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Smallholder farmers' willingness to pay for access to agricultural market information in Tanzania

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ABSTRACT

Introducing user access charges to smallholder farmers accessing agricultural market information is considered as a strategy of financing operations of agricultural market information services. This research studied smallholders' willingness to pay for access charges as a strategy of sustaining information provision operations. Using questionnaires, data were collected from smallholders, randomly selected from three regions in Tanzania. Econometric models were used for data analysis. The Probit model indicated that factors that determine mobile phone use by smallholders included age, mobile phone use knowledge, reasons for growing crops, channels to available markets, and changes in farming practices. The Ordered Probit model indicated that road condition to markets, changing farming practices, and awareness on agricultural market information usefulness determined smallholders' willingness to pay for access charges. The Censored Tobit model indicated that the premium smallholders are willing to pay depends on their mobile phone use knowledge, farming techniques practiced, changes in farming practices, bargaining ability, and awareness on agricultural market information usefulness. To boost production, smallholders need to develop capabilities in different farming practices. For best information provisions, private sector can provide platform and resources needed for platform management while the government can ensure conducive environment for agricultural marketing and of information dissemination.

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1. Introduction

Smallholders access agricultural market information (AMI) of different kinds when marketing their agricultural produce. The assumption is that the access to AMI will help the smallholders improve their bargaining power, identify competitive markets, sell their produce at a specific time for the best prices, and locate compelling buyers (Magesa, Michael, and Ko 2020). Smallholders require accurate information in order to plan in advance when and where to sell their produce (Elly and Silayo 2010). The assumption is that access to, and the use of AMI will help smallholders to improve their bargaining power when selling their produce, identify competitive markets to sell their produce, sell their produce at a specific time for the best prices, and locate compelling buyers of their produce (Magesa, Michael, and Ko 2014a). The smallholders can be motivated when they decide on crops to grow based on the market demands and get better prices for their produce (Wyche and Steinfield 2016).

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However, potholes in information dissemination in developing countries, particularly in agricultural markets, affect smallholders (Nakasone 2013). Poor access to the details of competitive markets and AMI among the smallholders creates a barrier that exposes the unsuspecting smallholders to unreliable marketing channels and exploitative middlemen (Abebe, Bijman, and Royer 2016; Magesa, Michael, and Ko 2014a). Informed buyers have often been accused of exploiting smallholders by offering very low prices for agricultural produce. Remoteness, poor infrastructure, and market information asymmetries encouraged smallholders in Kenya to sell their harvests to local traders at the farm gate accompanied by low bargaining power vis-à-vis farm-gate traders (Fischer and Qaim 2012). agricultural market information services (AMIS) had been introduced to help smallholders access the rich information they need to get competitive markets and prices for their produce.

Details of the information AMIS provide include prices, supply and demand levels, and the availability of buyers (traders), contacts and locations. Shepherd (2000) indicates that AMIS can as well supply such details as historical price data over a number of years. The more AMI smallholders can access, the better the decisions they can make on their produce, markets, prices, business partners (traders), processors, and government intervention as in cases of food insecurity (CTA 2015). Historical price data can help smallholders decide whether it is profitable to start growing new crops, to continue growing existing crops out of season, or seek to produce higher quality crops (Zoltner and Steffen 2013). Thus, AMIS play important roles in increasing awareness of market realities to smallholders and enhancing the efficiency in market transparency.

Most public AMIS in Sub-Saharan Africa are hosted in public institutions and funded (at least partially) by the state budget. Galtier et al. (2014) point out that the AMIS serve dual purposes of improving public policies and ensuring market transparency at a national scale. Unlike the public AMIS, the private AMIS like NINAYO provide AMI but are not involved in the trade of agricultural commodities. NINAYO provides for free the selling and purchase services of agricultural produce to smallholders and traders in Tanzania (Magesa, Michael, and Ko 2020). For example, the AMIS established in 2010 by a farmers' organisation network (MVIWATA) in Tanzania uses mobile phones to promote food market transparency and ease the access of AMI for the members of the organisation (Okore 2014). In 2001, the Crop Marketing Bureau (CROMABU) project was designed to gather and disseminate relevant AMI to smallholders in Magu district, Tanzania (Magesa 2018). The farmer-to-farmer digital network, we-farm (https://wefarm.co/what-is-wefarm/), freely connects smallholders to solve problems, share ideas, and spread innovations, and also to gain insight into pricing of their agricultural produce.

Despite all these benefits, AMIS sustainability in developing countries is constrained by inadequate funding due to the high cost of setup and operation. As a result, most AMIS in these countries are largely dependent on donors such as USAID, CTA, Rockefeller Foundation, IFAD, WB and FAO, or government funds (Chiatoh and Gyau 2016). FAO survey in 1997 found numerous AMIS established by donors had problems once the donors left (Shepherd 1997). According to Zoltner and Steffen (2013), almost all AMIS in East Africa were still donor supported for lack of sufficient funds to cover annual operating costs. Lack of sustainable financing is characteristic of many AMIS, according to Galtier et al. (2014). Over 20 years after Shepherd's publication, the situation does not appear to have changed significantly, with AMIS continuing to close down regularly (FAO 2017). Kizito (2011) points out that the sustainability of AMIS is determined by *how it internally generates funds* (e.g., through user fees); *how it mobilises financial support from users*, especially farmers, traders and policy makers, and thus exerts "political" pressure on governments to provide financial support; and *how it controls costs* (i.e., managing the organisation such that the costs of information collection and diffusion are minimised).

This study is one of very few that have focused on examining the WTP of smallholders in developing countries for AMI delivered to them via Information and Communication Technology (ICT)

devices. The essence is to ensure AMIS' financial sustainability by internally generating funds, hence not relying on financial support from government or international donor agencies. The study has developed a conceptual framework with factors to explain the smallholders' WTP for AMI access from AMIS delivered to them via ICT devices. Other studies have employed econometric modelling in data analysis and establishing relationships. The present study has considered a selection bias when analysing the factors that determine the use of ICT devices by smallholders in accessing AMI because respondents were randomly sampled and included smallholders who tilled their plots. The study provides a platform for sharing knowledge with people who wish to study issues related to WTP.

2. Statement of the problem

It is assumed that AMI in developing countries like Tanzania would provide a viable solution to most problems facing smallholders regarding their agricultural produce. AMIS are expected to improve the bargaining power of the smallholders when dealing with traders and processors, reduce transaction costs by reducing risks, and increase income from agricultural commodities.

Despite the assumed benefits, the sustainability of AMIS has come under scrutiny of recent following the closure of several AMIS initiated through donor support or governments. In most developing countries, public AMIS come to demise after the end of the projects or after the donors withdraw leaving the AMIS in the hands of host governments with slim budgets to support AMI operations – pay for running costs, technical services, and maintenance. As a result of underfunding or lack of funding, AMIS may fail to cater for their operational costs, thus fail to provide the intended services.

Shepherd (1997) argues that an economic solution to the problems of sustainability many AMIS faces would be to oblige users to bear the costs by charging for the information. By targeting market players and using cell phones as the primary media of dissemination, the ability of AMIS to generate resources by invoicing information received by users emerged as a new opportunity (Galtier et al. 2014). The strategy of introducing user access fees raises two very pertinent questions yet to be answered in literature in Tanzania context. First, w*ill smallholder farmers be willing to pay for AMI access delivered to them via ICT from AMIS?* Second, *what factors contribute to smallholder farmers' WTP for AMI access while selling their farm produce?* Thus, the broad objective of this study is to examine the WTP of smallholders for AMI access and use when in need, especially while selling their agricultural produce.

To raise sufficient revenue to cover annual operating costs and to remain financially sustainable, AMIS may adopt strategies such as: *to raise operating income by incorporating user fees*, *to permit advertising on their websites to raise additional revenue*, and *to negotiate preferred rates with mobile network operators and then pass the remaining fee to the users*. Payments of such user fees may assure access to AMI by users. *User fees* may include *subscription fees* and *access fees*. Subscription fees may be paid periodically (e.g., annually), while access fees can be paid per every access or monthly depending on the prescribed regulations. Fee rates can also be set depending on the real environment in which AMIS will be operating. In 2014, Galtier et al. reported that some private AMIS were selling information to cover their operational costs. Zoltner and Steffen (2013) cautioned the idea of introducing user access fees as individual smallholders may have difficulty paying for AMIS services.

