An Analysis of Communication and Information Communication Technologies Adoption in Irrigated Rice Production in Kenya

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ABSTRACT

The objective of this paper was to examine Communication and Information Communication Technologies (ICTs) adoption in irrigated rice production in Mwea Irrigation Scheme, Kenya. A descriptive survey was adopted and it used both qualitative and quantitative methods. The cross-sectional survey design was adopted. The target population for the study were 6,500 households in the Mwea Irrigation Scheme, Kirinyaga County. The sample size for the study was 362 respondents and the researchers were able to collect 96 completed questionnaires which were used for data analysis. The sample of the study was therefore selected from the respondents identified in the primary indicative study. The researcher adopted the questionnaire as the primary tool for data collection which was administered to the respondents. Key informant interviews were used to collect data from the County Executive Committee (CEC) member in charge of Information Communication and Technology (ICTs) in Kirinyaga County, two extension officers and two agricultural officers. Descriptive statistics were used to summarise the data and create categories of responses for interpretation. The study found that ICTs were used to source for information on available paddy seed varieties, prices of the paddy seed and packaged rice. The major barriers facing ICT adoption among irrigated rice farmers in Mwea Irrigation Scheme in Kenya are lack of training, lack of ICTs skills and inability to use and cost of ICTS and/or funds and the most influence of ICT adoption among rice farmers was increase in rice production output, followed by increase of farmers' skills/knowledge in rice production and accessing agricultural market information. The study concludes that ICTs are used to source for information on available paddy seed varieties, prices of the paddy seed and packaged rice; that major barriers facing ICT adoption among irrigated rice farmers in Mwea Irrigation Scheme are lack of training, lack of ICTs skills and inability to use and cost of ICTS and/or funds and that the most influence of ICT adoption among rice farmers was increase in rice production output, followed by increase of farmers' skills/knowledge in rice production and accessing agricultural market information. That adequate workshops, training and awareness should be given to the rice farmers and be promoted by the county and central governments and other private organizations. That authorities should establish ICT centres in the rice irrigation schemes to provide rice farmers with access to ICT tools and services which may not be available to all farmers to utilise according to their needs. That media owner should broadcast more agricultural programmes on both radio and television and should make sure that the programmes are broadcast at appropriate and convenient times for farmers.

1.1 Introduction

Agriculture is the backbone of the Kenya's economy and it contributes to higher Gross National Production (GNP) for the country (Kenya National Bureau of Statics [KNBS], 2013). The demand for agricultural products in Kenya is increasing annually with the population that grows at an average rate of 2.27% per year. Achieving this continuously increasing demand is the challenge in the agriculture sector in Kenya (Oluoch & Osida, 2015).

Information is becoming a major input in Agriculture, whilst, knowledge and information plays a central role for farmers to respond to opportunities that could improve their agricultural productivity. Information Communication Technologies (ICTs) have therefore continued to be the best hope in developing countries to accelerate their development process (Nyamba & Mlozi, 2012). Information is essential for facilitating agricultural and rural development and bringing about social and economic change. Unfortunately, most African countries have not devoted adequate attention to providing their citizens with access to information, especially in rural areas, where 70-80% of the African population lives. ICTs facilitates exchange among women from diverse social groups; allow rapid access to information needed for exchanging, buying, producing, and selling products and lead to increased productivity gains (Agu, 2013).

Kenya’s vision of knowledge based economy aims at shifting the current industrial development path towards innovation where creation, adoption, adaptation and use of knowledge remain the key source of economic growth. ICT is a critical tool for expanding human skills and rests largely on a system of producing, distributing and utilizing information and knowledge that in turn plays a great role in driving productivity and economic prosperity (Government of Kenya, 2013).

1.2 ICTs and Agricultural production

In agriculture, the role of information and communication in disseminating agricultural knowledge has been well established (Das, 2013). Bachhav (2012) stated that, the use of information in agriculture sector is enhancing farming productivity in a number of ways. Providing information on weather trends, best practice in farming, timely access to market information helps farmer make correct decisions about what crops to plant and where to sell their produce as well as buy inputs. According to Richardson et al. (1998) the information needs of farmers change from time to time due to changing agricultural technologies, environmental changes, agricultural policies, and the emergence of agricultural innovations. Some of the challenges that rice farmers encounter include lack of an effective way to collect farm produce data, record farm input expenses, as well as expenditure on farm chemicals and receive information from other stakeholders (Oluoch & Osida, 2015).

