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Full Length Research Paper

Determinants of ICT use by rice farmers in Benin: from the perception of ICT characteristics to the adoption of the technology

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Abstract

Farmers' access to market remains very poor in so that farmers do not succeed to well negotiate commodity or input price on the market. The use of ICT tools in transaction process can help farmers improve their skills in marketing process. However, many factors determine the use of ICT for farming purposes. This study oriented toward rice farmers in Benin aims to identify these factors. The results are obtained from econometric modelling such as Logit, Probit and Poisson regressions. The evidence from rice producers in Benin gave a set of factors that included farmers' characteristics and physical environment in which they worked. The perception they had about ICT tools led them to the kind of choice they made and the intensity of ICT tools in use. These factors were seen as some facilities that should be enhanced to allow farmers to access and use ICT tools in agricultural production.

Keywords: ICT, adoption, agriculture, smallholder.

INTRODUCTION

Agricultural growth is essential for fostering economic development and feeding growing populations in most less developed countries (Datt and Ravallion, 1996). Lack of or poor access to information on the quantity and quality of produce traded, commodity and input prices, and credit sources results in opportunistic behavior by traders, input dealers and moneylenders. In the absence of information, smallholder producers face problems of adverse selection that limit the performance of agricultural commodity and input markets, and in turn the participation of small producers in these markets.

In Benin, smallholder farmers comprise of the majority of the farming community. Most of them produce small marketable surplus and are geographically dispersed. Market access is one of the most important factors influencing the performance of smallholder agriculture in developing countries, and in particular least developed countries. Access to new and better-paying markets for agricultural products is vital in enhancing and diversifying the livelihoods of subsistence farmers. In Benin support to easier access to information comes from the Sectoral Policy Statement of 1994 and 2006 "Benin Plan TIC" aiming either the enforcement or the stabilization of legal frame (Mondé, 2008). This intervention is followed by a widespread use of mobile phone in Benin (more than 1,000,000 users). ICT-based market interventions were undertaken by various external organizations in support of a few farmers and traders organizations in rural and urban areas, with the aim of improving farmers' access to markets of agricultural produce through reliable and up-to-date market information, namely for major food crops and new cash crops. Among the organizations that took ICT initiatives, MISTOWA (Market Information Systems and Traders' Organizations in West Africa) with its regional Network RESIMAO (Réseau des Systèmes d'Information sur les Marchés de l'Afrique de l'Ouest) played the most prominent role. Market actors targeted were the agricultural commodity traders and the producers belonging to the rice farmer organization in the central region of Benin.

ICT initiatives are justified by the role of agricultural information in resolving market failures. Smallholder farmers' access to markets is constrained by, among others, i) lack or asymmetry of information ii) lack of

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access to productive technologies, While lack of access to productive technologies can constrain commercialization, we focus only here on poor technology access due to lack of information iii) poor access to public and private goods (Barrett, 2008). Lack of information on the quantity and quality of produce traded, commodity and input prices, and credit sources results in opportunistic behavior by traders, input dealers and moneylenders. In the absence of information, smallholder producers face problems of adverse selection that limit the performance of agricultural commodity and input markets, and in turn the participation of small producers in these markets. Information and communication technologies offer the ability to increase the amount of information provided to all participants in the agricultural sector and to decrease the cost of disseminating the information (Kurtenbach and Thompson, 2000). ICT in the agriculture sector facilitates knowledge sharing within and among a variety of agriculture networks including researchers, exporters, extension services, traders and farmers.

The use of ICT can progressively reduce the costs of managing information, enabling individuals and organizations to undertake information-related tasks much more efficiently, and to introduce innovations in products, processes and organizational structures in agriculture sector in Benin. However, it reveals a certain number of disparities among rice farmers according to their socio-economic situation, the gender, the infrastructure availability and other factors. An understanding of the factors associated with ICT adoption and use in agriculture will enable the development of strategies to promote ICT adoption and increase the effectiveness and efficiency of information use in agriculture sector (Kurtenbach and Thompson, 2000). Then is justified the objective of this paper which consists of investigating the determinants of ICT use by rice farmers in the central region of Benin. The rest of the article is structured as follows. In section two, previous studies about ICT use are reviewed. In section three, theory on technology adoption and modeling is exposed. In section four, the empirical work is explained while in section five, the findings are presented and discussed. Finally in section six, concluding remarks along with policy implications are provided.