Answering the two questions above will help to realise the strategies of delivering AMI efficiently while sustaining such provision. Some scholars (e.g., Magesa, Michael, and Ko 2014b; Mwakaje 2010) have shown how ICTs, like mobile phones, have penetrated rural areas of Tanzania and thus making it possible for rural smallholders to access AMI. Other scholars (e.g., Lwoga, Stilwell and Ngulube 2011) have indicated factors limiting access to ICTs by rural smallholders such as poverty (i.e., failure to afford associated costs), illiteracy, and poor or no infrastructure (e.g., ICT, electricity, road, etc.), thus limiting their access to AMI.

The Tanzania government in its Agricultural Marketing Policy also acknowledges that AMI is vital in the development of the agricultural sector as it provides signals to stakeholders to maximise their efforts and help on how best to allocate resources (URT 2008). As pointed out by other scholars (e.g., Chalemba 2017; Getahun 2020; Magesa, Michael, and Ko 2014a), URT (2008) also accepted that AMI access and use improve the bargaining power of producers (including smallholders) when dealing with traders and processors, and reduces transaction costs by reducing risks. In Ghana, Chalemba (2017) recorded some successes of smallholders using AMIS "Esoko" to include improved bargaining power of smallholders when dealing with traders due to the availability of more accurate and current AMI on produce prices; hence, their income improved and improved ability of smallholders and associations of farmers to find international buyers for their agricultural commodities through Esoko. A project, African Farm Radio Research Initiative (AFRRI), which operated between 2007 and 2010 in five African countries, including Tanzania, dealt with the collection, analysis and dissemination of market information to smallholders associated with both crops and livestock (Huggins-Rao 2011). AFRRI impacts to farmers in Tanzania included more income earnings from sales of their produce due to accessing AMI and markets; group marketing of commodities promoted which enabled farmers to earn more income since the technique minimised transportation costs for both buyers and producers; and the project linked some farmers direct to buyers without the involvement of the middle-men; hence, farmers earned more income from sales of their produce.

3. Overview of agricultural marketing in Tanzania

The Tanzania economy is primarily agricultural based, with the rural agricultural sector being dominated by smallholders amounting to 75% of the entire population (FAO 2014; URT 2017a). This population depends on rain-fed crop production for food, employment, raw materials for industries, and foreign exchange earnings (URT 2017b).

Currently, agricultural production, marketing, and processing, under the new economic environment, are carried out by the private sector while the government has retained regulatory and public support functions (URT 2008). Processes such as assembling, storage, processing, transportation, packaging, grading, and distribution of different agricultural commodities across the country are carried out by different actors in the agricultural value chain. These processes are associated with several charges, raising the transaction costs while lowering the cost share that smallholders receive annually. Despite all these, Tanzania still relies on traditional export for 45–50% of export revenue (URT 2019). In 2018, strategic crop marketing systems were improved through research on market needs, strengthening cooperative societies, and managing contract farming which resulted in an increase in productivity, price stability, data availability, and improved crop quality (URT 2019).

Among the challenges identified in agricultural marketing system include inadequate value addition in agricultural produce; weak legal and regulatory framework on agricultural marketing; underdeveloped and improperly managed agricultural marketing infrastructure; inadequate marketing research, and intelligence which inhibit timely availability of data and information necessary for decision making; and inadequate marketing linkages (URT 2008). Informal barriers to trade leading to market imperfections include weak infrastructure leading to high transaction costs, individual constraints, and unstable political and economic institutions that provide a high cost of transacting in impersonal markets (Eskola 2005).

The channels that smallholders currently use for trade can be categorised into four types of markets: local village markets, regional markets, national markets, and export markets (Eskola 2005). However, smallholders also sell some of their farm produce at their homes, farm gates, or in streets. Village markets emerge along the roads near villages and are run by women and children to earn some money. The choice of products in these outlets is low, and the supply is unreliable

(Mayala and Bamanyisa 2018). Jeckoniah, Mdoe, and Nombo (2013) reveal that men are more involved in connecting with brokers and wholesalers for marketing in local village markets. Regional markets are located in the centre of the regions or in larger district capitals, and traders are large, medium, and small, and the produce supply is more reliable (Eskola 2005; Mayala and Bamanyisa 2018). Regional markets are well organised, and supply consists of different products from different districts and regions. National markets collect produce from all regions to be sold in Dar es Salaam; the supply is reliable, and traders are large scale (Eskola 2005; Mayala and Bamanyisa 2018). There are also export markets run by large traders, mostly foreigners and a few local traders (Mayala and Bamanyisa 2018). Supermarkets are also emerging in various cities, and among others, sell different farm produce.

4. Conceptual framework

Several variables can schematise the adoption of technology such as mobile phones by smallholders in accessing AMI. Different scholars (e.g., Asfaw et al. 2012; Mtega, Ngoepe, and Dube 2016) have attributed the socio-economic factors (e.g., age, gender, education level, income) to adoption and use of different technologies. Youth, males, and educated smallholders adopt modern technology more easily (Asfaw et al. 2012). Other factors that can lead to the adoption of technology by smallholders and thus help to determine their WTP for AMI access include:

- poor road infrastructure raises transportation costs and lowers the amount (profit margin) received by smallholders (Eskola 2005);
- mobile phone ownership and use – improve the knowledge of smallholders in using mobile phones and also help them to interact with AMIS, they can send and receive text messages through their mobile phones (Wyche and Steinfield 2016);
- farm size and quantity/volume of produce harvested (Magesa, Michael, and Ko 2014a; Mgale and Yunxian 2020) – the more the harvest, the more AMI can be accessed while selling;
- farming practices – smallholders conducting subsistence farming, depending on rain-fed agriculture or practicing traditional farming methods are likely to harvest a little and thus access no AMI;
- changing farming practices develop capability and aptitude of smallholders to be flexible and respond to changing market conditions. This can be a factor that can determine their WTP for AMI access (Wang and Ahmed 2007);
- reasons for growing – type and purpose (i.e., cash or food crops) of growing crops (Mgale and Yunxian 2020) – if cash crops are grown, the more AMI can be accessed while selling;
- ability to bargain – access to AMI improves smallholders' ability to bargain with buyers and traders for a better price while selling their farm produce (Magesa, Michael, and Ko 2014a);
- receive farming support – smallholders who receive farming support via extension, smart subsidies, and credit can work more to improve production and also can seek information, including AMI (Haug and Hella 2013; Magesa, Michael, and Ko 2014a);
- support market access – smallholders supported to access markets for their farm produce can get better prices and in turn be motivated to search the markets and AMI for themselves (Al-Hassan, Irene, and Abakah 2013; Magesa, Michael, and Ko 2014a); and
- market channels (selling points) (Mgale and Yunxian 2020) – smallholders who are searching for markets while selling their farm produce are likely to pay for AMI access.

These factors were used to formulate the conceptual framework presented in Figure 1, which was used to investigate the WTP of smallholders for AMI access. The essence is to ensure AMIS' sustainability. The next section will provide the model for estimating and assessing the WTP of smallholders to AMI access.

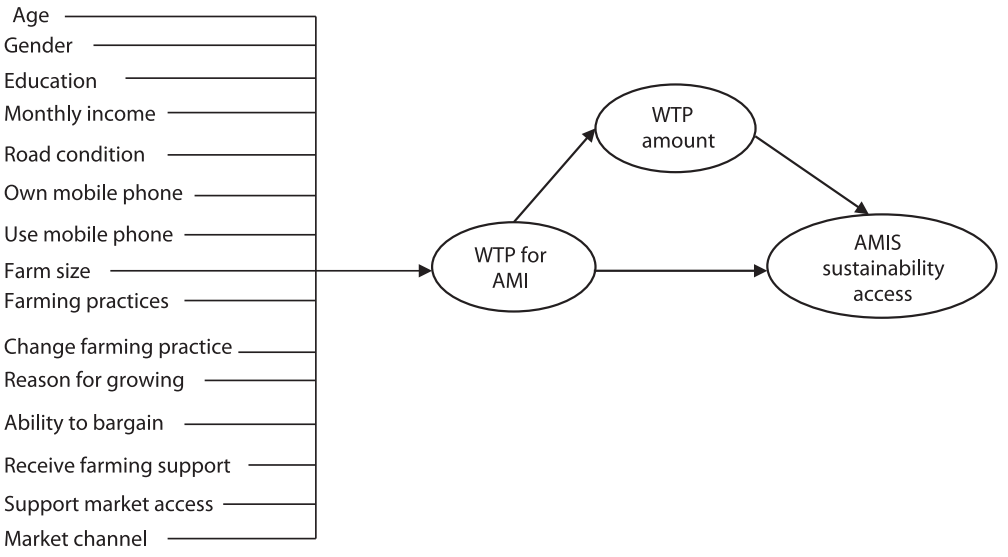

Figure 1. Conceptual framework – factors for smallholders' WTP for AMI access

5. Research data model

This study employed the Contingent Valuation Method (CVM) for estimating the value that a person places on a good. This approach asks people to directly report their WTP to obtain specified goods rather than inferring them from observed behaviours in regular market places (Alberini and Cooper 2000). It requires the respondent to directly express his WTP for a product or answer several successive questions on whether he would, or would not, buy the product at a given price (Le Gall-Ely 2009). The choices made by the respondent are then analysed in a similar manner as the choices made by buyers in physical markets (Carson 2000).

