Vol 4, 2019 Issue, ISSN 2001-2837, Pages 24-40

International Journal of Technoscience and Development (IJTD)

Vol 4, 2019 Issue, ISSN 2001-2837

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Vol 4, 2019 Issue, ISSN 2001-2837, Pages 24-40

Digitization of Agricultural Extension Services: A case of Mobile Phone-based Extension Delivery in Central Uganda

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ABSTRACT

Agricultural extension services are essential for effective production at household level. Over the years, traditional extension delivery has metamorphosed to digitization of extension services including mobile phone-based platforms. Mobile phone-based extension delivery involves lay extension agents that use mobile applications; customised on a smartphone to disseminate agricultural knowledge and practices to last mile farmers in real time. This paper examines the mobile phone-based agricultural extension approach used in Central Uganda. I adopted agency-structure theory to analyse three research questions. Foremost, what kind of information is digitized on a mobile phone-based platform? Second, which extension services are adopted by smallholder farmers? Lastly, what are the motivational factors for farmers to adopt good agricultural practices disseminated through a digital platform? The study used a mixed methods research design; with 390 surveys, key informant interviews and focus group discussions. Study results revealed that five broader categories of extension information are digitized namely: agronomic, climate change, market information, financial services and others generalised practices. The perceived ease of use, usefulness and expected economic gains were the main drivers for adoption of mobile phone-based extension services. Agronomic practices were adopted more than others due to the perceived direct influence on agriculture production and productivity, as well as expected economic returns. Regular and intense interaction of farmers with extension agents, low cost information, use of pragmatic skills development techniques, social influence of extension agent to farmers and farmers' social networks also swayed adoption. However, amidst the desire to adopt good agricultural practices, smallholder farmers are constrained by poverty, adverse effects of climate change and technical know-how. Thus, to enhance farmers' use and adoption of digitized extension services, farmers' personal resources, social networks, a web of community extension agents and structures of producer organisations should be harnessed and strengthened.

Key words: Digitization, Mobile phone, Agriculture extension, smallholder farmers, agency-structure

1.0 INTRODUCTION

Agricultural extension services are essential for effective production and productivity at household level. Extension service delivery is a channel for disseminating innovation, expert knowledge and practices to a wider audience including farmer peer learning, farmer group networks, extension workers and farmers interface and feedback mechanism (Christoplos, 2010; Christoplos & Farrington, 2004; Davis, 2008; Hakiza, Odongola, Mugisha, & Semana, 2004; Isubikalu, 2007; MAAIF, 2016; McCole, Culbertson, Suvedi, & McNamara, 2014; Musemakweri, 2007; Vignare, 2013). Extension services enable farmers to acquire new products, services, practices and acquire inputs for better agriculture performance.

For the past four decades, Uganda's extension system has evolved with several approaches adopted at different historical moments according to changing governments and policies. Extension approaches have revolved around government regulation, advisory, educational and farmer led approaches to disseminate technologies (Agwaru, Matsiko, & Delve, 2004; Benin et al., 2011; Hakiza et al., 2004; Isubikalu, 2007; Musemakweri, 2007; Semana, 1999; Wairimu, Christoplos, & Hilhorst, 2016). For example, in 1998 to 2002 there was a paradigm shift in extension delivery; with pluralisation of extension including players from civil society organisations (CSOs), government and private service providers (Semana, 1999). Based on the previous experiences with mixed challenges and missed opportunities within extension delivery, the Plan for the Modernization of Agriculture (PMA) was instituted. Later National Agriculture Advisory Services (NAADS) program mandated by the NAADS ACT 2001, as a campaigner for agricultural extension service delivery in Uganda (Bahiigwa, Rigby, & Woodhouse, 2005; Benin et al., 2011; Davis, 2008; Isubikalu, 2007; MAAIF, 2010; Ninsiima, 2015; Semana, 1999; Wairimu et al., 2016). Nevertheless, NAADS has had its share of challenges such as; mismanagement of funds, policy uncertainty, political interference, embezzlement, under funding, high rate of farmer to extension workers, and exclusion of most farmers: focuses on economically active farmers as oppose to majority of poor smallholder farmers (McCole et al., 2014; Naluwairo, 2011).

