensive for the respondents. Moreover, the Internet signal in the studied area is limited. Only around 24.7% and 12.5% of respondents read print materials several times per month or listened to the radio at least five times per week, respectively. On the other hand, around 90% of the respondents reported that they watched television at least

five times per week. There are various types of agricultural information that farmers can get from printed materials, television, radio, the Internet, such as weather, agricultural technologies, price of agricultural input and output, advanced or new agricultural models, policies, etc. Farmers can use mobile phones to directly connect with friends, local government staffs, and extension agents to ask or access the internet to get information related to their agricultural activities.

Regarding personal sources, about 76.7% of the sample are members of at least one agricultural group, but only a small proportion had visited an advanced agricultural model (15.8%). There are some agricultural groups whose purpose is to help and advice farmers in farm activities such as women, farmer, and credit groups. Advanced agricultural models are any kind of agricultural operations on a farm, such as breeding, cultivation, forestry, or fishery activities, which use little input but can get high profits and higher income. In this respect, the extension agent may be a good information source, because only 21.4% of the respondents reported that they could receive support from extension services. In Son La province and the entire Vietnam, the current extension activities are focused on setting up models and transferring new advanced techniques to farmers, such as organizing training for farmers by forum in the fields, face-to-face, via TV (Television), radio, brochures, VCD (Video Compact Disc), and websites, and creating opportunities for some advanced farmers to utilize advanced agricultural technologies. Additionally, the extension system takes the responsibility to transfer new policies and market information. There are many actors participating in agricultural extension activities, such as government extension system, universities, research institutions, enterprises, NGOs, and volunteer exten-

Table 1 Descriptive statistics of dependent variables on the use of information sources

Variable	Description of variables	Proportion	Standard deviation
<i>Media sources</i>			
Print material	Reads print materials several times a month	0.247	0.432
Radio	Listens to the radio at least 5 times per week	0.125	0.331
Television	Watches television at least 5 times per week	0.900	0.300
Mobile phone	Has at least one cell (mobile) telephone	0.986	0.117
Internet access	Mobile phone can access the Internet	0.011	0.105
<i>Personal sources</i>			
Extension services	Receives information from extension services	0.214	0.411
Visited agricultural model	Has visited an advanced agricultural model	0.158	0.366
Membership	Is a member of an agricultural group	0.767	0.424

Note: All variables are coded 1=yes and 0=no
Source: Own survey, 2014

sion organizations (associations, local common interest groups). However, the government extension plays as the key role, and top down or the supply-driven extension approach is the main operation method (Bo <<http://www.syngentafoundation.org/index.cfm?pageID=736>> 2016). Please see Linh et al. (2015b) for details on these information sources.

Factors influencing use of information sources

Previous studies have identified numerous factors expected to influence the adoption of certain information sources. Table 2 describes the variables in this study, expected to influence use of the eight information sources. Household heads are most likely to be males with a mean age of around 45 years and between six and seven years of education. The average number of household members is five, although the largest household has 13 people. The largest farm size is 12.6 ha, with a mean size of 1.84 ha. However, the geography of the study site dictates that large area farms have hilly and sloping lands. The mean gross household income was VND (Vietnam Dong) 91 million per year (USD 4,323 as of March 2014). The household incomes at the top of the distribution were obtained from off-farm economic activities. Vietnamese labor laws indicate that the minimum working age is 15 and the statutory retirement age 60 for men and 55 for women. Therefore, in our research, we calculate the number of labor force in that range. Table 2 shows that the average laborers in each household are around three with a minimum of one and a maximum of 11.

The three districts, based on the three types of altitudes in the study area, are indicated in the analysis as dummy vari-

ables. Phu Yen is at the highest attitude, 2,000 m, where transportation and engaging the economy are difficult and less developed. This region serves as the reference group in the statistical analysis and is, thus, used for comparison to the other regions in the logistic regression models.

In our study, we assumed that household income is an endogenous regressor, and the number of household members of working age and livestock activity were used as the instrument variables.

Considering multicollinearity, we also examined the correlation matrix, and the results show that the multicollinearity does not exist among all variables.

Results and Discussion

Before conducting the ivprobit model to analyze the factors that may influence each type of information source, we check the strength of instrument variables, which shows the partial and sufficient correlation between endogenous and instruments variables and its strength. This was achieved by regressing the endogenous regressor (household income) with all exogenous and instrument variables and then calculating the F-statistic on the estimators of the instrument variables. The results indicate an F-statistic of 11.09 ($p < 0.001$). Hence, our instrument variables are strong enough and ivprobit will lead to consistent estimators (Staiger and Stock 1997, StataCorp 2013).

