

Full Length Research Paper

Determinants of mobile phones usage in sweet potato vine business in Gulu district northern Uganda

Ronald Obong^{1*}, Basil Mugonola¹ and David Paul Phillips²

¹Department of Rural Development and Agribusiness, Gulu University, Laroo Division, Municipality 166, Gulu, Gulu, Uganda.

²Natural Resources Institute (NRI), University of Greenwich, Old Royal Naval College, 30 Park Row, London SE10 9LS, UK.

Received 8 February, 2017; Accepted 11 April, 2017

Seed systems that provide farmers with planting materials may be divided into formal and informal systems. For the sweet potato sector, the informal seed system is the main provider of planting materials to small and medium sized farmers in developing countries. This informal system provides planting materials to smallholder farmers at the right time, place and quantity. However, for it to be effective there must be an appropriate means of communication between multipliers and buyers of sweet potato vines. This may be achieved with the use of mobile phones. Mobile phones are said to have great impact in improving trade through provision of accurate and timely information directly to farmers. However mobile phones usage in agriculture is still low. Many farmers still rely on the traditional way of accessing information which seems inadequate. This study characterized users and non-users of mobile phones and assessed factors that influenced mobile phones usage in sweet potato vines trade. A cross sectional causal comparative survey research design was used. The study obtained primary data from 140 randomly selected respondents in three purposively selected project sub-counties in Gulu district. Descriptive statistics and probit regression were used to analyse the data. Our results indicated that users and non-users of mobile phones in sweet potato vines marketing differed in a number of socio-economic characteristics. Users of mobile phone were on average younger, better educated and had bigger sweet potato fields. The Probit regression results revealed that the farmers' age negatively influenced the decision to use mobile phones in sweet potato vines trade. On the other hand, education and household income positively influenced the decision to use mobile phones in sweet potato vine trade. Mobile phones therefore have potential for improving the livelihoods of smallholder farmers and should be specifically targeted to lure the youths into agriculture.

Key words: Mobile phones, sweet potato vines, seed system, marketing, Gulu district.

INTRODUCTION

Sweet potato is vegetatively propagated using cuttings preferably from the tip of the growing plant (Wilson, 1988). Long dry seasons destroy the planting material and require an effective seed system to facilitate early planting and to assure farmers of a good crop (Gibson et

al., 2009). A seed system refers to an organised, formal or informal mechanism through which farmers get planting materials (Louwaars et al., 2010). There are two major seed systems. The formal seed system which involves production of seeds by institutions following

specific rules and regulations, maintaining distinctiveness, uniformity of seeds and following an organized channel of distribution (FAO, 2004). While the informal seed system sometimes referred to as the traditional or farmer seed system is where farmers select, produce and manage their own seeds usually local varieties and the distribution is through farmer to farmer networks (Wekundah, 2012). The informal seed system accounts for over 80% of the total area planted under subsistence crops (FAO, 2004). In Uganda, sweet potato planting materials spread through the informal seed system which is always affected by dry seasons. However, closer to the equator at 1° a sweet potato crop planted in the previous rainy season can survive the short dry season, allowing farmers to obtain planting materials from their own surviving crops or from their neighbours', but in Gulu just at 2° north of the equator, farmers need to conserve sweet potato planting materials in wetlands or shade during the long dry season in northern Uganda (Gibson et al., 2009). The trend in the agricultural seasons in northern Uganda therefore creates opportunities for those near wetlands, to conserve and multiply sweet potato vines in dry seasons and sell at the onset of the rainy seasons. However, this can only benefit farmers far from wetlands when mobile phones are put into good use to communicate information on the availability of sweet potato vines and make business transactions.

Mobile phones are known to speed up the pace at which farmers access and use different agricultural information (Nyamba and Mlozi, 2012). However, farmers always seek information from one another on: Where to buy agricultural inputs and who pays the highest output price in the market, but rarely find answers to these questions even if related ones arise yearly (World Bank, 2011). This has been linked to poor access to production and market information especially in rural areas where farmers rely on neighbours and friends to access market information. These traditional methods of accessing and disseminating information seem inadequate and do not provide timely information and hence affect crucial decisions including planting time of sweet potatoes. It is therefore important to find and use alternative ways to access production and market information and mobile phones could be the answer.

Many development partners have been trying to introduce the use of mobile phones in the agriculture sector to improve access to production and market information (Akiiki, 2006), but their efforts end with the projects due to poor targeting as characteristics of people likely to adopt and use the intervention are not clear. The factors that influence use of phones in agriculture seems not clear and identifying these factors will enable

stakeholders devise possible strategies to address the issues limiting mobile phone usage in agriculture. This study characterized users and non-users of mobile phones for information access and investigated factors influencing smallholder farmers' decision to use mobile phones' in sweet potato vine marketing business in Gulu district of northern Uganda.

