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Full Length Research Paper

Determinants for adoption of information and communications technology (ICT)-based market information services by smallholder farmers and traders in Mayuge District, Uganda

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Market access is increasingly relying on Information and communications technologies (ICTs) like telephony and internet that are only adopted haphazardly. Despite need for ICTs in Market Information Services (MIS), ICT usage in Africa is low. Little is known about ICTs for use in MIS including, technology, its potential users and characteristics of both entities. Closing such gaps was justified. The study determined ICT components used and factors influencing adoption and choice of components. Stratified random sampling was used to collect data using structured questionnaires from 150 farmers and 50 traders and analysed using STATA. Radio was most used old ICT whereas mobile phones were most used new ICT. Expensive handsets, poverty, poor power supply, lack of expertise and poor network coverage limited ICT use. Farmers with knowledge of ICT groups and those thinking that ICTs benefited agriculture were more likely adopters of ICT-based MIS. Family size and land farmed influenced farmers' adoption, whereas age, trading experience, family size and monthly expenses influenced traders' adoption. Farmers and traders who majorly used ICTs for making profit were more likely to use mobile phone whereas those who stayed further from towns were less likely to use the component.

Key words: Information and communications technologies (ICTs), smallholder farmers, adoption, determinants, market information services, logit model, traders.

INTRODUCTION

Access to markets has been one of the major factors that have influenced smallholder agriculture in developing countries. Accessing markets allows smallholder farmers buy inputs and sell surplus of their subsistence and semi subsistence agriculture to enhance household incomes (Barrett, 2008). These markets can be between communities, villages, sub counties or countries. Markets that are often accessed by smallholder farmers who form majority of the poor in developing countries are characterised by poor infrastructure and limited investment capital (Barrett and Swallow, 2006). Market access helps alleviate poverty through commercialising agriculture and result in uniform distribution of incomes in developing countries (DCs).

Income distributions in DCs are biased by corruption tendencies which have hindered improvement in household welfare. Progress in household welfare is dependent on increments in productivity of household stocks of land,

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labour and capital through adoption of better agricultural technologies that foster economic growth and alleviate poverty (Barrett and Moser, 2003). Even though important innovations continuously occur in many developing countries globally, Africa inclusive, new technologies are only adopted at a slow pace and haphazardly (Singh, 2006). The slow pace of new technological adoption has kept household incomes low. However increase in incomes would enable poor households save more financial resources and consequently gain required financial ability to invest in new technologies that are needed in commercial agriculture (Okello, 2005).

In many policy frame works of developing countries, there has not yet been a general format agreed upon to enable smallholder farmers and traders access to markets. Most developing countries are characterised by poor infrastructure in roads and poor administrative systems that are ethnic based and usually marginalise sections of poor farmers and traders, hence restricting smallholders' access to markets. Restriction of smallholders from market access locks them into persistent poverty for generations (Barrett, 2008). However markets' liberalisation shifted the role of markets' control and service delivery from governments to private investors who are attempting to target every clientele, smallholder farmers inclusive. Private investors who need a safe policy environment to operate effectively have come with new technologies for use in promoting agricultural commerce with quick and easy information exchange. These new technologies in information exchange are generally referred to as new Information and Communication Technologies (ICTs) that include cellular telephony, internet/email, World Wide Web, Print media, and digital radio receivers. These new ICTs complement older ICTs that include radios and Television sets (TVs) that were earlier mostly used by farmers to access information about agricultural commodities (Singh, 2006).

Despite the great need for these ICTs in Market Information Services (MIS), ICT adoption and usage in Africa is very low. For instance in Uganda, according to UBOS (2011), by the year 2010 only 0.99% of Ugandans had fixed telephone lines, 0.29% had operating pay phones and 38.9% were mobile subscribers, though 70% of the population is covered by mobile telephony as Farrell (2007) asserts. These figures are, respectively low given Uganda's literacy rate of 68.2%, full school attendance of 31.5% and a population of 32.94 million annually, growing at an average of 3.2% (UBOS, 2011). Farrell (2007) also adds that only 1.8% of this population are internet users, 0.5% has personal computers, only 6% of households have televisions and VSAT providers are only 8. Currently, mobile cellular operators in Uganda are 6 including, Airtel, UTL, MTN, Orange, Smile and Warid telecom while private FM radios are 238 and private TV stations are 55 (UBOS, 2011).

Research problem

Sustainable information exchange in agricultural markets, technology and knowledge is becoming a critical area of agricultural development. Information exchange seems to be given limited priority and in agriculture the bulky load of agricultural information exchange between farmers and agricultural experts and advisors has been left to extension agents. The effectiveness and efficiency of these extension agents have been declining partly due to limited funding from support organisations like government and donor agencies, and the high costs required in maintaining and sustaining the physical movements of these agents between the rural areas where farmers are found, and the urban areas where agricultural experts are mostly stationed.

With the current need of efficiency in understanding market price trends, accessing inputs and support services, farmers and traders need to use more efficient and appropriate new ICTs to take advantage of the existing opportunities. Timely access to market information, inputs and other necessary information services like weather changes, pest control techniques and others would increasingly enable small-scale farmers and traders make timely, reliable, realistic and economically viable decisions concerning what crops to grow, when to grow them, what products are for sale when and where, what inputs to use and how to use them. Despite this acknowledgement, little is known about the available ICTs for use in market information exchange including the characteristics of both the technology and its potential users. Closing such knowledge gaps will enable small-scale farmers and traders draw informed and timely reliable decisions for better business margins.

Objectives and hypotheses of the study

The main objective of this study was to assess the adoption of ICT-based market information services (MIS) by smallholder farmers and traders in Mayuge district, specifically aiming to determine ICT components and combinations used by farmers and traders in MIS, identify factors influencing farmers' and traders' adoption of ICT-based MIS, and establish factors influencing choice of ICT components used by households. The study hypothesised that for its mobility, cellular telephony was among ICT components households used, with formal education, farmers/traders gained capacity to adopt and use ICTs and with better incomes, households are more likely to use cellular telephony.

