Received 17 January 2018
Revised 2 August 2018
6 September 2018
Accepted 10 September 2018

Influence of socio-demographic factors on the use of mobile phones in accessing rice information on climate change adaptation in Tanzania

Nicholaus Mwalukasa
Information and Record Studies, Sokoine University of Agriculture, Morogoro, United Republic of Tanzania, and

Malongo R.S. Mlozi and Camilius A. Sanga
Sokoine University of Agriculture, Morogoro, United Republic of Tanzania

Abstract

Purpose – The purpose of this study was to examine socio-demographic factors influencing the use of mobile phones in accessing rice information on climate change adaptation by rain-fed farmers in Tanzania with reference to Morogoro region.

Design/methodology/approach – A cross-sectional research design was used to collect data from 400 randomly selected rain-fed rice farmers owning mobile phones. Semi-structured questionnaires were used for data collection in eight selected wards in two districts of Kilombero and Kilosa districts in Morogoro Region, Tanzania.

Findings – The findings of the study showed that the use of mobile phones to access rice information on climate change adaptation was statistically significantly influenced by respondents' sex, age, education level, marital status, farm size, farming experience, radio ownership and off-farm incomes. Furthermore, the use of mobile phones in accessing rice information on climate change adaptation among the study districts was not statistically significant.

Practical implications – This paper provides practical recommendations on how to improve accessibility of rice information through mobile phones on climate change adaptation. Implementation of information delivery system to farmers using mobile phones without ascertaining farmers' socio-demographic characteristics leads to resource underutilization.

Originality/value – The paper provides appropriate knowledge that is needed in improving access to information through mobile phones by Tanzanian farmers and in other communities in developing countries with the aid of the additional theoretical moderators of unified theory of acceptance and use of technology as the research findings suggest. Moderators' variables have high influence on farmers' use of mobile phones on accessing rice information on climate change adaptation.

Keywords Tanzania, Climate change, Mobile phones, Information access, Morogoro, Socio-demographic factors

Paper type Research paper

1. Introduction

Rice (*Oryza spp.*) is the second most grown among the three leading cereal food crops in the world; first being maize (*Zea mays*) and third being wheat (*Triticum spp.*). The world rice production is about 482 million metric tonnes and the leading rice producing countries are

Global Knowledge, Memory and Communication
Vol. 67 No. 8/9, 2018
pp. 566-584

2514-9342
DOI 10.1108/GKMC-01-2018-0006

China and India with the former producing 215.7 and the latter producing 161.3 million metric tons (USA Department of Agriculture [USDA], 2017a). Africa produces an average of 30.8 million metric tonnes of rice per year under rain-fed upland and aquatic ecologies in 40 countries on nearly 10 million hectares (Food and Agriculture Organization [FAO], 2017). Rice production in Africa is constrained with outdated production systems, biotic and abiotic constraints as well as low investment in production technologies, thus, only 60 per cent of the consumer demand is met through local production: the rest is imported (Zenna *et al.*, 2016).

Tanzania produces 2.6 million metric tonnes of rice per year (USDA, 2017b). This annual production is rated as relatively low as it does not meet local rice demand. Consequently, Tanzania imported a total of 2.0 million metric tons of the rice in 2016 to meet its domestic demand (USDA, 2017b). In Tanzania, rice is mostly produced in five regions including Mbeya, Morogoro, Mwanza Shinyanga and Tabora, which produce over 60 per cent of national production, Morogoro region being the second largest producer (URT, 2014). Rice is mostly grown by smallholders under rain-fed conditions (United Republic of Tanzania [URT], 2017).

Regrettably, most of the rain-fed rice production is vulnerable to impacts of climate change such as the now common irregular patterns of rainfall (Tumbo *et al.*, 2015; Tumbo and Sanga, 2015). As a consequence, rice production in Tanzania has declined. This has serious implications on local food security and farmers' livelihood (URT, 2010; Bucheyeki *et al.*, 2011; Rural Livelihood Development Company [RLDC], 2011). Rice production is constrained by a number of factors, which include lack of adoption of technological innovations such as use of improved seeds, fertilizers, herbicides, appropriate and low adoption of rainwater harvesting and post-harvest technologies (Boniphace *et al.*, 2015; Msangya and Yihuan, 2016). In addition, smallholder farmers lack information that would immensely increase their rice production and productivity, especially that which addresses climate change adaptation (Komba and Muchapondwa, 2012).

Information is crucial in making right decisions in agricultural production. Each stage of agricultural production requires a number of specifications or decisions that a farmer needs to make for climate change adaptation (Umunakwe *et al.*, 2014). Farmers need information on the most adequate types of rice seed, pest, weed and agronomic practices for climate change adaptation. The importance of information related to farmers' adaptation to climate change has been emphasized by previous studies (Mittal *et al.*, 2010; Ospina and Heek, 2010; Ospina and Heeks, 2011; Churi *et al.*, 2012).

The major source of information in most developing countries including Tanzania is the use of public agricultural extension officers who disseminate knowledge and skills on good rice production practices. Extension officers, however, are inadequate (Daniel, 2013) as the number of farmers per agricultural extension officer is 2,500 (Ragasa *et al.*, 2015). The extension agent–farmer ratio is high, which reflects that most farmers cannot access extension services from the village agricultural extension officers. For that reason, it is conceived that information and communication technologies (ICTs) through the use of mobile phones, television and radio can complement the extension staff efforts. It can also enhance farmers' decision-making efforts by providing information about the best time to plant, water requirement, and which fertilizer is to be used under the changing climate (Ospina and Heeks, 2011; Umunakwe *et al.*, 2014). There are, however, some shortcomings in the use of ICTs. For example, to access rice information for adaptation to climate change through radio and television, farmers have to listen or watch at the time the programme is broadcast (Mwamakimbula, 2014). In addition, mobile phones can be used with other ICTs like radio and television to access various information (Sanga *et al.*, 2013).

Despite the importance of using mobile phones in accessing information, still there is a low adoption of mobile phone for accessing climate change information in Tanzania (Churi *et al.*, 2012). The adoption of technology is a complex issue that is influenced by a variety of factors including performance expectancy, effort expectancy and social influence (SI) and facilitating conditions (Venkatesh and Davis, 2000). However, while performance expectancy, effort expectancy and SI are the indirect determinants of new technology usage while intention and facilitating conditions are direct determinants of usage behavior. These factors are moderated by socio-demographic characteristics of the respondents such as age, sex and experience (Venkatesh *et al.*, 2003).

Serenko *et al.* (2006) assert that moderators can potentially increase the predictive validity of models. The study further elaborates that low explanatory powers and inconsistencies of UTAUT, theory of reasoned actions, technology acceptance model and theory of planned behavior. Rosen (2005) and Kripanont (2007) opted for adding or dropping some of the moderators while others retained the same variables as those in the original UTAUT model. This revelation forms the bottomline of this study to examine empirically and analyze the demographic factors which explain the adoption of mobile phone for accessing rice information on climate change adaptation in Tanzania. This can increase knowledge for designing and implementing policies related to the dissemination and application of ICTs in rural areas to enhance farmers' access to information for making informed choices with regard to climate change adaptation.

In Tanzania, few studies have been done on socio-economic characteristics influencing farmers' use of mobile phones in communicating agricultural information, especially in maize production (Nyamba, 2011; Nyamba and Mlozi, 2012) but none on socio-demographic factors influencing farmers' use of mobile phone to access rice information on climate change adaptation. With this regard, this study investigated socio-demographic factors influencing mobile phone use for accessing rice information on climate change adaptation in Morogoro region, Tanzania. The study findings may provide useful information to policymakers, academicians, researchers, agricultural extension officers and other stakeholders when designing and implementing policies for climate change adaptation to improve farmers' rice production.