HISTORY OF TELEPHONE/MOBILE PHONE IN UGANDA

South-eastern African region collectively provided the telephone services to their members by the government of Uganda, Kenya and Tanzania before the year 1977 (Econ One Research, 2002). However in 1977 Uganda left the regional shared services model by establishing the Uganda posts and telecommunication corporation (UPTC) as a state owned monopoly provider of telecommunication services. The services provided by UPTC by then were poor with limited innovation (Econ One Research, 2002). To address the above gap, transformation of the industry was done through privatization and liberalization. In 1993 Celtel, was issued a license to provide telecommunication services other than UPTC in Uganda. However, the license was for cellular not fixed-line services. Celtel Uganda started providing services in 1995. In 1998, Uganda telecommunication limited (UTL) was established as state owned company but was privatized in 2000 and started operating in 2001. In the same year (1998), mobile telephone network (MTN) and started operating in October the same year. These were then followed by other companies (Warid, Orange, Africel) among others.

The introduction and establishment of the many telephone companies in Uganda increased competition and rapid development of mobile phone use in Uganda from 1% in 2000 to 48% in 2012 (World Bank 2, 2013). This also came with a lot of initiative such as mobile money services which enables one to save, send, money to another, pay bills through ones' subscriber identification module- card (SIM-Card) (Aker and Mbiti, 2010) and mTrac that was initiated by ministry of health together with United Nations International Children Efficiency Fund (UNICEF) (Maree et al., 2013), alongside voice and SMS application.

Mobile phone in agriculture

Mobile phones serve a number of purposes. Phones have shifted from being just voice device to a multimedia

*Corresponding author. E-mail: ronald_obong@yahoo.com. Tel: +256 (0) 773465162.

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

Table 1. Variables used in the study.

Variable	Description
Dependent variable	
Decision to use a mobile phone for vine marketing	1 if used mobile phones for sweet potato vine business, 0 otherwise
Independent variables	
Age	Age of the farmer in years
Gender	1 if Male 0 otherwise
Marital Status	1 if married, 0 otherwise
Education level	Number of years spent at school
Occupation	1 if farming, 0 otherwise
Group affiliation	1 if belong to a group, 0 otherwise
Income level	Total income earned in a year in Uganda shillings
Household size	Number of household members
Field size	Total acreage under sweet potato for vines
Distance to market	Distance from home to Market in Kilometres
Vine marketing experience	Number of years spent in sweet potato vine marketing
Sweet potato production experience	Number of years spent in sweet potato production
Ownership of mobile phone	1 if own a phone, 0 otherwise
Volume of sweet potato Vine sold	Total of sweet potato vine small bundles sold in one year
Source of sweet potato vines sold	1 if grow, 0 otherwise
Frequency of sweet potato vine sales	1 if once a week, 0 otherwise
Ease of getting buyers	1 if easily get, 0 otherwise
Quantity of vines lost	Total number of sweet potato vines lost in a year in small bundles
Price	Unit price for each small bundle of sweet potato vines

communication tool capable of downloading, uploading text, can be used as a wallet, calculator, television, alarm clock, camera and many more (World Bank, 2011). Farmers use mobile phones for obtaining agricultural related information (Muto and Megumi, 2009; Mwakaje, 2010; Lashgarara et al., 2011). Mobile phones usage facilitates transactions and provides producers access to relevant and timely information, allowing them to make wise decision (Dhaliwal and Joshi, 2012). Mobile phones can be used by farmers in coordinating access to agricultural inputs; including agricultural training, seeds, livestock and pesticides from local dealers, governmental, non-governmental organizations, agriculture extension agents and community members without any physical contact and access to the market (Martin and Abbott, 2011). In the past individuals would travel to seed dealers only to find all seeds had been sold but today, individuals call or send SMS and make appointments before travelling and payments can be made through mobile money services provided by telephone companies (M-pesa, Airtel money, MTN mobile money) (Olwande et al., 2013). Information according to Lashgarara et al. (2011) is needed by smallholders to enable them make an informed decision at each stage of the agricultural production cycle.

Limited information constrains farmers to know about prices in only few nearby markets within a village or town since they cannot move to more than one market a day

due to high transport costs (Jensen, 2007). Improved information access through mobile phones may help to improve poorly performing markets through reduction of price disparity within markets (Jensen, 2007; Abraham, 2007) and reduction of transport cost and other transaction costs.

MATERIALS AND METHODS

This study was carried out in three sub-counties in Gulu district. Bungatira, Unyama and Koro. These sub-counties are characterized by presence of wetlands and year round flowing streams that can be used to support dry season sweet potato growing and reliance on sweet potato to earn a living.

A sampling frame was drawn up and respondents were randomly selected using random numbers table in proportion to the number of sweet potato vine multipliers in each sub-county. All the town sweet potato vine sellers were surveyed because they were only 9. The procedure resulted into 140 respondents with; 131 multipliers and 9 town sellers.