The output of the ivprobit model gives us the Wald test of exogeneity for instrument variables. If the test is significant, we reject the null hypothesis that assumes no endogeneity. Other-

Table 2 Descriptive statistics of variables influencing information sources

Variable	Description of variables	Mean (SD)	Min	Max
Gender	Gender of household head, 1=male, 0=female	0.872 (0.334)	0	1
Age	Age of household head (years)	44.781 (11.662)	21	87
Education	Education attainment of household head (years)	6.669 (3.270)	0	12
Household size	Number of household members (persons)	4.856 (1.594)	2	13
Farm size	Total farm size (ha)	1.836 (1.444)	0.09	12.6
Income	Total household income (VND millions) per year	91.328 (62.749)	2.55	355
Off-farm	Takes 1 if the farm has off-farm job, 0=otherwise	0.139 (0.346)	0	1
Labor	Number of household members in working age (person)	2.942 (1.251)	1	11
livestock	Takes 1 if the farm has livestock activities, 0=otherwise	0.461 (0.499)	0	1
Moc Chau	Takes the value 1 if farmer lives in Moc Chau district, 0=otherwise	0.342 (0.475)	0	1
Mai Son	Takes the value 1 if farmer lives in Mai Son district, 0=otherwise	0.328 (0.470)	0	1
Phu Yen	Takes the value 1 if farmer lives in Phu Yen district, 0=otherwise	0.330 (0.471)	0	1

Source: Own survey, 2014

wise, we can not reject the null hypothesis because of insufficient sample information, a regular probit model being more appropriate (Wooldridge 2013, 2010). Literature suggests that the point estimates are likely to have smaller standard errors and those from ivprobit are still consistent (StataCorp 2013). The Wald test is explained along with its theory in Wooldridge (2010). For the MLE with a single endogenous variable, the Wald test simply tests the correlation between the reduced-form equation for the endogenous variable and the error terms in the structural equation. However, in the two-step estimator, in the second stage, the residuals from the first-stage OLS regression are used as regressors. Therefore, the Wald test, in this case, is a test of significance on those residuals' coefficient. Additionally, they will be presented directly in the output of the ivprobit regression model, using Stata. In our results, the Wald tests of the exogeneity of the instruments are reported in the penultimate row of Tables 3 and 4 for media information sources and personal information sources, respectively. The results show that all information source models deal with endogeneity and ivprobit regression should be used, except for models for mobile phone, internet, and extension services, which use regular probit regression. To verify our result, we also perform the procedure suggested by Wooldridge (2010) to check the endogeneity problem. The results shown the same statistical report if using "Wald test of exogeneity" indicator in Stata.

The first step of the models which used ivprobit regression method is reported in Tables 3 and 4. It shows the relationship between endogenous and instrument variables. For the MLE, these parameters are estimated jointly with the parameters of the probit equation. The results report that livestock is positively significant with total household income in all models while labor is only significant in the model of membership. This indicates that livestock is a very important source to increase income, and labor is not as important. In fact, labor is easy to solve in the rural area of Vietnam because if households do not have enough labor, they can ask their relatives and neighbors to help or exchange labor force in busy times such as tilling, transplanting or harvesting.

Media sources

Table 3 reports the results of each parameter for each of the media source models. The penultimate reports that mobile phone and internet models do not have an endogeneity problem, so we applied probit regression for these two models. Additionally, while running the mobile phone model, the off-farm variable is omitted because of perfect multicollinearity. The literature implies that dropping variables and perfectly predicted observations will not affect the result of remaining coefficients and increase the stability of regression (StataCorp 2013). The last row of the table shows the results of the likelihood ratio test of

the combined significance of all the parameter estimates. All of the models were statistically significant at the 1% or 5% level. This indicates that the variables used are appropriate.

Household income was positively significant with all media information sources except mobile phones, which indicates that farmers with higher income are likely to get more information about social, agriculture, economics, etc. through all types of media sources. Households with high income can easily buy many types of printed materials, radio, television, and expensive mobile phone, which can access the internet easily. Additionally, many of the households with relatively high incomes owned more than one television, and household members spent their evenings watching television.

Farm size was negatively significant regarding the use of printed material, radio, and television as a sources of information at the 10%, 5%, and 1% levels, respectively. This means that respondents with larger farms were less likely to read printed materials, listen to radio, and watch television. Farmers who have large farms are too busy with farm activities so they do not waste time or need to get information from media sources.

