

ICT supported Extension Services in Conservation Agriculture Information Access for Small Holder Farmers in Laikipia County, Kenya

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Abstract - This paper examines how Information Communication Technologies (ICTs) are used in the Conservation Agriculture (CA) knowledge pathways. It discusses the parallel knowledge pathways smallholder farmers' use to access conservation agriculture information. The objective of this study is to develop an effective dissemination model that exploits the use of ICTs in existing pathways in order to improve Conservation Agriculture knowledge flows.

Design, Methodology and Approach: A total of one hundred and twenty-five respondents were interviewed, with a purposively selected sample of 110 CA farmers interviewed using semi-structured questionnaires. Using the snowball method, 15 key informant interviews were conducted with Policy makers and ICT service providers. 69% of the respondents were female and 51% male. The focus of the study was on the different ICTs used in the CA knowledge pathways, the dissemination pathways, institutional and socio-economic factors. Data was analyzed manually and using SPSS ver. 21.

Preliminary findings indicate that a variety of knowledge pathways exist through which farmers can access CA knowledge. Four different kinds of ICT led models were identified, Government ICT led models, Government-NGO led models, Government-NGO-Private Sector ICT led model and NGO ICT led models. However the study notes a lack of harmonization and weak linkages between institutions in the utilization of the existing ICT models, utilization of the ICTs access and ownership at the household level and harmonization of the CA messages. Furthermore, even though there was 100% mobile phones ownership, 94% radio, 64% television, 10% Laptop and 9% Computer (desktop) access and ownership among the respondents, farmers and a large number of the extension staff lacked the skills to fully exploit the use of these tools to access CA knowledge.

Implication: New emerging and existing communication technologies have a very high potential to improve agricultural knowledge flows if taken advantage of by the "change agents" in the diffusion process of new innovations. New online technologies

known as Web 2.0 and 'social media' are slowly emerging as platforms for collaboration, sharing of product and market information. Open chain models of village information centres also provide numerous economic opportunities, and do also network communities while providing public/private services. The opportunity of using real time communication tools has been greatly embraced especially by the youthful farmers and the advantage of these new emerging tools is their unique attributes, similar to the traditional oral cultures of communication seen in the African social systems where one can see, hold a discussion, get immediate feedback and use the written media to convey messages. **The high percentage of ownership and accessibility of ICTs among the survey population also offers the potential to fully exploit ICTs in the improvement of the CA knowledge pathways and agricultural information provision.**

Keywords - ICTs, ICT models, Conservation Agriculture, e-extension, knowledge pathways, farmers, Laikipia, Kenya.

I. INTRODUCTION

One of the targets of the Millennium Development Goal No. 8, emphasizes the benefits of new technologies, especially Information communication technologies in the fight against poverty. E-Agriculture was one of the outcomes of the MDGs following the World Summit on the Information Society meetings in 2003 and 2005 respectively. Agriculture was one of the development sectors discussed, and looked at how ICTs could improve agriculture and contribute to rural development. (Mekonnen and Okyere, 2012). The use of ICT applications in agricultural knowledge pathways offers the potential for wider dissemination and awareness of agriculture information. This paper therefore discusses the use of different ICTs models in improving the CA knowledge pathways.

Conservation Agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. The term

summarizes a farming concept that embraces the simultaneous application of three basic principles of minimal soil disturbance through limited or no-tillage practices, permanent soil cover, with either dead mulch or cover crops, useful crop rotations that are in line with local preferences. It is a way of farming, that conserves, improves, and makes efficient use of natural resources through integrated management of the available resources combined with external inputs” (Kassam, Frederick, Shaxson, Pretty, 2009).

Conservation Agriculture has been practiced in Laikipia County for more than twenty years, but uptake has been generally slow. The technologies and knowledge required to enable smallholder farmers reach their production potential are already in existence, however the slow uptake of these technologies has mainly been due to technology barriers, limited access to information and lack of knowledge on what appropriate dissemination channels to use. (Sseguya H., Mazur R., Abbot E. and Matsiko F., 2012; Jones, 2013). In response to this challenge, the use of e- extension in the Conservation Agriculture knowledge pathways has been introduced by governments and NGOs to support the conventional approaches of information dissemination and extension services.