The study employed a cross sectional causal comparative research design. Data were collected in 2015 using personally administered pre-tested questionnaires. Data were entered in SPSS version 20 and analysed using STATA package version 13. Variables used in the study are presented in Table 1.

Conceptual framework

The need to improve smallholder farmers' access to agricultural and

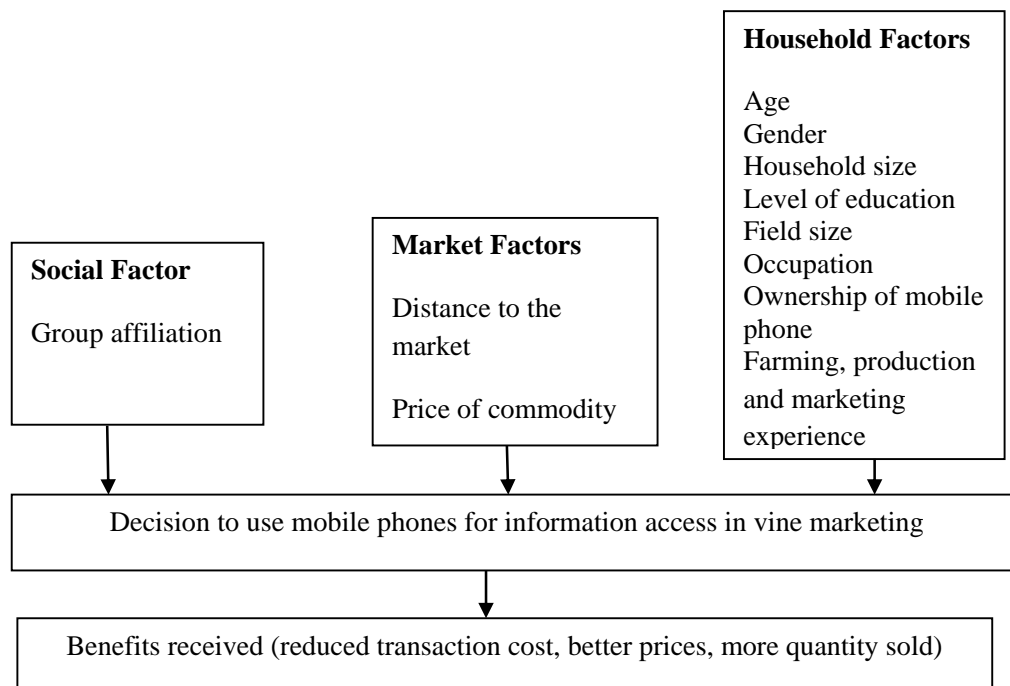


Figure 1. Factors influencing mobile phone usage in sweet potato vines marketing.

market information which in the past relied on extension agent and yielded limited impact has led to development of new models. The new models of information dissemination include the use of radio, television, newspapers, computers, and mobile phones (Aker, 2011). Of the above, mobile phones stand out as a cheap, timely and direct means of informing farmers (Dhaliwal and Joshi, 2012). This study uses random utility theory, to analyse adoption of innovations under uncertainty (Pannell, 2003). The concept of utility was first put forward by Bentham in 1748 (Read, 2007). Following Bentham's idea a farmer will only use a mobile phone in sweet potato vine marketing transactions if he/she expects to benefit from it.

The decision to use a mobile phone is likely to depend on a number of factors such as market, household and social factors (Figure 1). Household factors such as age and primary occupation positively influence farmers' decision to use ICTs including mobile phones (Okello et al., 2012), gender has both negative and positive influences (Mwakaje, 2010). Males and high income earners are more likely to use mobile phones for agricultural purposes than their counterparts; phone ownership also increased its use (Nyamba and Mlozi, 2012). Group members are also more likely to use ICT/mobile phones to access agricultural information than non-group members (Okello and Mensah, 2011).

Furthermore, market factors for example expected price and distance to the market positively influenced mobile phone use in agriculture. People far away from the market use more of mobile phones to access market information than their counter parts closer to the markets. They can also sell more and receive better prices through better connections to markets (Mwakaje, 2010). Mobile phones can also benefit farmers by reducing transaction time, reducing market and inputs search cost (Mittal and Mehar, 2012).