Henceforth over the years, traditional extension delivery has metamorphosed to digitization of extension services including mobile phone-based platforms. The first mobile phone-based extension intervention was developed and implemented by Grameen Foundation with the Village Phone network. In partnership with MTN Uganda and Google, Grameen Foundation leveraged MTN's network of 35,000 public phone operators to test and deliver mobile information services to rural communities (Gantt & Cantor, 2010; Okyere & Mekonnen, 2012). In addition, a network of Community Knowledge Workers (CKWs) were identified, recruited and trained as mobile phone-based lay extension agents within their communities (Gantt & Cantor, 2010; Kimbowa, 2015; McCole et al., 2014; Ninsiima, 2015). The CKW experience precipitated other players to undertake digitized extension delivery approaches. A case in point is the Village Enterprise Agent (VEA) model implemented by the Sustainable Enterprises for Trade Engagement project in central Uganda; in the districts of Masaka, Kalungu, Lwengo, Bukomansimbi, Kyotera and Lyantonde (Mugabi, State, Omona, & Jansson, 2018).

Since 2014, Lutheran World Relief (LWR), her partners the Community Enterprises Development Network (CEDO) and Gutsinda Development Group rolled out a mobile phone-based agricultural extension approach using lay persons branded as Village Enterprise Agents (VEAs). Using smartphones reloaded with agriculture content inbuilt in the Kulima Application, VEAs disseminate agriculture information to rural smallholder farmers (Kimbowa, 2015; Mugabi et al., 2018). In response farmers are expected to adopt extension knowledge so as to improve on-farm production and productivity. The digitization of extension services is intended to reduce on the deficits in traditional extension service delivery characterised by very low extension worker to farmer ratio. For example, in Uganda extension officer to farmers ratio is at 1:2,500 against the FAO recommended ratio of 1:400 (Ongachi, Richard Onwonga, Hillary Nyanganga, & Okry, 2017). In essence VEAs are expected to mitigate the extension delivery gap, since they are farmers themselves, live in proximity to their peers as opposed to extension officers that are based at sub-county and district local governments.

1.1 *Kulima* Mobile phone-based Extension Platform

Gutsinda Development Group has put information in the hands of rural communities by developing and deploying *Kulima* mobile phone-based Platform. The *Kulima* application features an agricultural library with information on farming techniques across different value chains (Gutsinda, 2014). *Kulima* platform is named after a Luganda word *Kulima* which means to till or plough. *Kulima* mobile platform integrates image and voice capture to assist explaining practical good agricultural practices to farmers. The platform content package is designed in English language but translated into Luganda (appropriate indigenous dialect) by VEAs during dissemination session (Mugabi et al., 2018). VEAs deliver agricultural information in a style described as verbally, motion mimic, physical and written (Fangohoi, Sugiyanto, Keppi, & Edi Dwi, 2017). At a click VEAs share information with farmers during planned farmer visits and within groups. Below is figure 1 showing the screenshoot of *Kulima* mobile phone-based platform.

Figure 1: *Kulima* Mobile Platform
Sources: Adopted from Gutsinda (2014)

However, farmers' access to digitized extension services is not an end in itself, rather adoption of knowledge and practices is critical to improve on the quantity and quality of yields. Previous studies have asserted that end users' resistance or acceptance of the technology is a major driver for its adoption or non-adoption (Bell, 2015; Murendo, Wollni, de Brauw, & Mugabi, 2015; Mustonen-Ollila & Lyytinen, 2003). This though depends on the kind of technology infrastructure: where, for whom, by whom and for what communication and information is used, what is referred to as technology developers' and end users' perspective (Castells & Cardoso, 2006). Against this background, this article addresses three research questions. First, what kind of information is digitized on *Kulima* mobile phone-based platform? Second, which extension services are adopted by smallholder farmers? Lastly, what are the motivational factors for farmers to adopt good agricultural practices disseminated through digital platform?

1.2 THEORETICAL FRAMEWORK

Anchored in the above research questions, I adopted the actor oriented agency-structure theory to analyse study findings. Contrary to the structural theories, agency-structure theory puts a central position to social actors as conscious, active, powerful and constructive within a given social environment (Long, 1990). I apply the agency-structure theory to analyse the

agency of smallholder farmers as end users of digital extension services. The theory was used as an analytical framework to discuss the farmers' consciousness in making decisions about access to and use of particular mobile phone-based extension knowledge and practices. The theory was also applied to explain the structures that enable farmers' adoption of digitized extension services. Two theoretical concepts were used namely; the agency (capacity and knowledgeability) and subjective-objective duality (Bourdieu, 1977; King, 2000; Long, 1990, 2001; Sewell, 1992). The focus is on social actors with capacity to process social experience, devise ways of coping with life, even under the most extreme forms of coercion, uncertainty and the other constraints (Long, 1990). The concept of agency is premised on the notion that human beings are gifted by nature; with reasoning capacity and a will to make conscious decisions whether good or bad. The agency attempt to solve problems, learn how to intervene in the flow of social events around them, but this depends upon the capability of the individual to make a difference to a pre-existing state of affairs or course of events, also referred to as agent power (Giddens, 1984). In this study, the focus is on the agency of smallholder farmers within a micro household environment as opposed to institutional and organizational levels.

