# 4. Willingness to pay for market information received by mobile phone among smallholder pineapple farmers in Benin

**Chapter** · March 2016

DOI: 10.3920/978-90-8686-825-4_4



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# 4. Willingness to pay for market information received by mobile phone among smallholder pineapple farmers in Benin[1]

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## Abstract

Access to up-to-date information on market prices and quality requirements remains a key issue for smallholder farmers' access to high income markets. The aim of this chapter is to explore the problem of information asymmetry between farmers and buyers in the pineapple supply chain in Benin, and to assess strategies using mobile phones to overcome this problem. Data was collected from an exploratory case study in Ghana and a survey with 285 farmers in Benin. Results show that farmers face market information asymmetry leading to lower prices and income. In Ghana, market price alerts through mobile phones messaging allowed decreasing transaction costs for farmers. In Benin, farmers expressed a willingness to pay a premium of up to US$ 2.5 per month to get market price and quality information. Econometric analysis showed that decisive factors for the size of the premium include farm location, market channel, profit margin, contact with agricultural extension services, and technical support from buyers.

**Keywords:** information asymmetry, contingent valuation, food quality, market price, willingness to pay

## 4.1 Introduction

Recent trends towards higher food safety standards and stricter traceability requirements in key importing countries of agricultural products increase the information asymmetry between buyers and producers, thereby raising the bar for smallholders to enter such markets due to high compliance costs (Suzuki *et al.*, 2011).

[1] Parts of this book chapter have been published before under: Arinloye, D.D.A.A., Linnemann, A.R., Hagelaar, G., Coulibaly, O. and Omta, S.W.F., 2015. Taking profit from the growing use of mobile phone in Benin: a contingent valuation approach for market and quality information access. Information Technology for Development 21: 44-66.

J. Bijman and V. Bitzer (eds.) **Quality and innovation in food chains**
DOI 10.3920/978-90-8686-825-4_4, © Wageningen Academic Publishers 2016

Information asymmetry refers to the fact that many transactions are characterised by incomplete, imperfect or unbalanced information among the transactional parties (Claro *et al.*, 2004; Williamson, 1985). The quality of agricultural products and their safety attributes depend on how they were grown in the field; for instance by organic or conventional farming methods. Such information is obviously known to the farmer, but not to third parties, because the cultivation practices cannot be determined simply by looking at the final product (Mikami and Tanaka, 2008). In contrast, buyers in the markets are much better informed about market prices and their fluctuations.

This issue of information asymmetry becomes more important when the number of intermediaries (collectors, middlemen, wholesalers, and retailers) along the supply chain increases. If price information is distributed asymmetrically between farmers and buyers, the market for agricultural products may fail to achieve an efficient resource allocation because of (the risk of) moral hazard or adverse selection (Akerlof, 1970; Holmstrom, 1979; Ozer and Wei, 2006; Resende-Filho and Hurley, 2012). These informational problems could be avoided if farmers had access to accurate market information, like current prices (Mikami, 2007). Reduced information asymmetry between farmers and buyers implies a more informed trade, which, in turn, increases the market impact of the buyers' trades. Hence, farmers may be able to increase their profit by sharing cost information with buyers. When there is high information asymmetry between farmers and buyers, this generally results in low profits for the farmers (Mendelson and Tunca, 2007).

The introduction of mobile phones has brought new possibilities for people to communicate and share information, for instance, on markets and services. The impact of this development was felt across all sub-Saharan African (SSA) countries. For example, in Ghana, farmers in Tamale are able to send a text message to learn about maize, pineapple and tomato prices in Accra, over 433 kilometres away. In Niger, day labourers are able to call acquaintances in Benin to find out about job opportunities without making the US$ 40 trip (Aker and Mbiti, 2010). In Kenya, those affected by HIV and AIDS can receive text messages daily, reminding them to take their medicines on time (Pop-Eleches *et al.*, 2011). Citizens in countries as diverse as Kenya, Nigeria and Mozambique are able to report violent confrontations via text messages to a centralised server that is viewable, in real time, by the entire world (Aker and Mbiti, 2010). In Benin, data has been collected for decades on market prices of food products (ONASA, 2011), but this information fails to reach users (farmers, traders and processers) at the right time in an accessible and usable manner. On the one hand, research suggests interesting strategies on how to promote agricultural extension services to farmers, but on the other hand it is unclear how this information must be managed. Therefore, it was investigated if and how the mobile phone can be used in the pineapple chain, which is one of the promising export crops in Benin, where the above mentioned challenges of information asymmetry are present and where there is limited access to high income markets by smallholders farmers because of the quality norms and standards barriers they face.

Although the increased market information flow (especially on commodity prices) can potentially benefit marketing of all kinds of crops, it has a larger impact on reducing information asymmetry on market prices for perishable products, where quality is strongly related to the freshness at the time of exchange (Kalyebara *et al.*, 2007; Muto and Yamano, 2009). The new flow of information made available by mobile phones in African countries can help farmers and traders by providing accurate market information, allowing them to transport and trade their perishable products quickly to avoid spoilage. Access to information by mobile phones can also help farmers to decide whether or not to accept the price offered by traders, by obtaining price information from other sources.

Mobile phone services that provide accurate and up-to-date market information can be financially supported by governments, development projects, investment programs, or international partners for development (Donner, 2009; Donner and Escobari, 2010; Kizito, 2011). In Mali, for instance, contracting for the provision of market information is at the national level, but with a mix of funding sources from public and private sectors (Kizito, 2011). In most of the cases, however, these services do not sustain after the development and investment programs terminate, which raises doubts as to the (perceived) benefits of these services to users and users' respective willingness to pay for the services.

A number of questions have, so far, not been answered in the literature. First, to which extent are smallholder farmers able and willing to pay a premium to access market information services – excluding external subsidies? Second, does the market price and quality information asymmetry really matter in supply chains? Answering these questions will help design a short message service (SMS) based framework for sustainable and efficient market information systems (MISs) that are easily accessible for smallholder farmers in less developed countries.

With respect to these issues, much has been written on the role of information and communication technologies in Africa with a special focus on factors that affect the spread of mobile coverage and the impact of mobile phone use on pro-poor labour market access, employment creation and health care (Aker, 2008; Bosch, 2009; Brouwer and Brito, 2012; Buys *et al.*, 2009; Lawson-Body *et al.*, 2011; Maranto and Phang, 2010; Porter, 2012; Porter *et al.*, 2012). However, most of these studies did not investigate the perceptions of the subscribers and the premiums they are willing to pay for a sustainable use of the mobile phone as a device to access market information in rural and peri-urban areas.

As elucidated by Donner (2008) and Aker and Mbiti (2010), economic research on smallholders' adoption and use of mobile phones in less developed countries has been limited. Using a contingent valuation approach, the present study aims to assess farmers' willingness to use a mobile phone to supply and receive market and quality information on agricultural products, as well as to investigate the premium that they are willing to pay for these services.