Literature review

Studies addressing the effectiveness of ICT in rural area revealed some factors which influenced the use of ICT tools. The use of ICT requires positive attitude from the actors, such emphasized and proved by a number of previous studies (Kenneth and Liquat, 2006; Simpson, 2005 and Loh et al., 2009). Referring to attitude, Horne (1985) states it represents a mental and neural state of readiness, organized through experience. It exerts a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. For Breckler et al., (1992), attitude can be formed based on individual's degree of like or dislike towards something.

Usually attitude portrays either positive or negative views towards a person, place, thing or event. A positive attitude is an important requirement for ICT usage. Based on what has been completed by Shiro (2008), the rural communities have a very positive attitude towards ICT and they welcome any ICT project to be developed in their areas. However, their lack of ICT knowledge prohibits them from using ICT frequently. Dixon (2009) has stressed that frequent usage and exposure to ICT must be considered if someone wants to form a positive attitude towards ICT. When people frequently use and expose to ICT, it will inform them that ICT is helpful and beneficial to them thus creating a positive attitude towards ICT usage. Zhang and Aikman (2007) have revealed that attitude can be a mediator on the role of attitude toward object on behavioral intention. In this case, related development government agencies or private companies should understand that a positive attitude toward a particular ICT will lead potential users especially the rural communities to decide to accept or use the ICT. Besides, efforts should be put into identifying factors that can contribute for positive attitude toward ICT usage.

There are a lot of factors that can be associated with attitude towards ICT usage. D' Silva et al., (2010), in their study, have specifically focused on six variables that have the potential to influence attitude towards ICT usage and the variables are self-efficacy, perceived usefulness, perceived ease of use, subjective norm compatibility and job relevance. There are a lot of existing papers that have proven the influence of self efficacy (Techatassanasoontorn and Tanvisuth, 2008; Compeau and Higgins, 1995; Johnson and Marakas, 2000; Olfman and Mandviwalla, 1994; D' Silva et al., 2010), perceived usefulness and perceived ease of use (Venkatesh and Morris, 2000; Argawal and Prasad, 1999; Hu et al., 1999), compatibility (Joseph and Andrew, 2007 and Al-Ghaith et al., , 2010), job relevance (Comfort et al., , 2005 and Joseph and Andrew 2007) and subjective norm (Pee *et al,* 2010 and Gilligan, 2004) on ICT usage. In self efficacy side, as D' Silva et al., (2010), Gilligan (2004) and Pee et al., (2010) noticed, subjective norm is a dominant factor for attitude towards ICT usage. Gilligan (2004) for example has explained why, subjective norm is important to constitute positive attitude towards ICT usage. She stressed that rural people, who live in areas where less people use ICT due to their limited access to ICT related information good and services, compared to their counterparts in the urban areas, will have a low level of ICT usage (Gilligan, 2004).

Perceived usefulness is crucial for constructing positive attitude towards ICT usage. When communities

perceive that ICT is useful, it will create a positive attitude towards ICT usage (Silva et al., at 2010). According to Rogers (2003), perceived usefulness must be persistent. In order for ICT to be perceived useful it must be low cost, has the ability to reach a wider market and able to gather large information within a short time (Laudon and Laudon, 2000). Another factor that was detected to have a positive association with attitude towards ICT usage was compatibility. Findings from previous studies have agreed with this study and the main reason why this is happening is that people with higher ICT compatibility are expected to use ICT more, hence creating a better and positive attitude towards ICT usage (Gulbahar and Guven, 2008 and Joseph and Andrew, 2007). The last factor that was identified to have a significant and positive relationship with attitude towards ICT usage was job relevance, thus it is consistent with what have been revealed by Comfort et al., (2005) and Joseph and Andrew (2007). All these studies agreed on one thing, rural community will use ICT more if it is highly related with their daily tasks and jobs and will use ICT less if it is not related to their daily tasks and jobs (D'Silva et al., , 2010).

For their works on the use of computer in rural area, D'Silva et al., (2010) has stressed that possession of ICT alone is not enough for the benefits of ICT to emerge. This possession must be accompanied by persistent exposure to ICT courses and seminars (D'Silva et al., 2010). Al-Ghaith et al., (2010) has focused on the importance to attend persistent ICT courses and seminars that can enhance people's ICT interests, skills and compatibility. To conduct the ICT courses or seminars in the rural areas, Joseph and Andrew (2007) have stressed that the ICT courses andseminars will be effective if the ICT trainers assigned are of the same gender with the rural communities (for example, female trainer for female villagers and male trainer for male villagers). Besides, notice that the environment is highly determinants in ICT use, according to the facilities available in the area (Adekoya, 2006).