Because this method creates a hypothetical marketplace where virtual (not physical) transactions are made, CVM has been used successfully for commodities that are not exchanged in regular markets, or when it is difficult to observe market transactions under the desired conditions (Alberini and Cooper 2000). Most of the early CVM studies focused on use values such as health benefits, visibility, and water quality improvements (Desvousges et al. 2010). The method has been used in developing countries to elicit preferences of an individual for basic infrastructural projects such as water supply and sanitation (Venkatachalam 2004); sanitation in Burkina Faso (Altaf et al. 1993) and Ghana (Altaf et al. 1993); the preservation of national parks in Kenya (Navrud and Mungatana 1994), and exploring the setting of entrance fees to national parks in Costa Rica (Shultz, Pinazzo, and Cifuentes 1998).

Arinloye et al. (2016) used CVM to assess the willingness of the farmers to use mobile phones to supply and receive market and quality information on agricultural products, as well as to investigate the premium that farmers in Benin were willing to pay for such services. Torero, Chowdhury, and Galdo (2003) used CVM while assessing the WTP for the rural telephone services in Bangladesh and Peru. Oduh and Oduh (2012) used CVM while assessing the determinants of WTP for Mobile Telecommunications Services in Nigeria.

This study employed three complementary approaches of econometric modelling in analysing and establishing relationships between different factors and the WTP of smallholders for AMI access. First, while taking a selection bias into account and using the Probit model, the factors that determine the use of mobile phones by smallholders in accessing AMI were determined. The study considered a selection bias as it employed random sampling with restrictions (respondents

included smallholders who owned a piece of land and were farming) to sample the underlying population of smallholders. Second, the Ordered Probit model was employed to assess the factors that are relevant in explaining the WTP of smallholders for AMI access. The Ordered Probit model determines the robustness of the results and explains better the variation in an ordered categorical (ordinal) dependent variable as a function of independent variables (determinant factors) as the distance between the categories need not be equal. Last, the Censured Tobit model was used to estimate the extent to which smallholders are willing to pay an affordable price for AMI access. The choice of the Tobit model was based on the fact that it allows the decomposition of the data set to examine more closely the effects of the independent variables (determinant factors) on the WTP of smallholders for AMI access. The choice of these approaches is associated with the method used to collect the research data and the nature of how smallholders make decisions while selling their crop produce.

For smallholders to access AMI, technology (e.g., mobile phone) needs to be in place (i.e., be owned by farmers), and several factors can motivate them to pay for access to AMI. Thus, studying the effects of using or not using mobile phones on measuring the WTP for AMI access is crucial in this framework. Not only can the explanatory variables be used to explain the effective WTP for AMI of smallholders but also the use of mobile phones, thus attributing to selection bias leading to erroneous conclusions. Selection bias is a threat to internal validity in that independent variables are correlated with a disturbance term (i.e., error), and analyses based on biased samples can lead to inaccurate estimates of the relationships between variables (e.g., regression coefficients) (Cuddeback et al. 2004). The presence of the bias in the sample can be detected and statistically be corrected by including a sample selection term in the regression. To take into account of a possible selection bias in regression analysis, the Inverse Mills Ratio (IMR) was generated from the estimation of a Probit model and then included as an additional explanatory variable in both the Ordered Probit and Tobit models. The Probit model assumes that the error term follows a standard normal distribution.

In a Probit model, the dependent variable can take only two values, either *zero* or *one*. With mobile phone use by smallholders, the dependent variable is *use*, a dummy variable equalling either *one* (a smallholder owns a mobile phone and uses it) or *zero* (a smallholder does not own a mobile phone). Based on Greene (2002), a modified selection equation determining whether a farmer uses a mobile phone or not in accessing AMI is presented below:

$$Z_{ij}^{*} = \alpha_{ij} \sum W_{ij} + \mu_i \tag{1}$$

where W_{ij} presents a set of explanatory variables and μ_i is the error term. But instead of observing Z_{ij}*, we observe a binary variable Z_{ij} indicating the sign of Z_{ij}*, vector of binary variables that, for each individual, takes the value 1 if she or he uses a mobile phone and 0 otherwise:

$$Z_{ij} = \begin{cases} 1 if Z_{ij}^{*} > 0 \\ 0 if Z_{ij}^{*} \leq 0 \end{cases} \tag{2}$$

The IMR is then generated from the parameter estimation of a Probit model in Equation (1) and then included as an additional explanatory variable while estimating the WTP Ordered Probit and Tobit models to correct for selectivity bias. For the Ordered Probit, the WTP of farmers for AMI access is of most importance. The Ordered Probit is selected because the nature of the dependent variable is categorical and will provide a greater generality of the pay likelihoods. The Ordered Probit model for the WTP by smallholders can be described by the equation:

$$Y_{ij} = \sum \beta_{ij} X_{ij} + \mu_j \tag{3}$$

where Y_{ij} is the target-dependent variable (i.e., individual *i*'s response to the survey questions), X_{ij} is a set of independent (or explanatory) and control variables explaining the attitude of a respondent and μ_j is a vector of error terms. Y_{ij} being a categorical variable (i.e., 5 level Likert scale responses), the Ordered Probit model is based on one underlying latent variable but with a different match

from the latent variable, Y_{ij}^{*}, to the observed one (Y_{ij} = 1, 2, 3, 4, 5). Based on Greene (2002), Verbeke and Ward (2006) and Verbeek (2008), the relationship between Y^{*} and the observed variable Y (i.e., the WTP for AMI access by smallholders) is:

$$Y_{ij} = \begin{cases} 1 \text{ stronglydisagree} & \text{if } \eta_0 \leq Y_{ij}^{*} < \eta_1 \\ 2 \text{ disagree} & \text{if } \eta_1 \leq Y_{ij}^{*} < \eta_2 \\ 3 \text{ indifferent} & \text{if } \eta_2 \leq Y_{ij}^{*} < \eta_3 \\ 4 \text{ agree} & \text{if } \eta_3 \leq Y_{ij}^{*} < \eta_4 \\ 5 \text{ strongly agree} & \text{if } \eta_4 \leq Y_{ij}^{*} < \eta_5 \end{cases} \tag{4}$$

The η's are unknown parameters to be estimated with β. It is assumed that μ is normally distributed across observations and that a smallholder will only express a WTP if she or he has an operational technology for accessing AMI (i.e., $Z_{ij}^{*} > 0$).

The models of sample selectivity in this study can be regarded as extensions of Heckman's (1979) canonical model, thus ignoring the selection issue produces biased and inconsistent estimators of all the model parameters. Scholars such as Greene (2002) have worked on estimating the canonical model by two step methods.

It is assumed that the error term in the selection equation υ, has a zero conditional mean: $E[X|\upsilon] = 0$, implying that it is independent of X. It is also assumed that υ follows a standard normal distribution. A problem may arise when there is a non-zero correlation between μ and υ. If all of these processes are normally distributed with zero means the conditional expectation $E[\mu|\upsilon] = \rho\upsilon$ where ρ is the correlation of μ and υ. Equation (3) can be re-written as:

$$E[Y_{ij}|Z_{ij}^{*} > 0] = \sum X_{ij}\beta_{ij} + \mu_j\upsilon_j \tag{5}$$

We cannot observe υ, then Equation (5) becomes:

$$E[Y_{ij}|Z_{ij}^{*} > 0] = \sum X_{ij}\beta_{ij} + \rho E[\upsilon_i|\gamma] \tag{6}$$

The conditional expectation $E[\upsilon|\lambda]$ for unit sample selection indicator is merely λ, the IMR. We can "correct for selectivity" by following the logic of the Heckman two-step estimator, that is, by constructing $\lambda = \phi(\beta x)/\varphi(\beta x)$from an estimate of the Probit selection equation and adding it to the outcome equation, where φ is the probability density function of a univariate normal distribution and Φ is the cumulative distribution function. Thus, the Ordered Probit model for the expected smallholders' WTP based upon the possession of a working technology can be expressed as:

$$E[Y_{ij}|Z_{ij}^{*} > 0] = \sum \beta_{ij}X_{ij} + \mu_j + \rho\frac{\phi(X_i'\beta_j)}{\varphi(X_i'\beta_j)} \tag{7}$$