CA Knowledge pathways. A knowledge pathway is the knowledge acquisition process, where actors generate, acquire and share information on a particular product. It is also the methods and different approaches that agricultural extension services use to disseminate CA technologies from research to small holder farmers. It is based on the premise that knowledge diffusion occurs through multiple pathways. CA knowledge dissemination in Africa was introduced through on- station, on-farm trials and experimentation to enable small holder farmers adapt CA technologies to their own environment. These dissemination approaches however, were not designed to reach all farmers but a few selected Farmer Field schools (FFS) and individual farmers, unfortunately this trend has continued until today. In Laikipia County, CA has been promoted through various pathways. These include the Farmer Field schools, field days, radio programs and trainings (Kaumbutho, Kenzle, 2007). In addition lead farmers, service providers, the private sector especially input suppliers have been active in CA knowledge transfer. Other pathways include Communities of practice, national CA task forces and student placement on CA research projects within organizations.

The theoretical Framework

This study is anchored on two theories, the Diffusion of innovations theory and the Social Network theory. The Diffusion of Innovations theory seeks to explain how, why and at what rate new ideas and technology spread through cultures. The diffusion theory has four main elements that influence the spread of a new idea, the innovation, communication channels, time, and the social system (Rogers, 1995). These four elements work in conjunction with one another. To complement this theory, the study uses the Social Network theory and focuses on the connectionist view, where a network is seen as a set of connections through which resources like information, knowledge and new technologies flow freely and effectively and where social networks play an important role in the diffusion of an innovation. Social processes are part of knowledge systems in societies. Knowledge initially exists in the mind of an individual and is transmitted through social groups, networks and practice. (King W. R., 2009) To enable

replication of practices and spread of knowledge, pathways that facilitate the flow of information are created and supported through transmission channels. Conservation Agriculture is an innovation in the traditional farming systems, the awareness of such an innovation depends to a large extent on the nature of the communication channels and the social systems within which the diffusion is taking place. Within social systems, are networks through which information flows and innovations occur. These networks may be open or closed networks therefore influencing information flows. This study therefore focuses on the three elements, the innovation, the communication channels and change agents in the diffusion theory and from the social network theory, the network structures in the social systems.

II. MATERIALS AND METHODS

Data was collected from the two sub counties of Laikipia East and Laikipia North in the wards of Tigithi and Ngobit through key informant interviews using interview guides and a household survey using semi- structured questionnaires. Both qualitative and quantitative approaches were used. Data was analyzed both manually and using SSPS software. Responses from the open ended questions were transcribed, coded and categorized to enable study of the merging patterns. The focus of the study was on the knowledge pathways farmers’ use to access agricultural information, the different dissemination pathways, the different ICT models, the use of ICTs in the knowledge pathways, the ICT providers in the county, access and ownership of ICTs at the household level and the most appropriate ICTs farmers use to access CA information.

Laikipia County is a semi-arid area, averaging 650 mm of rainfall annually. Located on the leeward western slopes of Mt Kenya, both its culture and its topography are diverse. Farmers keep livestock and grow subsistence and commercial crops like maize, beans, potato, wheat and horticultural crops like cabbage, tomato and snow peas.



Fig. 1. County Map of Laikipia Study site

III. RESULTS AND DISCUSSION

Overview of knowledge pathways in Laikipia County:

Knowledge pathways are the different ways in which extension services disseminate agricultural information and technologies from research to small holder farmers. It is based on the premise that knowledge diffusion occurs through multiple pathways. This study found a diversity of channels through which agricultural advisory services are offered to farmers.

These included both the conventional and ICT led services. Table 1: below shows the thematic presentation of the different dissemination channels and pathways used in Laikipia County.