LITERATURE REVIEW

ICTs are generally defined as a combination of activities

that enhance capture, storage, processing, transmission and display of information by electronic means (Rao, 2004). Majority of factors affecting adoption of ICTs for MIS are generic in nature. For instance cost effectiveness and speed of information transfer, organisational characteristics like business size, system characteristics like availability and access to ICT services, and internal and external characteristics of the business household like education, past experience in using ICTs, attitude towards ICTs, business objectives and incomes among others (Windrum and Berranger, 2002; Dholakia and Kshetri, 2004). Galloway and Mochrie (2005) further said that usage of ICTs by smallholder households that inhabit mainly rural areas is constrained by limited education and poor technological infrastructure. That poor road infrastructure fails ICT service providers from realising profits from such rural markets that are not easily reachable and have a small customer base especially in developing countries; though however sixty seven percent of the world's mobile subscribers are in the developing world (Bhavnani et al., 2008).

Jacobs and Herselman (2006) said that the perceived lack of need for ICTs by smallholder farmers is responsible for farmers' failure to adopt ICTs and their services. Market information needs are equated to the way information users behave with regards to market information systems and services accessible. This implies that any market information service (MIS) to be beneficial to the user, such a service, has to be necessary for a particular information need and compatible with available information systems (Amponsah, 1995; Wilson, 2000; Buyya and Vazhkudai, 2001). ICTs have several forms that include mobile phone calls, SMSs, radio and TV programs, electronic mails and internet blogs.

Lee et al. (2008) notes that some of these forms are well established in most countries, and they foster human resources and infrastructural developments by allowing such countries have ICT volunteers, experts and trainees. Developing the human resource and infrastructure intermediated by various ICT components empowers the vulnerable and enhances capacity of the poor, including small-scale farmers and traders towards better livelihoods (Heeks et al., 2004). Using new ICT components like computers and mobile phones, with wide scale coverage in an economy enabled with ICT forms like electronic mails, videos and calls enhances formation of a competent business ecosystem, leading to growth in businesses like farming, development of respective business enterprises and improvement of labour force skills (Nachira, 2006). For farmers such new ICTs enable exchange of information across a unified ground of interest that may be agricultural market prices, innovations, planting varieties, connecting farmer groups and or agricultural policy advocacy among others (Garrett, 2006).

The use of ICTs in global market is more wide spread In developed than in developing world. For instance 75% of farmers aged between 20 to 29 years participating in precision agriculture in Denmark and 50% of such farmers in U.S use internet daily to acquire specific information with a prime objective of limiting uncertainties in decision making (Fountas et al., 2007). In India, over 50% of grassroots projects use modern ICTs for the benefit of rural communities (Rao, 2004). In most African countries, modern ICTs like e-mails, World Wide Web (www) and cellular telephony have been used by rural farmers along traditional ICTs like radio and TVs (Farrell, 2007).

Modern ICTs have bettered information exchange amongst farmers and improved farmers' ability to make decisions, develop ideas and consequently improve their livelihoods (Rathgeber and Adera, 2000; Bartholomew et al., 2009). ICTs have also made access to MIS cheap and unlimited thus allowing all market actors including smallholders engage in balanced negotiations that ensure uniform market prices and efficient allocation of goods and services (Jensen, 2007). Sometimes such market information services include providing market information on labour opportunities and needs available in sectors of the economy like agriculture. Such labour market information services also facilitate job-access and employment-broking that is necessary in efficient labour markets needed to develop agricultural sectors of developing world (Thuy et al., 2001).

METHODOLOGY

Research was carried out in Mayuge district in eastern Uganda, purposively selected to exploit her farmers' experience with ICT-based MIS under BROSDI (Busoga Rural Open Source and Development Initiative) (Brosdi, 2007). While at BROSDI headquarters, five sub-counties in which BROSDI operated were identified using a regional coordinator. There were 47 BROSDI participants in Nawanjiri, 59 in Bugodi, 49 in Nalwensambula, 52 in Waina and 50 in Wanzuki sub-counties. The sub-county coordinators provided links to particular village knowledge brokers that we walked around villages with. A structured walk was made through villages to interview randomly selected households. Household heads were asked if they were subscribed to a rural initiative (BROSDI) for MIS, and a positive reply would confirm that they were ICT-based MIS adopters.

If the current household would be described by the broker as BROSDI participating, the head would be interviewed confirming whether he/she was a BROSDI participant or not. If the response tallied with the broker's description and he described the next household as also BROSDI participating, then the next household was skipped, unless it was described otherwise. If the third household would be described as BROSDI participating ahead of the first interviewed and the second that was skipped, then the third was interviewed. The sequence was followed for both BROSDI participants and non-participants to generate a sample composed of adopters and non-adopters of ICTs for MIS. Respondents were also asked if they were aware of ICT services providing groups in their area, even though such respondents were not members of these groups. A positive reply confirmed to us that such respondents had knowledge of existence of ICT groups in their area.

Identification of the starting household was random but maintained intervals of one if more than one household were in the vicinity as immediate neighbors and of a similar BROSDI participation status. We kept the intervals at one because households that were BROSDI participating at the time was relatively small (only 257) compared to the district population of thousands. A sample of 37 responses from Nawanjiri, 55 from Bugodi, 24 from Nalwensambula, 43 from Waina and 41 from Wanzuki sub-counties was collected. The randomness was practiced at the point of identifying the first respondent. The decision maker in the business was the respondent.

Theoretical framework

The consumer theory was used to describe the theoretical framework of this study. The main objective of the consumer theory is to determine the impact on observable demands (choice) for commodities (ICT components for MIS) of alternative assumptions on the objectives and on the behavioral rules of the consumer, and on the constraints which he faces when making a decision. Traditionally, consumers take preferences over alternative bundles (available ICT components for use in MIS) to describe their objectives. Consumer behavior entails maximizing their preferences and or utility under budget and other constraints that determine their final choices.

Principally, the consumer theory takes care of qualitative implications on observed demand of changes in parameters determining consumers' decision (Barten and Bohm, 1982). The consumer theory describes consumer behavior as a utility and or a preference maximizing behavior (Frisch, 1926; Barten and Bohm, 1982). This study relied on the utility theory part of the consumer theory. Some ICT components were a no possibility for use by certain households, given the physical and logical restrictions on households. The ultimate decision of the household to choose and use a certain component for ICT-based MIS depended on utility (satisfaction) derived by the household given communication needs and abilities of the household. Such utility was continuous to enable the on-going use of such chosen components by the consumer (Katzner, 1970).