Censored Tobit model helps to study the output when data on the dependent variable is limited and not on the explanatory variables. With this, the Tobit model may help to study the different amounts the smallholders are willing to pay for access to AMI via the available technologies. Based on Maddala and Lahiri (1992), for the standard Tobit model, Equation (2) can be modified to read:

$$Z_{ij} = \begin{cases} Z_{ij}^{*} if Z_{ij}^{*} > 0 \\ 0 if Z_{ij}^{*} \leq 0 \end{cases} \tag{8}$$

and the expected values for the Tobit model can be expressed as:

$$E[M_j|Z_{ij}^{*} > 0] = \sum X_{ij}\alpha_j + \rho\lambda \tag{9}$$

where M_j is the amount of the premium smallholders are willing to pay to access AMI via the technology they own. Then, substituting the value for the IMR, λ, in Equation (9) gives Equation (10):

$$E[M_i|Z_{ij}^{*} > 0] = \sum \alpha_{ij} X_{ij} + \rho \frac{\phi(X_i' \beta_j)}{\varphi(X_i' \beta_j)} \tag{10}$$

6. Research methodology

6.1 Data collection

Before final data collection, the questionnaire was initially tested with a sample of 42 respondents drawn from Morogoro Region to learn how it fitted the purpose of the study. Initial phase responses and comments helped to fine-tune the questionnaire and develop a more compelling questionnaire that was used for actual data collection. The questionnaire consisted of a combination of close-ended items, yes/no responses, five-point Likert scale, and open-ended items. Table 1 presents variables extracted from the questionnaire, their descriptions, and expected values.

The sample included smallholders from three regions in Tanzania, namely Kilimanjaro, Morogoro, and Lindi, who owned a piece of land and were involved in small-scale farming. The selection of the three regions was based on the fact the trio are among key crop-producing regions in Tanzania. The estimated population of smallholders engaged in crop production in Lindi was 80.9%, Morogoro 69.4%, and Kilimanjaro 27.0%, respectively (URT 2017b). Kilimanjaro led in the planted area under

Table 1. Explanation of variables

Variable	Description	Value	Hypothesis
Age	Age of a farmer in years	Continuous	±
Education	Education level	1 – did not complete standard seven, 2 – standard seven, 3 – form four, 4 – form six, 5 – university level	+
Farm size	Farm size in hectares	continuous	+
Road condition	Condition of the roads to the markets	1 – very rough, 2 – rough, 3 – good, 4 – very good	+
Monthly income	Farmer's monthly income, in TShs[a]	Continuous	+
Own mobile phone	Whether a farmer owns a mobile phone	0 – no, 1 – yes	+
Use mobile phone	Knowledge of a farmer in using mobile phone in accessing information	1 – very poor, 2 – poor, 3 – good, 4 – very good	+
Reason for growing	Reason for a farmer to engage in agriculture	1 – food, 2 – cash, 3 – both food and cash	±
Market channel	Market where a farmer sells the agricultural produce	1 – local markets, 2 – town markets, 3 – both local and town markets	+
Farming practise	Practices used by farmer in agricultural farming	1 – traditional, 2 – modern	
Change farming practice	Whether a farmer changes farming practises as a response to buyers' opinion	1 – strongly disagree, 2 – disagree, 3 – indifferent, 4 – agree, 5 – strongly agree	±
Ability to bargain	Bargaining power of a farmer with buyers of produce	1 – low, 2 – medium, 3 – high	+/-
Receive farming support	Whether a farmer receives support during farming	1 – no support, 2 – very little, 3 – little, 4 – some support	±
Support market access	Whether a farmer receives support to access markets	1 – no support, 2 – very little, 3 – little, 4 – some support	±
Willing to access market information	Willingness of a farmer to access market information	1 – strongly not willing, 2 – not willing, 3 – indifferent, 4 – willing, 5 – strongly willing	+
Amount willing to pay	The extent to which the farmer is willing to pay to access market information	1 – < TShs. 2100 2 – < TShs. 3100 3 – < TShs. 4100 4 – < TShs. 5100 5 – ≥ TShs. 5100	+

[a]Tanzania shillings (1 USD = TShs. 2310).

irrigation (44,483 ha; 22.6%), had the highest average yield of Irish potatoes (8.9 tonnes/ha), and was recorded the second in banana production (14,672 ha; 14.1%) (URT 2017b). Lindi recorded the highest sesame production with 13,300 tonnes (23.4%) and was the second in cashew nut production (126,353 tonnes; 32.6%) (URT 2017b). Morogoro had the highest paddy production with the crop yield of 4.0 tonnes/ha (i.e., 332,280 tonnes; 24.0%) and also had the highest tomato production (155,745 tonnes; 65.6%), followed by Kilimanjaro (18,630.5 tonnes; 7.8%) (URT 2017b).

Random sampling procedure was employed in selecting smallholders who were involved in the study. Agricultural Field Officers assisted in identifying smallholders who were requested to take part in the study.

After the data collection exercise, only those questionnaires which were completely filled out were included for data analysis. Incomplete and wrongly filled questionnaires were discarded. The reliability of the questionnaires were tested and found to be adequate (i.e., Cronbach Alpha coefficient of 0.72).

7. Results and analysis

7.1 Characteristics of respondents

A total of 378 respondents (smallholders) from Kilimanjaro, Morogoro, and Lindi regions were involved in the study. Based on gender and proportion, there was no marked difference between males and females – there were 185 (48.94%) males and 193 (51.06%) females. Table 2 summarises the characteristics of the respondents. Based on education level, most respondents, that is, 333 (88.09%), had attended schools while a few – 45 (11.90%) respondents did not complete the

Table 2. Characteristics of respondents

	Male		Female	
Region	Freq	Perc	Freq	Perc
Kilimanjaro	22	5.82	26	6.88
Lindi	44	11.64	61	16.14
Morogoro	119	31.48	106	28.04
Total	185	48.94	193	51.06
Income (TShs)				
<100,000	240	63.49		
100,000 ≤ income < 200,000	60	15.87		
200,000 ≤ income < 400,000	48	12.7		
400,000 ≤ income < 600,000	12	3.17		
600,000 ≤ income < 800,000	4	1.06		
800,000 ≤ income < 1,000,000	4	1.06		
≥1,000,000	10	2.65		
Total	378	100		
Education level				
Did not complete primary schools	45	11.9		
Completed primary school	189	50		
Completed secondary school	120	31.75		
Completed high school	12	3.17		
University degree	12	3.17		
Total	378	100		
Age (Years)				
18 < age < 28	60	15.87		
28 ≤ age < 38	125	33.07		
38 ≤ age < 48	103	27.25		
48 ≤ age < 58	57	15.08		
58 ≤ age < 68	24	6.35		
≥68	9	2.38		
Total	378	100		

primary school level of education. Of those who attended schools, the majority – 309 (81.75%) had lower education level (i.e., 189 (50.00%) had completed primary school education, 120 (31.75%) respondents had completed secondary school education) while a few – 24 (6.34%) respondents had higher education level (high school and university degrees, each 12 (3.17%)). Based on age, the majority (i.e., 288 (76.19%)) were below 48 years old, and based on income, the majority (i.e., 240(63.49%)) were earning less than TShs. 100,000 (i.e., $44) per month. Generally, the results suggest that smallholders have low education level, are below 48 years, and earn less than $44 per month.

Crops grown by smallholders in the three regions include rice, banana, maize, beans, sesame seeds, cashew nuts and sunflower. The market channels used by smallholders include nearby local villages and town/regional markets. Farmers in Kilimanjaro sell their farm produce mostly in Moshi town, Arusha, Dar es Salaam, and sometimes they export to Kenya. Smallholders in Morogoro sell their crops in Morogoro town, Dodoma, and even in Dar es Salaam while those in Lindi sell their crops in Lindi town and in the nearby regions.

7.2 AMI access and use

To access AMI, respondents indicated that they get the prices of produce by visiting specific markets, talking to other smallholders, through radio broadcasts and even reading the daily magazines. Some smallholders said that they use mobile phones to call or send SMS to other smallholders asking for market information. Some respondents identified AMIS website such as NINAYO (https://www.ninayo.com/) and Esoko (http://esoko.co.tz/) from which they accessed AMI. The AMI, the respondents, indicated they frequently accessed included information about crop prices at the markets, availability and scarcity of a specific produce in the market, availability of buyers and traders of their produce and logistics information (e.g., transport and storage at the markets).