Jayathilake, et al (2008) suggested in the result of their study that the most important limiting factor which affects the use of ICT in agriculture is cost of technology. Lack of training and inability of farmers to use ICT is the second factor that affects. The factors namely trust level in the ICT system; lack of technological infrastructure and lack of ICT proficiency are the third level category that affects the use of ICT in agriculture. Thus, in general, to ensure the effectiveness of ICT, the rural community especially their leaders must have a positive attitude towards ICT usage.

Conceptual framework

The choice/adoption of technology in rural level

Different approaches were used to analyze the use of technology in rural area.

Empirical analyses by Adesina and Zinnah, (1993) found that farmers' perception about characteristics of rice varieties affected the adoption decision. The perception of technology characteristics is so important in choice process. Bakkabulindi et al., 2009) in their study considered ICT as an innovation and from the literature, built a conceptual framework that explained ICT adoption as dependent on some four perceived innovation (in this case ICT) characteristics.

Relative advantage and innovation adoption

Relative advantage (or superiority) is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 2003; Kotler, 1991), and is often expressed in terms of economic profitability and/ or social prestige (Rogers, 2003; Kyewalabye, 2001); in terms of productivity (Sentamu, 2001); in terms of convenience and/ or satisfaction (Kyewalabye, 2001); and so on. Lunkuse, (2004) refers to the relative advantage of an innovation as its perceived usefulness, that is "the degree to which the user's subjective probability that using a specific system will enhance his or her productivity". The greater the perceived relative advantage/ superiority of an innovation, the more rapid is it adoption (Rogers, 2003). Lunkuse, (2004) argues that the importance of perceived usefulness in user behaviour is based on the Expectancy Theory which asserts that "the relative attractiveness of various options is related to people's beliefs about the consequences that each option will lead to their beliefs about the desirability of these consequences"(Bakkabulindi et al., 2009).

Compatibility and innovation adoption

Apart from perceived relative advantage, another important characteristic of an innovation affecting its rate of adoption is its perceived compatibility or acceptability (Kotler, 1991; Rogers, 2003; Sentamu, 2001). Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. Rogers (2003) contends that an innovation can be compatible or incompatible with (i) socio cultural values and beliefs (ii) previously introduced ideas and/ or (iii) client needs for the innovation. Eason (1988) distinguishes between user acceptability and organizational acceptability of an innovation, saying that as far as user acceptability is concerned, an innovation must offer its services in a way which its users will perceive, at a minimum, as not threatening aspects of their work and will perceive it as positively facilitating goals they wish to pursue. On organizational acceptability, Eason (1988) observes that since an organization at large has goals, policies and

structures, the innovation must not only serve immediate task needs but must not impede other aspects of organizational functioning. Ideally it will serve as a vehicle to promote wider organizational goals; as a minimum it will provide an organizational match. Perceived compatibility is positively related to its rate of adoption (Rogers, 2003) in that an idea that is more compatible is less uncertain to the potential adopter and fits more closely with the individual's situation. Such compatibility helps the individual give meaning to the new idea so that it is regarded as more familiar (Bakkabulindi et al., 2009).

User friendliness and innovation adoption

User friendliness (or usability, ease of use or non-complexity) is the degree to which an innovation is perceived as relatively easy to understand and use (Rogers, 2003). Lunkuse, (2004) observes that technology users perceive a technology as user-friendly if it is easy to learn, become skillful, flexible and is controllable. Dawa, (2004) refers to the ease of use of an innovation as its usability, quoting the International Standards Organisation (ISO 9241-11) as defining usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a given context" (Dawa, 2004: 43). For Eason (1988) usability of a system is the system offering its functionality in such a way that the planned users will be able to master and exploit it without undue strain on their capacities and skills. It is in this domain that the importance of user friendliness, ease of use and ease of learning are usually emphasized (Bakkabulindi et al., 2009). The complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption (Rogers, 2003).