The research question that guided this study was as following:

RQ1. What socio-demographic factors influence farmers' use of mobile phone to access rice information on climate change adaptation?

From the research question, we hypothesize that:

H1. There is no significant influence of socio-demographic factors on the use of mobile phone to access rice information on climate change adaptation.

2. Literature review

Information is considered a vital resource, alongside land, labor, capital and skills. Farmers need relevant information for the purpose of making right choices for them to adapt to climate change. Climate change adaptation means initiatives and measures taken to reduce the impact of climate change (Paavola, 2003). To do so, information (is power). It is among the five features that determine the farmers' adaptive capacity. Others include economic wealth, technology, infrastructure, institutions and equity (Smit and Wandel, 2006). Every farmer needs information for decision-making (Umunakwe *et al.*, 2014).

There is an increase use of ICTs including mobile phones in developing countries (Cieslikowsk *et al.*, 2009). The use of mobile phones, however, is always influenced by various factors (Venkatesh *et al.*, 2003). The review of related literature shows that various studies have examined socio-demographic factors influencing the use of ICTs in different parts of the world. Education has been valued as a means for increasing knowledge about innovation. An individual with education becomes more critically aware of the need and scope for social change. More years of education are associated with high level of comprehension of new technologies (Machumu, 1995). Therefore, many adoption studies show some relationship between the use of mobile phones and education levels of the users (Nyamba, 2011; Ali, 2012; Mittal and Mehar, 2016).

Marital status is another factor influencing adoption of mobile phones. A study by Van den Ban and Hawkins (1996) contend that married couples tend to share experience on the use of technologies. Married farmers are likely to be under interest to produce more food for both family consumption and sale. The aspiration to produce more could influence seeking for agricultural information through modern technology such as mobile phones.

Additionally, studies show that land ownership is a common variable which influences adoption of technology. It has been recognized that, small and large farm operators differ in the speed in adopting and using technology to access information. Mittal *et al.* (2010) assert that large-scale farmers enjoy a high socio-economic status; hence, they have higher rates of using ICTs in accessing agricultural information than the small scale ones. In other words, the higher the farm size farmers have, the more the propensity to seek for information through the use of different ICT facilities including mobile phones for increased production (Mwombe *et al.*, 2014). For instance, studies carried out by Mittal *et al.* (2010) and Ali (2012) in India found that farmers with large farm sizes had higher chances of adopting and using ICTs for accessing agricultural production.

Sex is another factor which has been found to influence adoption of mobile phone use for accessing information. Women are key players of the day-to-day agricultural tasks. They are the investigators of activities that generate agricultural and non-agricultural income (Machumu, 1995). In most cultures, women are responsible for planting, watering, weeding, harvesting, transporting and storing crops. Despite their crucial roles, women have less access to extension services. They also have low adoption rates to new technologies (Van den Ban and Hawkins (1996). Studies show that female have less adoption rate of using mobile phone for accessing agricultural information than their male counterparts (Fadiji, 2011; Mittal *et al.*, 2010).

Likewise, farmer's age is another variable used to determine innovation adoption (Rogers, 1995). Older people are less interested in adopting technology than the young. This is supported by a study by Nyamba and Mlozi (2012) who found that younger respondents in Tanzania had higher chances of using mobile phones for accessing information than the older ones.

Furthermore, household size is another factor that can influence the adoption of technology. Vosough *et al.* (2015) note that the bigger the size of a family in a household, the higher the chance of adopting recommended innovation. To illustrate, studies carried out by Sekabira *et al.* (2012) in Uganda and Yaseen *et al.* (2016) in India and China found that there was an increase on the usage of ICTs as household sizes increased.

In this era of climate change, agricultural information is an important component in enabling farmers to adapt to climate change. In Tanzania, like in many other developing countries, dissemination of agricultural information depends much on the agricultural extension officers. In addition, ICTs such as mobile phones, television and radio can complement the extension staff efforts. Mobile phones are cheap to buy and can enhance

farmers' access to information at any time. However, a study by Mwalukasa (2013) found that the most frequently stated source of agricultural information for climate change adaptation was reliance on personal experience and the least cited source was ICTs. Reviewed literature has also revealed that farmers' use of mobile phones is influenced by the socio-demographic characteristics of the framers. There is, however, little scientific evidence on socio-demographic factors influencing the use of mobiles to access rice information on climate change adaptation in rain-fed farmlands.

3. Theoretical framework

The study was guided by the unified theory of acceptance and use of technology (UTAUT). This model has also been used in several studies conducted previously, including small- and medium-sized enterprises adoption of wireless technology (Anderson and Schwager, 2004), scholarly use of open access resources (Dulle, 2008) and the user acceptance of internet banking (Cheng *et al.*, 2009).

UTAUT model hypothesizes that performance expectancy, effort expectancy, and SI are the indirect determinants of new technology usage while intention and facilitating conditions are the direct determinants of usage behavior (Venkatesh *et al.*, 2003). Moderators such as sex, age, voluntariness and experience were identified to play specific moderating roles to the indirect and direct determinants of technology use behavior. According to UTAUT model, it is expected that individuals will build intention of using a technology if they hope it will enable them to improve their performance. This implies that unless the new technology improves efficiency or quality of individuals' activities, it will likely attract their interest on it. However, the relationship between performance expectancy and intention is moderated by age and sex such that performance expectancy directly affects intention of technology usage and is stronger for men and younger respondents (Venkatesh *et al.*, 2003).

The model hypothesizes that individuals are likely to show interest in technology usage if that technology is easy to use (Venkatesh *et al.*, 2003). This implies that less complex technologies can easily attract usage intention of many users than complicated technologies. Age, sex and experience are considered to play significant moderating roles for effort expectancy toward technology usage behavioral intention. Individuals' intention to use new technology is expected to be high if such individuals expect that technology to draw the attention of their peers. Again, SI is moderated by sex, age, experience and voluntariness of use. Moreover, the usage of technology is dependent on the availability of an enabling environment for its application. However, the influence of facilitating conditions toward the usage of technology is moderated by age and experience such that its effect is higher for older person and those with more experience. It is expected that older people would be less willing in adopting the technology than would be the case with young one. An experienced person is expected to have higher adoption rate of the technology than an inexperienced one (Venkatesh *et al.*, 2003).

Based on the literature review, it has shown that socio-demographic characteristics of the respondents act as moderators of indirect and direct determinants of technology use behavior. However, no study has so far validated influence moderators in use of mobile phone by farmers in Tanzania. Instead, a close attempt was made by Nyamba (2011) to fill this gap but employed innovation diffusion theory (Davis, 1989) using individual characteristics (age, education, income and sex) to examine factors influencing the use of mobile phones in communicating agricultural information among farmers in Tanzania. The objective of this study was to examine socio-demographic characteristics influencing use of mobile phone in accessing rice information on climate change adaptation. The study adapts three original UTAUT model moderators and adds eight more factors specifically

considered important under the current study. Voluntariness moderator was not adapted in the current study due to the fact that the use of mobile phones by farmers to access information usage is not mandated. Voluntariness is frequently used under circumstances where technology usage is mandatory (Venkatesh *et al.*, 2003). The moderator variables included are land ownership, off farm income, farming experience, ownership of ICT devices, household size, cost of mobile phones and owning smartphone as the moderators influencing the use of mobile phones by farmers.