The agency is however exercised within a duality relationship; a given structural boundaries (social context) and rules of the game that have both a constraining and enabling effect on social behaviour of actors (Giddens, 1984; King, 2000; Long, 1990, 2001; Sewell, 1992). In addition, though human beings live within social boundaries, at the same time they reconstruct the practices of the structure (Long, 1990, 2001). The wellbeing of actors is a relationship between the structure and the agency; described as subjective-objective dualism (Bourdieu, 1977; King, 2000). Social structures are both constituted by human agency, and yet at the same time the very medium of this reconstitution (Giddens, 1984). Hence the agency of farmers functions along the social context of subjective; individual choices and actions, as well as structural boundaries. The duality relationship is not static though, rather it is fluid depending on how the actors constructs social reality to enhance her agency power. For example, smallholder farmers belong to social networks of groups as structures for diffusion of digitized extension services. Such structures operate within group dynamics, leadership and rules that are formulated by members themselves.

2.0 RESEARCH METHODS

The study adopted a mixed methods research design, combining both quantitative and qualitative methods and techniques in data collection and analysis. Specifically, I adopted the convergent parallel mixed methods (Creswell, 2014). The study involved 390 survey respondents, 9 key informant interviews and 7 focus group discussions (FGDs) conducted in central region. On one hand, the survey sample size of 390 participants was determined following the level of precision, level of confidence and degree of variability of the study populations (Israel, 1992).

The estimated number of farmers in central region (Masaka, Kyotera, Kalungu, Lyantonde and Lwengo districts) was 689,385 (UBOS, 2016), and out of which 17,000 had access to mobile phone-based extension services (Mugabi et al., 2018). In this case, I adopted Cochran equation to generate a representative sample (Cochran, 1963), to have a representative sample:

$$n_0 = \frac{Z^2pq}{e^2} \quad (1)$$

Where $\mathbf{n_0}$ is the sample size, $\mathbf{Z^2}$ is the abscissa of the normal curve that cuts off an area at the tails (desired confidence level is 95 percent which 1.96 on Z table), **e** is the desired level of precision (5 percent), **p** is the estimated proportion of an attribute that is present in the population (smallholder farmers in Uganda accessing mobile phone 52 percent (UCC 2015), and **q** is 1-p. Thus, the calculated sample size was 384 smallholder farmers, which was slightly adjusted to 390. On the other hand, purposive sampling was used to select specific FGD and key informant interview participants with exceptional experience and knowledge about mobile phone-based agricultural extension approach.

The study area was purposively selected due to the unique mobile phone-based extension service delivery intervention implemented since 2014. The selected districts were part of the Sustainable Enterprises for Trade Engagement project which implemented the *Kulima* mobile extension approach. In this study, central region includes the current districts of Masaka, Kyotera, Lwengo, Lyantonde, Rakai, Bukomansimbi and Kalungu. Thus, the study used a convenient sample of households that had access to digitizes extension services. I used a convenient sample because of the uniqueness; not every farmer within the study area had access to mobile phone-based extension services, to apply all rules of randomisation.

On one hand, quantitative data was collected using smartphones with customised Open Data Kit (ODK) web-based mobile data collection technology. The data was directly uploaded to the electronic system using the Smartphones at the end of every survey interview. The uploaded data entries were then exported into IBM SPSS Windows 25.0 computer software for analysis. Qualitative data were analyzed using Nvivo12 Computer Assisted Qualitative Data Analysis Software; based on specific attributes, nodes, ties and relationships corresponding to the key research questions.

3.0 RESULTS AND DISCUSSION

3.1 Demographics and socio-economic characteristics of farmers

It is imperative to contextualise the study findings as far as socio-demographic characteristics of participants are concerned. In terms of sex composition, 52% and 48% were female and male participants respectively. Almost all farmers (99%) live in male headed households and only 1% were female headed. Household headship is important in this community because head of household is responsible for day-to-day running and decision making, though he or she may not necessarily be the main household income earner (UBOS, 2017). My study has majority male headed households compared to national statistics where male headed households are 68% and 32% female headed (UBOS, 2017). This is because the study was conducted in rural agrarian community which is predominantly patriarchal. As opposed to the national statistics that combined both rural and urban households.