Household size was negatively significant related to the frequent listening of radio and watching television, suggesting that households with more members are less likely to listen to radio and watch television programs. In fact, in rural and remote areas in Vietnam, households with many family members are having low income because most members are dependent, such as children or elderly. Therefore, households with more member will take more time to work and have less time to listen to radio or watch television.

Education has a statistically significant influence on ownership of mobile phones, but is not significant with the use of printed materials, suggesting that farmers with more education might be more interested in using mobile phones rather than reading books, magazine, leaflets, etc. This finding is not in line with Gloy et al. (2000), which found that education influences with crop/livestock- specific farm publication in the United States.

Farm location mattered to the use of television as a source of information. The coefficient of Moc Chau was positively related to the use of television ($p < 0.1$), meaning that respondents who live in the Moc Chau district were watching television more often than respondents in Mai Son and Phu Yen districts. This area has a relatively good television signal, and some respondents can watch television programs using a digital rather than analog signal. Moreover, this area has relatively stable sources of electricity, a relatively flatter topography, and higher incomes than Mai Son and Phu Yen districts. Therefore, farmers might need less time to do farm activities and have more time to relax. In addition, The Moc Chau district has better environmental and transportation conditions conducive to information exchange.

Table 3 Results of the media information sources

Variables	Probit with continuous endogenous regressor (ivprobit)						Probit	
	Print material		Radio		Television		Mobile	Internet
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage		
Gender	10.725 (7.747)	−0.125 (0.226)	10.326 (7.759)	0.080 (0.263)	10.605 (7.748)	−0.142 (0.245)	0.245 (0.591)	−1.553* (0.825)
Age	0.084 (0.237)	−0.003 (0.007)	0.127 (0.238)	0.002 (0.007)	0.096 (0.237)	−0.001 (0.007)	−0.024 (0.017)	−0.036 (0.036)
Education	1.586* (0.829)	0.044 (0.029)	1.553* (0.831)	0.005 (0.027)	1.574* (0.829)	−0.009 (0.028)	0.166** (0.081)	0.162 (0.140)
Household size	4.490** (2.093)	−0.091 (0.056)	5.597*** (2.104)	−0.112** (0.055)	4.836** (2.064)	−0.165*** (0.055)	0.268 (0.252)	0.063 (0.246)
Farm size	21.408*** (1.873)	−0.207* (0.104)	21.579*** (1.186)	−0.239** (0.104)	21.461*** (1.872)	−0.391*** (0.079)	−0.016 (0.259)	−0.349 (0.317)
Income	—	0.013*** (0.004)	—	0.014*** (0.003)	—	0.022*** (0.002)	0.009 (0.008)	0.009* (0.005)
Off-farm	15.278** (7.441)	0.316 (0.242)	15.767** (7.454)	−0.063 (0.228)	15.423** (7.441)	0.266 (0.384)	—	1.168 (0.741)
Moc Chau	6.274 (6.464)	−0.264 (0.181)	5.657 (6.629)	−0.292 (0.193)	6.040 (6.457)	0.554* (0.300)	0.291 (0.690)	−0.670 (0.871)
Mai Son	21.349*** (6.284)	−0.099 (0.198)	20.967*** (6.295)	−0.098 (0.207)	21.236*** (6.285)	0.282 (0.291)	−0.607 (0.578)	0.136 (0.744)
Labor	3.719 (2.455)	—	1.269 (2.443)	—	2.941 (2.309)	—	—	—
Livestock	22.753*** (5.058)	—	23.614*** (5.059)	—	23.227*** (4.993)	—	—	—
Constant	−26.159* (13.906)	−0.918* (−0.491)	−26.119* (13.926)	−1.217** (0.597)	−26.157* (13.909)	0.454 (0.412)	0.879 (1.224)	−2.202 (1.957)
Log likelihood	—	−2079.519	—	−2020.018	—	−1975.032	−17.672	−11.847
Wald test of exogeneity (/athrho=0)	—	**	—	***	—	***	—	—
Model significance ^a	—	***	—	***	—	***	**	**

Source: Own survey, 2014

Note: a) Likelihood ratio test result for combined significance of parameters.

***, **, and *=>Significance at the 1%, 5%, and 10% levels, respectively.

Number in parentheses is standard deviation.

Number of observation: 360

Moreover, this district is an attractive tourist destination throughout the year because of its wide and beautiful plateaus in the northern highlands, where there are many national roads, green hills, and cool weather.