Model specification

Usage of mobile phone is associated with costs and benefits. Costs

may arise from purchase of airtime (credit/data), charging of phone batteries and maintenance. Benefits on the other hand may arise from better access to information, reduced transaction costs, higher sales volume, minimal losses, and better prices. The decision to use a mobile phone in agriculture by a farmer can therefore be modelled building on random utility theory model framework mainly used to analyse adoption of innovations under uncertainty (Pannell, 2003). A farmer uses a mobile phone if the expected benefit out weights the cost of using a mobile phone. The decision to use a mobile phone is therefore a binary choice variable assuming utility maximization subject to household resource constraint(s), social factors and market factors. The actual utility level of each individual

farmer U_i is unobserved. The part of the utility function that is observed can be expressed as a function of the vector of exogenous variables X_i and a vector of parameters β to be estimated. $V(X_i)$, where:

$$U_i = V(X_i) + u_i \quad (1)$$

The vector X_i includes farm and household characteristics like income, age, group affiliation, etc., part of the farmer's utility which is unobserved is represented by an error term u_i . The farmer chooses to use a mobile phone if the utility U_m derived from mobile phone usage is greater than the utility U_n derived from non-usage. The probability of a farmer using a mobile phone is given by $\Pr(U_i < \beta X_i)$. This can be estimated using probit or logit models. The Probit model was selected because the error term assumes a normal distribution (Dow and Endersby 2004). The probit model was estimated as follows:

Table 2. Differences in characteristics of users and non-user of mobile phones in sweet potato vine marketing.

Variable	Users (n=87)	Non-users (n=53)	Mean difference (non-user-users)
	Mean (SD)	Mean (SD)	
Age	35.474 (12.468)	41.396 (15.105)	5.922**
Education	6.038 (3.694)	3.962 (3.311)	-2.076***
Household size	7 (2.692)	8 (3.911)	1.000*
Farming experience	15.256 (9.955)	20.491 (14.888)	5.234**
Sweet potato production experience	13.795 (9.898)	19.774 (14.820)	5.979***
Vine marketing. experience	7.051 (6.418)	6.094 (6.792)	-0.957
Income level	2610995 (3330786)	1699057 (977511)	-911938*
Field size	0.679 (0.659)	0.418 (0.382)	-0.261**
Quantity sold in year	3393 (1051)	1149 (135)	-245.000
Price per small bundle	367 (122)	379 (140)	13.000
Quantity lost in year	49 (75.296)	31 (57.540)	-18.000
Distance	4.281 (1.882)	3.796 (1.953)	-0.485
Categorical variable			Chi-square
Gender			0.0027
Marital status			10.7127
Primary occupation			0.0768
Group affiliation			1.4758
Freq. of sales			25.8520***
Labour hire			7.8229**

Significant level: *10%, **5%, ***1% level.

$$\Pr(M_i = 1) = \Pr(u_i < \beta X_i) = \beta X_i + u_i \quad (2)$$

Where $M_i = 1$ if $U_m > U_n$ and $M_i = 0$ if $U_m < U_n$

RESULTS AND DISCUSSION

Differences in characteristics of users and non-user of mobile phones in sweet potato vine marketing

Users and non-users of mobile phones in sweet potato vine marketing were compared; t-tests and chi-square test were used for continuous and categorical variables respectively. Significant differences were observed between users and non-users of mobile phones in sweet potato vine marketing (Table 2). Results further indicate that there were significant differences in the mean age, mean number of years spent in school, farming and sweet potato production experience, annual income, household size and sweet potato field size between users and non-users of mobile phones. Mobile phone users were on average younger, spent more years at school, had less farming and sweet potato production experience, and had higher annual incomes and bigger sweet potato fields but with smaller household sizes. There was no significant difference in the mean quantity of sweet potato vines sold in a year and mean quantity lost in a year between users and non-users of mobile

phones. There were also no significant differences between users and non-users of mobile phones in-terms of, vine marketing experience, prices received and distance from home to the markets. For categorical variables, gender, marital status, primary occupation and group affiliation were not significantly different between users and non-users of mobile phones in sweet potato vine marketing business. Frequencies of sweet potato vine sales and labour hire were significantly different between users and non-users ($X^2=25.8520$, $P= 0.000$ and $X^2=7.8229$, $P=0.020$, respectively).

Demographic characteristics of respondents

Of the 131 multipliers surveyed, 106 (80.9%) were female while 25 (19.1%) were male. On the other hand all the 9 town sweet potato vine sellers surveyed were women. Majority of those involved in sweet potato vine marketing business are females. Most multipliers surveyed were young (youth) aged < 36 years 68 (51.9%) and middle aged from 36-55 years 47 (35.9%) categories. The other category considered old was aged > 55 years 16 (12.2%). On the other hand, of the 9 town sellers surveyed 3 (33.3%) were young aged < 36 years, 5 (55.6%) were middle aged (36-55 years) and 1 (11.1%) was old aged > 55 years. The minimum age of those surveyed was 18 years and maximum was 78 year.