The consumer derived sub utility from purchase of a certain ICT component for use in MIS and such a component had a vector of characteristics. The sub utility derived from use of a particular ICT component was combined with other sub utilities from use of other component(s) to give the household an overall utility. If the household used only one component for ICT based MIS, then its overall utility was derived from a single component that influenced household choice for that component (Diewert, 2003).

Conceptual framework

ICTs were viewed as a link between various actors in agricultural markets, enabling flow of information. Activities of farmers' groups such as awareness and training programs enabled farmers to know the use and relevance of ICTs in agricultural production. Attributes of services like costs, accessibility and availability influenced farmers' decisions on using particular ICT components. Farmers' attributes like education, incomes and age enabled or disabled farmers' adoption of ICTs for MIS. Market attributes like distance, network coverage, power supply also influenced adoption of ICT-based MIS.

Analytical methods

Descriptive statistics were generated using SPSS. A Jarque-Bera test was carried out to establish data skewness, kurtosis and distribution (Gujarati, 2004). Coefficients showed that continuous variables were not normally distributed, thus were transformed with natural logarithms, square roots, inverse square roots and squares to care for heteroscedasticity. Correlation tests were done and multicollinearity found nonexistent. STATA was used to run the models.

Empirical framework

Binary responses were encountered, thus choice models were necessary to address the data (Bogdan and Bilken, 2009). Choice models are the most feasible when analyzing choice decisions for example Probit, Logit models (Tambi et al., 1999; Chunrong and Norton, 2003). According to Greene (2002), choice models are based on random utility, where the i^{th} adopter is exposed to j choices. If the utility function of j is U_{ij}, then;

$$U_{ij} = \sum \beta X_{ij} + \varepsilon_{ij} \quad (1)$$

where X_{ij} is a vector of a particular characteristic of individuals who choose a particular choice, β is vector of parameters to be estimated and ε_{ij} are error terms. If an household takes the j choice, then the assumption that U_{ij} is the maximum of all J utilities holds, therefore the model is moved by the probability that the j choice is taken and thus; $\Pr ob(U_{ij} > U_{ik})$ for all other $k \neq j$,where *k* is any possible choice. The mathematical friendliness of Logit model makes it easier, thus it is used. Assuming that Y_{ij} represents the final decision of farmer/trader for a particular choice taken from a pool of various choices, then with J disturbances being distributed identically and independently, Logit model is defined as;

$$\Pr ob(Y_{ij} = 1 | \Sigma(X_{ji})) = \frac{e^{\alpha_j + \mathbf{X}'_{ji}\beta}}{1 + e^{\alpha_j + \mathbf{X}'_{ji}\beta}} \quad (2)$$

Utility is based on particular aspect features of person (X_i) and the choice he/she makes; therefore it is necessary to separate the utilities. Greene (2002) adds that binomial Logit is the unique case where J = 1, specified as below, used to determine factors influencing farmers/traders adoption of ICT-based MIS.

$$\Pr ob(Y = 1 | \mathbf{X}) = \frac{e^{\mathbf{X}'\beta}}{1 + e^{\mathbf{X}'\beta}} = \Lambda(\mathbf{X}'\beta) \quad (3)$$

$\Lambda(.)$ indicates the logistic cumulative function. Based on the behavior of unobservable responses for the other choice when a respondent chooses a particular choice, Greene (2002) specifies the binomial Logit model as;

$$y = \mathbf{X}'_i\beta + \varepsilon \quad (4)$$

Equation 3 represents a multinomial Logit model specified by Nerlov and Press (1973), cited by Greene (2002) that provides a set of probabilities for the J + 1 choice for the decision taker with characteristics X_i. These probabilities can be generated as;

$$\Pr ob(Y_i = j | \mathbf{X}_i) = \frac{e^{\beta'_j \mathbf{X}_i}}{1 + \sum_{k=1}^{J} e^{\beta'_k \mathbf{X}_i}}$$ For j = 0, 1, 2, …, J, and

$$\beta_0 = 0 \quad (4b)$$

Integrating equation 3 and 4b, we compute J log-odds ratio as;

$$In\left(\frac{P_{ij}}{P_{ik}}\right) = \sum X_i^{'}(\beta_j - \beta_k) = \mathbf{X}_i^{'}\beta_j$$

if k = 0 (5)

Specification of the farmers' logistic model

From equation 4, Logit model with a constant for farmers is specified as;

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ...+ \beta_8 X_8 + \varepsilon_i \quad (6)$$

where Y_i = dependent variable, ADOPT (1 if farmers used ICTs for MIS, 0 Otherwise); β_0 = intercept, β_1 to β_8 = parameters to be estimated, X_1 to X_8 = vector of explanatory variables; ε_i = error terms, X_1 = gender, 1 if male, 0 otherwise; X_2 = knowledge of existence of ICT groups, 1 if Yes, 0 otherwise; X_3 = perception towards ICTs, 1 if positive, 0 otherwise; X_4 = education as years spent in school; X_5 = monthly costs on ICTs, in Uganda Shillings; X_6 = family size, number of persons; X_7 = distance to nearest town, in kilometers; X_8 = land farmed previous season.

Specification of traders' model

Traders' model is specified as foolwed;

$$K_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + ...+ \alpha_7 X_7 + \varepsilon_i \quad (7)$$

where K_i = dependent Variable, ADOPT (1 if traders used ICTs for MIS, 0 otherwise); α_0 = intercept, α_1 to α_7 = parameters to be estimated, X_1 to X_7 = vector of explanatory variables; ε_i = error terms; X_1 = age, years of life; X_2 = family size, number of persons; X_3 = monthly costs on ICTs, in Uganda shillings; X_4 = trading experience in years; X_5 = square of age; X_6 = square of formal education in years; X_7 = log of asset base, in Uganda shillings.
According to Greene (2002), squared independent variables explain a possibility of opposite direction of influence exerted on dependent variable at different magnitudes of independent variables. Squaring them allows the model execute a conceptual experiment that might not be observed in actual data especially if the data set is small. Thus some variables are squared.

Specification of the multinomial logit model (MNL)

The MNL has been used to identify factors influencing households' choice for use of particular components in MIS amongst available options including mobile phone, pay phone and others aggregated (CD-ROM, WWW and internet/email). For its universality almost in every household, radio component was not considered in this analysis as its independence, as a component across households would not be realized. The MNL method has previously been used to analyze choice of adaptation strategies against climate change by farmers (Deressa et al., 2009; Hisali et al. (2011), crop choices (Kurukulasuriya and Mendelsohn, 2008) and livestock choices (Seo and Mendelsohn, 2008). Therefore, MNL was appropriate for use to analyze factors influencing choice for given components of ICTs by households. MNL enables examination of decisions across more than two available categorical options for choice; thus permitting determination of choice probabilities for each categorical option (Madalla, 1983). The MNL is also mathematically easy to deal with (Greene, 2002). However for unbiased and consistent parameter estimates, MNL assumes independence of irrelevant alternatives (IIA).