The median age of farmers was 49 years; 77% were above 35 years, and 23% were young adults between 18 to 35 years. In addition, 68% had primary and below primary level of education, 27% had secondary level and only 5% had tertiary education (mostly certificate) after secondary level. It was also revealed that most farmers have limited landholdings: 69% had less than an acre (0.41 hectares), 28% had one to four acres (0.41 to 1.6 hectares) and only 3% own more than four acres (1.6 hectares). Farmers hardly hired land; with an average of only 0.34 acres (0.14 hectares) hired for agriculture. Notably, 81% of farmers are *mailo* land holders (tenants as bonafide occupants) and 11% freehold. There were 5% with private *mailo* and 3% hold leasehold land tenure systems. The above socio-economic characteristics are critical resources and structures that enable or hinder farmers to exercise their agency as far as adoption of digitized extension services is concerned. Farmers' socio-economic characteristics are resources that provide various options and opportunities to make informed

decisions, influence change of attitude to participate in development including adoption of mobile phone-based good agricultural practices.

3.2 Digitized extension information on a mobile phone-based platform

The first research question was concerned with: what kind of information is digitized on a mobile phone-based platform? As a result, findings revealed five broader categories of extension information that were customized on *Kulima* mobile extension platform namely: agronomic, climate change, market information, financial services and others generalised practices. Digital agronomic information included all extension services related to site selection, planting materials, fertiliser application, spacing, weed control, crop management, pruning and pest and disease control among others. Climate change information included: weather information alerts, soil conservation, quality planting materials and agro-forestry. In addition, market information was concerned with post-harvest handling, storage, collective bulking and marketing through producer organisations. Financial services are associated with access to credit or agriculture financing and Village Saving and Loan Associations (VSLA). Lastly, other generalised extension services included record keeping, poultry and livestock management among others. To note however, *Kulima* mobile extension platform was lop-sided to crop production extension services more than livestock, fisheries and agro-forestry among other value chains. A review of *Kulima* mobile platform revealed considerable content packages based on mainly crop value chains such as banana, coffee, maize, rice and tomatoes. The digital agriculture library is tailored to the various crop seasonal calendar activities. Besides, key informants also underscored varied digitized extension services. For example, a male VEA (trained extension assistant) narrated that:

There is an application called *Kulima* where we find information concerning agriculture. For instance, about the growing of beans, knowing the different types of beans, the pests and diseases that attack the beans then I can go back to the farmer and see what is happening. The information is in English language that is easily understood. The information is sufficient enough; there is a lot of information in *Kulima* platform **(Male VEA, Kyotera District).**

The above narrative matches with the evidence in Figure 2 that shows a pictictorial demonstration of the various information digitized on *Kulima* mobile platform.

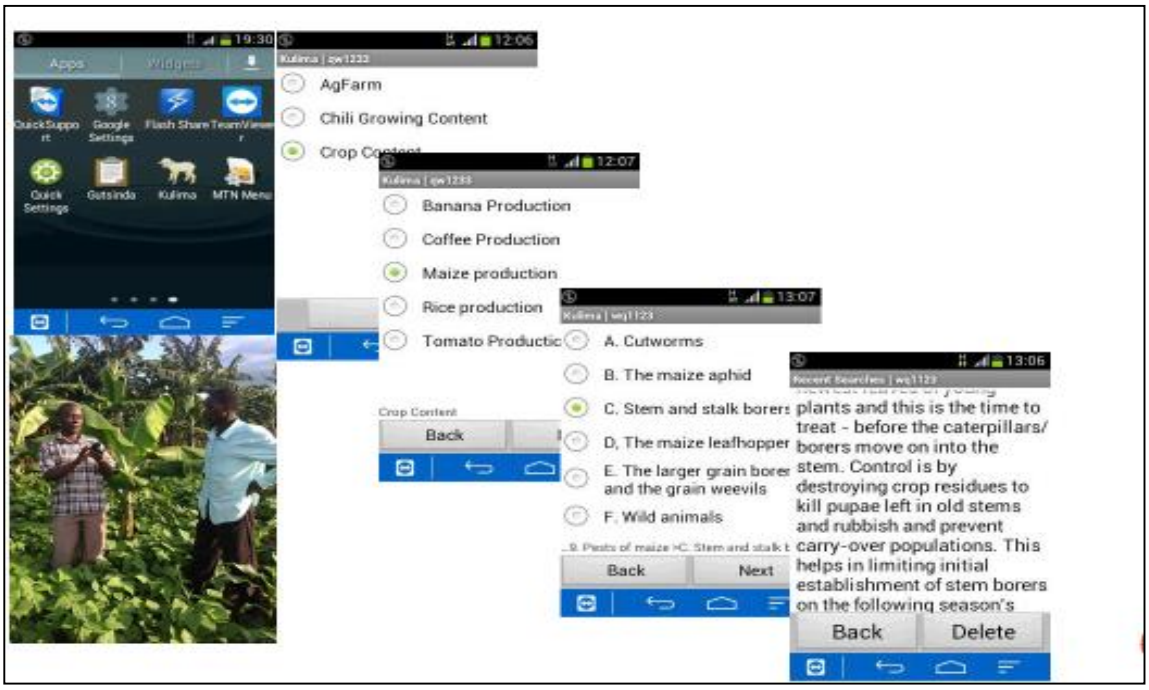

Figure 2: Information Disseminated to Farmers using *Kulima* Platform
Sources: Adapted from Gutsinda (2014)