Information is crucial for increasing agricultural production and improving marketing and distribution strategies (Oladele, 2006). Information also opens windows of giving out experiences, best practices, sources of financial aids and new markets. The availability of information communication technologies offer irrigation rice farmers the opportunity to collect, gather, share and disseminate information on emerging production techniques, market information, new varieties of rice which will enhance their production levels. ICTs-interventions have attracted attention because they are more effective in communicating knowledge to rural farmers; are more cost-effective and they facilitate access to markets (Katengeza, 2012).

The use of ICTs in Malaysia (Hassan et al., 2009) and India (Syiem & Raj, 2015) among irrigated rice producers have shown that there is a positive effect of ICTs use on access to markets, sharing knowledge on emerging technologies for production, sharing of value addition activities in irrigated rice production and availability on weather information.

1.3 Communication and ICTs Use in Irrigated Rice Production

Many of the questions asked by farmers (including questions on how to increase yields, access markets, and adapt to weather conditions) can now be answered faster, with greater ease, and increased accuracy through use of ICTs. Many of the questions can also be answered with a dialogue where farmers, experts, and government can select best solutions based on a diverse set of expertise and experience (Bohara, 2014).

ICTs enabled services often use multiple technologies to provide information. This model is being used to provide rural farmers localized (non-urban) forecasts so that they can prepare for weather-related events. In resource constrained environments especially, providers use satellites or remote sensors (to gather temperature data), internet (to store large amounts of data), and mobile phones (to disseminate temperature information to remote farmers cheaply) to prevent crop losses and mitigate effects from natural adversities (Joshi & Ayyangar, 2010).

Adegbidi, Mensah, Vidogbena and Agossou (2012) conducted a study on determinants of ICTs use by rice farmers in Benin. The results revealed that all the farmers surveyed were not using ICTs tools for farming. About 31% of them were ICTs non-users while 69% of them did use ICTs tools in their farming activities. All the ICTs tools used did not have the same importance of use. Nearly did all users (90%) use radio program as type of media. The three most common types of media after radio program were mobile call-up (41%), television (17%) and mobile SMS (10%). The study was however limited in its methodology as it targeted respondents from an ICTs project, a sample which could be influenced by training received from the project. There is need to conduct a study among farmers who have not been involved in any ICTs project.

ICTs can be used to strengthen communities and farmer organizations strengthen their own capacities and better represent their constituencies when negotiating input and output prices, land claims, resource rights and infrastructure projects. Rural communities are able to interact with others via the use of ICTs which reduces social isolation that they would otherwise be facing. Besides that, ICTs technologies are able to make processes like law-making and land-title approvals more transparent (Sangbuapuan, 2012).

Berman (2008) showed that new ICTs methods had played a crucial role in the development of emerging countries. There are several ICTs that have been adopted in agricultural production globally. According to Jayathilake, Jayaweera and Waidyasekera (2008), there are several good examples of ICTs adoptions and applications in agriculture sectors. Kenya Agricultural Commodity Exchange (KACE) is harnessing this ICTs to disseminate market information and intelligence. In Philippine there are lots of portals, e-commerce applications and innovative technologies used to provide relevant agricultural information in the country and especially the rural areas.

Abdegbidi et al. (2012) conducted a study on determinants of ICTs use by rice farmers in Benin. The study found that the proportion of farmers using ICTs tools in their farming activities (69 %) was greater than those of farmer members of ICTs project. The four main common types of media used for farming purposes were the radio program, the mobile call-up, the television and the mobile Short Messaging Service (SMS).

Armstrong and Gandhi (2012) found that most of the farmers were found to use television and mobile phone to collect agricultural information, which suggests that farmers are better equipped to access agricultural information and implement better practices to improve agricultural production. This ultimately has a positive impact on the agricultural production at a regional level.

1.4 Barriers to Communication and ICTs Use in Agriculture

Barriers to adoption of ICTs in agricultural production includes lack of ICTs proficiency, lack of ICTs benefit awareness, too hard to use, lack of technological infrastructure, cost of technology, trust level in the ICTs system, lack of training, system integration and software availability among farmers (Taragola & Gelb, 2005).