First, an explorative case study was undertaken in Ghana – a country with many years of experience in mobile phone-based market information management – to gain further insight into smallholders' perceptions of SMS-based MIS. Lessons learnt from Ghana were used to design a survey to investigate the premium that pineapple farmers in Benin are willing to pay for receiving SMS-based product price information (hereafter called price-SMS) and SMS-based product quality information, such as information on standards, inputs and crop diseases (hereafter called quality-SMS). The outcome of this study was used to formulate policy and development recommendations for improving market access of smallholder pineapple farmers and agrifood chain actors.

The remainder of the chapter is organised as follows. First, we present an overview of the pineapple supply chain in Benin. Second, we present the analytical framework, and explain the methods we used for data collection and analysis. Third, the major findings and lessons learnt in Ghana and the major findings of the econometric analysis of farmers' willingness to pay for price-SMS and quality-SMS in Benin are presented. The implementation strategies and implications for policy and practitioners are put forward in the last section.

## 4.2 Overview of pineapple supply chains in Benin

There are five main supply chains for pineapple in Benin: the domestic fresh chain, the domestic juice chain, the regional fresh chain, the international fresh chain and the dried pineapple chain (Figure 4.1).

- *Domestic fresh consumption*. This marketing channel is one of the major outlets in Benin, absorbing about 35% of production in 2010. The produce is sold at urban (Dantokpa in Cotonou) as well as rural (Glo-Djigbé, Sekou, Sèhouè, Zinvié, Ouegbo, Ze) markets.
- *The West African (regional) markets for fresh pineapple*. The supply of pineapples in Benin exceeds national demand. Therefore, producers need to find other marketing channels to sell their surplus pineapples. Although there are no official statistics on the quantity of pineapples exported to neighbourhood countries, it is estimated to be around 40% of the national production. Wholesalers in Dantokpa market (Cotonou) stated that the Nigerian market alone absorbs more than 40% of the national production. Regional export markets operate differently from the European and Asian export markets and are dominated by informal transactions with lower quality requirements.
- *Juice from fresh pineapple*. Pineapple juice is produced in traditional and semi-industrial processing factories and packed in 0.25 or 0.33 litre bottles. This market channel is not well developed and is dominated by individual traditional producers and some farmers' associations. The juice is mainly sold on the domestic market and not exported to Europe, because of shelf-life difficulties. This channel consumes almost 15% of national production (which increases the domestic consumption of fresh pineapples to about 50%).

- *Fresh pineapple exports*. The international market (beyond West Africa) accounts for about 2% of total production. This market includes EU countries (France, Belgium, Luxembourg, Italy, Germany, the Netherlands), Asian countries (United Arab Emirates and Saudi Arabia) and North African countries (Algeria and Libya). Exports, either by air or by sea, are problematic. Until 2008, plane freight cost 518 €/tonne by KLM/Air France and 609 €/tonne on DHL[2]. By boat, the freight cost is 380 €/tonne, less expensive than by plane, but it is necessary to ship quite large batches. International exports require a wide range of additional inputs (boxes, bags, and other packaging materials) to ensure that the perishable fruit is effectively preserved. These inputs need to be available and affordable.
- *Dried pineapple and marmalade export chain*. This market channel is not well developed. The major destinations are France, Switzerland, Belgium and Austria. The Tropical Fruit Drying Centre (CSFT-Benin) is the main factory that supplies dried pineapple export from Benin, including pineapple marmalade and syrup.

Participation in the export chain involves fulfilling certain quality attributes, such as size, sugar content, and the absence of external and internal damage. These attributes determine the price paid. The lowest prices for pineapple in the rural, urban and regional markets are recorded during May and June. One respondent indicated that one of the main causes is market competition with other fruits (oranges, mangoes, and bananas), which ripen in the same period. Farmers selling during this period report prices that are below the costs of production, but these can be compensated for by an increase in price from July to September. During this period, the average price of

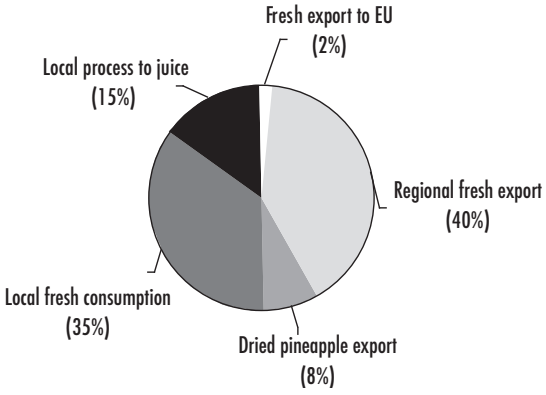


*Figure 4.1. Fresh and processed pineapple markets (adapted from Agbo* et al.*, 2008).*

[2] Data provided by ADEx (*Association des Exportateurs*), the association of exporters in Cotonou-Benin during an interview in 2009.

forty pineapples[3] can be as much as US$ 30 corresponding to US$ 0.75/kg (for the 'Smooth cayenne' cultivar).

There are three causes for the annual cycle of price fluctuations. First, pineapple production in Benin mainly depends on natural rainfall patterns that do not allow farmers to apply inputs, mainly fertilisers and ethylene for flowering induction treatment (FIT), during the dry seasons. In south Benin the dry season occurs in December, January and early February. It is difficult to apply the FIT at this time, meaning that there is a shortage of pineapples eight months later, between July and September. Second, there is a socio-cultural condition that affects the profitability of pineapple chains: Muslims' fasting period generally falls in the period between July and September. During this period there is a peak in the demand for fruits, and the local prices experience a significant increase. In the normal season a bunch of forty Cayenne smooth pineapples might fetch between 2,500 and 3,500 CFA Francs[4], or even as little as 1,500 CFA Francs. In the period of Ramadan the same fruit might sell for between 4,000 and 5,000 CFA Francs and large size fruits might even reach 11,000 CFA Francs. The market price for the 'Sugarloaf' variety is normally between 1,500 and 2,000 CFA Francs (for forty), but can increase to 2,500 or 4,000 CFA Francs during the fasting period. Aware of this price fluctuation, farmers now try to manage their production systems so that they can produce during the peak price season. Third, a similar pattern of seasonal demand from other neighbouring countries with significant Muslim populations, such as Nigeria, Burkina Faso and Niger, adds to this high price.

## 4.3 Data collection and methods

### *4.3.1 Research models*

The analytical framework used in the present study is built around three complementary methods of econometric modelling. We first estimated the determinants of mobile phone use (using a Probit model to take selection bias into account). In the second stage, the factors relevant to explaining farmers' willingness to pay (WTP) for MIS were assessed, using an Ordered Probit model. Finally, the extent to which farmers are ready to pay an affordable price for this service was estimated using a Censured Tobit model approach. This section presents a detailed explanation of each of these analytical approaches.