Observability and innovation adoption

Observability, also known as communicability, demonstrability or describability, is the degree to which results of an innovation are visible to others (Bakkabulindi et al. , 2009).. Whereas some ideas are easily observed and communicated to other people, other innovations are difficult to observe or to describe to others. For example, the innovation in this study, ICT, has two components; (i) hardware which is the physical part of the tool, and (ii) software that consists of the information base for the tool (Bakkabulindi et al., 2009). Thus the software component of a technological innovation (e.g. ICT) is not so apparent to observation: So innovations in which the software aspect is dominant possess less observability, and usually have a relatively slower rate of adoption (Rogers, 2003). Rogers and Shoemaker (1971) and Denisoff and Wahran (1983) explain that Ogburn's (1922) Cultural Lag Theory, which claims that material innovations diffuse and are adopted more readily than non-material ideas, fits very well into the present discussion of observability. The observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption (Rogers, 2003).

Estimation of adoption models

Studies conducted by rural sociologists have documented sigmoid diffusion curves over time for several agricultural innovations (Beal and Buhlen 1957; Rogers 1957). Many of these studies have focused on the role of communications in determining the pace of the diffusion process and the shape of the diffusion curve. For example, Rogers discusses empirically the existence of different stages of the adoption process for different categories of adopters of hybrid corn in the United States. He found that the awareness gap and the experimentation period are shorter for the early adopter than for followers (Feder et al., 1985). Using data on diffusion of weed spraying in Iowa, Rogers constructed an aggregate adoption measures changed over time. Both functions are S-shaped, but the horizontal gap between them becomes greater with time, implying shorter awareness and experimentation gaps for early adopters.

Dichotomous and Continuous Adoption Variables

In most studies, adoption variables are categorized simply as “adoption” or “non-adoption”. On the basis of a comprehensive review of adoption studies, Schutjer and Van der Veen, (1977, p.14) conclude that “the major technology issues relate to the extent and intensity of use at the individual farm level rather than to the initial decision to adopt a new practice.” Adoption apparently cannot be represented adequately by a dichotomous qualitative variable in many cases.

Ordinary regression methods were used in some studies to determine econometrically, the quantitative importance of various explanatory variables (Rochin and Witt 1975; Parthasarathy and Prasad, 1978). However, many such studies have attempted to explain only the decision of adoption versus non-adoption rather than the extent or intensity of adoption (Feder et al., 1985). Normality of disturbances is obviously inappropriate for such regressions; and thus the estimated standard errors and t-ratios produced by an Ordinary Least Square (OLS) regression are not appropriate for investigation hypotheses about the role and importance of various factors in the adoption process (Feder et al., 1985).

Second, ordinary linear-regression estimates produce predictions other than zero or one for the dependent

Table 1. Descriptive statistics of the number of ICT tools (types of media) used for farming activities

Number of ICT tools (types of media) used	Frequency	Percent	Percent among users
0	111	30.8	-
1	157	43.6	63.052
2	61	16.9	24.498
3	25	6.9	10.040
4	5	1.4	2.008
5	1	0.3	0.402
Total	360	100.0	100

variable; if these predictions are considered as probabilities, then predictions less than zero or greater than one are nonsensical. Some studies recognize that normal hypothesis testing procedures are invalid in this approach but still claim the unbiasedness of their estimated equations (Cutie, 1976). These claims are also not appropriate, as the econometric literature on limited dependent variables makes clear (Pindyck and Rubinfeld, 1976).

Turning to the econometric literature, one finds that appropriate estimation methodology has been developed for investigation of the effects of explanatory variables on dichotomous dependent variables (Amemiya, 1973). The most commonly used quantitative response models are the logit model, which corresponds to a logistic distribution function, and the probit model, which assumes an underlying normal distribution. These models specify a functional relation between the probability of adoption and various explanatory variables.

In adoption decision, a discriminant analysis is a procedure for classifying observations in one category or another based on several explanatory variables (Yapa and Mayfield, 1978). The usefulness of discriminant analysis, however, is often confused with that of logit analysis (McFadden, 1976). The relative odds of correct binary classification are given by the logit formula for this case, but the discriminant estimator is not generally a consistent estimator of the parameters of the logit model when selections are generated thereby (McFadden, 1976, Press and Wilson, 1978). Hence, the probit-logit methodology appears to be preferable to discriminant analysis for analyzing the adoption decision (Feder et al., 1985).