Chete and Fayosiro (2014) conducted a study on the impact of ICTs-Based Initiative (Mobile Phone) on Market Access by Women Farmers in Nigeria. The authors enumerated barriers and challenges to developing rural ICTS facilities for farmers to include lack of content and for rural society, human resource capacity, coordination weakness, strategic coordination, poor infrastructures, risk of investment, poor rural infrastructure.

Jayathilake, Jayawira and Waidayasekera (2008) conducted a study on ICTs adoption and its' implications for Agriculture in Sri Lanka. The result of their study showed that the most important limiting factor which affects the use of ICTs in agriculture is cost of technology. Lack of training and inability of farmers to use ICTs is the second factor that affects its adoption. Other factors like trust level in the ICTs system; lack of technological infrastructure and lack of ICTs proficiency are the third level category that affects the use of ICTs in agriculture.

Bohara (2014) study indicated that technical challenges significantly influenced the use of ICTs in disseminating agricultural information. The findings indicated that limited ICTs centres and lack of skilled technicians are the major issues that need immediate attention. Musa et al. (2012) found that 50.8 % of farmers have little or no access to electricity (grid or solar) making it difficult to use ICTs gadgets such as TV that cannot easily run on batteries. Similar figures were obtained for access to roads with 54.2% of the farmers indicating that there is little or no road infrastructure in the places they lived. With regard to telecommunications infrastructure, 30.8 % reported little or no infrastructure indicating relatively good coverage of the target population.

ICTs adoption based on working within communities takes longer in many cases because of the lack of understanding and awareness of the needs and challenges of small-scale farmers, lack of understanding on what ICTs can do including unexpected deviations from initial farmer and community expectations. For instance, Chukwunonso and Tukur (2012) study found that dissatisfied farmers will discourage others from using ICTs, even after installation. Musa et al. (2012) study on the adoption and use of ICTs by small scale farmers in Gezira State, Sudan revealed that 53 % of the participants rated the scarcity of skilled staff and technicians as the top hurdle. Twenty one percent rated weaknesses in methods of dissemination as the second most important barrier to adoption with 13 % rating inappropriate information packaging and shortage of ICTs centres tying in third place.

Kituyi-Kwake and Adigun (2008) conducted a study on analyzing ICTs use and access amongst rural women in Kenya. The study suggested that some of the constraints to ICTs adoption were: ICTs services are unaffordable (32.0 %), time (13.5 %), ICTs services are far away (19.0 %), and computer illiteracy (16.0 %), roads are poor (8.0 %) and cultural taboos (11.5 %). Musa et al. (2012) conducted a cross-tabulation between ICTs and cultural factors that included cultural beliefs, legal frameworks and politics. The findings indicated that there is a statistically significant relationship between adoption of ICTs and these cultural factors.

2.1 Diffusion of Innovation Theory (DIT)

The first framework is the diffusion of innovation (DoI) based on early work by Rogers (1962, 1995) and then informed by more recent studies of ICTs adoption (Mustonen-Ollila & Lyytinen, 2003; Wainwright & Waring, 2007; Aleke, 2010). The main impact of this framework is that it

provides considerable insight into the complexities of ICTs innovation across three distinct stages. This model is of particular interest to this research, because a key element of the model resides on the exploration of patterns of communication and relationship between actors in ICTs adoption (Aleke et al., 2010).

Rogers (2003), whose adoption models is one of the most referred to in the literature of innovation diffusion, outlines four main elements in the diffusion of innovations which are the innovation, communication channels, time and the social system. Rogers describes innovation "as an idea, practice, or project that is perceived as new by an individual or other unit of adoption (p.12). One of the obstacles to adoption of innovations is uncertainty. To reduce the risk of rejection due to uncertainty, stakeholders should be well-informed through appropriate channels. There are four components to the DIT, which are time, social system, and innovation and communication channels. In this study, the most relevant components are communication and social systems.

There are various diffusion models that have been proposed in the ICTs adoption in agriculture. The oldest type of diffusion model, based on communication channels, can be valuable in identifying four stages of the innovation decision-making process (Knowledge, Persuasion, Decision and confirmation) proposed by Rogers (2003). However, the model is a very simple linear one that helps to understand innovation diffusion, but many scholars criticized it for its operationalization limitations. The most influential models in the area of diffusion of agricultural innovations was published by Rogers (1995), who identified a number of factors which influenced the likelihood of adoption, with the most important being the perceived attributes of innovation. He also included factors relating to the nature of the innovation decision, communication channels, and nature of the social system and the extent of extension workers promotional effort.

