FACTORS INFLUENCING MOBILE PHONE USE ON CLIMATE-SMART HORTICULTURE IN TAITA-TAVETA COUNTY, KENYA

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ABSTRACT

The role of mobile phones in reducing agricultural information gaps and improving access to wide range of services cannot be underestimated. While climate change poses a serious threat to crop production, mobile phones have steadily been used to provide a solution by facilitating sharing of real time information and enhancing virtual networks beneficial to farmers. However, there is still low application of mobile phone in horticulture. This study analyzed the factors influencing the use of mobile phones on climate-smart horticulture. The study surveyed 403 tomato and green gram farmers randomly drawn from three sub-counties (Wundanyi, Mwatate and Taveta) in Taita-Taveta County. A binary logit model was applied to analyze the factors influencing mobile phone use on climate-smart horticulture. The results showed that gender, trust on the information received through mobile phone, access to electric power (solar and hydro-electricity) and access to credit improved mobile phone use on climate-smart horticulture while farmer's age exhibited negative influence. National and County governments should partner with local telecommunication service providers and other agricultural stakeholders to educate farmers and extension agents on mobile phone use on farming and develop a mobile phone digital platform that would provide real time and credible weather, agronomic, market and price information.

Key words: Mobile phone, climate-smart, binary logit, influence, digital platform

INTRODUCTION

Mobile phone penetration has rapidly grown in Kenya since 1999 (Malack *et al*., 2015) and is currently estimated at 126% (CAK, 2020). Similarly, mobile phone ownership and use among smallholder farmers increased (GeoPoll, 2018). The farmers use mobile phones to access a wide range of agricultural information including input and output prices, weather and agronomic information (Akinola, 2017). According to GeoPoll (2018), more than half of the farmers in the study area were using smartphones.

As the mobile phones and telecommunication sector continues to grow, more customized features also emerge. For instance, there are more than 50 mobile phone-supported agricultural applications that serve different sections of farmers (Qiang *et al*., 2011). With these developments, farmers are able to reduce information gaps and transaction costs along agricultural value chains through their mobile phones (Ogutu *et al*., 2014; Suarez and Suarez, 2013). However, Okello *et al*. (2014) argue that mobile phone use is dependent on farmer-specific and capital endowment factors. Specifically, Krell *et al*. (2020) showed that smartphone ownership and high level of education positively influenced the use of mobile phone-based agricultural services.

In horticulture, mobile phone plays a key role in linking farmers to the markets, since most crops (such as tomatoes) are highly perishable (Pokhrel, 2021; Tadesse and Bahiigwa, 2015).

Likewise, the mobile phones can be viewed as enablers in achieving climate-smart horticulture (CSH) objectives including increased productivity and building resilience to climate change (Sahu, 2016). This is because they enable transmission of real time weather, price and market information to farmers (Mittal, 2016). Despite the perceived importance of mobile phone use in horticulture, there is still low evidence of mobile phone use for agricultural purposes. Aminou *et al*. (2018) suggested that mobile phone is a consumer good if not used for production purposes. Chhachhar *et al*. (2014) also found that most farmers were not using their mobile phones for agricultural information despite owning one. However, evidence on the factors affecting application of mobile phones in horticulture is limited. Therefore, this study contributes to addressing this knowledge gap by providing such evidence.

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METHODOLOGY

The study interviewed 403 green gram and tomato farmers randomly drawn from Wundanyi, Mwatate and Taveta sub-counties in Taita-Taveta County. The three sub-counties were purposively selected due to high concentration of tomato and green gram farmers. Also, green grams and tomatoes are important crops used for generating income in the three locations. The sample size was calculated using a formula adapted from Cochran (1977) as presented in equation (1).

$$n_o = \frac{(Z^2 p^q)}{e^2} \quad \text{.............................} \ (1)$$

where; n_0 is the sample size, Z is the *Z-critical* value at a particular confidence level, p is the maximum level of variance, q is $(1-p)$ and e is the desired margin of error.

This study used 95.1% confidence level and 0.049 desired margin of error. The p was presumed to take a value of 0.5, since the disparity among CSH farmers was not known and the fact that green gram farmers' characteristics are slightly different from tomato farmers. Therefore, the sample size was calculated as shown in equation (2) and 5% was added to cater for potential non-response.

$$n_o = \frac{(1.96^2 \times 0.5 \times 0.5)}{0.049^2} = 400 \quad \text{........................} \ (2)$$

Binary logit model (Corlett and Aigner, 1972) was used to analyze the factors influencing mobile phone use in CSH. The use of logit was based on its robustness in error term distribution. Wooldridge, (2013) noted that logit model is mathematically convenient and error term is assumed to be logistically distributed. In a logit model, the likelihood *(p)* that a farmer uses mobile phone in CSH is expressed by the logistic distribution function shown in equation (3) (Gujarati and Porter, 2009). In this study, a 'climate-smart farmer' was defined as a farmer who was actively practicing one or more of the CSH techniques.