DATA AND METHODS

Data used in this study were those collected in project eARN that aims to understand the effectiveness of electronic-based interventions in linking African farmers to markets. A sample of 360 rice farmers has been selected randomly and purposively over 12 villages in Dassa-Zoume and 5 in Glazoue, two communes of central region of Benin. During the case study interview, [1] A case study is a previous stage of research step to figure out the conditions that prevail the implementation of ICT project for farmers in Benin, the lists of all the farmers' organizations included in the rice producers' network as well as their members have been established. As the project lasted one year so that only 40 farmers were the first participants, all these farmers have been selected in the sample. Each of the 12 villages of Dassa-Zoume and the 5 of Glazoue is selected from the lists of all the villages of the two councils of Dassa-Zoume and Glazoue on the basis that it is the dwelling of at least one project participant. For the selection of non participants the ratio participants/sample size (40/360) is estimated. This ratio has been applied all over the list of farmers to obtain the number of non participants to draw randomly with replacement when necessary.

Simple descriptive statistical methods were used to drive proportion/frequency concerning the use of ICT and the number of ICT tools used. The descriptive analysis aimed to target the kind of ICT tools used and which can be considered for deep analysis. Regression models were estimated to obtain factors that explained the use of ICTs for farming purposes. Thus, Poisson model were used to draw factors influencing the intensity of the use of ICT tools in farming activities; Probit model for adoption/use of Mobile calls in farming activities and Tobit model for the intensity of the use of Mobile calls in farming activities.

RESULTS AND DISCUSSION

Descriptive analysis

All the farmers surveyed were not using ICT tools for farming. About 31% of them were ICT non-users (those who have 0 as frequency of ICT tools numbers used in table 1) while 69% of them did use ICT tools in their

Table 2. Main types of media used

ICT tools (types of media) used	Proportions of users (n=249)
Radio program	90.4 %
Television	16.9 %
Mobile call-up	41.0 %
Mobile SMS	10.0 %
Radio call-in	3.2 %
CD Rom	3.2 %
Video	4.0 %
Internet/email	3.2 %

Table 3. Perceptions on the characteristics of the four main types of media used

Characteristics		Radio program (n=225)	Mobile call-up (n=102)	Television (n=42)	Mobile SMS (n=25)
Is the information from this type of media timely?	No	30.2 %	2.9 %	59.5 %	40.0 %
	Yes	69.8 %	97.1 %	40.5 %	60.0 %
	Total	100.0 %	100.0 %	100.0 %	100.0 %
Is the information from this type of media reliable?	No	8.0 %	5.9 %	19.0 %	52.0 %
	Yes	92.0 %	94.1 %	81.0 %	48.0 %
	Total	100.0 %	100.0 %	100.0 %	100.0 %
Is the information from this type of media easy to use?	No	88.9 %	14.7 %	38.1 %	56.0 %
	Yes	11.1 %	85.3 %	61.9 %	44.0 %
	Total	100.0 %	100.0 %	100.0 %	100.0 %
How does the cost of using this information source compare to your usual source of information?	Same	39.8 %	6.0 %	20.6 %	0.0 %
	Lower	29.6 %	56.0 %	32.4 %	66.7 %
	Higher	30.6 %	38.0 %	47.1 %	33.3 %
	Total	100.0 %	100.0 %	100.0 %	100.0 %

farming activities, though with different intensities (Table 1). Users of only one (1) ICT tool represented 63% of the sample of users while users of two (2) ICT tools 24.5% and users of more than two (2) ICT tools 12.5%. As participants in ICT project systematically used ICT tools but represented only 3% of the total sample, the greater percentage obtained for the users of ICT tools indicated that some non-participants also used information from the ICT project. The average number of ICT tools used was 2.20 for user-participants in ICT project whereas it was 1.47 for user-non-participants in ICT project. In fact, non-participants using ICT-based information obtained that information mainly from the spouse member and the friend member of the ICT project. This can be gathered in the facilities that allowed actors to quickly adopt technology, as stressed by Adekoya, (2006) “the environment is highly determinant in ICT use, according to the facilities available in the area”

All the ICT tools used did not have the same importance of use. Nearly did all users (90%) use radio program as type of media (Table 2). The three most common types of media after radio program were mobile call-up (41%), television (17%) and mobile SMS (10%). Less than half of television users perceived the information from this type of media timely while it was not the case for the information from radio program, mobile call-up or mobile SMS (Table 3). This can be understood insofar as there are low media coverage for television in this region and little market price information. All information sources except mobile SMS were reliable. Information from mobile call-up and television was easy to use oppositely to information from radio program and mobile SMS. In addition, the cost of using these information sources, compared to the usual source of information, was the same for the radio program, lower for the mobile call-up and the mobile SMS and higher for the television (Table 3). These characteristics showed that mobile call-up would be the most preferred type of media for farming. Nevertheless, its comparative advantage could be in question when the costs of buying equipment and getting information from the media were considered (Table 4).