Production and sale of sweet potato vines are mostly done by youth and middle aged people, probably because dry season growing and marketing of sweet potato vines are so demanding in terms of time and labour and need energetic and patient people. Of the 131 multipliers surveyed, 64 (48.9%) had spent 0-5 years in school, 56 (42.8%) had spent from 6-10 years in school and 11(8.4%) had spent from 11-15 years in school. On the other side, of the 9 town sellers, 3 (33.3%) had spent 0-5 years in schools and 6 (66.7%) had spent from 6-10 years in school. Majority of sweet potato vine multipliers and town sellers could have stopped in primary education. In case of marital status, 114 (87%) of multipliers surveyed were married, 2 (1.5%) were single, 6 (4.6%) were divorced and 9 (6.9%) were widowed. However, for the 9 town sellers, 5 (55.6%) were married, 2 (22.2%) were divorced and 2 (22.2%) were widows. On household size, of the 131 multipliers surveyed, 31 (23.7%) had < 5 people, 88 (67.2%) had household size of 5-10 people, 10 (7.6%) had size of 11-16 people and 2 (1.5%) had household size of > 16 people. On the other hand, of the 9 town sellers surveyed 2 (22.2%) had household size of < 5 people and 7 (77.8%) had household size of 5-10 people. Majority of respondents had household size of more than 5 people, probably because most of the people in the study areas marry when they are young and stay as extended families.

As expected, nearly all respondents 129 (98.5%) and 5 (55.6%) for multipliers and town sellers respectively reported that they rely on farming as their primary occupation and 2 (1.5%) multipliers and 4 (44.4%) town sellers said they rely on small businesses. This is likely because most of them did not attained high level of education and most likely they cannot be hired to do formal jobs and probably have limited capital to venture into medium and large size businesses.

Mobile phone ownership in the study area

Slightly less than half 62 (47.3%) of the 131 multipliers owned mobile phones. However, all the town sellers surveyed owned mobile phones, probably because they were given mobile phones by Commercialization of sweet potato Planting Materials in Northern Uganda –project. Of the 62 multipliers who owned phones, 47 (75.8%) were females and 15 (24.2%) were male. This is probably because sweet potato vine marketing business is done mostly by women. Of the 47 females that owned mobile phones, 43 (91.5%) used it in sweet potato vine marketing business. On the other hand, of the 15 males that owned mobile phones, 13 (86.7%) used them in sweet potato vine marketing business.

Use of mobile phones

All the respondents had used mobile phones in the last one year mainly for social communication (calling loved

ones). However, in the study, 53 (40.5%) of the multipliers used mobile phones exclusively for social communication while the rest 78 (59.5%) used mobile phones for both social communication and sweet potato vine marketing purposes. On the other hand, all the 9 town sellers used mobile phones for both social communication and sweet potato vine marketing purposes. This shows that social communication still takes the larger portion of activities for which mobile phones are used. This finding coincides with other findings for instance that of (Mittal and Mehar, 2012). Of the multipliers that used mobile phones for conducting sweet potato vine marketing business, 65 (83.3%) were females and 13 (16.7%) were males. This could be because more females than males are involved in sweet potato vine marketing business.

Other mobile phone services and applications used other than voice calls

Of the 78 multipliers who used mobile phones, 16 (20.5%) of them used other services and applications. Of the 16 multipliers, 10 used mobile money services only, 7 used both mobile money services and SMS, 4 used SMS only, none used both mobile money services and mobile phones as calculator, 2 used mobile phones as calculator only. The total number of users of other mobile phones services and application exceeds 16 because of multiple uses (one person using more than one services and applications). On the other hand, of the 9 town sellers surveyed only 4 used other mobile phone services and applications. Of the 4, 3 had used mobile money services only and 1 used both mobile money service and SMS. The low number could be due to lack of knowledge and confidence to operate mobile phones.

Volume of calls and districts where calls were made from

The average numbers of calls received and made by multipliers were approximately 2 in a week in each case. On the other end, town sellers received on an average 22 calls and made 28 calls in a week. This could be liked to limited income among multipliers of sweet potato vines. The town sellers received and made more calls probably because they are connected to many customers, sell more and get better income. Of the multipliers who used mobile phones in sweet potato vine marketing 24 (30.8%) received calls from other districts as orders for sweet potato vines. In the case of town sellers 8 (88.9%) received calls from other districts as orders for sweet potato vines. The districts where calls were made include: Apac, Kitgum, Nwoya, Amuru, and Pader among others. However, most calls were made from Kitgum and Pader districts. This could probably be because of high sweet potato vines demand in the two districts.

Table 3. Probit estimates of the factors that influence the decision to use mobile phones in sweet potato vine marketing.