In the sample, none of respondents had computers, so the Internet was necessarily accessed via smartphones. Female household heads were more likely than their male counterparts to access the Internet, even through smartphones. However, the price of smartphones with Internet access capability and Internet provider fees were relatively high, and the Internet speed

slow. Moreover, those respondents who did use the Internet via smartphones did so for entertainment and not agricultural purposes. This finding is contrary to Adamides et al. (2013), who found that Internet use of farmers in Cyprus was not influenced by the gender of the household head, but by the age and educational level of the household head, farm income, and agricultural activity. In large US farms, age and educational attainment are the most influential factors of Internet use (Gloy and Akridge 2000)

Table 4 Results of the personal information sources

Variables	Probit	Probit with continuous endogenous regressor (ivprobit)			
	Extension services	Visited advanced agricultural model		Membership	
		1st stage	2nd stage	1st stage	2nd stage
Gender	−0.311 (0.227)	10.542 (7.748)	−0.312 (0.205)	10.827 (7.745)	−0.255 (0.201)
Age	−0.010 (0.007)	0.103 (0.236)	0.003 (0.007)	0.073 (0.236)	0.005 (0.006)
Education	−0.005 (0.025)	1.569* (0.829)	−0.005 (0.024)	1.599* (0.829)	0.001 (0.023)
Household size	0.052 (0.055)	5.011** (2.021)	−0.082 (0.052)	4.192** (2.016)	−0.117** (0.047)
Farm size	−0.119 (0.081)	21.488*** (1.871)	−0.365*** (0.069)	21.362*** (1.871)	−0.297*** (0.081)
Income	0.002 (0.001)	—	0.0176*** (0.002)	—	0.017*** (0.002)
Off-farm	−0.442* (0.258)	15.499** (7.441)	0.083 (0.215)	15.159** (7.437)	−0.633*** (0.189)
Moc Chau	−0.007 (0.201)	5.936 (6.453)	−0.052 (0.175)	6.511 (6.452)	0.144 (0.182)
Mai Son	0.157 (0.191)	21.177*** (6.285)	−0.336* (0.178)	21.441*** (6.282)	−0.252 (0.166)
Labor	—	2.551 (2.106)	—	4.399** (2.099)	—
Livestock	—	23.392*** (4.981)	—	22.171*** (4.993)	—
Constant	−0.266 (0.415)	−26.152* (13.912)	−0.916* (0.497)	−26.152* (13.907)	0.241 (0.359)
Log likelihood	−180.599	—	−2035.852	—	−2070.489
Wald test of exogeneity (/athrho=0)	—	—	***	—	***
Model significance ^a	—	—	***	—	***

Source: Own survey, 2014

Note: a) Likelihood ratio test result for combined significance of parameters.

***, **, and *=>Significance at the 1%, 5%, and 10% levels, respectively.

Number in parentheses is standard deviation.

Number of observation: 360

Personal sources

The results of the analyses of the three personal information sources are shown in Table 4. The Wald test of exogeneity of instrument variables is not significant only in the case of the model of extension services, where regular probit regression was applied. The likelihood ratio test results of the combined significance of the independent variables of two of the sources were statistically significant, the exception being the analysis of extension services as an information source. Extension services are objective information sources that reach out to villages, originating from the government, research institutions, universities, companies, NGOs, and volunteers, all extension activities being controlled and managed by the government extension service with top-down, supply driven operation methods. Extension is regulated and implemented by the Ministry of Agriculture and Rural Development. Bo <<http://www.syngentafoundation.org/index.cfm?pageID=736>> (2016) found some limitation of current extension services, such as most of extension workers being specialized only in livestock and crops, lack

of professional extension workers, the extension methods have not satisfied the demand for agricultural activities, the extension programs and policies are only followed government extension system and extension without payment, and improper monitoring and evaluation systems. Therefore, this does not depend on farmers or farm characteristics.

Similarly to media information sources, household income is the most important factor influencing the use of personal information sources. The coefficients are positively influenced by visiting advanced agricultural models and agricultural memberships as information sources at $p < 0.01$. Households with higher incomes may be more likely to have visited an advanced agricultural model and become members of agricultural groups because they may want to get more experience, extend their business networks, exchange ideas, or find more suitable (or profitable) agricultural activities.

Farm size is strongly and negatively related to having visited advanced agricultural model and becoming member of an agricultural group at the 1% level. In the studies area, if farms are

larger, they have larger sloping land where they could only cultivate by monocropping. In fact, maize is the main crop and main income from cultivation activities (Linh et al. 2015a). Additionally, maize crops require much more labor and are time consuming because farmers mainly use human power for cultivating it. Therefore, households with larger farm size spend more time on their farm activities all year round. As such, they are not interested in or have time to visit other advanced agricultural models or join agricultural groups.