In the sub-sample of 102 farmers using mobile call in their farming activities, 60 farmers provided information on the percent of calls they made to traders and 96 farmers on the number of calls (made plus received)

Table 4. Descriptive statistics of the costs related to the ICT tools used

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Initial cost of buying the equipment of the media					
Radio program	225	0.00	75000.00	9903.50	11275.79
Mobile call	102	0.00	90000.00	20840.00	15523.63
Television	42	0.00	400000.00	50810.00	61055.05
Mobile SMS	25	0.00	35000.00	8044.00	10374.17
Cost of getting information from the media					
Radio program	225	0.00	1000.00	140.58	155.46
Mobile call	102	0.00	500.00	232.84	145.65
Television	42	0.00	1000.00	204.76	336.37
Mobile SMS	25	0.00	200.00	30.00	40.82

Table 5. Descriptive statistics of the intensity of mobile call-up use for farming

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Total Percent of calls made to traders in 2009					
Participants	7	10.00	70.00	37.86	23.78
Non-participants	53	0.00	95.00	22.34	23.54
Total	60	0.00	95.00	24.15	23.90
Total Number of calls for agric transactions in one month during 2009					
Participants	9	0.00	95.00	43.89	35.84
Non-participants	87	0.00	230.00	15.71	38.48
Total	96	0.00	230.00	18.35	38.95

concerned by agricultural transactions. For both intensity indicators, Table 5 showed that participants intensified their use of mobile calls for farming more than non-participants.

Determinants of ICT tools use for farming purpose

Three drivers of the intensity of the use of ICT tools in agriculture were found from the model in Table 6. Two drivers influenced positively the number of ICT tools used and included the transport costs to the produce market and the use of any information from the project. First, if transport costs to the produce market determine the number of ICT tools used by farmers, it can be interpreted that, the farther the distance to the selling market, the greater the use of ICT tools by farmers. Second, farmers (participants and non-participants to ICT project) using any information from such project were more likely intensifying their use of ICT tools in agriculture than non-participants who were not using any information from the ICT project. Moreover, participants in ICT project were more expected to use a higher number of ICT tools for farming purposes than non-participants using information from the ICT project. So, information provided by the project had positive direct effects on participants and positive indirect effects on non-participants obtaining the project's information from the participants. Furthermore, the land in fallow was the factor influencing negatively the number of ICT tools used. As farmers had less land in fallow during the short season (so had cultivated large crop plot), the more they searched inputs and negotiated output price, resulting in a higher number of ICT tools used.

The use of mobile calls in farming activities was positively influenced by land owned and cultivated during the 2009 short rain season, and whether the farmer was owner of the mobile phone in use, participated in ICT project and could read/write (Table 7). Thus, farmer-owners of mobile phones used these tools in farming activities for making transaction in production process. The participation in ICT-based project was important to develop skills in mobile phone use for farming activities. So, it would seem that project allowed farmers discovering mobile phone utilities and some advantages that it provides in making transaction. The skills of

Table 6. Poisson model of the intensity of the use of ICT tools in farming activities

Dependent variable: number of ICT tools (types of media) used for farming			
Independent variables	Coef.	Std. Err.	z
Constant	-2.923*	1.559	-1.87
Ln(1 + Household size)	-0.193	0.163	-1.18
Ln(1 + Age in years)	0.314	0.396	0.79
Ln (1 + Education in years)	-0.026	0.123	-0.21
Ln(1 + Farming experience in years)	-0.080	0.134	-0.60
Ln(1 + Years of experience in other nonfarm activity)	-0.012	0.052	-0.24
Ln (1 + Per capita value of farm and household asset endowments in FCFA/person)	0.002	0.024	0.08
Ln (1 + Land owned and cultivated during the 2009 long rain season in acres)	0.110	0.122	0.90
Ln (1 + land owned and in fallow during the 2009 long rain season in acres)	0.054	0.110	0.49
Ln (1 + Land owned and cultivated during the 2009 short rain season in acres)	0.152	0.137	1.11
Ln (1 + land owned and in fallow during the 2009 short rain season in acres)	-0.392***	0.126	-3.12
Ln (1 + Transport costs to the local market)	-0.126	0.133	-0.95
Ln (1 + Transport costs to the input market in F CFA)	-0.239	0.161	-1.48
Ln (1 + Transport costs to the produce market in F CFA)	0.381***	0.123	3.09
Ln(1 + Distance to the nearest center that has electricity in km)	0.067	0.086	0.78
Use any information from the project (0= Non-participant and non-user; 1=Non-participant but user; 2=Participant)	1.977***	0.209	9.45
Gender (1=Male; 0=Female)	0.248	0.163	1.53
Can respondent read/write? (1=Yes; 0=No)	0.195	0.246	0.79
Member of farmer organization (1=Yes; 0=No)	0.194	0.224	0.86
Valid observations = 264			
LR chi2(18) = 173.21			
Prob > chi2 = 0.000			
Log likelihood = -249.465			
Pseudo R^2 = 0.26			