4. Methodology

This study used a cross-sectional research design. Two districts of Kilosa and Kilombero out of the seven districts of Iringa region were purposively selected based on their high rain-fed rice production quotas. Besides, the two districts have good ICT infrastructures which enable different uses of mobile phones. Also, these districts have been experiencing effects of climate change (Paavola, 2003; Mutabazi *et al.*, 2014). A total of eight wards in the two districts were purposively selected. Those from Kilosa were Tindiga, Rudewa, Kimamba A and Msowero and those from Kilombero were Kiberege, Kisawasawa, Msolwa-ujamaa and Signali. Thereafter, in each ward, one village was purposively selected and a stratified sampling technique was used to select smallholder farmers who possessed mobile phones and were involved in rain-fed farmland rice production. In this process, gender balance was considered. The sampling frame in this study was a list of rain-fed rice producers. The list was developed in collaboration with Village Executive Officers and the Village Agricultural Officers in the selected villages. A stratified sample of 50 farmers per village (25 males, 25 females) was randomly selected producing a total of 400 respondents in the eight villages. Data were collected from the respondents using a semi-structured questionnaire method. The questionnaire contained questions on the socio-demographic characteristics of the respondents and their use of mobile phonesin accessing rice information on climate change adaptation.

To determine the respondents' socio-demographic factors that influence farmers' use of mobile phones to access rice information on climate change adaptation, a farmer was defined as user if he or she used a mobile phone to access rice information on climate change adaptation. The response variable was binary, taking the value of one if the farmer used mobile phone and zero otherwise. The independent variables were both continuous and discrete.

Independent variables were measured as follows:

- Age of the farmer was measured as respondent's age in number of years.
- Sex was measured as being male or female (coded as 1 = Female, 0 = Male).
- Education level was measured in terms of level of literacy (Coded as: 0 = No formal education, 1 = primary education, 2 = secondary 3 = College education, 4 = Graduate and above).
- Marital status was measured as to whether the respondent was single or married (Coded as 1 = Married, 0 – Single).
- Household size is the number of people living in a household capable of using mobile phones.
- Farm size and rice grown area were measured in acres.
- Access to ICT gadgets captured farmers' ownership of radio and television (Coded 1 = Own, 0 = Do not own).
- Farming experience was measured as number of years the person had been engaged in rice farming.

- Experience of owning a mobile phone measured the number of years respondents had been using a mobile phone.
- Off -farm income was measured in Tanzanian currency (Tsh).
- District: Dummies representing districts were included in the study (1 = Kilosa, 0 = Kilombero).

To determine the reliability of the research instrument, the authors pre-tested the instrument using 20 farmers drawn from Kidete village in Kilosa District before being distributed among those in the main sample. The Spearman–Brown split-half Cronbach's alpha of the instrument was found to be 0.89 which is considered reliable (Hair *et al.*, 2010).

Quantitative data were coded on Statistical Package for Social Sciences (SPSS) spread sheet and analyzed to produce descriptive statistics such as frequencies and percentage. A chi-square test was used to test the association between the study districts and the socio-demographic characteristics of the respondents.

To assess socio-demographic factors influencing the use of mobile phones to access rice information on climate change adaptation, the Binary logistic regression model was used. The Binary logistic model was selected for this study, as the dependent variable is dichotomous in nature. Binary logistic regression is appropriate for describing and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictor variables (Ramirez and Shultz, 2000).

The binary logistic regression model was as given below:

$$\log\left(\frac{pi}{1-pi}\right) = b_0 + b_1X_1 + \ldots\ldots\ldots b_{17}\mathrm{x}_{17}$$

pi is the probability of the ith respondents using mobile for accessing rice information on climate change adaptation. β_1 to β_{17} = coefficients of the independent variables, X_1 to X_{17} = independent variables entered in the binary logistic regression model.

Prior to estimation of the model parameters, it is crucial to look into the problem of multicollinearity among the explanatory variables (Hair *et al.*, 2010). Variance inflation factor (VIF) was used to detect multicollinearity among the independent variables.

Pseudo R^2, namely, Cox and Snell R^2 and Nagelkerke R^2 were used to measure the goodness-of-fit of the model. These indices explain the proportion of the variation in the dependent variable to that of the independent variable in the model (Peng, *et al.*, 2002). Additionally, Hosmer–Lemeshow was used to test if the model was appropriate for the data as well.

The odds ratio was converted into predicted percentage change of the socio-demographic factors in the use of mobile phone in accessing rice information on climate change adaptation. This is because the numbers in the odds ratio show the odds change for a one-unit change in the independent variable while predicted percentage change expresses the effect of independent variables on dependent variable on percentages (Ramirez and Shultz, 2000).

5. Results

5.1 Socio-demographic characteristics of the respondents

Table I shows the socio-demographic factors influencing the use of mobile phones in accessing rice information on climate change adaptation. These were age, marital status, household size, farming experience, area under rice, land ownership, number of chips owned, household ICTs assets ownership and an income from off farm. Of the 400

Variable	Kilosa (n = 200) n	(%)	Kilombero (n = 200) n	(%)	Total (n = 400) n	(%)	χ^2	df	p-value
Age category									
20-35	63	31.5	117	58.5	180	45.0	36.860	3	0.000
36-45	79	39.5	55	27.5	134	33.5			
46-55	39	19.5	26	13.0	65	16.2			
More than 55	19	9.5	2	1.0	21	5.2			
Marital status									
Married	150	75.0	157	78.5	307	76.8	20.501	1	0.000
Single	50	25.0	43	21.5	93	23.2			
Education level									
Never been to school	18	9.0	0	0.0	18	4.5	26.887	3	0.000
Primary education	152	76.0	143	71.5	295	73.8			
Secondary education	26	13.0	47	23.5	73	18.2			
College v	4	2.0	10	5.0	14	3.5			
Household size									
1-2	18	9.0	5	2.5	23	5.8	30.895	3	0.000
3-5	91	45.5	144	72.0	235	58.8			
6-8	79	39.5	46	23.0	125	31.2			
More than 8	12	6.0	5	2.5	17	4.2			
Rice farming experience									
1-5	60	30.0	96	48.0	156	39.0	14.830	2	0.001
6-10	72	36.0	46	23.0	118	29.5			
More than 10	68	34.0	58	29.0	126	31.5			
Land ownership									
Do not own land	92	46.0	59	29.5	151	37.8	63.417	4	0.000
1-2	65	32.5	30	15.0	95	23.8			
3-4	9	4.5	46	23.0	55	13.8			
4-6	5	2.5	30	15.0	35	8.8			
More than 6	29	14.5	35	17.5	64	16.0			
Annual income from off-farm activities									
Less than 5,000,000	103	51.5	96	48.0	199	49.8	0.719	2	0.689
5,000,001-10,000,000	4	2.0	3	1.5	7	1.8			
More than 10,000,000	93	46.5	101	50.5	194	48.5			
Total	200	100.0	200	100.0	400	100.0			

Table I. Socio-demographic characteristics of the respondents

respondents, 180 (45.0 per cent) reported that they were aged below 36 years. Of these, more than half, 117 (58.5 per cent) were from Kilombero District and 63(31.5 per cent) were from Kilosa District; the variable was statistically significant ($p \leq 0.01$). This implied that Kilombero District had more youths involved in rice production than Kilosa District.

Additionally, Of the 400 respondents, 295 (73.8 per cent) indicated that they had attained primary level education and of these, majority, 152 (76.0 per cent) and 143 (71.5 per cent) were from Kilombero and Kilosa District, respectively. Furthermore, 307 (76.8 per cent) reported that they were married and of these, 150 (75.0 per cent) and 157 (78.5 per cent) were from Kilosa and Kilombero Districts, respectively.Yet, over half of the respondents, 235 (58.8 per cent) indicated to have 3 to 5 people per household (Table I).