In more detail, the IIA assumption demands that probability of choosing a certain ICT component for MIS by a given adopting household is independent from the probability of choosing another component (Greene, 2002). This explains why consideration of the radio component has been dropped for this particular analysis, since radio was a universal component. Based on Greene (2002), parameter estimates of MNL are only used to tell the direction of influence of independent variable on the dependent. He adds that differentiating the MNL model equation with respect to explanatory variables enables generation of marginal effects. Marginal effects provide the expected change in probability of choosing a particular choice, considering a unit change from the mean of an independent variable (Deressa et al., 2009). Based on equation 5, a multinomial Logit model is used specified as;

$$In\left(\frac{p_s}{p_o}\right) = C_s = \alpha_o + \alpha_1 X_1 + \alpha_2 X_2 + \text{———} + \alpha_7 X_7 + \varepsilon_i \quad (8)$$

$$In\left(\frac{p_r}{p_o}\right) = C_r = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \text{———} \beta_7 X_7 + \gamma_i \quad (9)$$

where P_o = probability that household chooses to use the base alternative; P_s = probability that a household chooses the first component; P_r = probability that household chooses second component; C_s = household opts to use first alternative (1 if uses, 0 otherwise); C_r = household opts to use second alternative (1 if uses, 0 otherwise); α_o and β_0 = intercepts, α_1 to α_7 and β_1 to β_7 = parameters to be estimated; X_1 to X_7 = vector of explanatory variables; γ_i and ε_i = error terms; X_1 = knowledge of existence of ICT groups, (1 if Yes, 0 otherwise); X_2 = major objective of using ICTs, (1 if Profit, 0 otherwise); X_3 = experience in years; X_4 = family size in persons per household; X_5 = distance in kilometers; X_6 = monthly income in Ushs; X_7 = land farmed previous season, in acres.

Selection of variables

Literature was used for guidance on explanatory variables used to specify models. For instance, Hill et al. (2008) found age to be negatively associated with internet usage. Donner and Tellez (2008) established that distance was positively associated with mobile banking, Kovacic and Vukmirović (2008) found monthly costs negatively influenced internet use, Donner (2007) found incomes to positively impact ICT use, Simeunović and Russo (2010) established that education was important in ICT adoption, Harindranath et al. (2008) stated that family size was influential in using ICTs, Warren (2003) found that there was a positive association between farm size and ICT use, Wolcott et al. (2008) suggested that experience gained in using ICTs in daily systems was positively associated with ICT use, Peansupap and Walker (2005) found that a positive feeling for use of ICTs was positively associated with expansion in ICT use and Arun et al. (2004) established that there is improvement in asset base accelerated ICT use.

Table 1. Socio-economic characteristics of farmers and traders in discrete variables.

Variable		Over all sample percentage	Percentage				F-test
			Farmers		Traders		
			Adopting (N=84)	Non adopting (N=66)	Adopting (N=40)	Non adopting (N=10)	
Gender	Male	61.5	63.1	57.6	70.0	40.0	1.229
Knowledge	Yes	54.5	79.8	42.4	30.0	20.0	16.324***
Objective	Profit	11.5	22.6	0	10.0	0.0	7.327***
Membership	Yes	22.0	36.9	15.2	7.5	0.0	7.421***
Marital Status	Married	73.5	76.2	63.6	80.0	90.0	1.685
BEAGRI	Yes	80.0	97.6	47.0	92.5	100.0	33.438***

***, Significance at 1% level; BEAGRI, thought if ICTs benefit agriculture, Source: Survey data (2010, 2011). There was a difference in means of variables at differing levels of significance. Mean values of experience in using ICTs and distance to and from nearest town were statistically different at 1% level, incomes at 5% whereas education and family size were different at the 10% level.

Table 2. Socio-economic characteristics of farmers and traders in continuous variables.

Variable	Over all means (N=200)	Mean values of farmers and traders				F-test
		Farmers		Traders		
		Adopting (N=84)	Non adopting (N=66)	Adopting (N=40)	Non adopting (N=10)	
Experience	3.16 (3.81)	3.67 (4.35)	1.70 (3.15)	4.15 (3.17)	4.5 (2.7)	5.387***
Age	37.6 (11.4)	37.82 (12.12)	37.44 (11.87)	36.67 (9.47)	40.8 (7.9)	0.364
Education	6.52 (5.45)	6.68 (5.52)	5.71 (5.33)	8.08 (5.19)	4.3 (5.8)	2.184*
Income	75,322 (66,504)	72,428 (75,435)	62,705 (57,186)	103,916 (57,800)	68,516 (47,836)	3.467**
Family size	4.79 (3.34)	5.02 (3.32)	3.98 (2.74)	5.30 (4.05)	6.1 (3.3)	2.280*
Monthly costs	5,008 (6,019)	4,867 (6,772)	4,284.1 (6,780)	6,437.5 (2,678)	5,250 (1,296)	1.093
Distance	2.36 (1.05)	2.49 (1.00)	2.70 (0.96)	1.719 (1.04)	1.55 (0.59)	11.131***

*, **, ***Represents significance at 10, 5 and 1% levels, respectively, figures in parenthesis are standard deviations. Source: survey data (2010, 2011)

RESULTS

Socio-economic characteristics of farmers and traders

The sample consisted of 62% males of whom 66% adopted ICTs-based MIS. Of adopting farmers, 37% were females and of non adopting farmers, 42% were females. For adopting traders, only 30% were females; thus in all categories males were more participative in use of ICTs. Discrete variable results are presented in Table 1 and continuous variables in Table 2. Table 3 presents characteristics in levels. The class of households' monthly income, costs and distance covered to and from the nearest town were statistically different across groups. Table 4 presents a focus on some characteristics of the sample considering two broad sample strata; adopters and non-adopters. Means of education, experience in using ICTs, monthly income and distance to nearest town were statistically significantly different between adopters and non-adopters of ICT-based MIS.