TABLE I. AGRICULTURAL DISSEMINATION CHANNELS AND KNOWLEDGE PATHWAYS

Category	Description
Conventional Extension	<ol style="list-style-type: none"> 1. Barazas - local community meetings 2. Field days – Farmers and promoters show case technologies 3. Farmer Field Schools- Demonstration plots of new or improved technologies and Farmer to farmer trainings 4. Field Extension officers visits to farmers 5. Farmer to farmer visits
Specialized extension packages	<ol style="list-style-type: none"> 1. Exchange tours 2. Household Economic empowerment program 3. Agricultural shows of Kenya 4. Brochures by organizations 5. Posters by organizations 6. County Magazine- The Laikipia County Times.
ICT extension	<p>Government e- extension program introduced in 2014. In this system, an E-extension officer generates farmers’ databases and these are used to update farmers on inputs, weather changes, diseases and pests, creating a platform for information dissemination. Officers have been equipped with laptops, modems and mobile phones and they can source for information online from different sources. Information is disseminated using sms, calls, farmer visits, exhibitions and information desks.</p> <p>The ICT models</p> <ol style="list-style-type: none"> 1. Website + databases + Mobile phone (sms) 2. Mobile phones (calls) + farmer visits 3. Mobile Phones (sms) + social media (twitter & facebook) 4. SMS + Emails 5. Media <ul style="list-style-type: none"> ▪ Television- national broadcasts ▪ Radio (FM) - Sauti ya Mwananchi Radio, Musyi Radio and Inooro FM 6. Main websites used are the Agricultural Information centre, Kenya Meteorological Services, Agricultural Sector Development Support Program and ALIN

A. Conservation agriculture knowledge pathways and linkages

The main knowledge pathways through which CA knowledge reaches the farmers are crosscutting and the three main categories identified were the (i) the conventional pathways, (ii) the specialized packages which are project based and require high budgets to run and (iii) the ICT based extension. The activities in these categories were cross cutting and there was limited linkages and collaborations across the implementing institutions. The study found out that the institutions performed similar activities each with its own set of messages and dissemination pathway, with the risk of duplicating and/or sending conflicting messages to farmers. NGOs at 41% were the major disseminators of CA information, Governments at 22% and fellow farmers at 11% as illustrated in *Table 2*, below.

TABLE II. MAIN SOURCES OF CA INFORMATION

Table 2: Main sources of CA information

Sub county	Non-response	FFS	Fellow Farmer	Government Extension	NGOs	Trainings	Field days	Total
Laikipia East	0	2	11	3	27	1	11	55
Laikipia North	4	9	1	21	18	0	2	55
Total	4	11	12	24	45	1	13	110
Percentage	4	10	11	22	41	1	12	100

B. Institutional factors influencing the use of ICTs

Institutions provide the most suitable environment for CA extension, (Balarabe.O.et al, 2009) since they provide an enabling governance and institutional environment needed to promote CA (FAO, 2012). Balarabe O., et al (2009) ascertain that complementarily to agronomic designing of CA, institutional adaptation is necessary and should be based on certain key institutional factors which among others include access to markets. Market imperfections which include failure of providing certain facilities like access to credit, agricultural inputs, or information may in certain conditions influence the farmers’ decision to invest in CA. Although there were institutional linkages existing between a few institutions like the ASDSP program with the Kenya Meteorological services and the Arid Lands information Network, most of the linkages were between the NGOs and the County government and the NGOs and individual extension officers respectively. The County government however was in the process of mainstreaming CA by allocating a budget for it as well as spear heading a multi-stakeholder framework and co-financing approach.

C. Main ICTs used to access CA Information

Mokotjo W, Kaluspa T, (2010) indicate that the available technologies, if adopted by farmers, can enhance agricultural production considerably. During this study, it was found that ICT technologies exist both at the higher tier level down to the farmers’ level. A government e-extension system rolled out nationwide in 2014, provides a solid base, upon which organizations could take advantage to improve use of ICTs for CA dissemination in the county. The study showed that at the household level, 56% of the farmers could access CA information through mobile phones and were receiving information through sms, 31% could access through the radio and 5% through televisions. The availability of ICTs at the household level, for instance ownership and access to mobile phone was at 100%, Radio at 94%, television at 64%, laptop and computers (desktops) at 10% and 9% respectively indicated that there was a high potential for the use of ICTs to disseminate CA knowledge, however how the “change agents” made use of these modern technological opportunities to enhance agricultural information flow was minimal. Figure 2, below illustrates the ICT ownership and access at the household level.