Variable	Probit regression	Marginal effect
	Coefficient	Coefficient
Distance to market (Km)	0.127 (0.077)	0.048 (0.029)
Household income (Ugx)	0.493*** (0.143)	0.185*** (0.055)
Age in years	-0.025** (0.011)	-0.009** (0.004)
Marital Status (1 if Married 1, 0 Otherwise)	0.245 (0.157)	0.092 (0.059)
Vine marketing experience in years	0.038 (0.024)	0.014 (0.009)
Group Affiliation (1 if group member, 0 Otherwise)	0.187 (0.353)	0.071 (0.137)
Primary Occupation (Farming = 1, 0 Otherwise)	-1.074 (1.703)	-0.403 (0.640)
Education (No. of years spent in school)	0.089** (0.041)	0.033** (0.015)
Gender (Male = 1, 0 Otherwise)	-0.389 (0.371)	-0.053 (0.142)
Quantity of vines lost in a year (in small bundle)	0.002 (0.002)	0.001 (0.001)
Price (Ugx)	0.001 (0.001)	0.001 (0.0004)
Frequency of Vine sale (Once a week = 1, 0 Otherwise)	0.226** (0.167)	0.085** (0.186)
Source of vine sold (1 if grow, 0 Otherwise)	0.223 (0.167)	0.083 (0.063)
Model characteristics		
No. of observation		131
Pseudo R^2		0.258
Log likelihood		-65.56
p- Value		0.0000

Payments for sweet potato vines ordered through mobile phone calls were received by multipliers in the following ways: Through bodaboda riders (people who use motorcycles to carry passengers), 72 (92.3%) of multipliers, 4 (5.1%) went and picked their money and 2 (2.6%) received payment through mobile money services. Surprisingly, no town market sellers received payment through mobile money services but physically from transporters. The mode of payment made through transporters is risky because they are likely not to deliver the money to the intended owners.

Benefits of using mobile phones in sweet potato vine marketing

Use of mobile phones in sweet potato vine marketing has been of benefit. This is in line with Mittal & Tripathi, (2009). There were increased incomes through increased sales, enabling multipliers and sellers of sweet potato vines to meet their basic needs. Mobile phones made connection easier, improved the relationship between the trading parties by reducing conflicts, reduced losses and transaction costs and improved the quality of sweet potato vines sold to customers as they were delivered fresh on call.

Challenges of using mobile phones in sweet potato vine marketing

A number of challenges limit the use of mobile phones in sweet potato vine trade; inability to operate mobile

phones, poor telephony network in the areas, mobile phone number of the other party being off/unavailable on the network and charging difficulties due to lack of power are the major challenges of using mobile phones in the business. Charging difficulties was also reported by (Syiem and Raj, 2015) among the tribal farmers in Meghalaya State in North-East India.

Factors influencing smallholder farmers' decision to use mobile phones in sweet potato vine marketing

In Table 3, a number of factors were revealed to influence smallholder farmers' decision to use mobile phones in sweet potato vine marketing. Farming experience and sweet potato production experience were highly correlated with age of respondents and therefore were excluded from the model. Similarly, quantity of sweet potato vines sold in a year and field size were also excluded because of their high correlation with income. Town market sellers were also excluded here because they were given mobile phones by the project. The probit model fit the data with 63.8% ($p < 0.0000$) correct prediction of users and non-users of mobile phones in sweet potato vine marketing. The likelihood and pseudo R^2 of the probit model are also presented. Income significantly influences farmers' decision to use mobile phones in sweet potato vine marketing ($P < 0.001$). Farmers with higher incomes are more likely to use mobile phones than their counterparts. A unit increase in income increases the likelihood of using mobile phones by a marginal effect of 0.185, probably because with high

income a farmer can afford to buy a phone, buy airtime vouchers, re-charge battery and pay phone maintenance cost. This finding agrees with that of Nyamba and Mlozi (2012). Age has significant but negative influence ($P < 0.023$) on the decision to use mobile phones in sweet potato vine marketing, this was anticipated. An increase in age by one year decreases the probability of using mobile phones in sweet potato vine marketing business by a marginal effect of 0.009. This finding indicates that the use of mobile phones is greater among younger sweet potato vine sellers and multipliers than their older counterparts, probably because they are better educated. Also as one grows older, one may start experiencing visual problem making it difficult to operate mobile phones. Other scholars found that age negatively influences adoption and use of new technologies (mobile phones). This was found in Ali and Erenstein (2013). Frequency of sweet potato vine sale positively influences ($P < 0.015$) one's decision to use a mobile phone in sweet potato vine marketing. Sweet potato vine multipliers who sell once a week are more likely to use mobile phones by a marginal effect of 0.085 than their counterparts who sell more than once a week. Probably because they need to look for market and get more customers to be able to sell more frequently. Furthermore, as was expected education has significant and positive influence ($P < 0.029$) on the use of mobile phones in sweet potato vine marketing. Educated people are more likely to use mobile phones in sweet potato vine marketing by a marginal effect of 0.033 compared to their other uneducated counterparts. This is likely because educated people may find it easier to operate mobile phones than uneducated. This finding is in disagreement with that of Nyamba and Mlozi (2012) who found that education has no significant influence on mobile phone use in communicating agricultural information. Quantity of sweet potato vines lost, primary occupation, group affiliation (group membership), sweet potato vine marketing experience, marital status, gender, source of sweet potato vine sold, distance to the market and price of sweet potato vines have no significant influence on the decision to use mobile phones in sweet potato vine marketing. The findings probably mean both users and non-users of mobile phones fairly have the same sweet potato vine marketing experience and receive the same price for each small sweet potato vines bundle.