Table 5 presents components of ICTs that farmers and traders used for various functions. Note that the radio is not presented in Table 5 because it was in 99% of sampled households. Table 6 presents reasons that limited use of ICTs to farmers and traders. Insufficient incomes barred majority of households from using ICTs for agricultural MIS.

Logit model are presented in Table 7 and show that knowledge of existence of ICT groups perceived benefit of ICTs to agriculture and family size and land farmed in previous season significantly influenced adoption of ICTs for MIS by farmers.

A one person increase in family size increased the probability of farmers to adopt ICTs for MIS by 60%. Contrary to *a priori* expectations, an acre increase in land farmed previous season reduced probability to adopt ICTs for MIS for farmers by 15.3%. Farmers who had positive perception towards ICTs and those who had knowledge of existence of ICTs were more likely adopters than their counterparts. Though had a low participation in ICT usage (Table 1), women were more likely to

Table 3. Socio-economic characteristics of farmers and traders in levels of variables.

Variable		Overall sample percent	Percentage				F test
			Farmers		Traders		
			Adopting (N=84)	Non adopting (N=66)	Adopting (N=40)	Non adopting (N=10)	
Education	≤7years primary	55.0	54.8	65.2	35.0	70.0	1.913
Age	>30 to 50 years	51.0	50.0	47.0	57.5	60.0	0.481
Income	<70,000 (30 $)	62.0	66.7	71.2	35.0	70.0	3.852**
Family size	<=6 persons	78.0	76.2	83.3	75.0	70.0	0.606
Costs	<2,500 or 1 $	45.5	61.9	59.1	0	0	17.6***
Experience	≤5 years	80.5	77.4	92.4	67.5	80.0	1.972
Distance	≤2 km	54.5	47.6	40.9	60.0	90.0	8.24***

, *, Significance at 5 and 1% levels, respectively. Source: survey data (2010, 2011).

Table 4. General socio-economic characterization of the sample based on adoption.

Variable	Mean values of sample (Std. deviations)		t-test
	Adopters (N=124)	Non-adopters (N=76)	
Education	7.129 (5.43)	5.526 (5.37)	-2.03**
Experience in using ICTs	3.823 (3.99)	2.066 (3.22)	-3.24***
Age	37.452 (11.35)	37.882 (11.45)	0.259
Monthly income	82,586 (71,537)	63,470 (55,792)	-1.99**
Family size	5.109 (3.56)	4.263 (2.88)	-1.75
Distance to town	2.24 (1.07)	2.549 (0.997)	2.013**

, *, Significance at 5 and 1% levels, respectively. Source: survey data (2010, 2011).

Table 5. Components of ICTs used by farmers and traders.

Variable	Components	Over all sample (%)	Frequency (percentage)	
			Adopters (N=124)	Non Adopters (N=76)
Components used	Pay phone	41 (20.5)	13 (11)	28 (37)
	Mobile phone	110 (55)	92 (74)	18 (24)
	Others (WWW, Internet/email, CD-ROM)	49 (24.5)	19 (15)	30 (39)

Source: survey data (2010, 2011).

Table 6. Reasons limiting Use of ICTs for farmers and traders.

Variable		Percentage			
		Farmers		Traders	
		Adopting (N=84)	Non adopting (N=66)	Adopting (N=40)	Non adopting (N=10)
Major reason limiting the use of ICTs	Insufficient income	66	84.4	48.7	44.4
	Poor power/network supply	8.5	6.6	48.8	55.5
	Ignorance	12.8	6.6	0	0
	Fake parts and theft	12.7	0	0	0

Source: survey data (2010, 2011).

Table 7. Logit model estimates of determinants of farmers' adoption of ICT-based MIS.

Variable	Coefficient	Marginal effects
Gender^	-2.058 (1.185)*	-0.409
Knowledge of ICT groups (KN)^	2.318 (0.967)**	0.522
Thought if ICTs benefit agriculture (BENAGRI)^	5.941 (1.395)***	0.872
Education of respondent[a] (LNEDC)	1.387 (1.115)	0.340
Monthly cost on ICTs[a] (LNCOST)	-0.268 (0.388)	-0.066
Family size[a] (LNFS)	2.453 (0.715)***	0.602
Distance to nearest town center[a] (LNDISTTWN)	0.691 (0.748)	-0.169
Land farmed previous season (LAND)	-0.626 (0.278)**	-0.153
Constant	-7.213 (4.264)*	

Dependent variable: Adoption of ICTs for MIS (1 if adopted and 0 otherwise); logistic regression number of observations = 96; LR $chi^2(10)$ = 80.54; Prob > chi^2 = 0.0000; Log likelihood = -25.248491; Pseudo R^2 = 0.6146; ^=dummy variables; [a] = Logarithm; *, **, ***, significance at 10, 5 and 1% levels, respectively in parentheses are standard errors.Source: Survey data (2010, 2011).

Table 8. Logit model estimates of the determinants of traders' adoption of ICT-based MIS.

Variable	Coefficient	Marginal effects
Family size[a] (LNFS)	6.793 (3.105)**	0.00091
Age (AGE)	-5.778 (2.499)**	-0.0008
Trading experience (EXP)	-1.875 (0.809)**	-0.0003
Asset base[a] (LNASSETBASE)	-3.803 (1.872)**	-0.0005
Age[s] $(AGE)^2$	0.063 (0.027)**	0.00008
Education[s] $(EDC)^2$	0.102 (0.044)**	0.00001
Monthly cost[a] (LNCOST)	13.076 (5.558)**	0.00175
Constant	55.687 (39.126)	

Logistic regression number of observations = 47; LR $chi^2(7)$ = 24.22; Prob > chi^2 = 0.0010; Log likelihood = -12.214723; Pseudo R^2 = 0.4979; ^ = dummy variables; [a] = Logarithm, [S] = square transformations; *, **, significance at 10 and 5% levels, respectively in parentheses and standard errors. Dependent variable: Adoption of ICTs for MIS, (1 if adopted and 0 Otherwise).Source: Survey data (2010, 2011).

likely to adopt ICTs for MIS than males. Table 8 presents Logit model results of factors influencing Traders' adoption of ICT-based MIS. Age of the trader, trading experience and monthly costs, family size, asset base, later age and better education significantly influenced the probability of adopting ICTs for MIS by traders

A one person increase in the family size of traders' household increased the probability of adopting ICTs for MIS by 0.09%, as a one year increase in age and trading experience reduced such adoption by 0.08 and 0.03%, respectively. At later age, adoption of ICTs reduced more rapidly. A one shilling increase in monthly costs increased probability of ICT adoption by 0.18%. Table 9 presents results of a MNL for factors influencing choice for components. Analysis was intended to study behaviour influencing choice of households for particular ICT components. A one kilometre increase in distance to and from nearest town centre increased the probability of using pay phone by 10.1%, as compared to mobile phone. There was a 27% increase in the probability of using the www, CD-ROM and internet/email for every year increase in experience of using ICTs compared to the mobile. Households that were using ICTs with the main objective being to make profits and those who had knowledge of existence of ICT groups were more likely to use the mobile phone as compared to both the pay phone and others.