The researcher sought to assess smallholders' knowledge in using mobile phones. In this regards, details of ownership, use, and knowledge of using mobile phones were inquired. The findings are presented in Table 3. The majority of the respondents (i.e., 350(92.59%)) indicated they owned and were using mobile phones, and nearly a third quarter (i.e., 272 (71.96%)) of the respondents indicated that they knew how to use mobile phones. Generally, ownership of mobile phones by smallholders has increased while their knowledge in using mobile phones is improving.

The use of mobile phones may enable smallholders to access current AMI. This AMI can facilitate the selling of farm produce. Information from distant markets and traders can be available to farmers via mobile phones, and this can help the smallholders bargain better to get better deals of their produce. The ultimate goal of using mobile phones is to ensure that smallholders benefit from what they sell.

The premium that a smallholder was willing to pay per month for accessing and supplying AMI was also assessed, and results are presented in Table 4. More than three quarters (i.e., 290(76.72%)) of the respondents indicated WTP from TShs. 2,100 (<$1) per month to send – and receive AMI. A few

Table 3. Ownership and use of mobile phones

Use of mobile phone	Freq	Perc
No	28	7.41
Yes	350	92.59
Total	378	100
Knowledge in mobile phone use		
Very poor	69	18.25
Poor	37	9.79
Good	221	58.47
Very good	51	13.49
Total	**378**	**100**

Table 4. The extent to which smallholders are willing to pay per month to access AMI

Amount (TShs)	Freq	Percent	Willingness	Freq	Percent
Less than 2,100	290	76.72	Strongly not willing	44	11.64
2,100 and less than 3,100	40	10.58	Not willing	99	26.19
3,100 and less than 4,100	24	6.35	Indifferent	65	17.2
4,100 and less than 5,100	9	2.38	Willing	158	41.8
5,100 and above	15	3.97	Strongly willing	12	3.17
Total	378	100	Total	378	100

respondents – 15 (3.97%) were willing to pay as high as TShs. 5,100 (<$2) or more. Smallholders who were willing to pay for sending and receiving AMI were 170 (44.97%), a total of 143 (37.83%) respondents were not willing to pay, and about 65 (17.2%) respondents were neutral.

7.3 Relationship among variables

Based on the method of covariance and using Pearson correlation coefficients, relationships between variables were analysed. Results in Table 5 show that the correlation coefficients were less than 0.50, indicating a weak relationship among the variables (Ratner 2009). As variables are weakly related, they are sufficiently independent to be modelled due to lack of multicollinearity problems (Alin 2010), and thus were used in the CVM for analysis using different models.

7.4 Willingness of smallholders to pay for AMI access

The willingness of smallholders to access and use AMI depends on a number of factors, as presented in Table 1. The results of the analysis of the factors based on the Probit and Ordered Probit models are presented in Table 6. The results show that the IMR calculated after the Probit model and incorporated while computing the Ordered Probit model was not significant for smallholders' WTP for accessing (receiving) AMI. Thus, issues pertaining to the selection bias could not have been considered by considering smallholders who owned a piece of land and who were farming.

To determine if explanatory variables in a model are significant and thus can contribute to the explanatory power of the model, the researcher used the Wald Chi-Squared Test. The results for both models show that the Wald test is statistically significant at 1% level, and thus the set of coefficients of each model are jointly significant and that the explanatory power of the factors included in the model is satisfactory.

7.4.1 Factors which determine the use of mobile phones

Probit model results in Table 6 indicate that five factors are significantly correlated with the use of mobile phones by respondents who wished to access AMI; these are *age*, *knowledge in using mobile phones*, *reasons for growing crops*, *channels available to markets*, and *their abilities in changing farming practises as responses to buyers' opinions*. Thus, smallholders who use mobile phones have good knowledge of using mobile phones, have reasons for growing crops, they search for different channels to market crops, and are able to change their farming practices as a response to buyers' opinions and preferences.

Some scholars have also shown similar results for factors that determine the use of mobile phones among the smallholders. While studying factors influencing access to agricultural knowledge by smallholders in Tanzania, Mtega, Ngoepe, and Dube (2016) revealed that the level of acquisition of agricultural knowledge increased with an increase in age. Mutayoba and Ngaruko (2015) also found that age was among the factors that determine market participation by smallholders while studying the determinants of the smallholders' participation in high-value crops in Tanzania. Mtega, Ngoepe, and Dube (2016) outline knowledge as among the factors that facilitate market access by smallholders. Krone, Dannenberg, and Nduru (2016) indicate that positive use of mobile

Table 5. Correlation matrix

Variable		AG	ED	MI	MP	FS	RG	MC	RC	FP	CF	RF	RM	AB	WI
Age	AG	1													
Education	ED	−0.33	1												
Monthly income	MI	−0.03	0.12	1											
Mobile phone use knowledge	MP	−0.19	0.12	0.01	1										
Farm size	FS	0.25	−0.14	0.10	−0.17	1									
Reason for growing	RG	−0.18	0.10	−0.06	0.07	0.07	1								
Market channel	MC	−0.03	0.06	0.20	−0.02	0.07	0.02	1							
Road condition	RC	−0.18	0.23	-0.04	0.19	−0.09	0.36	0.07	1						
Farming practise	FP	−0.15	0.08	0.20	−0.01	0.13	0.11	0.30	0.09	1					
Change farming practice	CF	−0.01	0.05	0.02	0.15	−0.05	−0.16	0.05	−0.06	0.05	1				
Receive farming support	RF	0.02	0.07	−0.05	0.11	−0.07	0.00	−0.08	0.11	0.09	0.22	1			
Receive market access support	RM	0.09	−0.02	−0.08	0.08	−0.15	−0.04	0.00	0.05	0.12	0.24	0.47	1		
Ability to bargain	AB	−0.09	0.15	−0.07	0.10	−0.12	0.15	0.14	0.15	0.11	0.09	0.14	0.16	1	
Willing to access market information	WI	−0.11	0.16	−0.02	0.14	−0.20	0.12	0.09	0.22	0.10	0.12	0.23	0.15	0.36	1

Table 6: Probit and ordered probit results

	Use of mobile phone			WTP for AMI		
	Probit regression			Ordered Probit regression		
Variable	Coef.	Robust std. err.	Sign. value	Coef.	Robust std. err.	Sign. Value
Age	–0.024	0.010	0.01	0.007	0.006	0.22
Education	0.201	0.141	0.15	0.031	0.068	0.65
Monthly income	0.000	0.000	0.22	0.000	0.000	0.50
Mobile phone use knowledge	0.150	0.100	0.13	0.008	0.072	0.91
Farm size	–0.001	0.016	0.97	–0.002	0.011	0.87
Reason for growing	–0.423	0.157	0.01	–0.051	0.089	0.56
Market channel	0.415	0.224	0.06	0.079	0.083	0.34
Road condition	0.010	0.125	0.94	–0.184	0.079	0.02
Farming practise	–0.210	0.267	0.43	0.141	0.138	0.31
Change farming practice	0.272	0.098	0.01	0.134	0.059	0.02
Receive farming support	0.114	0.158	0.47	0.087	0.117	0.46
Receive market access support	–0.006	0.163	0.97	0.108	0.111	0.33
Ability to bargain	–0.204	0.150	0.17	0.018	0.107	0.87
Awareness to AMI access	0.029	0.087	0.74	0.403	0.070	0.00
Constant	1.705	0.907	0.06			
IMR				0.107	0.123	0.38
Number of observations		378			378	
Wald $chi^2(14, 15)$		42.45			78.78	
Prob > chi^2		0.000			0.000	
Pseudo R^2		0.19			0.09	
Log pseudolikelihood		–80.57			–476.60	

phones influence access to simple and complex knowledge of the smallholders in Tanzania and Kenya. They also observe that mobile phones present an opportunity to overcome spatial barriers to building up and maintain linkages to a broader base of buyers and markets. In a study of roles of mobile phones to smallholders in Babati, Tanzania, Matotay and Furuholt (2010) found that knowledge created using mobile phones empowered smallholders in agricultural marketing, enhanced opportunities for increased income, and reduced vulnerability to risks of smallholders while selling their crops.

Smallholders can sell their farm produce to cater for their different needs at various markets to buyers (traders). The knowledge of a good marketing channel helps smallholders earn better prices for their crops.