The diffusion of innovation theory explains the rural farmers' network role in facilitating the use of ICTs. The diffusion theory is useful in explaining the use of ICTs among farmers due to their social network use. According to the diffusion theory, adoption of ICTs is much higher when other farmers in the social network of a farmers have adopted the ICTs. The theory is therefore significant to the study as it assisted in analysing how rice farmers use ICTs in irrigated rice production and how this influences farmers to adopt this ICTs However, a limitation of the theory is it does not explain the individual factors that influence adoption and non-adoption of ICTs in irrigated rice production.

2.2 Technology Acceptance Model (TAM)

The TAM model was proposed by Davis to predict the acceptance and use of new information technology (software and information systems) within organizations (Davis, 1989). Some studies use TAM to investigate the factors affecting the adoption and acceptance of technology. TAM is similar to diffusion theory, although it places more emphasis on psychological predisposition and social influences, such as beliefs, attitudes and intentions as important factors in the adoption of technology (Bates, Manuel & Oppenheim, 2007).

The theory suggests that there are a number of factors that influence the adoption and use theory of technology. These are external factors, perceived usefulness and perceived ease of use. External factors are external contextual variables that influence the acceptance of technology through perceived usefulness and perceived ease of use and may be important predictors of perceived usefulness or perceived ease of use (Musa, 2006).

The TAM model is relevant to this study as it explores the use of different ICTs in strategic communication in agriculture. Strategic communication relies on the specific use of one or two

ICTs that give the maximum effect in terms of communications in rice production. Strategic communication thus is guided by the TAM model as users of ICT will choose a specific tool due to its ability to give the most benefits to the user. The study seeks to identify the uses of ICTs use in irrigated rice production, the constraints of ICTs use in irrigated rice production and the influence of ICTs in irrigated rice production. The theory is significant to the study as the perceptions of the farmer on the usefulness of the technology influence their decision to adopt the technology. These perceptions can either be positive or negative and therefore may be motivators and may also act as barriers to adoption. The researcher therefore proposes to adopt the TAM model to guide the study.

3.1 Research Design

The research was a descriptive survey involving both qualitative and quantitative methods. The study used the cross-sectional survey design which refers to the collection of data during a specified duration of time. According to Arabu et al. (2015), descriptive research as a process of collecting data in order to test hypotheses or to answer questions concerning the current status of the subjects of the study. It is a survey as it is a self-report study which requires the collection of quantifiable information from a sample. The design is appropriate for the study as it sought to investigate the factors influencing ICTs adoption in irrigated rice production. The researcher adopted qualitative and quantitative research approaches. The advantage of using both approaches is enhancing the reliability and validity of the findings as each method strengthens the others' weaknesses.

3.2 Research Site

The Mwea Irrigation Scheme was started way back in 1956 and the predominant crop grown in the Scheme is rice. This is one of the seven public schemes under the management of the National Irrigation Board (NIB). It is situated in Kirinyaga South Sub County, Kirinyaga County. The Scheme is approximately 100 Km North East of Nairobi, the capital city of Kenya. The temperatures range from a minimum of 12°C to a maximum of 26°C with an average of 20°C. The rainfall ranges between 1,100 mm and 1,250 mm per annum.

Mwea Irrigation Scheme has a gazetted area of 30,350 acres. A total of 16,000 acres has been developed for paddy production. In addition to this, the scheme has a total of 4,000 acres of out grower / *jua kali* areas under paddy production. The rest of the scheme is used for settlement, public utilities, subsistence and horticultural crops farming (NIB, 2013). There is use of ICTs among rice farmers which was investigated. These include the use of mobile phone banking and communication among farmers and with extension workers.

3.3 Target Population

The target population for the study were farmers in the Mwea Irrigation Scheme, Kirinyaga County. The total number of farmers' households in the Scheme is 6,500 households (NIB, 2013).