On the other hand, of the 400 respondents, 151 (37.8 per cent) mentioned that they did not own land, and of these, 92 (46.0 per cent) and 59 (29.5 per cent) were from Kilosa and Kilombero Districts, respectively. In connection to this, 29 (14.5 per cent) and 35 (17.5 per cent) of the respondents from Kilosa and Kilombero Districts respectively reported that they owned more than 6 acres of land. The differences in land ownership among respondents in the two districts were statistically significant ($p \leq 0.01$).

Similarly, of all the 400 respondents, less than half, 99 (49.8 per cent), reported to earn annual incomes of less than Tshs 5,000,000 from off-farm activities. Moreover, 93 (46.5 per cent) and 101 (50.5 per cent) of the respondents from Kilosa and Kilombero Districts, respectively, mentioned that they earned more than Tshs 10,000,000 as an annual income from off-farm activities. This variable was not statistically significantly different ($p \geq 0.05$) (Table I).

Moreover, the majority of respondents, 373 (93.2 per cent), indicated that they owned one mobile phone, and of these, 186 (93.0 per cent) and 187 (93.5 per cent) were from Kilosa and Kilombero Districts, respectively. Few respondents, 27,(6.8 per cent) of all respondents owned two mobile phones, and of these, 14 (7.0 per cent) and 13 (6.5 per cent) were from Kilosa and Kilombero, respectively (Table II). Again, more than a half 226 (56.5 per cent) of the respondents reported to have more than one mobile phone chipand of these, less than

Table II.
Aspects related to ICTs gadgets ownership ($n = 400$)

Variable	Kilosa ($n = 200$) n	(%)	Kilombero ($n = 200$) n	(%)	Total ($n = 400$) n	(%)	χ^2	df	p-value
Number of mobile phone owned									
One	186	93.0	187	93.5	373	93.2	0.04	1	0.842
Two	14	7.0	13	6.5	27	6.8			
Cost of mobile phone									
Less 50,000	137	68.5	131	65.5	268	67.0	18.031	3	0.000
50,000-70,000	39	19.5	32	16.0	71	17.8			
70,001-100,000	20	10.0	12	6.0	32	8.0			
More than 100,000	4	2.0	25	12.5	29	7.2			
Own smartphone									
Yes	24	12.0	39	19.5	63	15.8	4.239	1	0.040
No	176	88.0	161	80.5	337	84.2			
Number of chip owned		0.0		0.0					
One	101	50.5	73	36.5	174	43.5	12.432	1	0.006
More than one	99	49.5	127	63.5	226	56.4			
Experience of owning mobile phone									
1-2	32	16.0	18	9.0	50	12.5	25.341	3	0.000
3-4	52	26.0	21	10.5	73	18.2			
4-6	61	30.5	75	37.5	136	34.0			
More than 6	55	27.5	86	43.0	141	35.2			
Radio									
Do not own	60	30.0	48	24.0	108	27.0	60	1	0.177
Own	140	70.0	152	76.0	292	73.0	140		
Television									
Do not own	188	94.0	145	72.5	333	83.3	188	1	0.000
Own	12	6.0	55	27.5	67	16.8	12		

half, 99 (49.5 per cent) and 127 (63.5 per cent) were from Kilosa and Kilombero Districts, respectively. This variable in the two districts was not statistically significantly different ($p \geq 0.05$).

Furthermore, of the 400 respondents, most 337 (84.2 per cent) indicated that their mobile phones were not smartphones. A few, 63 (15.8 per cent) owned smartphones and, of these, 24 (12.0 per cent) and 39 (19.5 per cent) were from Kilosa and Kilombero Districts, respectively. Of the 400 respondents, more than half 292 (73.0 per cent) in Kilombero District and few, 67 (16.8 per cent) in Kilosa District indicated that they owned radios and televisions, and the variable was statistically significant ($p \leq 0.01$), while ownership of radio on the two districts was not statistically significant ($p \geq 0.05$) (Table II).

5.2 Social demographic factors influencing the use of mobile phones in accessing rice information for adaptation to climate change

Table III shows a regression model of the selected socio-demographic factors influencing the use of mobile phones in accessing rice information on climate change adaptation. Multicollinearity diagnosis was conducted prior to running the regression model. The VIF for all variables in the model ranged from 1.40 to 5.63, which meets the VIF as stipulated by Pallant (2011). The −2 log likelihood improved from 56.98 for the model with constant only to 36.55. This implies that addition of the explanatory variables explained more of the variance in the outcome. Chi-square value was 316 with df = 17 and was statistically significant ($p \leq 0.01$) (Table III), indicating that the independent variables had statistical influence on the dependent variables. Furthermore, the Hosmer–Lemeshow test results were 0.571, with df = 8 and a p-value ≥ 0.05. According to Pallant (2011), the p-value greater than 0.05 implies that the fitting effect between the model and data was good.

In total, 16 socio-demographic factors were included in the regression model. These factors explained 55 to 73 per cent of the use of mobile phones in accessing rice information

Variable	B	SE	Wald	Sig.	Exp(B)	Predicted (%) change	VIF
(Constant)	0.286	0.376	0.58	0.79	1.33	33.11	
Sex (1 = Female,0 = Male)	−0.438	0.312	1.97	0.02	0.65	−35.47	5.63
Age	−0.063	0.034	3.43	0.04	0.94	−6.11	2.83
Marital status	0.186	0.383	0.24	0.03	1.20	20.44	1.99
Education level	0.201	0.244	0.68	0.04	1.22	22.26	3.08
Household size	0.211	0.12	3.09	0.13	1.23	23.49	4.20
Number of mobile phone owned	0.312	0.454	0.47	0.08	1.37	36.62	3.16
Cost of mobile phone	0.281	0.208	1.83	0.54	1.32	32.45	1.40
Whether is smartphone	0.12	0.477	0.06	0.09	1.13	12.75	5.07
Experience of owning mobile phone	0.274	0.234	1.37	0.09	1.32	31.52	2.68
Number of Chip owned	0.234	0.23	1.04	0.97	1.26	26.36	2.64
Farm size	0.038	0.018	4.46	0.01	1.04	3.87	2.43
Area grown rice	0.267	0.234	1.30	0.00	1.31	30.60	3.71
Farming experience	−0.183	0.034	28.97	0.03	0.83	−16.72	2.61
TV ownership	0.257	0.245	1.10	0.13	1.58	29.30	1.77
Radio ownership	0.268	0.256	1.10	0.03	1.97	30.73*	2.06
Off farm income	0.301	0.23	1.71	0.01	1.35	35.12**	2.34
District (1 = Kilosa, 0 = Kilombero)	−0.256	0.567	0.02	0.06	0.77	−22.59	4.07

Notes: −2 log likelihood = 36.55; Nagelkerke $R^2 = 0.730$; Cox and Snell $R^2 = 0.555$, Model Chi square = 316, Df = 17, $p = 0.000$, Hosmer and Lemeshow Test; chi square = 0.571, df = 8, $p = 0.07$, Dependent variable: Use of mobile phone for accessing rice information on adaptation to climate change

Table III. Socio-demographic factors influencing use of mobile phones for accessing rice information on climate change adaptation

on climate change adaptation (The Cox and Snell R^2 = 0.73; Nagelkerke R^2 = 0.55, $p \leq$ 0.001). Table III indicates that, only nine socio-demographic factors significantly influenced farmers use of mobile phones in accessing rice information on climate change adaptation. These were sex, age, marital status, education level, farm size, rice grown area, farming experience, radio ownership and off-farm income.