In general, the endogeneity issue[5] related to the difficulty of disentangling the effect of using a mobile phone (or not) on the willingness to pay for a MIS is a key determinant

[3] Selling pineapples in heaps containing forty single pineapples is a common practice among pineapple retailers in Benin. Heaps are sold either on the road (e.g. in Sékou, Zè, Toffo) or in rural and urban markets.

[4] US$ 1= 502 CFA Francs during data collection in 2009.

[5] For further details on endogeneity issues with endogenous variables see Greene (2008).

in the analytical framework. Hence, rejecting the null hypothesis by observing the significance of the explanatory variables in the model may not imply any causality in terms of farmers' effective WTP. A third driver – the use of a mobile phone – may also affect the dependent variables, inducing a spurious correlation and a selection bias that may lead to erroneous conclusions. The presence of this bias can be tested for by including a sample selection term in the regression. To take account of a possible sample bias that may be related to the inclusion or not of mobile phone users in the model, we first ran a Probit model to generate the Inverse Mill's Ratio (IMR) (2008), which was later on included in the Ordered Probit and Tobit models.

For the Probit model, we define the dependent variable as a dummy with a value of 1 if the farmer has an operating mobile phone and 0 if not. Following White (2004) this leads to a 'selection equation' presented as follows:

$$Z^{*}_{ij} = \gamma_{0i} + \gamma_{ij}\Sigma W_{ij} + \mu_{j} \quad (1)$$

where $Z^{*}_{ij}$ is a variable defining whether the farmer has already access to (and uses) a mobile phone or not, and $W_{ij}$ presents a set of explanatory variables. The IMR is then generated from the parameter estimates of the Probit regression of Equation 1. In the second step, using only the observations of farmers who have and use this technology, and including the IMR as a dependent variable, we estimated the WTP Ordered Probit (Equation 4) and the Tobit (Equation 5) models. For the WTP Ordered Probit, the general analytical framework consists of the following equation:

$$Y_{ij} = \alpha_{0i} + \Sigma\alpha_{ij}X_{ij} + \varepsilon_{j} \quad (2)$$

where $Y_{ij}$ is the target dependent variable (with 5 level Likert scale responses), $X_{ij}$ is a set of control and independent variables and $\varepsilon_{j}$ is a vector of error terms. More specifically, the null hypothesis is that all the slope coefficients of the explanatory factors ($X_{ij}$) are equal to zero ($H_{0:}\ \alpha_{ij} = 0$). The basic assumption is that a farmer will only express a WTP if he has an operational mobile phone. While $Y_{ij} = s$ (with s = 1-5) implies that the equation has been precisely measured, there exists an unobservable (latent) variable $Y^{*}_{ij}$, such that $\eta_{ss} \leq Y_{ij} \leq \eta_{s}$ with s = 1-5. Following Verbeke and Ward (2006), farmers' WTP for the mobile phone-based MIS is expressed as follows:

$$Y_{ij} = \begin{cases} 1 \Rightarrow \text{strongly disagree} & \Rightarrow \text{if } \eta_0 = \text{f ong} Y^{*}_{ij} < \eta_1 \\ 2 \text{ disagree} & \Rightarrow \text{if } \eta_1 \leq Y^{*}_{ij} < \eta_2 \\ 3 \text{ indifferent} & \Rightarrow \text{if } \eta_2 \leq Y^{*}_{ij} < \eta_3 \\ 4 \text{ agree} & \Rightarrow \text{if } \eta_3 \leq Y^{*}_{ij} < \eta_4 \\ 5 \text{ strongly agree} & \Rightarrow \text{if } \eta_4 \leq Y^{*}_{ij} < \eta_5 \end{cases} \quad (3)$$

The variable $Y_{ij}$ is observed only when $Z^*_{ij}$ is larger than zero (Equation 1). Hence, the expected farmers' WTP, premised upon the possession of a working mobile phone in the Ordered Probit model is expressed as:

$$E(Y_{ij}|Z^*_{ij} > 0) = \alpha_{0i} + \alpha_{ij}\sum X_{ij} + \sigma_{ij}\frac{\emptyset(X_i^P\alpha_i)}{\Phi(X_i^P\alpha_i)} + \varepsilon_j \quad (4)$$

Where Ø is the probability density function of a univariate normal distribution and Φ is the cumulative distribution function. The term $\emptyset(X_i^P\alpha_i) / \Phi(X_i^P\alpha_i)$ is the IMR.

To assess if the WTP for mobile-based MIS was sufficiently high, farmers were asked the amount of money they would be willing to spend to get that service. If they did not express a WTP of any premium, the measure of desire is zero (Paolisso *et al.*, 2001). Following Maddala and Lahiri (2006), the estimated Tobit model is expressed as follows:

$$E(\pi_{ij}|Z^*_{ij} > 0) = \beta_{ij}\sum X_{ij} + \sigma_{ij}\frac{\emptyset(X_i^P\alpha_i)}{\Phi(X_i^P\alpha_i)} + \varepsilon_j \quad (5)$$

where $\pi_{ij}$ is the amount of money *i* that farmer *j* is ready to pay to get or supply market information using a mobile phone (assuming current possession of an operational mobile phone) ($Z^*_{ij}$>0), $X_{ij}$ is the set of explanatory variables that are hypothesised to affect the amount that farmer *j* is willing to pay, $\beta_{ij}$ is the parameter to be estimated and $\varepsilon_j$ the error terms' vector.

If the IMR has a significant coefficient in both Equation 4 and 5, this means that running the regression models without differentiating between farmers who are using a mobile phone from those who are not – as a basic condition – would have led to selection bias. Before running the econometric models, each variable was checked for normality using a Skewness and Kurtosis tests (D'agostino *et al.*, 1990).

From the literature, several factors ($X_{ij}$) are hypothesised as affecting farmers' willingness to adopt innovations (Adegbola and Gardebroek, 2007; Adesina and Zinnah, 1993; Adesina *et al.*, 2000; Binam *et al.*, 2004; Feder *et al.*, 1985; Herath and Takeya, 2003; Sall *et al.*, 2000). These factors include socio-economic characteristics, such as age, farming experience and income or profit (Adegbola and Gardebroek, 2007; Adesina and Zinnah, 1993; Arinloye *et al.*, 2010a). The farmers' dynamic capability, i.e. their aptitude to be flexible in response to the market and environment changes, is also a determinant (Clark and Fujimoto, 1991; Wang and Ahmed, 2007; Woiceshyn and Daellenbach, 2005). The awareness level, which is determined by contact frequency with extension agents and support received or membership of an association, has also been found to significantly affect farmers' willingness to change (Adegbola and Gardebroek, 2007). The institutional environment and market context in which farmers are embedded, also determine their decisions about whether or not to adopt a new technology (Adegbola and Gardebroek, 2007; Thangata and

Alavalapati, 2003). Detailed descriptions of these variables as included in the models and the hypothesised coefficient signs are presented in Appendix 4.1.