DISCUSSION

Much of small-scale household farming in the study area was mostly practised by women who had the primary responsibility of farming for household food security as mothers. Therefore males were less likely to devote to the use of ICTs in agricultural market information exchange. Having knowledge of ICT groups' existence availed farmers with an opportunity that attracted them to use and adopt ICTs for MIS. ICT groups were the sources of information and learning on how to use ICTs

Table 9. MNL estimates for determinants of households' choice for ICT components.

Variable	Coefficient	Marginal effects
Pay phone		
Knowledge of existence of ICT groups^ (KN)	-1.452 (0.817)*	-0.055
Profit making (OBJ)	-2.651 (0.763)***	-0.107
Experience of using ICTs[a] (LNEXP)	1.832 (0.699)***	0.0613
Family size[a] (LNFS)	-1.159 (0.539)**	-0.043
Distance to nearest town center[a] (LNDISTTWN)	2.457 (1.018)**	0.101
Monthly Income[c] (1/√INC)	177.69 (99.24)*	9.739
Land farmed previous season[b] (√LAND)	0.949 (0.791)	-0.038
(others) (www, CD ROM, internet/email and TV)		
Knowledge of existence of ICT groups^ (KN)	-1.127 (0.532)**	-0.1873
Profit making (OBJ)	-0.557 (0.486)	-0.071
Experience of using ICTs[a] (LNEXP)	1.643 (0.527)***	0.2704
Family size[a] (LNFS)	-0.609 (0.364)*	-0.0955
Distance to nearest town center[a] (LNDISTTWN)	0.372 (0.486)	0.041
Monthly income[c] (1/√INC)	-214.897 (125.55)*	-39.583
Land farmed previous season[b] (√LAND)	-0.265 (0.496)	-0.0369
Mobile phone is the base outcome		

Multinomial logistic regression Number of observations = 116; LR chi2(16) = 102.93; Prob > chi2 = 0.0000; Log likelihood = -75.975361 Pseudo R2 = 0.4038; ^ = dummy variables. [a] = Logarithm, [b] = square root, [c] = Inverse square root transformations; *, **, ***, significance at 10, 5 and 1% levels, respectively in parentheses and are standard errors. Dependent variable, choose pay phone or others, compared to mobile phone. Source: Survey data (2010, 2011).

and benefits of ICTs, thus the positive influence consistent with Pickernell et al. (2004). ICTs enabled farmers access general agricultural information like weather patterns, pests control, mobile money and others that were required in crucial decision making. That was consistent with Opata et al. (2011) and Peansupap and Walker (2005) who found positive perception towards ICTs being positively associated with expansion in ICT use. The more information varied due to several sources (family members), the more the household head was pushed to adopting ICTs for MIS, to access, verify and harmonise information.

Results were in agreement with Smoreda and Thomas (2001) and Warren (2004) who, respectively found that telephony is more used for family communications than direct physical contact between members. Harindranath et al. (2008) also established that the next useful reservoir of advice and support on using ICTs after ICT professionals was the family. Households mainly farmed for household food supply and mainly used rudimentary tools like hand hoes, knives and family labour. The average family size of farmers was small; below six persons (Table 3). An increase in farming area meant use of hired labour that competed against required expenses for ICTs including charging costs (500 Ushs = 0.2 US $ per charge that lasts for at most 3 days with a well functioning battery), transport charges to charging places, battery repairs and buying, airtime and service charges that were required frequently. Household average incomes were also very small and majority earned below 30 US $ per month (Table 3). Findings were consistent with Njuki et al. (2008) who found that large output proxied by large farm size in this research markets itself hence limiting need for market searches that were largely done using ICTs. However, Warren (2003) found that there was a positive association between farm size and ICT use.

Increase in monthly costs on ICTs implied increased use and realisation of economic purpose of ICTs to traders hence traders' attraction to ICT-based MIS as costs increased. Whenever monthly costs increased, traders shifted to more efficient ICTs like mobile phones that gave them quick and more reliable information per unit cost, thus an increase in costs positively influenced adoption of ICTs. Ulrich (2003) explained that as usage of ICTs expands with a growing deployment as business grows, ICTs enable a wider coverage of operations and this happens in phases. He added that technological alternatives deployed during such a growing coverage of an expanding business which are rapid and up-scaled in costs. However, such operations are usually cost-effective.

Nevertheless findings were contrary to *a priori* expectations and conclusions of Kovacic and Vukmirovic (2008) who found monthly costs to be negatively associated with the likelihood to use and adopt ICTs. With more age and trading experience, traders mastered business patterns, the trends and tactics of the business

environment, thus reduction in need and use of ICTs for MIS. Results were consistent with Hill et al. (2008) who found age to be negatively associated with the likelihood of ICT engagement. Samah et al. (2009) also established that the young age group adopted ICTs more easily. Note that age and trading experience were not correlated (correlation = 0.214). Because majority of household heads had not finished primary level formal education (Table 3), later education (adult education from rural initiatives) equipped traders with better skills to use ICTs for MIS.

Results were consistent with Galloway and Mochrie (2005) and Simeunović and Russo (2010) who found that education was an important aspect in adoption and use of ICTs. Assets locked up liquid capital like cash which was needed to facilitate ownership and maintenance of ICTs and their services for MIS. Such lock-up of resources was significantly felt in Mayuge, where the average monthly incomes were less than 30 U.S dollars per month (Table 3). Findings were in contrast with Arun et al. (2004) who established that improvement in asset base and ICT-based business management was positively associated.