Sex had a beta coefficient of-0.438, and the variable was statistically significant ($p \leq$ 0.05). This means that females had a 35.47 per cent less likelihood of using mobile phones in accessing rice information on climate change adaptation than males. Furthermore, age had a beta coefficient of -0.063 and was statistically significant ($p \leq 0.05$). This means that as age increased by one year, it lowered the use of mobile phones in accessing rice information on climate change adaptation by 6.11 per cent. This implies that younger respondents had higher chance of using mobile phones in accessing rice information on climate change adaptation in the study areas than older farmers.

Farm size had a positive beta coefficient of 0.038 and was statistically significant ($p \leq$ 0.01) on the use of mobile phones in accessing rice information on climate change adaptation. This implies that farmers with large farm sizes had higher chances of using mobile phones in accessing rice information on climate change adaptation.

Education levels attained by the respondents did influence their use of mobile phones in accessing rice information on climate change adaptation, and had a beta coefficient of 0.20 which was statistically significant ($p \leq 0.05$). This means that one unit increase in education produced 22.26 per cent increase in the likelihood of using mobile phone in accessing rice information on climate change adaptation. This implies that educated respondents had higher chances of using mobile phones in accessing rice information on climate change adaptation.

Earning from off-farm engagements did influence the use of mobile phone in accessing rice information on climate change adaptation, and the variable had a beta coefficient of 0.301. On the one hand, this means that one unit increase in off-farm earning resulted in 35.12 per cent increase in using mobile phone in accessing rice information on climate change adaptation. This implies that mobile phone driven information seems to influence agricultural decision making among farmers with secondary sources of income.

Size of land owned had a positive beta coefficient of 0.038 and was statistically significant ($p \leq 0.05$). This means that one unit increase in size of land owned resulted in 3.87 per cent increase in the use of mobile phone in accessing rice information on climate change adaptation, and the area under rice cultivation had a positive beta coefficient of 0.267 and was highly statistically significant ($p \leq 0.01$) (Table III). This means that one unit increase in area under rice cultivation resulted in 30.60 per cent increase in the use of mobile in accessing rice information on climate change adaptation. This implied that farmers with large farm had higher chances of using mobile phones for accessing rice information onclimate change adaptation.

6. Discussion

6.1 Socio-demographic characteristics of the respondents

More than one third of respondents were aged between 20 and 36 years. The implication here is that youth were more involved in rice production. These respondents were in the active age group and that could influence their use of mobile phones for accessing rice information onclimate change adaptation. Younger farmers would most likely be willing to spend more time to obtain information on improved technologies compared to the old farmers (Adeogun *et al.*, 2010). This is similar to the study by Mtega *et al.* (2016) done in

Kilombero District in Morogoro Region, Tanzania, who found that the majority of rice farmers were young.

Results show that the majority of respondents had low level of education. Education attainment could enhance efficient use of mobile phones in accessing rice information on climate change adaptation as it enables farmers to write messages or use various mobile phone applications. Similarly, the study by Nyamba and Mlozi (2012) in Kilolo District in Iringa, Tanzania, found that the majority of farmers in rural areas had attained primary education.

With regard to household size, over half of the respondents indicated to have three to five members in a household. This household size was within the country's average household size of 4.8 (URT, 2013). Furthermore, about two thirds, 244 (61.0 per cent) of the respondents reported that their rice growing experience ranged from 6 to more than 10 years. This is important because some agricultural activities could be done by other household members and enhance adoption of agricultural innovation.

Table II shows that most respondents had rice farming experience. Farming experience is an advantage to improving productivity, as it encourages rapid adoption of farming innovations (Koskei *et al.*, 2013). This could have an influence on the use of mobile phones for accessing rice information on climate change adaptation. The results showed that the majority of farmers did not own land. The results showed further that most of respondents grew rice on small farms. This could limit their adoption of mobile phones for accessing rice information on climate change adaptation. The findings conformed to a study by Mwatawala *et al.* (2016) in Mbalali District, Mbeya Region, who found that rain-fed rice production in Tanzania was managed by small-scale farmers.

The majority of respondents in this study indicated that they had low annual income from off-farm activities. This is becasue of the fact that the main source of income among the farmers was the rice production. The study by Piya *et al.* (2012) in Chepang District, Nepal found that, participating in off-farm activities enabled farmers to get money which could be used to buy agricultural inputs such as seeds, fertilizers and pesticides; also getting money for buying airtime for their mobile phones. Secondary sources of income can enhance farmers' use of mobile phones. Studies in Rajasthan and Maharashtra, in India showed that farmers with high off-farm income were more likely to use ICT devices than those in full time farming (Mittal *et al.*, 2010; Derso *et al.*, 2014).

Results in Table II show that the majority of respondents owned more than one mobile chip. Field observation revealed that the respondents owned more than one mobile phone enabled them to subscribe to more than one phone networks to take advantage of service promotions and network coverage. But also, it was found that most of the farmers perceived that it was cheaper to call a number on the same network than someone on different networks. This is in line with studies by Tadesse and Bahiigwa (2015) and Alhassan and kwakwa (2012) done in Oromia regional state, Ethiopia and Tamale Metropolitan, Ghana, respectively, who found that the majority of smallholder farmers owned at least one mobile phone. Results showed that most of the respondents owned mobile phones which were not smartphones probably because of lack of fund to buy them. The implication here is that that the majority of respondents could not access and share information through some social media which require installation of applications such as WhatsApp and YouTube.

The results also showed that ownership of radio among the respondents was high. Radio can enhance farmers' awareness on using mobile phones to access rice information climate changeadaptation. Furthermore, few respondents from Kilosa District had television sets because the major source of power in rural areas in Kilosa District was solar power, hence most farmers owned and used cheap solar powered ICT devices such as radios. This

conforms to the studies by Isaya *et al.* (2015) and Mtega *et al.* (2016) in Kilosa and Kilombero Districts, respectively, in Morogoro Region, Tanzania, who found high ownership of radios by the smallholder farmers.

6.2 Social demographic factors influencing the use of mobile phones for accessing rice information on climate change adaptation

First, education is one of the most important factor that influenced the use of mobile phones in accessing rice information on climate change adaptation. Educated farmers were more likely to make better informed decisions on agricultural practices. Education enables the individual farmers to know how to seek for information on improved farm practices. This is because, as an individual gets knowledge, they would extend the scope of their experience through the modern sources of information. This conforms to a study by Ali (2012) in Uttar Pradesh State, India, and Mittal and Mehar (2016) in Punjab, Haryana, Uttar Pradesh, India, who found that farmers with higher education levels had higher chances of using mobile phones in accessing information. Therefore, this implies that information service providers who may need to design a mobile information delivery model which may be beneficial to the farmers should take into consideration the education levels of farmers.

Second, engagement in off-farm activities positively influenced the use of mobile phones in accessing informationonclimate change adaptation. Farmers with secondary sources of income are in a better position to invest in innovative farm technologies. With this regard, they are more likely to look for appropriate sources of information including mobile phones to access information. Similarly, studies by Mittal *et al.* (2010) in Uttar Pradesh states, India, and Derso *et al.* (2014) in Tole Wareda in central highlands, Ethiopia, found that farmers with high off-farm incomes had higher chances of using mobile phones in accessing agricultural information. This encourages the rain-fed rice farmers to engage in off-farm activities which are less sensitive to climate change.

Third, findings show a positive influence of marital status on farmers' access to information on climate change adaptation using mobile phones. Married farmers were likely to be under pressure to produce more for not only family consumption but also sale. The desire to produce more could lead to seek for agricultural information through modern technology including mobile phones. These study findings are in line with those of Ajijola *et al.* (2015) in Afijio Local Government Area, Oyo State, Nigeria, who found that marital status of the farmers was among the factors that determined their use of ICTs in accessing information. This indicates that household status should be taking into consideration during design of mobile delivery system of agricultural information.