### *4.3.2 Data collection*

Data used in this study were collected in two phases. First, an exploratory case study (Yin, 1994) was undertaken in Ghana, predominantly to understand Ghanaian experiences in managing market information with smallholder farmers using mobile phone SMS, and to learn how subscribers perceive and appreciate this innovation in the agrifood sector. During this case study, 45 key informants were interviewed using a non-structured protocol and selected on a non-probabilistic basis. Respondents were chosen on the basis of their experiences and knowledge of the pineapple, production, marketing, supply chain organisation, the use of mobile phone in agriculture, and the existing institutional environment. Detailed information on the categories of actors interviewed in Ghana can be found in Table 4.1. Lessons learnt from this case study in Ghana were used to design a survey in Benin on price-SMS and quality-SMS willingness to pay.

In Benin, data were collected with a pre-tested, semi-structured survey questionnaire, which consisted of a combination of closed questions, Likert scales with a 5-point format (Allen and Seaman, 2007; Jamieson, 2004) and open questions. Figure 4.2 shows the mobile phone network of one mobile phone operator (MTN©) in Benin in 2012. It shows that most of the subscribers are located in southern Benin where our study was undertaken. From the literature (Arinloye *et al.*, 2010b, 2012) we learnt that more than 95% of pineapples produced in Benin are from southern Benin, in particular from the Atlantique Department. Respondents from this area were selected using a randomly stratified sampling scheme (StatPac, 2010). The criteria used were

*Table 4.1. Categories of actors interviewed in Ghana.*

| Categories | | Number of respondents |
|---|---|---|
| Farmer's organisation leader | | 3 |
| Individual farmers | | 21 |
| Traders in local markets | | 2 |
| Exporters | | 2 |
| Processing companies | | 2 |
| Support organisations and institutions | Input suppliers | 2 |
| | Ministry of agriculture (government) | 4 |
| | University & research centre | 2 |
| | Quality control services | 3 |
| | Non-governmental organisation | 2 |
| | Market information system (ESOKO) | 2 |
| Total | | 45 |

the acreage under pineapple cultivation in 2009 (differentiated into small scale (<1 ha), medium scale (between 1 ha-5 ha) and large scale (>5 ha)), the supplied market channels (local or export markets), the location of the pineapple farm (i.e. distance to the main market centre in Cotonou, see Figure 4.2) and the support of extension agents. Farmers were contacted with the assistance of agricultural extension officers, who provided the names and addresses of lead farmers in the villages where they intervene. Pineapple producers' associations and councils constituted a second source of information on pineapple farmers.

After data collection, incomplete questionnaires and non-qualifying respondents (i.e. farmers who did not provide accurate information) were eliminated, resulting in a final list of 285 observations in Benin. For data analysis we combined both descriptive and econometric approaches.

To design the WTP questions and assess the premium that farmers are willing to pay, we set a maximum affordable amount in order to avoid exaggerated and uncontrolled answers from respondents. The amount that was fixed, was based on a World Bank survey (World Bank, 2010), that estimated the affordable tariff for a prepaid mobile phone to be US$ 8 per month in the sub-region. This served as a reference to fix the maximum premium threshold at 4,000 CFA Franc (US$ 7.96) per month.

A correlation matrix and the descriptive statistics of the variables included in the models are presented in Appendix 4.2. The correlation coefficients were less than 0.4, generally indicating weak relations (Peters *et al.*, 1997). This clearly shows that

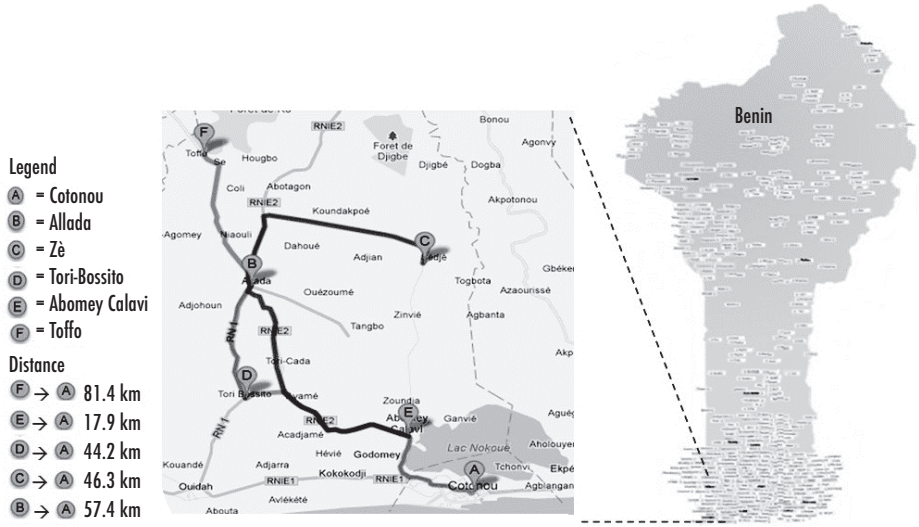


*Figure 4.2. Mobile phone network in Benin with study areas, and distance to the main urban market in the south of the country (Adapted from MTN-Benin, 2012).*

the variables were sufficiently independent to be modelled without multicollinearity problems (Verbeek, 2008). We used STATA SE software (Statacorp, College Station, TX, USA), which also controlled for the models' robustness – using the *robust* option. The Robust standard errors are reported in Table 4.2.

## 4.4 Mobile phone-based market information system experiences in Ghana: Esoko case study

The exploratory case study in Ghana was aimed at gaining insights into smallholders' perceptions about an existing SMS-based market information system. Esoko – formerly known as TradeNet – is an agricultural market information platform created in 2006 with the objective to disseminate useful market information to smallholder farmers in less developed countries (https://esoko.com). The organisation is active in 16 East and West African countries, including Ghana. It is a response to the explosive growth of mobile services in Africa. Esoko is a private initiative based in Accra, Ghana, supported by a team of over 60 local developers and support staff. Although the knowledge that farmers have is often underestimated, an asymmetry of information exists throughout agriculture, which rewards some and excludes others. To overcome this situation, Esoko assists smallholder farmers by providing them with a package of weekly advisory services including current market prices, matching bids and offers, weather forecasts, and news and tips.

*Table 4.2. Determinants of mobile phone use, willingness to pay (WTP) for SMS on quality and price.*[1]

| Variables | Determinant of mobile phone use | Determinant of WTP for SMS on quality | Determinant of WTP for SMS on price |
|---|---|---|---|
| Socio-economic and farm characteristics | age | – | age |
| | education level | – | – |
| | profit margin | – | profit margin |
| | farm size | farm size | farm size |
| Market attributes | distance | distance | distance |
| Market channels targeted | – | local market | local market |
| Institutional support | public support | public support | public support |
| | – | quality support | quality support |
| Inverse Mill's ratio (IMR) | – | -0.85 (1.81) | -1.59 (1.98) |
| Observations | 285 | 247 | 247 |
| Wald chi$^2$(df) | 53.4(16)$^{***}$ | 90.51 (17)$^{***}$ | 53.46 (17)$^{***}$ |
| Pseudo $R^2$ | 0.38 | 0.14 | 0.12 |
| Log pseudolikelihood | -69.14 | -212.93 | -181.32 |

[1] Numbers between brackets are robust standard errors; $^{***}$ significant at 1%.