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_1 + \beta_2 X_i + \varepsilon \quad \text{....} \ (3)$$

where,

L_i is the logit transformation and Z_i is the latent variable that takes the value of 1 if a farmer is using mobile phone in CSH and 0 otherwise. $X_i X_i$ is a group of independent variables which include; education, age, gender, land size, electricity connection, off-farm income, group membership, access to credit, geographic location and access to extension services. ε is the error term that is assumed to have a logistic distribution.

RESULTS AND DISCUSSION

Characteristics of mobile phone users and non-users on climate-smart horticulture

Table I presents the characteristics of CSH farmers in Taita-Taveta County with respect to mobile phone use. In terms of gender, results show that there is a significant difference in gender between mobile phone users in CSH and non-users. The results indicate that more male farmers used their mobile phones in CSH than their female counterparts. The finding is attributed to the fact that more male farmers owned smartphones which improved their access to CSH information. The average age of mobile phone users and non-users was about 45 and 50 years, respectively, which indicates that mobile phone users are younger than non-users. This is because young people have the capacity to access various internet sites and access the information they need compared to older farmers who mainly depend on guidance from agricultural extension officers. Similar results were obtained by Andone *et al.* (2016) who showed that young people used their phones more than their older counterparts. Also, mobile phone users had spent two more years in education than non-users. This finding is consistent with Antoun (2015) who found that most mobile internet users were more educated.

Similarly, the difference between mobile phone users and non-users in CSH was very significant in agricultural extension services, access to electric power, number of CSH practices adopted, trust on information received through mobile phone, climate change and climate-smart awareness. In addition, to a smaller extent, there was a difference between users of mobile phones in CSH and non-users in amount of off-farm income, farming experience and access to credit. Access to agricultural extension, electric power and trust on information received encouraged the use of mobile phones among farmers. Furthermore, having off-farm income increased the capacity of the farmer(s) to own a mobile phone hence improving its use.

TABLE I- DIFFERENCES BETWEEN MOBILE PHONE USERS AND NON-USERS ON CLIMATE-SMART HORTICULTURE.

Variables	*Mobile phone users (n=224)*	*Mobile phone non-users (n= 179)*	*Mean difference*	*Pooled (N=403)*
Gender of the farmer (male =1)	0.71	0.46	0.25***	0.60
Farmer's age (years)	44.71	50.04	-5.33***	47.08
Farmer's education level (years)	9.20	7.22	1.98***	8.32
Household size (count)	5.33	5.37	-0.04	5.35
Off-farm income (Kshs)	5425.89	3526.26	1899.64*	4582.13
Farming Experience (years)	8.56	10.48	-1.92**	9.41
Farm size (under crop) (acres)	1.42	1.35	0.07	1.39
Access to agricultural extension service (yes =1)	0.69	0.55	0.13***	0.63
Group membership (yes =1)	0.46	0.39	0.07	0.43
Credit access (yes =1)	0.13	0.07	0.07**	0.10
Electric power access (yes =1)	0.94	0.78	0.16***	0.87
Distance from farm to bank (Km)	19.63	18.13	1.50	18.97
Number of CSH practices (count)	7.25	4.53	2.72***	6.03
Trust on information received (yes =1)	0.64	0.36	0.28***	0.51
Climate change awareness (yes =1)	0.96	0.88	0.08***	0.92
CSH awareness (yes =1)	0.79	0.56	0.23***	0.69

*, ** and *** *denote 10%, 5% and 1% statistical significance levels, respectively*

Note: pooled sample includes the total number of respondents from the 3 crop categories (403).

Factors influencing the use of mobile phone on climate-smart horticulture

Table II presents binary logit regression model results, which is the first stage analysis, of the factors influencing mobile phone use on CSH. The use of mobile phone on CSH was interpreted as the application of mobile phone in searching for any CSH information and/or using the phone to pay (or receive money) for related products and services. The pseudo-R^2 shows that the model fits the data well (Wooldridge, 2013). Pooled results (which includes all farmers under the study) indicate that household level features such as farmer's gender, age and education have significant effect on the likelihood of using a mobile phone on CSH.

In terms of gender, the finding shows that male farmers are 84% more likely to use a mobile phone on CSH. This is because more male farmers own smartphones and have access to internet than their female counterparts. An increase in the age of the farmer by one year decreases the likelihood of using mobile phone in CSH by 3%. This is due to the fact that older people, in the study area, had little knowledge on the use of mobile phones to access CSH and related information, and this reduced their capacity to use their phones on CSH. The study shows that an increase in farmer's education level by a year increases the likelihood of using mobile phone on CSH by 8%. This finding conforms with Kirui *et al*. (2012) and Krell *et al*. (2020) who found that an increase in the level of education increased the likelihood of using mobile phone-based services. This is because educated farmers are able to read and navigate through various information services available in the mobile platform and find what they need to improve farming.