Fourth, age and farming experience negatively influenced the use of mobile phones to access rice information on climate change adaptation. Studies suggest that older farmers are less likely to adopt modern sources of information than younger producers (Soule *et al.*, 2000). In the current study, older people were frequently reluctant to adopt new technologies than the younger ones. This finding is in line with previous studies by Nyamba and Mlozi (2012) in Kilolo District, Iringa, Tanzania, and Animashaun *et al.* (2014) in Kwara, Nigeria which reported that young farmers had higher chances of using mobile phones in accessing agricultural information. Therefore, the use of mobile phone initiatives should take part in educating people of all age groups.

Fifth, the current study found that sex negatively influenced the use of mobile phones in accessing information on climate change adaptation. The significant relationship between sex and the use of mobile phones to access rice information on climate change adaptation is because of the fact that men are the decision-makers with regard to agricultural production in a household, have higher social capital and more free time to listen to the radio and watch

television agricultural programmes which can enable them to be aware of various ways of using mobile phones to access rice information. Women, on the other hand, are engaged in domestic chores and other productive activities, leaving them with little time to tune to the radio or watch television. Also, in many households, women were not decision-makers on issues related to agricultural production. This finding is in line with the study by Fadiji (2011) in North West, Nigeria, and Mittal *et al.* (2010) in Maharashtra, Rajasthan in Uttar Pradesh State, India, who found that men had higher chances of accessing information using mobile phones than women. This indicates that sex should be taken into consideration during the design of systems for delivering agricultural information using mobile phones to farmers.

Sixth, radio ownership positively influenced use of mobile phones in accessing rice information on climate change adaptation. The findings indicated that the respondents who owned a radio had higher likelihood of using their mobile phones in accessing rice information on climate change adaptation than those who did not own one. Radio plays a significant role in spreading information. It reaches larger percentage of the people irrespective of their location; it promotes the level of awareness of the people on various issues including the usage of mobile phones to access information (Mittal *et al.*, 2010). These results are consistent with the findings by Derso *et al.* (2014) in Tole Wareda in central highlands, Ethiopia who found that farmers with ICTs had greater chances of using such ICTs to access agricultural information.

Finally, results indicated that land ownership and size of the rice grown area, positively influenced the use of mobile phones in accessing rice information on climate change adaptation. Small and large farm operators differed in the speed of adoption of innovation. Farmers with large landholdings were more likely to use mobile phones as compared to small landholders. It is curious to note that large landholders are becoming more aware about adopting modern agricultural practices under climate change for better productivity and profitability. The findings in this study are in line with the previous studies by Mittal *et al.* (2010) in Maharashtra, Rajasthan and New Delhi, India, Uttar Pradesh State, India, and Ali (2012) in Uttar Pradesh, India, who found that farmers with large farm sizes had higher chances of adopting the use of ICTs for accessing agricultural information.

7. Conclusions

In this era of climate change, accessing rice information plays a decisive role in enhancing farmers' adaptation to climate change, as well as improving their production, productivity and livelihoods. The study determines the influence of socio-demographic factors on mobile phones use in accessing rice information on climate change adaptation. The study concludes that socio-demographic characteristics influence the farmers' use of mobile phones in accessing rice information on climate change adaptation. In addition, socio-demographic characteristics of farmers like sex, age, marital status, farm size, farming experience, radio ownership and off-farm incomes are significantly related to farmer's use of mobile phones in accessing rice information on climate change adaption. Older respondents tend to have a less chance of using mobile phones to access rice information on climate change adaptation than younger ones. Besides, respondents with high incomes earned from off-farm activities are more likely to use mobile phones in accessing rice information for climate change adaptation. Moreover, farmers with large rice plantations are more likely to use mobile phones in accessing rice information for adaptation to climate change. Furthermore, married respondents have higher chances of using mobile phones to access rice information for climate change adaptation than unmarried ones. Finally, respondents with higher education attainments are more likely to use mobile phones in accessing rice information for adaption to climate change. These results can be used further to design programmes specific to farmers' characteristics. Owing to the fact

that socio-demographic characteristics significantly influenced by the use of mobile phones to access rice information on climate change adaptation, developers of mobile-based agricultural advisory services such as Web-based farmers' advisory information system, mobile-based farmers' advisory information system and agricultural value-added services need to reflect on these characteristics when developing mobile phone applications. With respect to the theoretical perspective, this empirical study expands on previous studies that identified and verified the moderators that influence adoption of ICTs by the farmers. The current empirical study develops on previous studies that identified and verified the moderators (socio-demographic characteristics) that influence the use of mobile phones by farmers. Based on the conclusions above, the study recommends the following:

- Kilosa and Kilombero District Councils should consider socio-demographic characteristics of farmers when designing mobile phone delivery information systems to farmers.
- Kilosa and Kilombero District Councils and other development partners should foster education to farmers on mobile phones use for accesing information on climate change adaptation

8. Limitation of the study

This study has a limitation on the sampling design. The sample was purposive. First, the respondents were chosen based on mobile phone ownership leaving behind those without mobile phones. Second, the Wards and villages were purposively selected based on rain-fed rice production. Thus, the sample was not representative of the entire population. This has an implication on generalization of the findings in other areas.

References

Adeogun, S.O., Olawoye, J.E. and Akinbile, L.A. (2010), "Information sources to cocoa farmers on cocoa rehabilitation techniques (CRTs) in selected states of Nigeria", *Journal Media and Communication Studies*, Vol. 2 No. 1, pp. 009-015.

Ajijola, S., Awoyemi, D.A., Egbetokun, O.A. and Odetola, S.K. (2015), "Socio economic effect on the use of information and communication technology among rural farming households in afijio local government area, Oyo state, Nigeria", *Journal of Economics and Sustainable Development*, Vol. 6 No. 19, pp. 51-57.

Alhassan, H. and Kwakwa, P.A. (2012), "The use of mobile phones by small scale farmers in Northern Ghana: Benefits and challenges", *Journal of Entrepreneurship and Management*, Vol. 1 No. 3, pp. 40-45.

Ali, J. (2012), "Factors affecting the adoption of information and communication technologies (ICTs) for farming decisions", *Journal of Agricultural and Food Information*, Vol. 13 No. 1, pp. 78-96.

Anderson, J.E. and Schwager, P.H. (2004), "SME adoption of wireless LAN technology: applying the UTAUT model", in *Proceedings of the 7th annual conference of the Southern Association for Information Systems*, available at: http://sais.aisnet.org/sais2004/Anderson%20&%20Schwagers.pdf (accessed 20 October 2017).

Animashaun, J.O., Fakayode, S.B., Idris, K.A. and Khairat, F. (2014), "Patterns and drivers of mobile telephony for sustainable livelihood among farming households in Kwara state, Nigeria", *Journal of Agricultural Informatics*, Vol. 5 No. 2, pp. 34-44.

Boniphace, N.S., Fengying, N. and Chen, F. (2015), "An analysis of smallholder farmers' socio-economic determinants for inputs use: a case of major rice producing regions in tanzania", *Russian Journal of Agricultural and Socio-Economic Sciences*, Vol. 38 No. 2, pp. 41-55.

Bucheyeki, T.L., Shennkalwa, E., Kadadi, D. and Lobulu, J. (2011), "Assessment of rice production constraints and farmers preferences in nzega and igunga districts", *Journal of Advanced Development Research*, Vol. 2 No. 1, pp. 30-37.