Conclusions

This study characterised users and non-users of mobile phones in vine marketing and assessed factors that influence the decision for one to use phones in sweet potato vine marketing business. Results indicated that users were younger, more educated had more income, had less farming experience, sweet potato production experience and slightly more experienced in vine marketing. Social communication is still the main reason

for buying mobile phones. Reasons for not using mobile phones in sweet potato vines business were; non-ownership of mobile phones, nearness to markets, expenses associated with using mobile phones, inability to operate mobile phones, no phone contact of buyers and others sold through a focal person who liked them to buyers. Our results further revealed that 30.8% of the multipliers and 88.9% of the town market sweet potato vine sellers who used mobile phones in sweet potato vine business received calls from others districts as orders for sweet potato vines.

Mobile phones use in sweet potato vine trade was limited by: Battery charging difficulties due to lack of electricity, inability to operate mobile phones, poor telephony network and choice of channels to pass information to farmers. Despite the challenges, using mobile phones also had benefits. There was reduced conflict between the trading parties, reduced losses, reduced transport costs and improved connectedness and networking. Sweet potato vine multipliers called markets before cutting vines and got to know market situations prior to sending sweet potato vines to the market. Factors that significantly influenced the decision to use mobile phones in sweet potato vine business include; age, income, education and frequency of sweet potato vine sales.

This study therefore contends that use of mobile phones in agriculture has a great role in rural areas. Farmers received timely information by contacting the market without physically traveling to the market; they can receive payment for their products sent to the market while home through mobile money services and can find markets for their products elsewhere without leaving home as long as they have contacts of people in those places. The freshness of the product is not compromised since sweet potato vines are cut on request. Conflict between the trading parties and losses are reduced when full use of mobile phones is put to practice.

Poor access to information limits the economic potential of farmers as market participants and value chain actors. Use of mobile phones seemed to make information available to sweet potato vine sellers and improved their livelihood and position in the business, by improving their skills and knowledge. As such, mobile phones were said to have a great contribution in vine business. Multipliers/sellers were able to communicate and received payments for their products directly in their mobile phones without any geographical hindrance. The social aspect of getting people change to mobile money services is important; one can accumulate large sums of money by saving in his/her mobile money account, which can then be used to pay large bills. Saving in mobile money account also reduces unnecessary spending which is the case with physical cash. Women whose husbands are problematic are saved from their husbands taking money forcefully from them. Use of mobile phones in agriculture can help solve some of the market failures that smallholder farmers face as a result of lack of access

to market information especially in rural areas. Our findings allude to the fact that investment should be made in programs that make it easy for smallholder farmers to acquire and use mobile phones. Basic education/training is much needed to boost up smallholder farmers' confidence to operate mobile phones. Also to encourage use of mobile phones in promoting agriculture, government should introduce and promote the teaching of ICT skills including mobile phone used in business in secondary schools and vocational institutes. Specific interventions targeting use of phones in agriculture should focus on luring the youth into agriculture and hence contribution to the reduction of unemployment.

Our results also show that lack of electricity in rural areas also limits use of mobile phones by smallholder farmers. Therefore interventions like rural electrification and solar phone charging stations are much needed so as to unlock the full potential of mobile phones.

Using mobile phones reduces transaction costs of conducting business. However, it is still not clear to what extent use of mobile phones in agriculture reduces transaction cost of conducting business. Further research needs to be done to investigate the extent to which mobile phones use in agriculture reduces costs of conducting business.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

This study was part of the Commercialization of Sweet potato Planting Materials project in Northern Uganda, funded by the Bill and Melinda Gate Foundation. The authors appreciate the input of Dr. Richard Gibson, Mr. Stephen Wamala Kalule farmers and leaders of the study areas for their cooperation.