The mobile phone was more instant in information delivery, enabled two-way direct exchange of information and was readily movable wherever the user was other than the payphone, thus mobile was preferred. Small numbers of households used pay phones for communication with fellow farmers, traders, neighbours and family on business and market information matters. Rural households mainly lived in close proximity (built homesteads around the main homestead of their founding father), in that by the time such households moved to town centres for pay phones' access, they would have moved almost the same or more distances as those required to be moved physically to the people they needed to communicate with.

The likelihood to use the pay phone increased with more years of using ICTs because households gained a better perception towards pay phones and ability to use it, given guidance of the operators. Results were consistent with Bailey (2009) who found that good experience in using ICTs positively influenced demand to use such ICTs. Varying locations of family members necessitated more the need of communicating with each other using a more mobile device, thus increasing likelihood of using a mobile phone as compared to pay phone. Results were in agreement with Gutierrez and Gamboa (2008) who found that family size principally influenced mobile phone usage amongst residents from the South and North of Europe.

Cost effectiveness was more exhibited when using a pay phone where households never paid for costs like battery charging, network provider service fees, buying phone handsets, risks of theft and others than a mobile phone. Findings were similar to those of Donner (2007) and Shaffril et al. (2009) who found incomes to be positively associated with such ICT usage in small-scale business operations. Limited power and network availability (Table 6) as distances (Table 4) away from town centres increased, forced households to be more interested and likely to use pay phones, given the availability of power and network coverage at village pay phone stations, consistent with Soriano (2007) who found ICTs like pay phones necessary in information exchange to reduce physical distance burdens.

Knowledge of ICT groups attracted households to gain membership to these groups in which they were more likely to be advised on using modern ICTs like mobile phones, thus a decreasing likelihood to use pay phone as compared to mobile phone. Having ICT groups' knowledge constituted a human capital and consequently a social asset as defined by Parkinson and Ramirez (2006).

Increased experience in using ICTs enabled households acquire better skills and interest to use more complex ICTs like WWW and internet/email, consistent with Bailey (2009) who established that experience in using ICTs was positively associated with use of modern ICTs particularly the internet. The most commonly used ICT component in Mayuge was a mobile phone (Table 5), therefore information readily available and easily accessible from the population that also constituted ICT groups was more on mobile phone usage than internet/www/e-mails. With increasing incomes, households were less likely to use www, CD-ROM and internet/e-mail compared to mobile phone because these components were more capital intensive than mobile phones. Using internet or www required buying a computer and internet services.

Conclusions

The mobile phone was one of the most important ICT components used by households to access market information services. The importance of the mobile phone was made more possible by existence of rural initiatives like BROSDI that educated and trained households on use of ICTs and also provided the required agricultural market information. Family size significantly and positively influenced ICT-based MIS adoption for both small-scale farmers and traders. However, infrastructural limitations like rural poverty and rural poor power supply make it difficult for farmers and traders to access such ICT rural initiatives and the ICTs services. Efforts of rural initiatives like BROSDI that train and educate households on using ICTs for MIS need to be maintained within rural settings and continuously sufficiently supported with financial resources. If government extended formal adult education to Mayuge households through such rural based initiatives, it could better households' ability to use ICTs and their market participation through prompt agricultural market information exchange.

REFERENCES

Amponsah WA (1995). Computer Adoption and Use of Information Services by North Carolina Commercial Farmers. J. Agric. Appl. Econ. 27(2):565-576

Arun S, Heeks R, Morgan S (2004). ICT Initiatives, Women and Work in Developing Countries: Reinforcing or Changing Gender Inequalities in South India. University of Manchester, UK

Bailey A (2009). Issues Affecting the Social Sustainability of Telecentres in developing contexts. Elec. J. Info. Syst. 36(4):5-12

Barrett C (2008) Smallholder market participation' Concepts and evidence from eastern and southern Africa. Food Policy 34(2):299-317

Barrett C, Swallow B (2006). An ordered Tobit model of market participation, Evidence from Kenya and Ethiopia. Am. J. Agric. Econ. 88(2):324-337

Barrett CB, Moser CM (2003). The Complex dynamics of smallholder technology adoption the case study of SRI in Madagascar. Cornell University, USA

Barten AP, Bohm V (1982). Handbook of Mathematical Economics. 11, North-Holland Publishing Company

Bartholomew A, Wainwright D, Green G (2009). Policy Issues of e-Commerce Technology Diffusion in Southeast Nigeria. Case of Small Scale Agribusiness 2(1):39-48

Bhavnani A, Won-Wai Chiu R, Janakiram S, Silarszky P (2008). The Role of Mobile Phones in Sustainable Rural Poverty Reduction. The World Bank, USA

Bogdan RC, Bilken SK (2009). Qualitative Research for Education; An Introduction to Theories and Models.

Brosdi (2007). Busoga Rural Open Source and Development Initiative, Uganda

Buyya R, Vazhkudai S (2001). Compute Power Market: Towards a Market-Oriented Grid. University of Mississippi, USA

Chunrong A, Norton EC (2003). Interaction terms in Logit and Probit models. University of Florida, USA

Deressa TT, Hassan MR, Ringler C, Alemu T, Yesuf M (2009). Determinants of Farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Glob. Environ. Change 19:248-255

Dholakia RR, Kshetri N (2004). Factors Impacting the Adoption of the Internet among SMEs. Small Bus. Econ 23:311-322

Diewert EW (2003). Hedonic Regressions: A Consumer Theory Approach. University of Chicago Press, USA. pp. 321-324

Donner J (2007). Customer Acquisition Among Small and Informal Businesses in Urban India: Comparing Face-to-Face and Mediated Channels. Elec. J. Info. Syst. Dev. Countries 32(3):2-14

Donner J, Tellez C (2008). Mobile banking and economic development: Linking adoption, impact, and use. Asian. J. Commun. 18(4): 320-289

Farrell G (2007). Survey of ICT and Education in Africa. InfoDev, Uganda

Fountas S, Pedersen SM, Blackmore S (2007). ICT in Precision Agriculture – diffusion of Technology. University of Thessaly, Greece

Frisch R (1926), 'Sur un probleme d'economic pure'. Norwegian Mathematical Society Writings 1 (16):1-40

Galloway L, Mochrie R (2005). Use ICT Rural Firms 7(3):33-46.