Cheng, D., Liu, G., Qian, C. and Song, Y. (2009), "User acceptance of internet banking: an extension of the UTAUT model with trust and quality constructs", *International Journal of Services Operations and Informatics*, Vol. 4 No. 4, pp. 378-394.

Churi, A.J., Mlozi, M.R.S., Tumbo, S.D. and Casmir, R. (2012), "Understanding farmers information communication strategies for managing climate risks in rural Semi-Arid areas, tanzania", *International Journal of Information and Communication Technology Research*, Vol. 2 No. 11, pp. 838-845.

Cieslikowsk, D.A., Halewood, N.J., Kimura, K. and Zhen-Wei Qiang, C. (2009), "Key trends in ICTs development (World Bank Report)", available at: www.comminit.com/en/node/298770/307 (accessed 24 June 2017).

Daniel, E. (2013), "Assessment of agricultural extension services in Tanzania. A case Study of Kyela, songea rural and morogoro rural districts", a dissertation for Award of Master of Science, Wageningen University and Research Centre, Wageningen.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-340.

Derso, D., Mamo, Y. and Haji, J. (2014), "Analyzing socio-economic factors affecting the use of information and communication technologies among farmers in Central highlands of Ethiopia", *African Journal of Agricultural Science and Technology (AJAST)*, Vol. 2 No. 8, pp. 163-171.

Dulle, F.W. (2008), "An analysis of open access scholarly communication in Tanzanian public universities", Dissertation for Award of PhD at University of South Africa, Pretoria, South Africa, p. 325.

Fadiji, T.O. (2011), "Factors influencing usage of information and Communication technologies among village Extension agents in three selected states of North - west, Nigeria", a dissertation for Award of PhD Degree, Ahmadu Bello University, Zaria, Nigeria.

FAO (2017), "Rice market monitor: Production international trade rice utilization and domestic prices", available at: www.fao.org/3/a-i7964e.pdf (accessed 20 October 2017).

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010), *Multivariate Data Analysis*, 7th ed., Pearson Prentice-Hall, NJ.

Isaya, E.L., Agunga, R. and Sanga, C. (2015), "Sources of agricultural information for women farmers in tanzania", *Information Development*, Vol. 3, pp. 48-60.

Komba, C. and Muchapondwa, E. (2012), "Adaptation to climate change by stallholders framers in tanzania, economic research Southern Africa", Working Paper 299, available at: https://econrsa.org/publications/working-papers/adaptation-climate-change-smallholder-farmers-tanzania (accessed 15 April 2018).

Koskei, R.C., Langat, J.K., Koskei, E.C. and Oyugi, M.A. (2013), "Determinants of agricultural information access by small holder tea farmers in bureti district, Kenya", *Asian Journal of Agricultural Sciences*, Vol. 5 No. 5, pp. 102-107.

Kripanont, N. (2007), "Using technology acceptance model of Internet usage by academics within Thai Business Schools", a dissertation for Award of PhD Degree, Victoria, Footscray, Australia, available at: http://wallaby.vu.edu.au/adt-VVUT/public/adt-VVUT20070911.152902/index.html (accessed 20 May 2018).

Machumu, F.B.N. (1995), "Factors Associated with the Adoption of Agricultural Technologies: A Case study of Sasakawa Global 2000 Project in Dodoma Rural District, Tanzania", a dissertation for Award of Master of Science, Sokoine University of Agriculture.

Mittal, S. and Mehar, M. (2016), "Socio-economic factors affecting adoption of modern information and communication technology by farmers in India: Analysis using multivariate probit model", *The Journal of Agricultural Education and Extension*, Vol. 22 No. 2, pp. 199-212.

Mittal, S., Gandhi, S. and Tripathi, G. (2010), "Socio economic impact of mobile phones on Indian agriculture", Working paper No. 246, ICR IER, New Delhi, available at: www.researchgate.net/publication/46435402_Socio-Economic_Impact_of_Mobile_Phones_on_Indian_Agriculture (accessed 12 February 2018).

Msangya, B. and Yihuan, W. (2016), "Challenges for Small-Scale rice farmers: a case study of ulanga District-Morogoro, tanzania", *International Journal of Scientific Research and Innovative Technology*, Vol. 3 No. 6, pp. 65-72, available at: www.ijsrit.com/uploaded_all_files/2639137603_e6.pdf

Mtega, W.P., Ngoepe, M. and Dube, L. (2016), "Factors influencing access to agricultural knowledge:the case of smallholder rice farmers in the kilombero district of tanzania", *South African Journal of Information Management*, Vol. 18 No. 1, pp. 1-8.

Mutabazi, K.D., George, C.K., Dos Santos, A.S. and Felister, M.M. (2014), "Livelihood implications of REDD+ and costs-benefits of agricultural intensification in REDD+ pilot area of Kilosa, Tanzania", *Journal of Ecosystem and Ecography*, Vol. 4 No. 2, pp. 1-11, doi: 10.4172/2157-7625.1000144 (accessed 20 October 2017).

Mwalukasa, N. (2013), "Agricultural information sources used for climate change adaptation in tanzania", *Library Review*, Vol. 62 Nos 4/5, pp. 266-292.

Mwamakimbula, A.M. (2014), "Assessment of the factors impacting agricultural extension training programs in Tanzania: a descriptive study", a dissertation for Award of Msc Degree at Iowa state university, IA, United States of America.

Mwatawala, H.W., Mwang'onda, E. and Hyera, R.N. (2016), "Rice production in Southern Highlands of tanzania: Contribution to household income and challenges faced by rice farmers in mbarali district", Scholars Journal of Agriculture and Veterinary Sciences, Vol. 3 No. 3, pp. 262-269.

Mwombe, S.O.L., Mugivane, F.I., Adolwa, I.S. and Nderitu, J.H. (2014), "Evaluation of information and communication technology utilization by small holder banana farmers in gatanga district, Kenya", *Journal of Agricultural Educucation and Extension*, Vol. 20 No. 2, pp. 247-261.

Nyamba, S. (2011), "Factors Influencing the Use of Mobile Phones in communicating Agricultural Information: A Case of Kilolo District, Iringa, Tanzania", a dissertation for Award of Master of Arts in Rural Development, Sokoine University of Agriculture.

Nyamba, S.W. and Mlozi, M.R.S. (2012), "Factors influencing the use of mobile phones in communicating agricultural information: a case of Kilolo district, Iringa, Tanzania, Tanzania", *International Journal of Information and Communication Technology Research*, Vol. 2 No. 7, pp. 558-563.

Ospina, A.V. and Heek, R. (2010), *Linking ICTs and Climate Change Adaptation: A Conceptual Framework for e-Resilience and e-Adaptation, Centre for Development Informatics, Institute for Development Policy and Management*, University of Manchester, Manchester.

Ospina, A.V. and Heeks, R. (2011), *ICTs and Climate Change Adaptation: Enabling Innovative Strategies*, Strategy Brief, Centre for Development Informatics, University of Manchester, UK, available at: www.seachangecop.org/files/documents/2011_09_26_ICTs_and_Climate_Change_Adaptation_Strategy_Brief_1.pdf (accessed 25 January 2018).

Paavola, J. (2003), "Vulnerability to climate change in tanzania: Sources, substance and solutions", A paper presented at the Inaugural Workshop of Southern Africa Vulnerability Initiative (SAVI) in Maputo, Mozambique, June 19-21, 2003, available at: www.gechs.org/savi/workshop/maputo/papers/paavola_tanzania.pdf (accessed 20 December 2017).

Pallant, Y. (2011), *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows*, (3rd ed), Open University Press, McGraw Hill.