From the above narrative and in figure 2 above, it is evident that the digitized extension information is mainly concerning crop production. The skewedness of *Kulima* mobile extension platform to crop production information is due to the fact that central region is predominant a crop production region. Studies have also made similar observation, historically, central region is an agricultural hub for crops and some livestock (Anderson, Learch, & Gardner, 2016; McCole et al., 2014; UBOS, 2014). Hence *Kulima* extension package also reflects the tradition extension systems that emphasise crop production extension service (agronomy), with less attention on financial services, climate changes and market information (Agwaru et al., 2004; Bell, 2015; Christoplos, 2010; Hakiza et al., 2004; MAAIF, 2010, 2016; May, Karugia, & Ndokweni, 2007; McCole et al., 2014; Naluwairo, 2011; Ragasa, John, Jose, & Thaddee, 2016; Vignare, 2013). However, agriculture is a very complex activity; it requires a balanced content package for farmers to receive extension services across all value chain. I argue that the content package digitized in *Kulima* platform was built on the traditional extension approaches that are based on agro-ecological production structures and social-cultural context of the area of study. In reality though, farmers engage in mixed farming; integrating crops and livestock, and intercropping of a variety of crops. Thus, the platform gives less options of extension services to meet the fused and ever changing extension needs of farmers.

3.3 Adopted digital extension knowledge and practices

VEAs disseminated mobile phone-based extension services on a presumption that farmers would in response adopt the good agricultural practices. Accordingly, the study sought to explore the digital extension services which were adopted by smallholder farmers. Adoption was analysed on the basis of disseminated digital extension services namely: agronomy, climate change, market information, financial services among other practices. It was found out that agronomic practices were the most adopted by smallholder farmers. The most adopted agronomic practices were; use of quality planting materials (85%), fertiliser and manure application (83%), pest and disease control (75%), site selection (68%) and crop

management (66%) among others. As far as market information was concern, most farmers adopted good post-harvest handling practices (77%), but least got market information; better market options and prices. In addition, farmers' adoption of financial services through savings and access to loan facility within Village Savings and Loan Associations was at 57%. Knowledge and practices on climate change were the least adopted, as seen in table 1 below.

Table 1: Kind of Extension Information Adopted by farmers

No	*Good Agricultural Practices*	*Overall*
	Agronomic Practices	
1	Site Selection	**68%**
2	Good planting materials	**85%**
3	Crop management	**66%**
4	Agro-Inputs	**54%**
5	Use fertilizer & mature	**83%**
6	Pest and disease control	**75%**
	Market Information	
7	Market information	**28%**
8	Post-harvest handling	**77%**
	Climate Changes	
9	Soil Conversation	**28%**
11	Weather Information	**32%**
12	Tree planting	**24%**
	Financial Services	
13	Credit and VSLA	**57%**
	Other Practices	
14	Management of poultry	**19%**

Source: Research data, 2017/2018, *n=390*

In table 1 above, all extension information given by the VEAs was vital, however, adoption of climate change mitigation practices, market information, financial services were still low compared to agronomic practices. Adoption of agronomic practices were also highlighted by most FGD participants as the most adopted. A case in point was one participant who recounted that:

We have been trained and gained new ideas on agriculture especially coffee growing. We decided that every farmer in our group should have not less than two hundred plants of coffee. All the new ideas are then applied to our farms at home. We also adopt possible agronomic practices such as spacing, weeding, fertiliser/mature application, stamping pruning among others. Secondly, we used to lose a lot of water in our gardens but now we dig trenches in

order to keep some water-water conservation ***(Male Farmer, Jjogoza Farmer field school, Kyotera District).***

The above findings demonstrated that while digital extension services are biased to crop agronomic practices, likewise farmers' adoption is skewed in the same direction. In this case, agronomic practices more than other extension services are perceived to improve on farm productivity. In essence, both digital extension and traditional extension approaches are based on rules of the game that are overly biased to agronomic practices. With less focus on practices to mitigate unstable market and access to financial services. Such lopsided extension delivery approaches also create propensity for askew adoption. Survey and FGD findings revealed that the skewed adoption was due to number of constraining socio-economic arrangements and structure namely; poverty, limited technique skills and subsistence nature of farming systems. The adverse effects of climate change, fragile markets and limited access to agriculture financing as well limited farmers' adoption rate.