Garrett RK (2006). Protest in an Information Society: A Review of Literature on Social Movements and New ICTs. Info. Com. Soc. 9(2):202-224.,

Green HW (2002). Ecomometric Analysis, 5th edition, Prentice-Hall, Upper Saddle River, New Jersey. pp. 663-708

Gujarati (2004). Basic Econometrics, Fourth Edition, The McGraw–Hill Companies. pp. 108- 127, 148- 253

Gutierrez LH, Gamboa LF (2008). An Approximation to the Digital Divide among low income people in Colombia, Mexico and Peru. Documentos De Trabajo, Mexico.

Harindranath G, Dyerson R, Barnes D (2008). ICT Adoption and Use in UK SMEs: a Failure of Initiatives? Elec. J. Info. Syst. Eval. 11(2):94-95.

Heeks R, Arun S, Morgan S (2004). A Livelihoods Perspective; Women's ICT-Based Enterprise for Development project. University of Manchester, UK.

Hisali E, Birungi P Buyinza F (2011). Adaptation to Climate Change in Uganda: Evidence from micro level data. Global Environmental Change. pp. 1-17

Hill R, Davies PB, Williams MD (2008). Older people and internet engagement: Acknowledging social moderators of internet adoption, access and use. Info. Tech. People 21(3):244-255

Jacobs SJ, Herselman ME (2006). Information Access for Development; a Case Study at a Rural Community Centre in South Africa. Issues in Info. Sci. Info. Tech. 3(2006):296-298

Jensen R (2007). Market Performance and Welfare in the South Indian Fisheries Sector. The Digital Provide: Information (Technology), USA

Katzner DW (1970). Static demand theory, London, Macmillan. pp. 23-27

Kovacic ZJ, Vukmirović D (2008). ICT Adoption and the Digital Divide in Serbia: Factors and Policy Implications. Proceedings of the Informing Science & IT Education Conference, Bulgaria. pp. 368-388

Kurukulasuriya, Mendelsohn (2008). A Ricardian analysis of the impact of climate change on Africa crop land. Afr. J. Agric. Res. Econ. 2(1):1-23

Lee H, Jang S, Ko K, Heeks R (2008). Analyzing South Korea's ICT for Development AID Programme. Elec. J. Info. Syst. Dev. Countries. 35(2):1-8

Madalla G (1983). Limited Dependent and Qualitative Variables in Econometrics, Cambridge University Press, Cambridge. pp. 323-330

Nachira F (2006). Digital Business Ecosystems, DG Information Society and Media. Digital Ecosystems, European Commission.

Njuki JM, Mapila MT, Zingore S, Delve R (2008). The dynamics of social capital in influencing use of soil management options in the Chinyanja Triangle of southern Africa. Ecol. Soc. 13(2):9-16

Okello JJ (2005). Compliance with International Food Safety Standard, The Case of Green Bean Production in Kenyan Family Farms. PhD Dissertation, Michigan State University, USA

Opata PI, Nweze JN, Rahman MA (2011). 'The place of information and Communication technology in promoting agro-based enterprises in third world countries. J. Agric. Tech. 7 (2):211

Parkinson S, Ramirez R (2006). Using a Sustainable Livelihoods Approach to Assessing the Impact of ICTs in Development. J. Commun. Informatics 2(3):1-12

Peansupap V, Walker D (2005). Factors affecting ICT diffusion: A case study of three large Australian construction contractors. Eng. Constr. Archit. Manag. 12 (1):27-33

Pickernell DG, Christie MJ, Rowe PA, Griffiths JL, Thomas BC, Putterill LG (2004). Farmers' markets in Wales: making the 'Net work?. Brit. Food J. 106 (3):197-205

Rao SS (2004). Role of ICTs in India's rural community information systems. Conc. Pap. 6(4):261-269

Rathgeber EM, Adera EO (2000). Gender and the Information revolution in Africa. IDRC, Ottawa

Samah BA, Shaffril HAM, Hassan MDS, Hassan MA, Ismail N (2009). Contribution of information and communication technology in increasing agro-based entrepreneurs productivity in Malaysia. J. Agric. Soc. Sci. 5(3):94-97

Seo N, Mendelsohn R (2008). Animal husbandry in Africa: Climate Change impacts and adaptations. Afr. J. Agric. Econ. Res. 2(1):65-82.

Shaffril HAM, Hassan MA, D' Silva JL (2009). Developing Agriculture in Malaysia: Internet Utilization among Malaysian Youth Agro-Businessman. Eur. J. Soc. Sci. 11(2):215-223,

Simeunović D, Russo NL (2010). Prerequisite for Growth: ICT Usage in Secondary Education in Bosnia and Herzegovina. Infoteh-Jahorina 9(8):1028-1030,

Singh S (2006). Selected success stories on agricultural information systems. Emerald Group Publishing Limited, Pathumthani. pp. 1-11

Smoreda Z, Thomas F (2001). Social networks and residential ICT adoption and use. EURESCOM, Heidelberg.

Soriano CRR (2007). Exploring the ICT and Rural Poverty Reduction Link: Community Telecenters and Rural Livelihoods in Wu'an, China. Elec. J. Info. Syst. Dev. Countries 32(1):4-6

Tambi NE, Mukhebi WA, Maina WO (1999). The probit Analysis of live stock producers' demand for private veterinary services in high potential areas of Kenya. Agric. Syst. 59(1999):163-176

Thuy P, Hansen E, Price D (2001). The Public Employment Service in a Changing Labour Market. International Labour Organization (ILO)

Publications, Geneva, Switzerland
UBOS (2011). Uganda Bureau of Statistics, Census Results 2002
Ulrich P (2003). China's Rural Internet Information Centers: A Project to Reduce Poverty through Access to Information and Communication Technologies (ICTs) in Rural Areas. Elec. J. Info. Syst. Dev. Countries12(3):1-17
Warren M (2003). Farmers and the Internet, Six Years ON. EFITA, Debrecen, Hungary
Warren M (2004). Farmers online: drivers and impediments in adoption of Internet in UK agricultural businesses. J. Small Bus. Enter. Dev. 11(3): 373-379
Wilson TD (2000). Human Information Behavior. Info. Sci. Res. 3(2):49-52
Windrum P, Berranger P (2002). The Adoption of e-business technologies by SMEs. MERIT-Informics Research Memorandum series. ISSN, 023,
Wolcott P, Kamal M, Qureshi S (2008). Meeting the challenges of ICT adoption by micro-enterprises. J. Enter. Info. Manag. 21(6):620-628,