How does the Esoko platform help Ghanaian farmers? When questioned, farmers answered that the SMS services help them to improve their price negotiation capacities, find alternative markets, and enable them to sell timely at better prices. The platform provides automatic and personalised price alerts, buy and sell offers, bulk SMS messaging and stock counts. Services provided have transformed mobile phones into market bulletins and increased their utility beyond voice and text. It has succeeded mainly because it allows text messages to be sent and received in several languages, including local languages, and provides real-time commodity prices. Mobile phone applications include the provision of market information and electronic trading platforms, where farmers and traders can access information on commodities being (or to be) sold, their prices, the identity of their buyers and extension service messages.

Like all businesses, farming is based on having the right information at the right time. Farmers need to know what crops to plant to obtain the best return on their investment of time and money. Ghanaian farmers have shown interest in using their mobile phones to get a good yield, and in accessing the appropriate fertilisers and pesticides to apply to their crops. SMS-based market information is also helpful for buyers who sometimes have no information about what is growing where and in what quantity. Esoko has been able to respond to this demand by providing accurate and updated prices, offers and profiles. This data can be accessed by any mobile phone user anywhere in the country covered by the mobile phone network. SMS alerts are sent out either as-they-happen (offers to buy and sell) or on specific days of the week (prices), depending on the subscriber's preference. For farmers, text messages by phone were helpful in reducing costs for searching for information and significantly reduced information asymmetry and misunderstandings with their buyers.

However, the major challenge expressed by illiterate farmers (more than 40% do not have formal education and 35% have less than primary school level) was that they always have to ask the assistance of their children or neighbours to help them to read or send messages. In rural areas this is sometimes coupled with a lack of infrastructure, such as electricity to charge phones.

### 4.5 Information asymmetry and importance of mobile phone use by smallholder pineapple farmers in Benin

As stated in the introduction, market information asymmetry is a major factor affecting farmers' income in agrifood chains. As evidence, the price of pineapple at the farm gate is generally very low compared to the price at which it is sold to consumers, even in the same area. For example, our investigation shows that the price of 40 medium-sized pineapples of the 'Smooth cayenne' variety (i.e. about 50 kg) varies between 2,500 CFA Francs (US$ 5) and 9,000 CFA Francs (US$ 18) at different periods on the local market, and can even reach 10,000 CFA Francs (US$ 20) during the Ramadan, the fasting period of Muslims, when demand is high. Farmers receive on average only 3,500 CFA Francs (US$ 7) of this. Medium and large-sized pineapples of the second

variety, 'Sugarloaf', were sold to consumers on local markets for prices between 1,500 CFA Francs (US$ 3) and 4,500 CFA Francs (US$ 9) and this can reach a pick of 15,000 CFA Francs (US$ 30), while the average farm-gate price is 2,200 CFA Francs (US$ 4.3) for about 40 kg. This shows how variable and unstable the market price can be in the same location. Farmers indicated that they were not aware of the prices at which traders resell their products. For instance, in the survey area, more than 86% of farmers do not know the price paid by the third buyer of their products, as traders do not reveal such information to them. The other 14% of farmers who are (indirectly) informed about traders' market prices, either get the information by travelling to these markets to sell other agricultural products, such as maize, cowpea, and cassava, or by calling their relatives on these markets. This information asymmetry issue is reinforced by their low bargaining power in pineapple transactions (Arinloye *et al.*, 2012). The consequence is that farmers do not know what pineapple farmers in other villages were paid.

As witnessed in Ghana, an SMS-based platform that provides farmers with up-to-date market prices and also asks questions and receives answers from a remote computer-based platform could be a solution to these problems. This would allow farmers to have more information and therefore more bargaining power in their transactions with traders. This platform can match farmers' queries with a database of information about prices in local, urban and regional markets and send answers back to the farmers. Critical market information, such as price, offers, inventories, questions and answers about diseases, can be uploaded and shared through SMS by anyone with a mobile phone. The present study in Benin sheds light on farmers' responsiveness to a mobile phone based MIS.

First of all, it is important to know the proportion of smallholder farmers who are currently using a mobile phone as a communication tool in the study area. Our result shows that the use of mobile phone is widespread in the rural areas in Benin as reflected by the sample of pineapple farmers. On average, 87% of the sample use a mobile phone (Appendix 4.1), a value which does not differ much from the subscription proportion (80%) in SSA (World Bank and ITU, 2012). This can be explained by the increasing network coverage in rural areas. As shown in Figure 4.2, the population covered by Benin's five service providers (MTN©, Moov©, BBCom©, Libercom©, and Glo©), in 2010 was estimated to be 90%, much higher than in SSA in 2009 when it was estimated at 53% (World Bank, 2011; World Bank and ITU, 2012). Several factors can explain this high mobile phone adoption rate: falling communication costs (Sey, 2010), population density, increasing per capita income, and, especially, competition among mobile phone operators (as demonstrated by several authors (Aker, 2008; Aker and Mbiti, 2010; Demirhan *et al.*, 2006; Lin *et al.*, 2011).

In general, most pineapple farmers were positive about using their mobile phone to access and supply market information (4.4 on a 5-point scale). In other words, farmers (strongly) agreed about using their mobile for receiving and supplying market prices, and offering their products to potential buyers all over SSA (at least in the countries

covered by Esoko). Farmers also expressed a high level of interest (4.3 on a 5-point scale) in using this tool to get information that could help them improving their product quality and meeting market standards, such as information on agricultural practices, input supply, quality control and questions/answers on disease control.

The descriptive statistics show that farmers are generally willing to pay an average premium of 1,268 CFA Francs (US$ 2.5) per month to get price-SMS and almost the same average price (1,200 CFA Francs ~ US$ 2.4) to receive quality-SMS. This shows that farmers are equally interested in both product price and product quality information.

## 4.6 Farmers' willingness to pay for a mobile-based market information system in Benin

As presented in Table 4.2, the IMR was not significant for the WTP for either the price-SMS, or quality-SMS. This implies that there was no need to consider selection bias issues by including users and non-users of mobile phone in the models. In other words, both current and potential mobile phone users were highly interested in paying to get and supply information via SMS. The Wald test examines whether any of the parameters of the model that currently have non-zero values could be set to zero without any statistically significant loss in the model's overall goodness of fit ($\alpha_{1j} = \alpha_{2j} = \alpha_{3j} = jt\alpha_{ij} = 0$). It tests the overall significance of the variables included in the econometric models (McGeorge *et al.*, 1997; Ryan and Watson, 2009). Results show that the Wald Chi$^2$ is statistically significant at the 1% level, which indicates that the set of coefficients of the model are jointly significant and that the explanatory power of the factors included in the model is satisfactory.