On the other hand, basing on the agency-structure theory (Long, 2001; Sewell, 1992), it was evident that smallholder farmers use their agency to make appropriate choices about the variety of digital extension knowledge and practice to adopt. This demonstrated that farmers were knowledgeable about their agricultural information needs. For example, smallholder farmers' adoption of agronomic practices more than others, is engrained within their lived experiences characterized by poor agricultural practices, low and poor yields, deficiencies of indigenous knowledge and socio-economic context. Unlike market information, climate change and financial services that are perceived not to contribute directly to on-farm productivity and production experiences. Thus, smallholder farmers' selective adoption is attributed to the perceived value; which value is within socio-economic context and past experiences, as well as available resources to enable adoption of good agricultural practices. In addition, despite of the digitized extension services, findings show that adoption of market information was still very low. Farmers do not get better prices, there are unstable markets and exploitative tendencies of buyers. Farmers reported that agriculture produce buyers, majority of whom are middle men exploit them through wrong weighing scales as well as low prices and price discrimination. On the hand, the high levels of poverty (monetary pressures) led to side-selling; selling produce to local traders rather than farmer cooperatives and unions. Farmers have enormous monetary pressures and need quick money to settle household needs. On the contrary, another study in Uganda revealed that banana growers realised better prices than maize farmers after getting access to market information through a mobile network (Muto & Yamano, 2011). However, a related study about the poultry farmers' information needs in Kilosa, Tanzania, revealed that most farmers who used "UshauriKilimo" sought information on health management aspects, chicken feeds and feeding, chicken breeds and housing aspects but information on markets was the least used (Msoffe, Chengula, Kipanyula, Mlozi, & Sanga, 2018). Okello *et al* (2012) described the agricultural markets as idiosyncratic market failure coupled with lack of access to market information. This challenge was also underscored by a study on commercial farmers' intention to use mobile phone-based communication technologies for agricultural market information dissemination in Uganda (Engotoit, Kituyi, & Moya, 2016).

Basing on the agency-structure theoretical stance, while the actors make informed decisions after weighing causes of action (King, 2000; Long, 1990, 2001; Sewell, 1992), farmers are entangled in economic structures and rules of market liberalism. The challenge of fragile market and unstable prices is however not new. It is embedded in the neo-liberal policies and rules of engagement, that emphasise a reduction in the government's role in regulating prices and markets to benefit producers, amidst the collapse or weak instrumental farmer

cooperatives (MoFPED, 2017). I also argue that even with access to market information, farmers are less empowered to engage in collective bargaining, stick to cooperative principles: collective bulking, bargaining and marketing due to poverty and weak cooperative structures. Hence, the private players especially middlemen are left scout-free to determine market prices with less regard to farmers' interest and expected return on investment. The liberal market structures perpetuate farmers' exploitation. Thus, while digitized extension services have empowered farmers with a wide range of agriculture knowledge and practices, adoption of climate change, market information and financial services is still weak compared to agronomic practices.

3.4 Factors for adoption of mobile phone-based extension services

The last research question addressed by this article was to understand, the motivational factors for farmers to adopt good agricultural practices disseminated through digital platform. It was found out that most farmers are motivated by a number of factors namely; the need to increase on household agriculture production and income (67%), availability of agro-inputs (35%) and influence of fellow farmers (27%). Other motivations for adoption included farmers' desire to strengthen their knowledge and skills, availability of land, influence of VEAs, affordability of materials to use, acquired technical knowledge as revealed in table 2 below.

Table 2: Motivating Factors for Adoption

No	***Motivational Factors***	***Overall***
1	Availability of agro-inputs	**35%**
2	Affordability	**11%**
3	Availability of land	**25%**
4	Technical know-how	**13%**
5	To increase on production & income	**67%**
6	Influence of VEA	**10%**
7	Influence of fellow farmers	**27%**
8	Increase on Knowledge & skills	**25%**

Source: Research data, 2017/2018, *n=390*

In addition to the evidence in table 2 above, matching FGD and key informant interview findings also demonstrate that the most important driver for farmers' adoption of good practices was expected economic gains. Farmers' desire to increase on household agriculture production and income was key incentive to adopt recommended extension practices. For instance, most FGD participants stressed economic motives for adoption of mobile phone-based extension services, a case in question was a female farmer who gave an account that:

Farming is our main livelihood, no body engages in it to work for losses. We were trained in using smart phones, get agronomic information to practice better methods for better yields and income. We are taught farming as a business, and that is what every farmer wants to achieve. We even have a group as VEAs where we share information with others. If you get valuable knowledge which others have not got, then we can be able to share what we learned.