REFERENCES

- Abraham R (2007). Mobile Phones and Economic Development: Evidence From the Fishing Industry in India. Published under Creative Commons Attribution NonCommercial-NoDerivativeWorks Unported 3.0 license, 4(1):5-17.
- Aker JC (2011). Dial "A" for Agriculture: A Review of Information and Communication Technologies for Agricultural Extension in Developing Countries Working Paper 269 September 2011.
- Aker JC, Mbiti IM (2010). Mobile Phones and Economic Development in Africa, 24(3):207-232.
- Aikiiki EK (2006). Towards improving farmers' livelihoods through exchange of local agricultural content in rural Uganda. *Knowledge Management for Development Journal*, 2(1):68-77.
- Ali A, Erenstein O (2013). Impact of zero tillage adoption on household welfare in. *Journal of Agricultural*, 9(7):1715-1729.
- Dhaliwal RK, Joshi V (2012). Mobile Phones - Boon to Rural Social System 2. *Tools Of Mobile Technology Mobile Technology Basket. Literacy Information and Computer Education Journal*, 1(4):1-5.
- Dow JK, Endersby JW (2004). Multinomial probit and multinomial logit: a comparison of choice models for voting research, 23:107-122.
- Econ One Research, Inc (2002). Uganda Telecommunications A Case Study in the Private Provision of Rural Infrastructure Submitted by: ESG Int. pp.1-63.
- Food and Agriculture Organization (FAO) (2004). Seed multiplication by resource-limited farmers production and protection. In *Proceedings of the Latin American Workshop Goiania Brazil*, pp. 1-90.
- Gibson RW, Mwangi, ROM, Namanda S, Jeremiah SC, Barker I (2009). Review of sweetpotato seed systems in East and Southern Africa. Working Paper 2009-1. Lima: CIP. 48 p.
- Jensen R (2007). The digital Divide: Information (Technology) Market Performance and welfare in the South India Fishers Sector. *The quarterly journal of economics*, 122(3):879-924
- Lashgarara F, Mohammadi R, Najafabadi MO (2011). Identifying appropriate information and communication technology (ICT) in improving marketing of agricultural products in Garmsar City , Iran. *The African Journal of Biotechnology*,10(55):11537-11540.
- Louwaars N, Le Coent P, Osborn T (2010). Seed Systems and Plant Genetic Resources for Food and Agriculture. Organization, pp.1-24.
- Maree J, Piontak R, Omwansa T, Shinyekwa I, Njenga K (2013). Developmental uses of mobile phones in Kenya and Uganda. In *Capturing the Gains: Economic and Social Upgrading in Global Production Networks*, pp. 1-37.
- Martin BL, Abbott E (2011). Mobile Phones and Rural Livelihoods: Diffusion, Uses, and Perceived Impacts Among Farmers in Rural Uganda. *Information Technol. Int. Dev.* 7(4):17-34.
- Mittal S, Mehar M (2012). How Mobile Phones Contribute to Growth of Small Farmers ? Evidence from India. *Q. J. int. Agric.* 51(3):227-244.
- Mittal S, Tripathi G (2009). Role of Mobile Phone Technology in Improving Small Farm Productivity. *Agricultural Economics Research Review*, 22:451-459.
- Muto M (2009). The Impact of Mobile Phone Coverage Expansion on Market Participation: Panel Data Evidence from Uganda. *World development*, 37(12):1887-1896.
- Mwakaje AG (2010). Information and Communication Technology for Rural Farmers Market Access in Tanzania. *Journal of Information Technology Impact*, 10(2):111-128.
- Nyamba SY, Mlozi, MRS (2012). Factors Influencing the Use of Mobile Phones in Communicating Agricultural Information : A Case of Kilolo District , Iringa , Tanzania. *International Journal of Information and Communication Technology Research*, 2(7):558-563.
- Okello JJ, Mensah ER (2011). Factors influencing Awareness and Use of Electronic- Based Market Information Services for Farming Business in Malawi.
- Okello Julius J, Kirui OK, Njiraini GW, Gitonga ZM (2012). Drivers of Use of Information and Communication Technologies by Farm Households : The Case of Smallholder Farmers in Kenya. *Journal of Agricultural Science*, 4(2):111-124.
- Olwande J, Kirimi L, Mathenge M, Oduol J, Mithofer D, Place F (2013). Improving Participation in Agricultural Commodity Markets for Smallholder Sweetpotato Farmers in Kenya : Assessing Growth Opportunities for Women in Rachuonyo District. Egato University 1:1-57.
- Pannell DJ (2003). Uncertainty and Adoption of Sustainable Farming Systems + Uncertainty and Adoption of Sustainable Farming Systems pp. 1-13.
- Read D (2007). Experienced utility: Utility theory from Jeremy Bentham to Daniel Kahneman, Available at: <http://www.tandfonline.com/doi/abs/10.1080/13546780600872627>.
- Syiem S, Raj S (2015). Access and Usage of ICTs for Agriculture and Rural Development by the tribal farmers in Meghalaya State of North-East India. *Journal of Agricultural Informatics*, 6(3):24-41.
- Wekundah JM (2012). Why Informal Seed Sector is Important in Food Security: African Technology Policy Studies Network Biotechnology Trust Africa: Special Paper series. *African Technology Policy Studies Network*, 43:1-20.
- Wilson J (1988). Sweet Potato (Ipomoea batatas) Planting Material. IRETA Publication 2(2):1-12.
- World Bank (2011). Connecting Smallholders to ICT in agriculture Connecting Smallholders to Knowledge, Networks, and Institutions. *eSource book: Report number 64605*.
- World Bank, (2013). Mobile cellular subscriptions (per 100 people): Accessed 2017-04-05 <http://data.worldbank.org/indicator/IT.CEL.SETS.P2>