### *4.6.1 Determinants of mobile phone use*

The Probit model of the determinants of mobile use shows that farmers' age, education level, profit margin, farm size, distance to the urban centre and contact frequency with public extension service agents, are significantly correlated with the mobile phone usage in Benin. Among these factors, education level, profit, and contact frequency with extension service agents showed a positive correlation with the adoption at a 1% significance level. In other words, farmers who use a mobile phone mostly have a higher education level, higher farming profit margins and more frequent contact with the extension service.

The results also show that mobile phone users are mostly younger, located close to the main roads and urban centres and produce on small-sized farms. These findings are in line with the expected correlation coefficient sign (Appendix 4.1) and add to the existing literature, especially the publications of Aker and Mbiti (2010) and Buys *et al.* (2009), who have found that the mobile network coverage probability is positively related to income per capita, closeness to the main urban centres and to the main

road. Most of the mobile phone users are smallholder farmers, which does not come as a surprise since 88% of the farmers produce pineapple on less than 5 hectares (Arinloye *et al.*, 2012).

### *4.6.2 Determinants of farmers' willingness-to-pay for quality-SMS and price-SMS*

The results of the econometric model of the factors that affect farmers' WTP for SMS based-quality showed that farmers who are most likely to pay for these services are smallholder famers who are located far from the urban centre (Cotonou), trade mostly with buyers coming from urban markets, and have little contact with the agricultural extension service (Table 4.2). In most of the cases these farmers have either received technical support for on-farm quality improvement from their buyers or from non-governmental organisations (NGOs). In fact, most farmers selling to exporters and some urban wholesalers have specific contracting farming arrangements with their buyers (the outgrowing scheme, Arinloye *et al.*, 2012), who provide technical or financial assistance in terms of training, input supply and loans to support the outgrowers and help them meet their specific quality requirements. We can therefore conclude that those who are highly interested in quality-SMS, are farmers with past experiences of having received capacity building or training on product quality improvement and who are aware of the importance of product quality in the supply chain.

Apart from the distance to the urban centre, all the factors that affect farmers' WTP for quality-SMS also significantly affect the WTP to pay for price-SMS, with the same coefficient signs. This implies that farmers who are willing to pay for these services are also smallholder farmers, located far from the urban centre, not trading with local market traders but with those coming from urban or regional areas, having little contact with agricultural extension services and receiving technical support for on-farm quality improvement from their buyers. Additionally, they are mostly smallholder farmers with lower farming profit margins ($P<0.05$) than the average pineapple profit in the study area, which is estimated at 400,000 CFA Francs (US$ 795) per cropping campaign.

### *4.6.3 Premium to be paid for quality-SMS and price-SMS*

Since the results from the Probit and Ordered Probit models presented so far do not allow isolating the marginal effects of each explanatory variable associated with the expected premium (amount) to be paid for both services, we ran a Censored Tobit regression. The goal was to determine how much each set of regressors, such as socio-economic characteristics, market attributes, marketing channels and institutional support received, accounts for farmers' WTP.

Here also, the IMR are not significant, implying that there was no need to consider selection bias issues in the Tobit models. Results show that the F statistics are statistically significant at the 1% level indicating that the subsets of coefficients of the

model are jointly significant and the explanatory power of the factors included in the model is satisfactory.

The marginal effect of the factors included in both Tobit models and their significance level are presented in Table 4.3. In terms of socio-economic characteristics, an increase in farmers' age by one year would decrease the premium they are ready to pay by 28 CFA Francs (US$ 0.05) per month for quality-SMS and by 36 CFA Francs (US$ 0.07) per month for price-SMS. This confirms the result of the ordered Probit model of WTP, which indicated that younger farmers are more willing to pay a higher price than older and experienced farmers. Apparently they are also inclined to pay a higher price for price-SMS than for quality-SMS. This can be explained by young farmers having a longer planning horizon and being more willing to take risks (Zegeye *et al.*, 2001). Moreover, farmers who showed a dynamic capability (e.g. having changed their farming practices in response to market and environmental changes to meet their buyers' requirements in the last five years) are willing to pay an additional premium of 371 CFA Francs (US$ 0.74) per month for quality-SMS and even more (394 CFA Francs ~ US$ 0.78 per month) for price-SMS than farmers who showed less dynamic capability. As for the farm size, we found that a reduction of the covered land by one hectare led to an increase of the accepted premium of 183 CFA Francs (US$ 0.36) per month for quality-SMS. A reason for this might be the predominance of pineapple supply chain by small-scale farmers mostly cropping less than one hectare of pineapple. Most of these farmers have shown more interest in the use of mobile phone to get price and quality information as they are the most concerned by this lack of information as compared to the very few big farmers. The pineapple farm ratio indicates farmers' cropping diversification (or specialisation). The results showed that an increase of diversity by 1% leads to an increase of the acceptable premium of 867 CFA Francs (US$ 1.73) per month for quality-SMS. This can be explained by the fact those farmers, with diversified production system, think beyond and have seen the application and relevance of this SMS service in other value chains (i.e. maize, cashew, cassava, shea) which are also affected by weak access to market information and demand attributes especially for international markets. The issue of market information asymmetry is not only observed in pineapple chain, but along the agriculture sector in Benin.

When looking at the market attribute factors, an increase of the distance between farm and main market centre by 1 km, decreases the premium that farmers would be willing to pay for price-SMS by 15 CFA Francs (US$ 0.03) per month. As far as the institutional support factors are concerned, farmers having regular contact with extension agents showed an interest in paying a higher premium of 536 CFA Francs (US$ 1.06) per month for quality-SMS and 257 CFA Francs (US$ 0.51) per month for price-SMS compared to those who do not have this contact. Moreover, farmers who have received support for quality improvement of their products would pay an additional premium of 330 CFA Francs (US$ 0.65) per month for quality-SMS and 132 CFA Francs (US$ 0.26) per month for price and offer SMS compared to those without any quality support experience. Summarising, farmers who are most willing

*Table 4.3. Marginal effects after Tobit models for expected premium to be paid (in CFA Francs) for quality and price SMS.*[1]

| Variables | | Premium for quality-SMS | Premium for price-SMS |
|---|---|---|---|
| Socio-economic and firm characteristics | age | -28.0*** | -35.8*** |
| | education level | -6.7 | -44.8 |
| | farming experience | 1.2 | 18.1 |
| | dynamic capability | 370.9** | 394.2** |
| | profit margin | -183.3** | -80.5 |
| | farm size | -183.3*** | -181.8 |
| | pineapple farm ratio | -867.1*** | -187.2 |
| Market attributes | information time | 22.4 | 25.5 |
| | distance | -5.1 | -14.8*** |
| Market channels | export market | 43.9 | 403.9 |
| | local market | 12.5 | 44.1 |
| Institutional support | extension service support | 536.1*** | 256.9* |
| | market support | 58.2 | 73.6 |
| | quality support | 330.1*** | 131.7** |
| | farming support | -23.7 | 75.2 |
| | input support | -3.1 | 25.5 |
| Inverse Mill's Ratio (IMR) | | 1,523.1 | 2,747.1 |
| Observations | | 247 | 234 |
| F statistic (df1; df2) | | 4.9 (17; 230)*** | 4.13 (17;217)*** |
| Log pseudolikelihood | | -1,849.1 | -1,730.6 |

[1] * Significant at 10%; ** significant at 5%; *** significant at 1%.

to pay for quality and price SMS are small-scale young famers, showing dynamic capability in improving and diversifying their agricultural practices and production systems, and located closest the city centre and urban markets.