7.4.2 WTP for access to AMI

Analyses of results (Table 6) of the econometric models of the factors that determine smallholders' WTP for AMI access identified three factors; namely *road condition to markets*, *changes in farming practices by smallholders,* and *smallholders' awareness of the usefulness of AMI access*. These factors may directly or indirectly affect the WTP of smallholders for AMI access.

In developing countries like Tanzania, rural infrastructure can be grouped into two. First, there are roads, tracks, and paths within the village and those providing access from the village to other villages, farms, and other places where there are socioeconomic activities. Second, there are roads connecting villages to district headquarters and regional headquarters. Most of these rural roads are not tarmac; some are passable during the dry season, and others are impassable during the rainy season. Poor rural roads limit access to markets by market actors and increase transportation costs and time. Because of transport and time limitations to reach town markets, smallholders sell their produce to buyers, middlemen, and traders reaching rural crop-producing areas. Thus, poor rural roads may encourage smallholders to willingly pay for AMI access in order to find buyers of their produce, reach the rich markets, and even learn prices of distant markets.

Smallholders can change their farming practices as a response to market demands due to AMI they have learned. Market demands can be such as shortage of certain varieties of crop produce in the markets, quality of crops needed, varieties of produces needed, and opinions of buyers

about produce. In response, farmers may decide to take such redress measures, such as applying fertilizers, use of improved seeds, practice crop rotation, practice inter-cropping, and even seek advice or help from agricultural officers. Because the ultimate goal of the smallholders is to harvest large volumes and a variety of quality produce, the smallholders will be willing to pay for access to AMI.

Awareness of the usefulness of AMI access and use by smallholders is very advantageous. Economies of smallholders can improve by getting good prices from sales of their crop produce. Such awareness will provide the smallholders with effective bargaining skills, allow them to sell their crops at a specific time for best prices, sell their produce at specific markets, and identify buyers or traders based on the prices offered. The awareness will also help the smallholders make informed decisions about what they do, reduce transport time, and costs. By and large, this will help the smallholders avoid middlemen who have always been accused of taking advantage of the smallholders. In other words, the smallholders will be able to sell their produce directly to markets or buyers (traders). Thus, a smallholder who is aware of the usefulness of AMI will be willing to pay for its access.

7.4.3 Amount to be paid for the AMI access

Results from both the Probit and Ordered Probit models discussed earlier have not isolated the marginal effects of each explanatory variables associated with the expected amount the smallholders can pay willingly for accessing AMI while selling their crops. With this, the Censored Tobit regression together with the associated marginal effect was computed. The goal was to determine how much each regressor accounted for smallholders' WTP.

Table 7 presents the results that show that the *F* statistics of the Tobit model is statistically significant at the 10% 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. A total of 14 regressors were considered in the Tobit model, out of which five (5) variables were found to significantly influence smallholders' WTP for AMI access ($p < .1$).

The parameter estimate of the knowledge of using mobile phones by smallholders was negatively and significantly related with WTP for access to AMI, as expected, indicating that the knowledge

Table 7. Tobit model estimates of WTP amount for AMI access

	Tobit model amount to be paid			Tobit model marginal effects		
Variable	Coef.	Std. err.	$P>\|t\|$	*dy/dx*	Delta-method Std. err.	$P>\|z\|$
Age	3.46	4.59	0.45	3.41	4.52	0.45
Education	7.84	61.18	0.90	7.72	60.22	0.90
Monthly income	0.00	0.00	0.81	0.00	0.00	0.81
Mobile phone use knowledge	−95.00	56.17	0.09	−93.51	55.24	0.09
Farm size	7.84	12.82	0.54	7.72	12.62	0.54
Reason for growing	−30.94	64.99	0.63	−30.45	63.96	0.63
Market channel	3.40	74.35	0.96	3.34	73.18	0.96
Road condition	−72.58	63.91	0.26	−71.44	62.82	0.26
Farming practise	315.15	120.25	0.01	310.19	118.15	0.01
Change farming practice	129.57	54.22	0.02	127.54	53.35	0.02
Receive farming support	−87.26	97.87	0.37	−85.89	96.35	0.37
Receive market access support	−23.83	93.99	0.80	−23.45	92.49	0.80
Ability to bargain	−103.61	71.47	0.14	−101.98	70.24	0.15
Awareness to access to market information	96.73	51.33	0.06	95.21	50.42	0.06
IMR1	−20.28	85.18	0.81	−19.96	83.85	0.81
Constant	2231.23	448.03	0.00			
Sigma	862.52	51.46				
Number of obs		378				
F(15, 363)		1.78				
Prob > *F*		0.0360				
Pseudo R^2		0.0055				
Log likelihood		−2992.71				

could be a factor influencing AMI access. This supports Probit analysis results that knowledge in mobile phone use can help smallholders to locate both markets and buyers of their farm produce. The marginal effects results presented in Table 7 show that when the knowledge of smallholder farmers in using mobile phones increases by one unit, it decreases the premium they are ready to pay to access AMI by TShs. 93.51 per month. Farming techniques, traditional or modern, practiced by smallholders were found to have a positive effect on the WTP of smallholders for AMI access. This would be expected as smallholders who employ good farming practices may harvest more and thus be willing to access AMI while selling their crops. The marginal effect results indicate that when farming practices of smallholders increase by one unit, the premium smallholders are ready to pay per month increases by TShs. 310.19.

The change of farming practices by smallholders as a response to market requirements has positively affected their WTP for AMI access. It means as changes in farming practices increase by one unit, the premium the smallholders are willing to pay for AMI access increases by TShs. 127.54. As Ordered Probit analysis results have depicted, changes in the farming practices by smallholders as a response to market conditions may lead to more production and quality produce, thus necessitating market information search and access by smallholders while selling their crops.

In markets and while selling produce, crop prices are negotiated between sellers and buyers, and sometimes there are no fixed prices, rather there are indicative prices. A smallholders who bargain better may get the best prices for their produce. The ability of the smallholders to bargain with buyers has shown to negatively affect their WTP for AMI access. The marginal effect results of the Tobit regression model indicate that when the ability to bargain increases by one unit, the premium smallholders are ready to pay per month decreases by TShs. 101.98. This implies that smallholders who have good bargaining ability may pay a little for access to AMI while selling their crops.

Awareness of the usefulness of AMI is another factor that has positively affected WTP for AMI access by smallholders. The marginal effect of the Tobit model estimates reveals that a one-unit increase in AMI access awareness by smallholders can increase the premium the smallholder is to pay by TShs. 95.21. This result supports the Ordered Probit analysis results that such awareness improves the bargaining power of smallholders, helps smallholders to bypass middlemen, contributes to the reduction of transaction costs, and integrates smallholders into the agricultural value chain.

Results from the three models revealed that some factors have been consistent in all three cases while others have not. These are described below.

(i) The variable *age* has shown only to be significant with the use of mobile phones in accessing AMI. As presented in Table 2, most respondents (i.e., 76.19%) were aged less than 48 years; and thus, age was not normally distributed. With this finding, age was not significant with both the Ordered Probit and the Tobit models.

(ii) Both *education level* variable and *monthly income* variable of respondents were not significant across the three models. About 11.90% of the respondents did not complete their primary school education, and 81.75% had lower education level (i.e., completed primary schools or secondary schools). This means that most school dropouts and those school failures engaged in agriculture. Consequently, smallholders might conduct subsistence farming and education might play no role in their agricultural activities. In terms of the respondents' income, data reveal that 63.49% of the respondents had a monthly income below $44, different from the estimated $83 monthly per capita income in 2017 (URT 2017a). Monthly incomes were not normally distributed, and a few (20.64%) smallholders had monthly income greater than $88 (i.e., above the estimated monthly per capital income). Thus, as educational level and monthly income of respondents were not normally distributed, they failed to be significant across three models.

(iii) The variables *farm size*, *receive farming support* and *receive support to market access* were all insignificant across the three models. The variable farm size was not normally distributed.

Most smallholders indicated that they received a little or no support (87.57%) during farming, while the same percentage (i.e., 87.57%) indicated that they received a little or no support to access markets while selling their crops. Thus, these three variables also have no significant effects in the three models.

8. Discussion

AMI access and use by smallholders are beneficial for their development and the improvement of the agricultural sector. However, smallholders in developing countries like Tanzania do not pay for access and use of AMI services. Several factors are hypothesised to influence and motivate smallholders to paying for access and use of AMI. The determinant factors for the adoption and use of AMI identified in this study were presented in the conceptual framework in Figure 1.