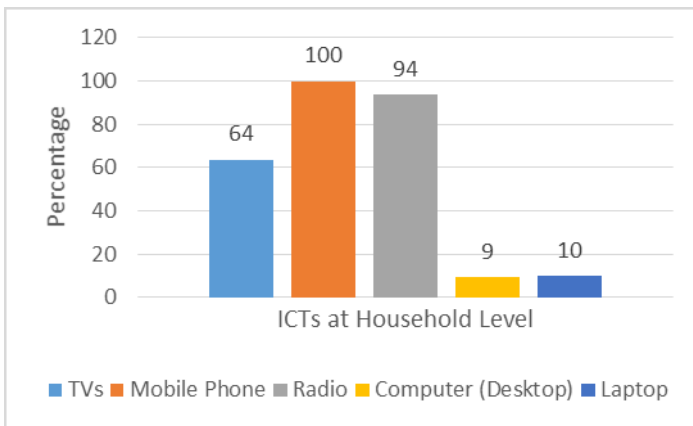


Figure 2: ICT Ownership and access at household level

D. Best ICT for CA Information

The use of ICT applications offers the potential for wider dissemination and awareness of the CA practice. ICTs have two main advantages, first farmers would be able to access content in different formats and secondly they would take advantage of the different options using voice, video, a mix of voice and data and on-line platforms. Response from the survey indicated that farmers preferred the radio at 53.6% as the best media for accessing CA information, followed by the mobile phone at 27.3%, the television at 10%, Newspaper 3.6% and the Information kiosk at 1.8% respectively.

E. Use of ICTs in the knowledge pathways

Radios especially the community radio is a prominent tool for disseminating agricultural information because they are able to reach remote areas. (Siraj 2010; Mokotjo and Trywell 2010). Indeed during this survey, radio (53.6%) featured as the prominent ICT tool for disseminating CA Information. Although there was no physical radio station in Laikipia at the time of this study, three radio stations, Inooro, Musyi and Sauti ya Mwananchi had reporters on the ground and the radio frequencies covered the whole county. Part of the reason for the choice of the radio could also be attributed to the use of the local language “Swahili” as the language of broadcast and this gives opportunity to the farmers to call in and to ask questions during the shows in the local dialect.

Banks and Burge, (2004) suggest that one of the advantages of the mobile phones over other forms of technologies is that the mobile phones are more accessible in areas that lack ICT infrastructure and are affordable because of prepaid phone cards. The oral nature of African societies further make it a better communication tool able to reach a large number of people. Beyond connectivity they offer security and mobility to owners and require basic literacy. In addition to voice communication they allow for transfer of data which can be used in context for applications for purposes of agriculture (Rashid and Elder, 2009). In Kenya, a study conducted to understand the actual usage of mobile services, products, and applications at the Base of the Pyramid (BoP) found out that over 60% of the respondents among the Kenyan BoP owned a mobile phone. (Crandall A. et al, 2012). Indeed during the survey, ownership of mobile phones was at 100% among the respondents. The convergence of the use of the radio and mobile phone offers a powerful communication model that can be exploited to strengthen the traditional knowledge pathways.

The Television although a powerful and an attractive medium in reaching out to many people quickly, serves an important and valuable function in stimulating interest in new ideas but many people cannot afford it. It also uses electricity and most rural farmers reside where electricity grid lines do not pass in Africa. During this study, the use of TV to access CA information came as the third choice at 10%, however access at the household level was at 64%, implying that previous studies, by Siraj (2010) indicating that many people could not afford it, and the fact that it also uses electricity since most rural farmers reside where electricity grid lines do not pass in Africa could be changing fifteen years down the road. Respondents in this study suggested that after the radio and mobile phones, TV was the next best alternative ICT at the household level.

TABLE III. BEST CHANNEL FOR CA INFORMATION

CA dissemination channels	Frequency	Percent	Valid Percent	Cumulative Percent
Field day	34	30.9	30.9	30.9
Farmer Field School	13	11.8	11.8	42.7
Trainings and Workshops	13	11.8	11.8	54.5
Fellow Farmers	3	2.7	2.7	57.3
Television	1	.9	.9	58.2
Others	8	7.3	7.3	65.5
Radio	19	17.3	17.3	82.7
Mobile Phone	19	17.3	17.3	100.0
Total	110	100.0	100.0	

The use of computers to provide internet services has increased and a number of agricultural information technology systems have been developed based on web technology. The internet has improved the provision of agricultural information among agricultural researchers and extension workers but not among smallholder farming communities due to the lack of ICT infrastructure in most rural areas and the high monthly internet access rates. And this still seems to be the case. However the majority of the government extension officers use the internet in the e-extension program to access websites and social media platforms to access agricultural information. In addition, the County Government, the NGOs and all media houses had organizational websites. For the print materials like newspapers, the main challenge has been on the knowledge of their existence and accessibility of such materials. In the county, there was one newspaper, the ‘Laikipia Times’ which did not specifically cover agricultural issues, but covered general issues happening in the county, including agriculture. Some articles on CA were covered in issue 37 of April 2015.