We want to be better and support our households ***(Female farmer, Butenga subcounty Bukomansimbi district).***

In addition, key informants affirmed to farmers' claims, underscoring economic gains as the most important driver for adoption:

Farmers look at the cost against output, for example, if you tell me to plant maize two by two and a half (spacing) in a certain area and then I get the same yield with someone who never even wasted time to do the same. The farmer will go and look at the cost of making line spacing, early weeding and such practices. So they look at what cost they incur in relation to output. That is what we call cost benefit analysis. Farmers do a cost benefit analysis in their own way and they are able to know the returns. In addition, farmers are driven by price e.g good price in previous season attracts farmer to invest in that crop ***(Masaka District Agriculture Officer)***.

In the above narratives, generally, farmers were mainly driven by utilitarian economic reasons. I assert that usefulness of extension services is embedded in expected economic returns for the end users, hence a driver for adoption. Households behavioural change to adopt good agricultural practices is determined by the confidence that the practices have better economic outcomes than what farmers have previously practiced. My findings reverberate with the argument that farmers use mobile communication technologies due to the greater performance such technology offers in their daily transactions (Engotoit et al., 2016). In essence, far from timely information dissemination of mobile extension as in the case with Napalese rural farmers (Devkota & Phuyal, 2018), adoption is entrenched in the expected economic benefits. This is true because economic returns give resources and strengthen capability sets for farmers to achieve the desired personal and household wellbeing. On the other hand, using the agency-structure theoretical concept of duality (King, 2000; Sewell, 1992), I assert that economic motives for adoption is also embedded within the capitalistic structures and rule of the game. The agency of the farmer is exercised within the context of capitalistic economic structures that focus more on profitability and economic gains and not otherwise. Economic motivate for adoption however are complemented by other drivers such as curiosity of farmers to prove whether the information received works, availability of land, agro-inputs, influence of VEAs, farmers' drive to continuous learning through pragmatic farmer field schools and demonstration sites among others.

Worthy mentioning, the influence of social networks was also reported as a driver for adoption. Influence of social networks of farmer to farmer (27%) and farmer to VEA (10%) was an incentive for adoption of mobile phone-based extension. Farmers' social ties and nodes were not only forms of identity and belonging, but also channels of communication, diffusion of mobile phone-based agricultural extension services and drivers of adoption. Farmers with the support of VEAs meet in groups, sharing information, exchange knowledge and benefits through peer to peer social learning. In addition, the influence of social networks on adoption was expressed by most farmers during FGDs. For instance, a FGD participant alluded that:

*Group membership has helped us a lot; we keep visiting each other's farm and check on the implementation of the good practices, we advise each other accordingly. We also ask the VEAs whatever we did not understand and what we forgot. The VEA reaches on the site and helps me to do the right thing for example pruning, digging trenches, fertiliser application and planting good seeds etc (****Female farmer, Butenga subcounty, Bukomansi district).***

Likewise, another participant explains the influence of group solidarity in facilitating adoption of good agricultural practices:
*…need to put a difference between those farmers who are in groups and also those who are not. We always want those other farmers (not in groups) to admire and see the value of being in groups. There is a time we were taught how to stamp coffee plants, but when I went back home and did it, some neighbours who were not in our group said that I had got a lot of money which has influence me cut down the coffee plantations. Little did he know I was simply putting in practise the good agronomic practices. The VEA gave us an example that someone who is having three hundred plants of coffee which are near each other (poorly spaced) and not well managed may get little output compared to someone who manages well the coffee gardens. Our coffee had grown older and they were not yielding much so we were taught to cut them down, so when we did it people laughed and never knew what we were doing. But now they are admiring the plants because they look very health (**Male Farmers, Lwanda Farmer's Cooperative Society Rakai district).***

In this case, the social influence of VEAs, farmer groups and cooperatives enhanced peer to peer learning. Farmers have a reference group influence in form of social pressure that yield people to perform a particular behaviour which would have not been the case if the actors live in isolations without significant others. Adoption is not only influenced by individual's perspective, but also influence of reference groups and collectivities (Durkheim, Simpson, & Spaulding, 1952; Giddens, 1984). In addition, previous studies have suggested that social networks aid social learning and information diffusion with ease; at no cost and information is likely to be given a higher value if it comes from trusted people (Katungi, Edmeades, & Smale, 2008). Likewise, the significance of social networks as a driver for adoption of innovations and extension information is underscored (Martin & Abbott, 2010; Thuo et al., 2014). Hence, mobile phone-based extension through fellow farmers and VEAs characterised by regular and intense interaction; pragmatic skills development techniques and low cost information created more propensity for adoption of good agricultural practices. On the other hand, non-adopters are less socially connected (Warren, 2002). Nonetheless, farmer groups and networks were found to be unique with variations in strength and weaknesses, group attributes; location, gender and agriculture enterprises engaged in. The power of social network is described as social influence: the prediction of the users' intention to use technology based on perceptions of the significant others' thoughts about the individual performing a specific behaviour (Venkatesh & Davis, 2000; Verma & Sinha, 2018). Social influence drives adoption because farmers trust each other more, are able to relate freely and make a livelihood under similar socio-economic conditions. Farmers also believe that their fortunes will improve if they adopted just like the other farmers who have benefited. To note however, although social networks were vital in driving adoption, they are not absolute. Social networks should be understood within the existing social arrangements; with constraints of inequalities, limited resources and varying power relations that could as well constrain the farmers' agency and capacity for effective adoption of good practices.