Further, the results reveal that trust on information received through mobile phone increases the likelihood of mobile phone use on CSH by 1.08 times. This is because farmers who believe the information received tend to use their phone more often to access current information on weather, crop husbandry and market information. Similar results have been shown by Mahatanankoon *et al*. (2006), Masrek *et al*. (2015) and Xin *et al*. (2013) who found that trust plays a critical role in the use of mobile phone device and its related services. Farmers who had access to credit were 1.48 times likely to use their mobile phones on CSH. This is because credit accessibility allows farmers to access farm assets and mobile phone can be viewed as such if used for farm activities (Aminou *et al*., 2018).

Likewise, being aware of CSH exposes farmers to various agricultural information services available and where to access them hence increased likelihood of using mobile phones in search of related information. However, CSH awareness was statistically insignificant. Access to electricity (hydro-electric and/or solar power) by farmers increases the likelihood of using mobile phones in CSH by 1.38 times. This can be attributed to the fact that power is an essential ingredient in a mobile phone and high-end smartphones are high power consumers. Thus accessing electricity improves farmer's convenience and reduces mobile phone battery charging costs hence likely to use it. The number of CSH practices adopted by farmers are 24% likely to positively influence mobile phone use in CSH. This can be seen as reverse causality since most studies have provided evidence on the effect of mobile phone on farming practices (Krell *et al*., 2020; Mittal and Hariharan, 2018; Mittal and Tripathi, 2009; Quandt, *et al*., 2020). However, this effect may be attributed to the fact that most farmers who adopted CSH practices were more enlightened, had more assets and were interested to learn more on improving their farm productivity in the context of climate change. Enlightened farmers have been revealed to use a mix of technologies in a bid to improve farm productivity (Li *et al*., 2020; Wordofa *et al*., 2021).

TABLE II- BINARY LOGIT REGRESSION RESULTS ON FACTORS INFLUENCING MOBILE PHONE USE ON CLIMATE-SMART HORTICULTURE

Variables	Tomato farmers (***n***=115)		Green gram farmers (***n***=259)		Pooled (***n***=403)	
	Co-efficient	*Std. Error*	*Co-efficient*	*Std. Error*	*Co-efficient*	*Std. Error*
Dependent variable						
Mobile phone use in CSH (yes =1)						
Independent variables						
Gender of the farmer (male =1)	0.658	0.666	0.838**	0.344	0.841***	0.272
Farmer's age (years)	-0.006	0.027	-0.036**	0.015	-0.027**	0.011
Household size (count)	-0.069	0.127	0.060	0.073	0.032	0.059
Farmer's education level (years)	0.056	0.095	0.111**	0.050	0.076*	0.040
Farming experience (years)	-0.062	0.041	-0.0004	-0.026	-0.013	0.019
Farm size under crop (acres)	-0.313	0.206	0.165	0.105	0.025	0.083
Trust on information received (yes =1)	0.724	0.491	0.919**	0.368	1.075***	0.268
Group membership (yes =1)	0.234	0.658	0.886*	0.470	0.340	0.309
Access to agricultural extension service (yes =1)	0.771	0.646	-0.829	0.559	-0.465	0.376
Access to credit (yes =1)	1.896*	1.105	1.527***	0.559	1.437***	0.447
Climate change awareness (yes =1)	-0.579	1.072	0.644	0.725	0.321	0.535
CSH awareness (yes =1)	-0.226	0.793	0.330	0.494	0.465	0.364
Access to electricity (yes =1)	2.680**	1.179	1.278**	0.561	1.383***	0.449
Distance from farm to commercial bank (km)	0.010	0.022	0.001	0.011	-0.004	0.008
Number of CSH practices adopted (count)	0.283**	0.133	0.279***	0.077	0.237***	0.052
	*Constant = -3.9525** *Pseudo R^2 = 0.2019* *Prob >chi2 = 0.0185* *Log likelihood = -56.40*		*Constant = -4.167**** *Pseudo R^2 = 0.2863* *Prob >chi2 = 0.0000* *Log likelihood = -127.82*		*Constant =-3.452**** *Pseudo R^2 = 0.2649* *Prob >chi2 = 0.0000* *Log likelihood = -203.48*	

*Note: *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively*

CONCLUSION AND RECOMMENDATIONS

The study determined the factors influencing mobile phone use on CSH practices. It was found that education, gender, access to credit, and trust on information received through the mobile positively influenced mobile phone use on CSH. However, farmer's age negatively influenced the use of mobile phone on CSH. There is need for the central government to partner with private companies (such as Microsoft and telecommunication service providers) to develop agricultural communication regulations that would lead to provision of credible information that can be trusted by the farming community. The national government should also create credit policies that would improve accessibility of loans by farmers to enhance adoption of CSH practices. The County governments should build the capacity of agricultural extension workers and farmers on CSH practices based on the agro-ecological zones.

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