## 4.7 Concluding remarks

The present study assesses the determinants of farmers' willingness to use a mobile phone to supply and receive market information on the price and quality requirements for agricultural products, and the premium they are willing to pay for these services. This would be a useful strategy for overcoming information asymmetry in the pineapple supply chain. Using an exploratory case study in Ghana to gain insights into smallholders' perceptions about SMS-based market information systems, followed by an in-depth survey in Benin, the results showed the high potential of mobile phones to improve smallholder agriculture in rural areas of SSA. In Ghana, and other countries

where Esoko is active, such a system allows farmers to get market information at the right time. Lessons learnt from this case study may be of great importance in developing and promoting agrifood quality improvement and market access, not only in Benin but also across other SSA countries that face the same challenges. Despite the existence of national institutes and support services involved in quality control and strengthening actors' capacity to comply with quality standards, there is a clear need to design a better mechanism for coordinating the supply chain. If small scale producers are to respond to the quality norms and standards for regional and international markets they need to make investments in their production. Additional investments, either from state, financial partners or NGOs, are needed for building roads, cold chain facilities, safe handling and storage facilities, chemical waste disposal pits, hand washing facilities, personal protective equipment, knapsack sprayers, and certified planting material. Pineapple production in Benin is recognised as having a huge potential. The supply chain is showing an increased international orientation despite the low adaptive capacities of smallholder farmers to comply with foreign norms and quality standards.

Even when mobile phones can enhance access to resources and information, they cannot replace investments in public goods, such as roads, electricity and water. In the absence of a proper infrastructure, smallholder farmers will face problems with efficiency and competitiveness (Roberts and Grover, 2012). As such, it is unrealistic to rely on improved access to market information as the only strategy for improving chain performance by smallholder farmers. A mobile MIS approach needs to be embedded in an enabling political and institutional environment, involving value chain actors to find a holistic solution to the pending issues of information asymmetric and market access. Poor infrastructure remains an obstacle to the development of many communities. Markets with a surplus are disconnected from markets with a deficit (and vice versa). Over the last twenty years the Beninese government through ONASA and INSAE[6] has been collecting information about markets, but has not created the channels to deliver this information to the general public or to farmers, certainly not at a speed to make it commercially valuable.

Implementing the mobile-based MIS, while simultaneously improving related infrastructures, may significantly contribute to helping rural communities to improve their livelihoods by achieving a better product quality and facilitating market access at national and continental levels. Such recommendations have been made by several authors (Cavatassi *et al.*, 2011; Mwesige, 2010; Thiele *et al.*, 2009, 2011), who call for multi-stakeholder platforms that will strengthen public and private actors' partnerships and enable smallholders to gain sustainable access to high income markets. The private sector could provide platform coordination and management staff (like Esoko is doing), important value chain actors (such as farmers' organisations) and

[6] ONASA refers to *Office National d'Appui à la Sécurité Alimentaire* an equivalent of national office of food security support. INSAE is the *Institut National de Statisque et de l'Analyse Economique,* corresponding to the national institute of statistic and economic analysis of Benin.

a mobile phone operator can serve as the intermediary between subscribers and the computer-based platform. The public sector could provide support through existing national statistical and market information management institutes (for monitoring the collection of and profiling market information) and research institutes and quality control services (to provide reliable answers to chain actors' requests on quality, inputs, and diseases). It could also provide support services that monitor and build the capacity of smallholders and the infrastructure facilities that they need – such as rural roads, packaging and cooling facilities, and finance. As suggested by White (2004), this would create an enabling environment for innovation and help deliver the resources required to build a complex multidimensional and dynamic range of knowledge, skills, actors, institutions and policy within specific political-policy structures capable of transforming knowledge into useful processes, products and services for agriculture. These recommendations could serve as a guideline for policy-makers and practitioners.

Even though farmers showed a high willingness to pay for a mobile phone-based MIS, it remains important to assess how the existing infrastructure and institutional environment can support such a process and make it effective. This offers opportunities for future development and policy-oriented research. One important limitation of the present study is that farmers' dynamic capabilities have been measured by asking them if they have ever changed their farming practices. Having changed farming practices, possibly only once and only slightly, does not necessarily show the dynamic attitude of the farmers. Entrepreneurship attitude could be measured by asking about farmers' changes in market orientation, in realising new resource configurations, strategies and organisation routines (Eisenhardt and Martin, 2000; Yin *et al.*, 2013), as well as about their flexibility in addressing rapidly changing environments (Teece *et al.*, 1994). Future investigations could put some emphasis on these aspects.

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## Appendix 4.1. Description of variables and hypothesised signs.

| Variables | Description | Value | Hypothesis[1] |
|---|---|---|---|
| Dependent variables | | | |
| Use mobile phone | Do you have/use a mobile phone? | 1 = yes; 0 = no | |
| WTP price info SMS | Are you willing to pay for sending/receiving marketing information (price, offers) via SMS? | 1 = strongly disagree; 2 = disagree; 3 = indifferent; 4 = agree; 5 = strongly agree | |
| WTP quality info SMS | Are you willing to pay for sending/receiving quality information (standards, input and disease) via SMS? | 1 = strongly disagree; 2 = disagree; 3 = indifferent; 4 = agree; 5 = strongly agree | |
| Premium for quality info | How much are you willing to pay for quality information (standards, input and disease) via SMS? | continue (CFA Franc/month )[2] | |
| Premium for price info | How much are willing to pay to send/receive pineapple information (price, offers) via SMS? | continue (CFA Franc/month)[2] | |
| Independent variables | | | |
| Socio-economic and farm characteristics | | | |
| Age | Farmer's age | continuous | +/- |
| Education | Education level of farmer | 0 = no (in)formal education; 1 = primary school/informal literacy; 2 = middle school, 3 = high school, 4 = university level | + |
| Experience | Years in pineapple farming | continue | + |
| Dynamic capability | Have you ever changed your farming practices in response to market or environment changes to satisfy your buyers? | 1 = yes; 0 = no | + |
| Profit margin | What was your pineapple production profit margin for the last cropping campaign (×1000 CFA Franc)[3]? | 0 = <0 CFA Francs; 1 = 0-100; 2= 100-500; 3= 500-1000; 4 = 1000-5,000; 5 = >5,000 | + |
| Farm size | Pineapple farm size in hectare | 1 = large scale (>5 ha); 2 = medium scale (1-5) ha; 3 = small scale (<1 ha) | + |
| Pineapple ratio | Proportion of pineapple land over the total covered land size – farm specialisation | continue [0-1] | +/- |
| Market attributes | | | + |
| Info-time | Time spent to get reliable market information | Number of days | + |
| Distance | Distance from farm to the central urban market | 1 = <30 km; 2 = 30-60 km; 3 = >60 km | - |
| Bargaining power | Bargaining power of the farmer with buyers | 1 = low; 2 = medium; 3 = high | - |
| Market channel | | | |
| Local market | Selling pineapple to local markets | 1 = local market; 0 = otherwise | - |
| Export market | Selling pineapple to export markets | 1 = export market; 0 = otherwise | + |