Peng, C.Y., So, T.S., Stage, F.K. and St. John, E.P. (2002), "The use and interpretation of logistic regression in higher education journals", *Research in Higher Education*, Vol. 43 No. 3, pp. 259-293.

Piya, L., Maharajan, K.L. and Joshi, N.P. (2012), "Vulnerability of rural households to climate change and extremes: Analysis of chepang households in the mid-hills of Nepal", *Selected paper prepared for presentation at the International Association of Agricultural Economics (IAAE) Triennial Conference, Fozdo Iguacu, Brazil*, 18-24 August 2012.

Ragasa, C., Ulimwengu, J., Randriamamonjy, J. and Badibanga, T. (2015), "Factors affecting performance of agricultural extension: Evidence from democratic republic of Congo", *The Journal of Agricultural Education and Extension*, Vol. 22 No. 2, pp. 113-143.

Ramirez, O.A. and Shultz, S.D. (2000), "Poisson count models to explain the adoption of agricultural and natural resource management technologies by small farmers in Central American countries", *Journal of Agricultural and Applied Economics*, Vol. 32 No. 1, pp. 21-33.

RLDC (2011), "Improving rice profitability through increased productivity and better marketing focusing on Tanzania's Central corridor: Rice sector strategy", available at: www.rldp.org/downloads/rice_strategy.pdf (accessed 21 September 2017).

Rogers, E.M. (1995), *Diffusion of Innovation*, (4th Ed). Free Press, New York, NY.

Rosen, P.A. (2005), "The effect of personal innovativeness on technology acceptance". a dissertation for Award of Master of Science, Oklahoma State University. available at: http://earchive.library.okstate.edu.dissertations/AA13179557/ (accessed 20 October 2017).

Sanga, C., Kalungwizi, V.J. and Msuya, C.P. (2013), "Building an agricultural extension services system supported by ICTs in tanzania: Progress made, challenges remain", *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, Vol. 9 No. 1, pp. 80-99.

Sekabira, H., Bonabana, J. and Asingwire, N. (2012), "Determinants for adoption of information and communications technology (ICT)-based market information services by smallholder farmers and traders in Mayuge district, Uganda", *Journal of Development and Agricultural Economics*, Vol. 4 No. 14, pp. 404-415.

Serenko, A., Turel, O. and Yol, S. (2006), "Moderating roles of user demographics in the American customer satisfaction model within the context of mobile services", *Journal of Information Technology Management*, Vol. 17 No. 4, pp. 48-52.

Smit, B. and Wandel, J. (2006), "Adaptation, adaptive capacity and vulnerability", *Global Environmental Change*, Vol. 16 No. 3, pp. 282-292.

Soule, M.J., Tegene, A. and Wiebe, K.D. (2000), "Land tenure and the adoption of conservation practices", *American Journal of Agricultural Economics*, Vol. 82 No. 4, pp. 993-1005.

Tadesse, G.A. and Bahiigwa, G. (2015), "Mobile phones and farmers' marketing decisions in Ethiopia", *World Development*, Vol. 68, pp. 296-307.

Tumbo, S. and Sanga, C. (2015), "Impacts of climate change on agriculture: What, when, where and how? policy brief, AgMIP",

Tumbo, S., Mzirai, O., Mourice, S., Msongaleli, B., Wambura, F., Kadigi, I., Sanga, S.K., Ngongolo, H., Sangalugembe, C., Mutabazi, K. and Sumari, N. (2015), *Assessing the Impacts of Climate Variability and Change on Agricultural Systems in Eastern Africa While Enhancing the Region's Capacity to Undertake Integrated Assessment of Vulnerabilities to Future Changes in climate – Tanzania*, Columbia University, p. 31.

Umunakwe, P.C., Nnadi, F.N., Chikaire, J. and Nnadi, C.D. (2014), "Information needs for climate change adaptation among rural farmers in owerri west local area of Imo state, Nigeria", *Agrotechnology*, Vol. 3 No. 1, pp. 1-6.

URT (2010), *Ministry of Finance and Economic Affairs: National Strategy for Growth and Reduction of Poverty II (NSGRP II)*, Government printer, Dar es Salaam.

URT (2013), *2012 Population and Housing Census: Population Distribution by Administrative Areas, National Bureau of Statistics, Ministry of Finance, Dar Es Salaam and Office of Chief Government Statistician, President's Office, Finance, Economy an, Development Planning Zanzibar*, Government printer, Dar es Salaam.

URT (2014), "Public expenditure review national agricultural input voucher scheme (NAIVS)", available at: www.mof.go.tz/mofdocs/PER/. . ./PER%20NAIVS%20Study%20Final%20Report.pdf (accessed 2 June 2018).

URT (2017), "Tanzania national food security bulletin", Voume 2, February 2017, available at: www.kilimo.go.tz/uploads/Tanzania_National_Food_Security_Bulletin_FEBRUARY-2017.pdf (accessed 20 October 2017).

USDA (2017a), "Rice outlook", available at: usda.mannlib.cornell.edu/usda/ers/RCS//2010s/2017/RCS-02-13-2017.pdf. (accessed 22 October 2017).

USDA (2017b), "USDA posts tanzania rice production estimates", available at: https://oryza.com/29735/usda-post-estimates-tanzania-rice-production-trade (accessed 22 October 2017).

Van den Ban, A.W. and Hawkins, H.S. (1996), *Agricultural Extension*, 2nd Ed., Black well Science Ltd, London.

Venkatesh, V. and Davis, F. (2000), "A theoretical extension of the technology acceptance model: four longitudinal field studies", *Management Science*, Vol. 46 No. 2, pp. 186-204.

Venkatesh, V., Morris, M., Davis, G.B. and Davis, F.D. (2003), "User acceptance of technology: toward a unified view", *MIS Quarterly*, Vol. 27 No. 3, pp. 425-478.

Vosough, A., Eghtedari, N. and Binaian, A. (2015), "Factors affecting ICT adoption in rural area: a case study of rural users in Iran", *Research Journal of Fisheries and Hydrobiology*, Vol. 10 No. 10, pp. 611-616, available at: www.aensiweb.net/AENSIWEB/rjfh/rjfh/2015/June/611-616.pdf (accessed 21 May 2018).

Yaseen, M., Xu, S.W., Yu, W., Luqman, M., Hassan, S. and Ameen, M. (2016), "Factors inhabiting ICTs usage among farmers: Comparative analysis from Pakistan and China", *Open Journal of Social Sciences*, Vol. 4 No. 5, pp. 287-294.

Zenna, N., Senthilkumar, K. and Sie, M. (2016), "Rice production in Africa", In Chauhan, E., S., Jabran, K. and Mahajan, G. (Eds), *Rice Production World Wide*, Springer, pp. 117-135, available at: https://link.springer.com/chapter/10.1007/978-3-319-47516-5_5 (accessed 20 October 2017).

About the authors

Nicholaus Mwalukasa is Academic Staff at the Department of Information and Records Studies, Sokoine University of Agriculture, currently is a PhD Student at the Department of Development Studies, Sokoine University of Agriculture. His research interests include information and communication technologies in education and research, technology adoption, information and communication management and knowledge management. Nicholaus Mwalukasa is the corresponding author and can be contacted at: nicholausmwalukasa@yahoo.com

Malongo R.S. Mlozi is a Professor of Agricultural Education and Extension at Sokoine University of Agriculture (SUA). His research interest include agricultural education, agricultural extension, urban agriculture systems and rural development.

Camilius A. Sanga is Associate Professor of Informatics, Centre for ICT, Sokoine University of Agriculture. His research interest include ICT for Development, ICT4D and ICTD.