Significance at 1%, 5%, and 10% levels is denoted respectively by ***, **, *.

Table 7. Probit model of adoption/use of Mobile calls in farming activities

Dependent variable: Use of Mobile call-up for farming (1=Yes; 0=No)			
Independent variables	Coef.	Std. Err.	z
Constant	-1.538*	0.894	-1.72
Ln (1 + Land owned and cultivated during the 2009 long rain season in acres)	0.160	0.167	0.96
Ln (1 + land owned and in fallow during the 2009 long rain season in acres)	0.210	0.161	1.30
Ln (1 + Land owned and cultivated during the 2009 short rain season in acres)	0.296*	0.176	1.68
Ln (1 + land owned and in fallow during the 2009 short rain season in acres)	-0.477**	0.186	-2.56
Ln (1 + Transport costs to the produce market in F CFA)	0.092	0.154	0.59
Ln (1 + Distance to the nearest mobile phone services in km)	-0.291***	0.109	-2.68
Ln(1 + Household size)	-0.491**	0.247	-1.99
Ln(1 + Experience in mobile phone use in years)	0.061	0.055	1.11
Owner of the mobile phone in use (0= non user; 1=use but non owner; 2= use and owner)	0.796***	0.144	5.52
Participation in ICT Project (1=Participant; 0=Non-participant)	1.562**	0.774	2.02
Gender (1=Male; 0=Female)	0.264	0.224	1.18
Can respondent read/write? (1=Yes; 0=No)	0.517**	0.209	2.47

Table 7. Continue

Valid observations	=	331
LR chi2(12)	=	150.89
Prob > chi2	=	0.000
Log likelihood	=	-115.215
Pseudo R^2	=	0.40

Significance at 1%, 5%, and 10% levels is denoted respectively by ***, **, *.

reading and writing were required to adopt mobile use in farming activities. According to Shiro (2008) their lack of ICT knowledge prohibits them from using ICT frequently. Dixon (2009) has stressed that frequent usage and exposure to ICT must be considered if someone wants to form a positive attitude towards ICT. When people frequently use and expose to ICT, it will inform them that ICT is helpful and beneficial to them thus creating a positive attitude towards ICT usage.

However, other factors have negative influence on mobile calls in farming activities; they included the land owned and in fallow during the 2009 short rain season, the distance to the nearest mobile phone services and the household size. These results could be understood in a way that, the more own land in cultivation, the more inclined to use mobile calls for farming activities; the less land in fallow let suppose that farming activities of the producer in concern were lower. Households with large size certainly had other off farm activities which required relatively more mobile calls in business than farm activities; so they made less mobile calls in farming activities. As well, they certainly had many family members to call so that their likelihood to use mobile for farming could be weak.

The intensity of mobile use for farming activities depended greatly on the distance to the nearest mobile phone services (Table 8). This was an important factor in terms of facilities given by the availability of ICT infrastructure for charging and repairing mobile phone. This result meets those of Adekoya, (2006) who emphasized that the environment is by far a determinant in ICT use, according to the facilities available in the area. Distance to the nearest center that has electricity, farming experience and owner of the mobile phone in use had positive influence on the number of mobile calls for agricultural transactions. In fact, farming experience conferred to farmer some skills in farming management, negotiation in input/output commercialization. Thus, these categories of farmers intensified the number of mobile calls when making farming business. They found in ICT tools, especially mobile phone, some facilities in doing farming business. Therefore, the more they have their own mobile phone, the more they call through mobile phone for farming business.

CONCLUSION AND POLICY IMPLICATIONS

In the absence of information, smallholder producers face problems of adverse selection that limit the performance of agricultural commodity and input markets, and in turn the participation of small producers in these markets. In Benin, smallholder farmers comprise of the majority of the farming community. Most of them produce small marketable surplus and are geographically dispersed.