The coefficients of off-farm jobs were negatively related to extension services and membership in the agricultural group at the 10% and 1% levels, respectively. Respondents with off-farm jobs are less likely to receive information from agricultural extension services because they may want to get more information related to their job and social activities. Additionally, respondents with off-farm jobs may not want to join nearby agricultural groups because, despite the variety of farmer groups, women's groups, credit groups, and veterans' groups, these groups might not have provided the expected benefits or were not effective (Linh et al. 2015a, 2015b).

Household size negatively influences agricultural membership as information source at $p < 0.05$. A larger family size was less likely to have joined a group because they need to work harder for income, food, and facilities of their own. Consequently, they could not join or consider joining agricultural groups. Moreover, farmers know that agricultural groups are not effective and might not want to join.

Respondents with farms in the Mai Son district were less likely to have visited an advanced agricultural model than those in Phu Yen or Moc Chau districts. One reason for this finding may be that Mai Son is the district nearest to the provincial city, the center of economics, culture, social, and entertainment of Son La province. Therefore, farmers in this district find it easier to obtain information from other sources and they may have more chances to get off-farm jobs.

Conclusion

Using household-level data for 360 farm households in three districts of Son La province, Vietnam, this study analyzes the influence of farmer and farm characteristics and factors on the use of eight types of information sources. Each information source has unique benefits to farmers. Certain information sources, such as television, mobile phones, and group memberships, were more popular than others. Others sources, such as the Internet and having visited an advanced agricultural model, were less common among the respondents.

The statistical results of the probit model with continuous endogenous regressor (ivprobit) and regular probit regression analysis show that household income, farm size, household size,

educational attainment, and off-farm jobs were the most important influences on whether the respondents use the media and personal information sources. The coefficient of household income was positively significant regarding six information sources, except mobile phone and extension services. This finding implies that households with higher income may be more encouragement, have more time, and be more interested in using information sources to seek knowledge, information, or entertainment. In the studied area, the main income of households comes from off-farm activities. This is the reason why households with larger farm size have to spend more time on farm activities and could not get higher incomes. Hence, households with larger farms less likely to spend time reading printed materials, listening to radio, watching television programs frequently, and also having visited advanced agricultural model or becoming members of agricultural groups.

The coefficient of household size was negatively significant related to the frequency of listening to the radio, watching television, and being a member of an agricultural group. In the survey area, larger household size means that the number of dependent people is higher, dependence being defined when a person under 15 and over 60. The dependency rate in the studies area is 60%, roughly meaning that one person of working age has to work for one more person. This is the main reason why in rural and remote areas larger families always have many children and low income. Therefore, they have to work harder and are less likely to get information by listening to the radio, watching television, or becoming group members.

Having an off-farm job was negatively significant regarding extension services and group membership. This result suggests that respondents that have off-farm income were less likely to get information from extension agents or to become members of a group because of irrelevancy with off-farm jobs and ineffectiveness of group activities, respectively. The coefficient of education was positively significant regarding mobile phones. This finding implies that knowledge is an important factor to the use of information sources.

These results offer some broad implications. First, off-farm employment for farmers should be provided and encouraged. The respondents in the studies area found it difficult to improve their households' well-being and incomes with agricultural activities alone. Additionally, if dependents have suitable off-farm job, the family can get more income and depend less on working age individuals. Hence, those farms with higher incomes and more off-farm jobs would likely use information sources more often. Second, local government and extension agents should work more effectively to enhance and help farmers diversify crops, by applying new technologies. Consequently, farmers can get more income from farming activities and are more likely desire to get information through all

sources. Third, it is recommended to increase the farmers' education attainment through short training seminars and workshops and offer no-cost education to their school-aged children. This education should not only focus on agricultural knowledge/skills, social activities, and governmental policies, but should train farmers to use information sources, such as the Internet, to their fullest. Fourth, agricultural extension should change the method from one-way and top-down to a two-way and farmer-led, demand-driven method. Moreover, it could socialize the extension system, improve the link between research and extension, and increase the number of professional extension workers. Finally, efforts should be made to close the gap among districts by increasing investments, expanding road infrastructure, and spreading national electricity and wireless towers to farmers in remote areas.

There are other important variables, such as quality of information and experience of using information sources. However, we do not have data on those variables and, as such, they are scope for future research.

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