Despite the novelty of digitisation of agriculture extension services, findings revealed that non-adoption was attributed to the factors related to inadequate resources: limited capital and some techniques are not applicable in the socio-economic context with limited investment capital. In addition, some farmers also reported adverse effects of climate change characterised by erratic rains and long drought spells, poor attitude or mind-set towards recommended agriculture practices, limited and expensive labour and agriculture financing as deterrents for adoption. Whether farmers access and use digitised or traditional extension approaches, these challenges cut-across and hamper the adoption of good agricultural practices at the farmer level.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The study was guided by three main research questions: what kind of information is digitized on a mobile phone-based platform? Which extension services are adopted by smallholder farmers? Lastly, what are the motivational factors for farmers to adopt good agricultural practices disseminated through digital platform? I therefore conclude that smallholder farmers have complex, insatiable and ever changing extension needs based on fused agricultural enterprises. To address these extension needs, knowledge and practices in agronomy, climate change, market information and financial services were digitized on *Kulima* mobile platform. VEAs as community extension agents use *Kulima* mobile phone-based extension platform to support fellow farmers within their radius through social networks of farmer groups. The digitised extension services are built on the VEAs and farmers agency-structure relationship. The duality of such a relationship depend on the farmers' resources, extension agents' accessibility and proximity to the farmers, farmer group structures; embedded in collective social rules and strong ties. However, unlike the traditional extension approach, digitized extension services are still limited in scope and content package; only covering crop farming, with no content on livestock, fisheries among other value chains. The disproportionate digitised extension information does not address all the extension needs of farmers. In essence, digitized extension services in the current form cannot be an independent alternative approach, rather are blended with traditional extension approaches. Intensive research and modifications in digitised extension service is required to ensure comprehensive agricultural content package on a wide range of enterprises; tailored to farmers' extension gaps.

Smallholder farmers leverage their agency to choose the perceived appropriate practices to adopt or not to adopt, with majority adopting agronomic practices that are perceived to directly enhance their production and productivity. Farmers consider agronomic practices to have more direct contribution to their production as economic value more than climate change, market information, and financial services among others. This does not negate the fact that apart from agronomy, agricultural practices are equally important and affect the farmers directly and indirectly. Results show that low cost information and expected economic gains were the main drivers for adoption of mobile phone-based extension services. Intense interaction of farmers with extension agents, pragmatic skills development techniques and social influence of extension agent to farmer, and farmers' social networks also swayed adoption. Smallholder farmers leverage their knowledge, skills and capacity to make decisions about the variety of good agriculture practices to adopt or not, its potential value: things of values to an individual farmer to enhance their agriculture production and welfare. Thus, farmers' behavioural change to use good agricultural practices is dependent on their attitude, perceived benefits, ease of use and usefulness of the practices than what they have been using previously.

However, amidst the desire to adopt digitized practices, smallholder famers encounter structural challenges: economic, environmental, technological and technical know-how. Thus, to strengthen adoption, personal resources, social networks, a web of community extension agents, producer organisations should be strengthened as vital resources, channels of dissemination and adoption of mobile phone-based good agricultural practices. Besides, government in partnership with both private sector and civil society organisations should strengthen and scale-up of the network of VEAs and other lay extension workers to support many agrarian households. The VEA network empowered with mobile phone-based application, and blended with appropriate traditional extension techniques to drive diffusion

of new agriculture innovation, ensure effective adoption, and support supervision: on-spot checks, mentorship of farmers, and report on emergencies for swift interventions.

5.0 ACKNOWLEDGEMENT

I am grateful to the Makerere University-Sweden Bilateral Research Program (MAK-SIDA Program) 2015/2016 Project 313-2014, with funding from Swedish International Development Agency (SIDA) whose support enabled me to conduct this study. Secondly, I appreciate my doctoral supervisors: Prof. Andrew Ellias State and Prof. Julius Omona at Makerere University, Uganda, and Dr. Birgitta Jansson at the Department of Social work, University of Gothenburg, Sweden for your mentorship, guidance and comments on the article.

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