| Variables | Description | Value | Hypothesis[1] |
|---|---|---|---|
| Institutional support | | | |
| Extension service support | Contact with public extension agents | 1 = yes; 0 =no | + |
| Market support | Receiving support to access market (selling) | 1 = strongly disagree; 2 = disagree; 3 = indifferent; 4 = agree; 5 = strongly agree | + |
| Quality support | Receiving support for pineapple quality improvement | 1 = strongly disagree; 2 = disagree; 3 = indifferent; 4 = agree; 5 = strongly agree | + |
| Farming support | Receiving support for farming systems improvement | 1 = strongly disagree; 2 = disagree; 3 = indifferent; 4 = agree; 5 = strongly agree | + |
| Input support | Receiving support to access inputs | 1 = strongly disagree; 2 = disagree; 3 = indifferent; 4 = agree; 5 = strongly agree | + |

[1] Expected correlation with dependent variables.

[2] Price in CFA Francs/month is generated by asking farmers the amount they are willing to pay per SMS times the frequency of sending/receiving SMS in a month. The threshold of total amount per month is fixed during the survey at a maximum of 4,000 CFA Francs (US$ 7.96) following World Bank (2010).

[3] US$ 1= 502 CFA Francs during data collection in 2009.

## Appendix 4.2. Correlation matrix and descriptive statistics of variables.

| Variable | Unit | Min | Max | Mean | Std. Dev. | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 | V13 | V14 | V15 | V16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variables | | | | | | | | | | | | | | | | | | | | | |
| Use mobile phone | (0-1)[1] | 0 | 1 | 0.87 | 0.34 | | | | | | | | | | | | | | | | |
| WTP price info SMS | (1-5)[2] | 1 | 5 | 4.4 | 1.22 | | | | | | | | | | | | | | | | |
| WTP quality info SMS | (1-5)[2] | 1 | 5 | 4.27 | 1.28 | | | | | | | | | | | | | | | | |
| Premium for quality info | Number | 0 | 4,000 | 1,268 | 1,137 | | | | | | | | | | | | | | | | |
| Premium for price info | Number | 0 | 4,000 | 1,200 | 1,109 | | | | | | | | | | | | | | | | |
| Independent variables | | | | | | | | | | | | | | | | | | | | | |
| Age (V1) | Number | 2.83 | 4.29 | 3.6 | 0.28 | 1 | | | | | | | | | | | | | | | |
| Education (V2) | (0-4)[2] | 0 | 4 | 1.05 | 1.04 | 0.21 | 1 | | | | | | | | | | | | | | |
| Experience (V3) | Year | 2 | 40 | 9.99 | 5.08 | 0.46 | 0.03 | 1 | | | | | | | | | | | | | |
| Dynamic capability (V4) | (0-1) | 0 | 1 | 0.72 | 0.45 | 0.33 | 0.23 | 0.3 | 1 | | | | | | | | | | | | |
| Profit margin (V5) | CFA Franc[3] | 0 | 5 | 2.29 | 1.07 | 0.33 | 0.28 | 0.37 | 0.31 | 1 | | | | | | | | | | | |
| Farm size (V6) | Ha | 1 | 3 | 2.33 | 0.7 | -0.4 | -0.11 | -0.26 | -0.16 | -0.4 | 1 | | | | | | | | | | |
| Pineapple farm ratio (V7) | Number | 0.02 | 1 | 0.46 | 0.27 | -0.04 | -0.13 | 0.02 | -0.01 | 0.24 | -0.4 | 1 | | | | | | | | | |
| Info-time (V8) | Number | 1 | 30 | 1.66 | 2.39 | 0.03 | -0.07 | 0.08 | 0.12 | 0 | -0.07 | -0.07 | 1 | | | | | | | | |
| Distance (V9) | Number | 17.9 | 81.4 | 49.98 | 21.1 | 0.07 | 0.22 | 0.05 | 0.27 | 0.26 | 0.02 | -0.06 | -0.07 | 1 | | | | | | | |
| Bargaining power (V10) | (0-1)[1] | 0 | 1 | 0.13 | 0.33 | -0.05 | 0.01 | 0.08 | 0.06 | 0.13 | -0.01 | 0.09 | 0.01 | 0.18 | 1 | | | | | | |
| Local market (V11) | (0-1)[1] | 0 | 1 | 0.27 | 0.45 | 0.09 | 0.05 | 0.01 | 0.12 | -0.02 | 0.08 | -0.15 | -0.04 | 0.09 | 0.26 | 1 | | | | | |
| Public support (V12) | (0-1)[1] | 0 | 1 | 0.3 | 0.46 | 0.21 | 0.06 | 0.06 | 0.19 | 0.23 | -0.17 | 0.02 | -0.02 | 0.32 | 0.16 | 0.25 | 1 | | | | |
| Market support (V13) | (1-5)[2] | 1 | 5 | 2.37 | 1.31 | -0.25 | -0.06 | -0.05 | -0.07 | -0.13 | 0.2 | -0.06 | -0.07 | 0.05 | 0.03 | -0.08 | -0.46 | 1 | | | |
| Quality support (V14) | (1-5)[2] | 1 | 5 | 3.6 | 1.26 | 0.17 | 0.08 | 0.2 | 0.13 | 0.34 | -0.19 | 0.07 | -0.1 | 0.16 | -0.03 | -0.08 | 0 | 0.06 | 1 | | |
| Farming support (V15) | (1-5)[2] | 1 | 5 | 3.96 | 1.11 | 0.32 | 0.16 | 0.29 | 0.22 | 0.38 | -0.34 | 0.05 | 0.04 | 0.16 | 0.12 | 0.01 | 0.38 | -0.35 | 0.43 | 1 | |
| Input support (V16) | (1-5)[2] | 1 | 5 | 2.4 | 1.25 | -0.22 | -0.08 | -0.11 | -0.19 | -0.18 | 0.09 | -0.08 | -0.02 | -0.14 | -0.03 | 0.01 | -0.08 | 0.34 | -0.26 | -0.24 | 1 |

[1] Dummy variables.
[2] Categorical variable.
[3] US$ 1= 502 CFA Francs during data collection period.