The combined use of Radio and Mobile phone provide a powerful ICT channel in supporting the use of Field days (30.9%) which was the most preferred knowledge pathway for dissemination of CA information.

IV. ICT LED BASED MODELS AND THE POTENTIAL TO REACH OUT TO FARMERS

Four ICT led models were identified during this study. These included Government led ICT models, Government-NGO ICT model, Government- NGO Private Sector model and NGO ICT models.

Model one, the Government based ICT led model is an E-extension agricultural system introduced nationally by the government of Kenya in 2014, to support agricultural extension services in the country. Through the Ministry of Agriculture, 654 E-Extension agents were trained nationally and each equipped with a smart phone, a laptop and a modem to enable extension officers reach out to more farmers effectively. Through an innovative approach of using sms, farmer training, whatsapp messaging tools and farmer visits, extension agents are placed at the county and ward level and use a push and pull method to disseminate information. It is a cost sharing approach where by farmers have to incur some costs in the form of airtime to be able to make calls or send sms inquiries. This e-extension service, complements the traditional extension channels used to disseminate agricultural information to farmers.

The second one was the Government- NGO led ICT model, where the county government was collaborating with some government agencies like the Kenya Meteorological Services, Agricultural Sector Development Support Program and NGOs like the Arid lands Information Network to provide climate and market information to farmers using sms each agency with its individual ICT platforms and approaches.

The third one was the Government-NGO-Private sector model, where the county government was collaborating with financial institutions like the Kenya Women Finance trust to provide financing linkages to farmers and was also collaborating with the media, Inooro radio, Sauti ya Mwananchi, Musyi radio and the Laikipia county times and Centre for training, Research and Dissemination to disseminate agricultural information.

The fourth one NGO ICT led models had NGOs providing information services using radio programs, information kiosks, websites and sms services. These were not exhaustive unlike in the models where there were more than one collaborative arrangement. The NGOs included ACT, ALIN, CETRAD, CARITAS and the Lutheran World federation.

The Potential of the ICT models

All the four models discussed above use multiple ICT tools with combinations of two or more ICTs as well as different approaches. (i.e websites, radios, mobile phones, laptops, social media apps, print materials and face to face meetings). Use of robust combinations of ICTs offer massive potential of reaching out information to large numbers of farmers. For example the Government based ICT led model was using a combination of institutional websites, mobile phones, laptops, the whatsapp app and radio. The extension agents had a target of reaching seven million farmers annually as opposed to the conventional extension system reaches less than two million farmers. This kind of model has taken advantage of the mobile phone and internet penetration rate which by September 2014 stood at 32.8million (80.5%) and 23.2 million subscribers respectively (Communications Authority Kenya, 2014) on the assumption that some of these subscribers were farmers. Therefore such a model has the potential to foster food security

through adoption of innovative communication pathways to reach massive numbers of farmers with up-to-date information. Secondly Government already has well established and stable institutional infrastructure nationwide, with government extension officers who can easily reach a wide population.

The use and harmonization of information that goes out to the farmers from a diversity of sources of information, for instance in the Government-NGO led ICT model partially addresses the challenge of offering unharmonised messages to farmers and attempts to resolve the challenge of looking for information from different sources for both the farmers and extension agents. Governments and NGOs are main sources of agricultural information in farming communities (table 2), this potentially offers a diverse knowledge platform.

Providing farmers with information, knowledge and skills alone has generally not been adequate to ensure adoption of technologies Government-NGO-Private sector model, where the county government collaborates with financial institutions like the Kenya Women Finance trust to provide financing linkages to farmers ensures that farmers have access to financing and can therefore afford inputs and other farming equipment to be able to produce according to the market demands. Knowledge and skills alone is not enough to ensure successful adoption, however the involvement of private sector is critical and linkages to their knowledge platforms is important in ensuring access to the kind of services they provide.