Support to easier access to information comes from the Sectoral Policy Statement of 1994 and 2006 “Benin Plan TIC” aiming either the enforcement or the stabilization of legal frame (Mondé, 2008). An understanding of the factors associated with ICT adoption and use in agriculture will enable the development of strategies to promote ICT adoption and increase the effectiveness and efficiency of information use in agricultural sector.

Studies addressing the effectiveness of ICT in rural area revealed some factors which influenced the use of ICT tools. These factors are associated with attitude towards ICT usage. With data from a sample of 360 rice farmers selected randomly and purposively over 12 villages in Dassa-Zoume and 5 in Glazoue, two communes in Benin, simple descriptive statistical methods were used as well as regression models for empirical evidences.

The use of ICT by smallholder farmers is surely a new technological change in rural area. A lot of factors determine the adoption and the use of ICT tools for farming purposes.

The proportion of farmers using ICT tools in their farming activities (69%) was greater than those of farmer-members of ICT project. The four main common types of media used for farming purposes were the radio program, the mobile call-up, the television and the mobile SMS. The intensity of the use of ICT tools in agriculture in terms of the number of media used had two positive drivers (transport costs to the produce market and use of any information from the ICT project) and one negative driver (land in fallow during the short season). Focusing specifically on mobile calls, its adoption in agriculture had four positive drivers (land cultivated during short rain season, mobile phone ownership, participation in ICT project and literacy) and three negative drivers (land in fallow during the short season, distance to the nearest

Table 8. Tobit model of the intensity of the use of mobile calls in farming activities

Dependent variable: Total number of Mobile calls (made and received) for agricultural transactions			
Independent variables	Coef.	Std. Err.	T
Constant	-311.723*	180.431	-1.73
Ln (1 + Per capita value of farm and household asset endowments in FCFA/person)	1.006	2.493	0.40
Ln (1 + Land owned and cultivated during the 2009 long rain season in acres)	8.036	13.261	0.61
Ln (1 + land owned and in fallow during the 2009 long rain season in acres)	6.082	11.850	0.51
Ln (1 + Land owned and cultivated during the 2009 short rain season in acres)	-10.658	16.579	-0.64
Ln (1 + land owned and in fallow during the 2009 short rain season in acres)	-23.613	15.123	-1.56
Ln (1 + Transport costs to the produce market in F CFA)	15.579	10.244	1.52
Ln (1 + Distance to the nearest mobile phone services in km)	-24.624**	10.833	-2.27
Ln(1 + Distance to the nearest center that has electricity in km)	26.070**	10.521	2.48
Ln(1 + Farming experience in years)	33.423*	18.843	1.77
Ln(1 + Years of experience in other nonfarm activity)	4.274	5.697	0.75
Ln(1 + Age in years)	-26.384	50.088	-0.53
Ln (1 + Education in years)	13.273	12.834	1.03
Owner of the mobile phone in use (0=non-owner and non user; 1= non owner but user; 2= owner and user)	52.771***	14.048	3.76
Participation in ICT Project (1=Participant; 0=Non-participant)	83.040	40.9266	2.03
Can respondent read/write? (1=Yes; 0=No)	28.274	24.674	1.15
Member of farmer organization (1=Yes; 0=No)	53.324	46.043	1.16
Sigma = 57.45			
Observations = 258 (Left-censored = 221; Uncensored = 37; Right-censored = 0)			
LR chi2(16) = 93.53			
Prob > chi2 = 0.000			
Log likelihood = -233.421			
Pseudo R^2 = 0.17			

Significance at 1%, 5%, and 10% levels is denoted respectively by ***, **, *.

mobile phone services and household size). Its intensity of use in agriculture in terms of the total number of calls had three positive drivers (distance to the nearest center that has electricity, farming experience and mobile phone ownership) and one negative driver (distance to the nearest mobile phone services). Consequently the main factors leading the use of ICT tools regarded the land holding and the access to mobile phone with its related services. The less land in fallow during the short season meant the more inputs to use and the more produce to expect, making farmers to adopt and intensify the use of ICT tools for guaranteeing input and output markets. In addition, owning personally the mobile phone in use and having mobile phone services closer gave sufficient reason to use more and more mobile calls in agricultural exchanges.

From these results, it is important to encourage the use of ICT tools in rural level, by some measures such as: ICT infrastructure development, training on ICT tools use toward farmers, especially smallholder, for getting market information.

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