This research calls for more actions to improve the situation. Investment in agriculture by governments and development agencies may help to improve the agricultural capabilities of the smallholders. Investment may include training smallholders on and promoting the best farming practices. Farming practices may include rotating crops and embracing diversity which lead to healthier soil and improved pest control; planting cover crops to protect and build soil health by preventing erosion, replenishing soil nutrients; reducing or eliminating tillage; applying integrated pest management to keep pest populations under control while minimising the use of chemical pesticides, and integrating livestock and crops for more efficient and profitable farms. Improving farming practices may boost agricultural production.

Improved agricultural production may encourage smallholders to increase their farm sizes and access more markets and AMI while selling their produce; and government may construct roads connecting rural areas to towns and markets. In this way, smallholders may seek AMI to access markets, traders, and buyers when selling their farm produce; and they may also find information about some processes such as packaging, storage, processing and post-harvesting. It is during this period when AMIS will be valued by smallholders and hence explaining the WTP for AMI access and use. In turn, AMIS will generate funds to cater to their different operations and sustain the service delivery. In this way, AMIS initiatives will become financially independent, sustainable, and beneficial to smallholders.

To generate more funds, AMIS can compile data into analytical and periodical reports that address the specific needs of the smallholders. However, this requires AMIS operators to carry out a baseline market research to identify buyers and traders and also to carry out aggressive marketing with potential clients.

Governments and the private sector have to take conspicuous measures to make AMIS available and accessible in the rural agrarian communities. Governments need to supply electricity, and telecommunication companies need to extend the communication infrastructure to rural areas. Equally important, the literacy level needs to be improved to ensure smallholders develop capabilities to use communication devices.

9. Conclusion

This research has examined the willingness of the smallholders to pay for AMI access when selling their produce. Access and use of AMI will help the smallholders to locate viable markets and potential buyers of their produce. The findings indicate that the use of mobile phones for AMI access is determined by *age*, *knowledge to use mobile phones*, *reasons for practicing agriculture*, *markets to sell crops*, and *the adaptability of farming practices according to buyers' opinions*. Other factors include *road conditions to markets*, *changes in farming practices* and *awareness of the usefulness of AMI* determined the WTP of smallholder for AMI access. The study further reveal that the premium the smallholders are willing to pay for AMI access is determined by such factors as

mobile phone use knowledge, *their farming technique practised*, *their ability to change farming practices*, *their bargaining abilities with buyers* and *their awareness on the usefulness of AMI access*.

Access and use of AMI depend on a number of other factors which involve different sectors. As the rural areas are underdeveloped, governments can consider constructing roads that link the rural areas to markets and town centres to facilitate transport of agricultural produce while, at the same time, lowering the associated transport costs. Governments and development partners can work to improve the literacy level of smallholders to help them develop AMI capabilities. Literate individuals can easily use communication devices to access information, including AMI. For effective use of communication devices to access AMI, governments should ensure rural areas are provided with electricity, while telecommunication companies should ensure rural areas are connected with communication infrastructure to enable rural smallholders to access information, including AMI.

As it is evident that good knowledge in farming practices improves agricultural production, governments and development partners can work to develop the capabilities of the smallholders in this respect. Regular training to smallholders can be organised, and agricultural field officers can be facilitated to reach rural areas and advice the smallholders on best farming practices. The impact of improved production is that farmers will increase their farm sizes, they will engage in growing cash crops, and ultimately access AMI when selling their farm produce.

Governments also need to construct markets to ensure that they support the storage of various crops for some time awaiting better deals. Such storage systems can safeguard crops from getting wet during the rainy season. The storage facilities can also safeguard crops from theft. But what should be the target markets for which market information should be accessed and supplied to smallholders? In most cases, the target has been in-country markets (local and urban markets). Smallholders near the country borders are also accessing nearby markets in the neighbouring countries. This research sees the opportunity of accessing export markets by smallholders. Information on the scarcity of a produce in a nearby country can be relayed to smallholders in Tanzania who can exploit such opportunity and thus establish an external linkages. However, to access the export markets, issues of the qualities of the produce are of more concern. Thus, access to export markets may motivate smallholders to adopt modern farming techniques to ensure quality crops.

To improve price quotations, efficient commodity weighing and grading systems may be adopted. There is a feeling that the current traditional method of weighing and grading commodities is overburdening the farmers while benefiting the buyers. The use of traditional weighing systems such as using sacks, buckets, or parcels is not proper, and modern weighing techniques (i.e., use of scales) can be adopted to improve the prices. Also, proper and uniform packing units (e.g., boxes, tins, sacks) labelled with prices may attract buyers.

Despite the hypothesised benefits of AMI access, some challenging issues will need to be addressed. AMI contents need to be delivered in a format relevant and understood by the smallholders for easy adaptation. Gender and diversity need to be considered as it is difficult for the women, elderly, poor smallholders, and people living in remote areas to access AMI. AMI should be delivered to smallholders using the right technology mix available in rural contexts.

To conclude, the private sector has paved the way for providing AMI by introducing working platforms. The public sector, through the government, is responsible to provide for a conducive environment for conducting agricultural marketing and the dissemination of AMI. After accomplishing these, policy-based researches can be conducted based on new contexts and improved determinant factors.

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References

Abebe, Gumataw K, Jos Bijman, and Annie Royer. 2016. Are middlemen facilitators or barriers to improve smallholders' welfare in rural economies? Empirical evidence from Ethiopia. *Journal of Rural Studies* 43: 203–213.

Alberini, Anna, and Joseph Cooper. 2000. *Applications of the contingent valuation method in developing countries: a survey. Vol. 146*. Rome: FAO.

Al-Hassan, Ramatu M, S Egyir Irene, and James Abakah. 2013. Farm household level impacts of information communication technology (ICT)-based agricultural market information in Ghana. *Journal of Development and Agricultural Economics* 5, no. 4: 161–167.

Alin, Aylin. 2010. Multicollinearity. *Wiley Interdisciplinary Reviews: Computational Statistics* 2, no. 3: 370–374. doi:10.1002/wics.84.

Altaf, Mir Anjum, Dale Whittington, Haroon Jamal, and Smith V. Kerry. 1993. Rethinking rural water supply policy in the Punjab, Pakistan. *Water Resources Research* 29, no. 7: 1943–1954. doi:10.1029/92WR02848.

Arinloye, D.D.A.A., A.R. Linnemann, G Hagelaar, S.W.F. Omta, O.N. Coulibaly, and M.A.J.S. van Boekel. 2016. "4. Willingness to pay for market Information received by mobile phone among smallholder pineapple farmers in Benin." In *Quality and Innovation in Food Chains*, 75–100. Wageningen Academic Publishers. doi:10.3920/978-90-8686-825-4_4.

Asfaw, Solomon, Bekele Shiferaw, Franklin Simtowe, and Leslie Lipper. 2012. Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy* 37, no. 3: 283–295. doi:10.1016/j.foodpol.2012.02.013.

Carson, Richard T. 2000. Contingent valuation: A user's guide. *Environmental Science & Technology* 34, no. 8: 1413–1418. doi:10.1021/es990728j.

Chalemba, Leonard. 2017. Incorporation of telecommunications technologies into agricultural market information systems: A comparative analysis of Ghana and Tanzania. *The Electronic Journal of Information Systems in Developing Countries* 79, no. 1: 1–15.

Chiatoh, Maryben, and Amos Gyau. 2016. *Review of Agricultural Market Information Systems in Sub-Saharan Africa*. ICRAF Working, Paper No. 235. Nairobi. doi:10.5716/WP16110.PDF.

CTA. 2015. *Agricultural Market Information Systems in Africa: Introduction to Agricultural Market Information Systems*. Arusha, Tanzania.

Cuddeback, Gary, Elizabeth Wilson, John G. Orme, and Terri Combs-Orme. 2004. Detecting and statistically correcting sample selection bias. *Journal of Social Service Research* 30, no. 3: 19–33. doi:10.1300/J079v30n03_02.

Desvousges, William, F. Reed Johnson, Richard Dunford, Kevin Boyle, Sara Hudson, and K. Nicole Wilson. 2010. *Measuring nonuse damages using contingent valuation: An experimental evaluation of accuracy*. RTI Press, Research Triangle Park.

Elly, Tumsifu, and Ephraem Epafra Silayo. 2010. Agricultural information needs and sources of the rural farmers in Tanzania: A case of Iringa rural district. *Library Review* 34, no. 1: 1–5.

Eskola, Elina. 2005. *Agricultural marketing and supply chain management in Tanzania: A case study*. ESRF Study on Globalisation and East Africa Economies. Economic and Social Research Foundation, Dar es Salaam, Tanzania.