The fourth model NGO ICT led primarily focuses on specialized agriculture information and have specific target groups. For example the African Conservation Tillage Network promotes the Conservation agriculture farming system. The organization therefore collects and disseminates information on Conservation Agriculture through its website, radio talk shows, documentaries, and social media and compliments this with the conventional field days, trainings, shows etc. Though this is a good model in the promotion of innovations because of its specialized focus, this model however does not wholistically address the diverse information needs of the farming communities.

Social systems among farming communities influence information relationships, the flows, the channels to use and provide a platform for successful transfer of knowledge from one generation to the next. With the combined models discussed above, the risk of passing on outdated and inadequate information is significantly reduced as current and relevant information becomes easily accessible. Use of voice channels and basic phones take advantage of social networks within the farming communities to transfer information on new innovations and even the weak linkages that would have formerly not benefited from the traditional extension systems are reached. Therefore the potential of using ICT led model in knowledge transmission cannot be underestimated as they fasten the communication and feedback processes.

A. Implementation Challenges

The challenges of implementing ICT initiatives are contextual and range from fragmented ICT initiatives, duplication of services across institutions, technological and infrastructural issues, as well as social and economic issues. Matavire et al, reiterate that ICTs in the developing world are often naively adopted without sufficient consideration to the

social, cultural and historical context in which implementation occurs.

During this study, some of the implementation challenges identified included but were not limited to skill challenges, infrastructural issues, institutional challenges, misinterpretation of short messages sent through mobile phones and fragmented ICT initiatives.

Some of the extension staff in government were non ICT compliant and therefore could not use the laptops given under the e-extension program. A skills assessment would have indicated what type of training would be needed for the extension staff before the roll out of the program, however it was difficult to assess if this had been carried out. Lack of skills however was observed to be both at the farmer level and institutional implementation level.

Electricity and other alternative power sources to charge the phones and laptops especially in the remote areas was not widely distributed. This meant that both the extension staff and farmers could not charge their phones as and when they needed to thus rendering the tools not useful at certain times.

At the institutional level, lack of coordination and proper collaborative efforts meant that messages sent out by the different actors sent mixed signals among the farmers. At the farmers' level, the challenge was in making sense of the short messages sent through sms therefore leading to misinterpretation. However some of the farmers suggested that if such messages were followed by radio talk-shows they would be able to call in to ask or clarify issues that did not seem clear to them.

V. CONCLUSION

The use of ICTs in agriculture is rapidly spreading as new and more technological innovations and applications are developed. The traditional practice of disseminating agricultural information through field days, farmer field schools and training is expensive and reaches small numbers as opposed to when supported by the use of innovative ICT models. In the rapidly evolving knowledge society, and technological advancement, the study showed that a combined use of radio and mobile phone to support the traditional agricultural extension systems could be exploited to communicate CA information. At the farmers' level, lack of skills proved to be a major challenge and the short messages provided through sms did not clearly communicate the messages. However the preliminary findings indicate that a number of ICT models exist and these could be fully exploited to provide agricultural information to small holder farming communities, if the challenges identified are addressed appropriately. The Government e-extension system that uses existing ICT platforms through collaborative efforts provides a unique sustainable model though at the same time, it should be noted that this comes with its own challenges that should be explored. Institutional collaborations therefore would need to be further examined as this could provide harmonized use of platforms as well as authentication of technical content. Furthermore mainstreaming ICTs and agriculture within the government agricultural extension framework provides it with more leverage and opportunities for multi-stakeholder e-extension systems. Therefore strategic interventions are needed at institutional level for supportive frameworks that enhance

the use of ICTs and take advantage of the opportunities these models provide.

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LIST OF ACRONYMS

ACT	African Conservation Tillage Network
ALIN	Arid Lands Information Network
ASDSP	Agricultural Sector Development Support Program
BOP	Base of the Pyramid
CA	Conservation Agriculture
CETRAD	Centre for Training, Research and Dissemination
FAO	Food and Agriculture Organization
ICTs	Information and Communication Technologies
LWF	Lutheran World Federation