FAO. 2014. *Country fact sheet on food and agriculture policy trends: Socio-economic context and role of agriculture*. Food and Agriculture Policy Decision Analysis, FAO. Tanzania.

FAO. 2017. *Building Agricultural Market Information Systems: A Literature Review*. Rome.

Fischer, Elisabeth, and Matin Qaim. 2012. Linking smallholders to markets: Determinants and impacts of farmer collective action in Kenya. *World Development* 40, no. 6: 1255–1268.

Galtier, Franck, Hélène David-Benz, Julie Subervie, and Johny Egg. 2014. Agricultural market information systems in developing countries: New models, new impacts. *Cahiers Agricultures* 23, no. 4–5: 232–244.

Getahun, Abebaw A. 2020. Challenges and opportunities of information and communication technologies for dissemination of agricultural information in Ethiopia. *International Journal of Agricultural Extension* 8, no. 1: 57–65.

Greene, William. 2002. *Econometric analysis*. 5th ed. Prentice Hall. Upper Saddle River.

Haug, Ruth, and Joseph Hella. 2013. The art of balancing food security: securing availability and affordability of food in Tanzania. *Food Security* 5, no. 3: 415–426.

Heckman, James J. 1979. Sample selection bias as a specification error. *Econometrica* 47, no. 1: 153. doi:10.2307/1912352.

Huggins-Rao, S. 2011. *Marketing on the airwaves: marketing information service (MIS) and radio*. Farm Radio International. Ottawa, Ontario.

Jeckoniah, J., N. Mdoe, and C. Nombo. 2013. Mapping of gender roles and relations along onion value chain in northern Tanzania. *International Journal of Asian Social Science* 3, no. 2: 523–541.

Kizito, Andrew Muganga. 2011. The structure, conduct, and performance of agricultural market information systems in Sub-Saharan Africa. Unpublished Ph.D. thesis, Michigan State University.
Krone, Madlen, Peter Dannenberg, and Gilbert Nduru. 2016. The use of modern information and communication technologies in smallholder agriculture. *Information Development* 32, no. 5: 1503–1512. doi:10.1177/0266666915611195.
Le Gall-Ely, Marine. 2009. Definition, measurement and determinants of the consumer's willingness to pay: A critical synthesis and avenues for further research. *Recherche et Applications En Marketing (English Edition)* 24, no. 2: 91–112.
Lwoga, Edda, Christine Stilwell, and Patrick Ngulube. 2011. Access and use of agricultural information and knowledge in Tanzania. *Library Review* 60, no. 5: 383–395. doi:10.1108/00242531111135263.
Maddala, Gangadharrao S, and Kajal Lahiri. 1992. *Introduction to econometrics. Vol. 2*. New York: Macmillan.
Magesa, Mawazo M, Kisangiri Michael, and Jesuk Ko. 2014a. Access to agricultural market information by rural farmers in Tanzania. *International Journal of Information and Communication Technology Research* 4, no. 7: 264–273.
Magesa, Mawazo M, Kisangiri Michael, and Jesuk Ko. 2014b. Agricultural market information services in developing countries: A review. *Advances in Computer Science: An International Journal* 3, no. 3: 38–47.
Magesa, Mawazo Mwita. 2018. A framework for enhancing sustainable access and use of agricultural market information by small-scale farmers in Tanzania. NM-AIST.
Magesa, Mawazo, Kisangiri Michael, and Jesuk Ko. 2020. Access and use of agricultural market information by smallholder farmers: Measuring informational capabilities. *The Electronic Journal of Information Systems in Developing Countries*, 86, 1–21.
Matotay, Edmund, and Bjorn Furuholt. 2010. Farmers empowerment, opportunities and risks: the role of mobile phones in Babati District in Tanzania. In *Proceedings of The 2nd International Conference on M4D Mobile Communication Technology for Development. 10–11 November, Kampala, Uganda*, edited by Jakob Svensson and Gudrun Wicander, 99–110.
Mayala, Nyanjige M, and Justinian M Bamanyisa. 2018. Assessment of market options for smallholder horticultural growers and traders in Tanzania. *European Journal of Research in Social Sciences* 6, no. 1: 27–42.
Mgale, Yohana James, and Yan Yunxian. 2020. Marketing efficiency and determinants of marketing channel choice by rice farmers in rural Tanzania: Evidence from Mbeya region, Tanzania. *Australian Journal of Agricultural and Resource Economics* 64, no. 4: 1239–1259. doi:10.1111/1467-8489.12380.
Mtega, Wulystan P, Mpho Ngoepe, and Luyanda Dube. 2016. Factors influencing access to agricultural knowledge: The case of smallholder rice farmers in the kilombero district of Tanzania. *SA Journal of Information Management* 18, no. 1: 1–8.
Mutayoba, Venance, and Deus Ngaruko. 2015. Determinants of farmers' participation in high value crops in Tanzania. *African Journal of Economic Review* 3, no. 2: 102–116.
Mwakaje, Agnes G. 2010. Information and communication technology for rural farmers market access in Tanzania. *Journal of Information Technology Impact* 10, no. 2: 111–128.
Nakasone, Eduardo. 2013. The role of price information in agricultural markets: Experimental evidence from rural Peru. In *2013 Annual Meeting, August 4-6, 2013, Washington, DC* (No. 150418). Agricultural and Applied Economics Association.
Navrud, Ståle, and E.D. Mungatana. 1994. Environmental valuation in developing countries: The recreational value of wildlife viewing. *Ecological Economics* 11, no. 2: 135–151. doi:10.1016/0921-8009(94)90024-8.
Oduh, Moses Onyema, and Maryann Ogechi Oduh. 2012. Determinants of willingness to pay for mobile telecommunications services in Nigeria. *Journal of Information Engineering and Applications* 2, no. 6: 33–43.
Okore, Maggie. 2014. *Rural agricultural markets reducing poverty: The case of MVIWATA*. Tanzania.
Ratner, Bruce. 2009. The correlation coefficient: Its values range between +1/−1, or do they? *Journal of Targeting, Measurement and Analysis for Marketing* 17, no. 2: 139–142. doi:10.1057/jt.2009.5.
Shepherd, Andrew W. 2000. *Understanding and using market information. marketing extension guide*. Rome: FAO, the United Nations.
Shepherd, Andrew. 1997. *Market information services: Theory and practice*. FAO Rome.
Shultz, Steven, Jorge Pinazzo, and Miguel Cifuentes. 1998. Opportunities and limitations of contingent valuation surveys to determine national park entrance fees: Evidence from Costa Rica. *Environment and Development Economics* 3, no. 1: 131–149.
Torero, Maximo, Shyamal K Chowdhury, and Virgilio Galdo. 2003. Willingness to pay for the rural telephone service in Bangladesh and Peru. *Information Economics and Policy* 15, no. 3: 327–361. doi:10.1016/S0167-6245(03)00002-7.
URT. 2008. *Agricultural marketing policy*. Ministry of Industry, Trade and Marketing, United Republic of Tanzania. Dar es Salaam.
URT. 2017a. *The economic survey 2017*. Ministry of Finance, Dodoma, Tanzania.
URT. 2017b. *2016/17 annual agriculture sample survey crop and livestock report*. Dar es Salaam: The United Republic of Tanzania.
URT. 2019. "Agriculture and cooperatives." In *The economic survey 2018*, 119–136. Ministry of Finance and Planning, Dodoma.
Venkatachalam, Lingappan. 2004. The contingent valuation method: A review. *Environmental Impact Assessment Review* 24, no. 1: 89–124. doi:10.1016/S0195-9255(03)00138-0.

Verbeek, M. 2008. *A guide to modern econometrics*. 3rd ed. John Wiley & Sons, Ltd. West Sussex.
Verbeke, Wim, and Ronald W Ward. 2006. Consumer interest in information cues denoting quality, traceability and origin: An application of ordered probit models to beef labels. *Food Quality and Preference* 17, no. 6: 453–467. doi:10.1016/j.foodqual.2005.05.010.
Wang, Catherine L, and Pervaiz K Ahmed. 2007. Dynamic capabilities: A review and research agenda. *International Journal of Management Reviews* 9, no. 1: 31–51. doi:10.1111/j.1468-2370.2007.00201.x.
Wyche, Susan, and Charles Steinfield. 2016. Why don't farmers use cell phones to access market prices? technology affordances and barriers to market information services adoption in rural Kenya. *Information Technology for Development* 22, no. 2: 320–333. doi:10.1080/02681102.2015.1048184.
Zoltner, J., and M. Steffen. 2013. *An assessment of market information systems in East Africa – Briefing Paper, USAID*.