3.4 Sampling Technique and Sample Size

In order to calculate the sample size for the study, the following relationship suitable for populations less than 10,000 as suggested by Mugenda and Mugenda (2003) was adopted.

$$n = \frac{n_0}{1 + n_0/N}$$

Where, n is the desired sample size for small populations.

n_0 is the desired sample size when population is less than 10,000 i.e. 384

N is the population size

By applying the sample size formulae,

$$n = \frac{384}{1 + 384/6{,}500}$$

The sample size for the study was 362 respondents. The study adopted purposive sampling technique. The purposive sampling technique is based on selecting the respondents of the study based on the researcher knowledge and judgement. The researcher did a primary indicative study and established that there was poor adoption of ICTs among irrigated rice farmers. The sample of the study was therefore selected from the respondents identified in the primary indicative study. The researcher was able to collect 96 questionnaires which were used for analysis.

3.5 Data Collection Methods

3.5.1 Questionnaire

The researcher adopted the questionnaire as the primary tool for data collection. This tool was administered to the farmers. The questionnaire comprised of three sections which included the respondents' demographic information, the types and use of ICTs adopted and the barriers facing farmers in adopting ICTs in rice production. The questionnaire comprised both close-ended and open-ended question items. Close-ended questions provided a choice of alternative answers from rice farmers are asked to select by ticking; open-ended questions enable the respondent to answer the question using his or her own words.

The researcher used interviewer-administered questionnaires. This involves each respondent being asked the same questions by the interviewer, in the same way, in order to eliminate as far as possible any bias. Advantages of this mode of administration include the collection of more detailed and complex data, the possibility to clarify misunderstandings and the opportunity for the interviewer to probe for additional information (Meadows, 2003). This approach assisted in interpreting the questionnaire to respondents who may be illiterate.

3.5.2 Key Informant Interviews

The study used the key informant interviews to collect data from the County Executive Committee (CEC) member in charge of information communication and technology (ICTs) in Kirinyaga County, two extension officers and two agricultural officers. The study adopted unstructured interviews. Unstructured in-depth interviews is one of the qualitative data collection methods since it encourages respondents to use descriptive mode in giving details, feelings and views on the issue under investigation (Kaddu, 2011).

3.6 Data Collection Procedures

The data collection was undertaken in between 29th June to 23rd July 2016. The researcher obtained a letter of authorisation from the University of Nairobi to undertake the data collection process. The researcher applied for a research permit from the National Commission of Science Technology and Innovation (NACOSTI) to undertake research in Kenya. The researcher made visits to the Mwea Irrigation Scheme and administered the instrument to the sampled farmers present or working in the

field during the data collection process. The interviews were conducted by the researcher where I visited the Kirinyaga County Offices in Kerugoya to interview the County Executive Committee (CEC) member in charge of information communication and technology (ICTs) and 1 agricultural officer and 1 extension officer in Kutus. These interviews were conducted in an environment of the respondents choosing to accommodate their schedule and availability to participate in the study. The researcher was able to administer 115 questionnaires. However, 96 questionnaires met the criteria for data analysis inclusion. Some of the questionnaires were self-administered and out of the 19 questionnaires that did not meet the criteria, 5 were not returned to the researcher and 14 had missing responses and were incorrectly filled.

3.7 Data Analysis and Presentation

The first step of data analysis was to check the questionnaires for completeness and coding of the responses. The data gathered from the questionnaires were entered into the Statistical Package for Social Sciences (SPSS) Version 22. This quantitative data was analysed using descriptive statistics. Descriptive statistics allowed the researcher to summarise the data and create categories of responses for interpretation. The researcher used the mean, frequencies and percentages to analyse the data. The qualitative data from the in-depth interviews was analysed by identifying the themes and relating these to the study research questions. The qualitative data was presented in verbatim and narrative form to complement the qualitative data. The quantitative data was presented in tables, charts and figures and the researchers' interpretation.

4.0 Data Analysis

4.1.1 Respondents Understanding of ICTs

The researcher sought to establish the understanding of IVTs??? among the study participants. Table 4.1 shows that majority did not know or understand the concept of ICTs as shown by 42.7 %, 34.4 % understood ICT to be the use of modern and new technologies to communicate, 18.8 % explained ICTs as An easier way of passing and getting information and 4.2 % indicated that it was the use of wireless communication tools/technologies.

Table 1: Understanding of ICTs among respondents

Respondents perception of ICTs	Frequency	Percent
An easier way of passing and getting information	18	18.8
Don't Know or Understand	41	42.7
Use of modern and new technologies to communicate	33	34.4
Use of wireless communication tools/technologies	4	4.2
Total	**96**	**100.0**

4.1.2 ICTs with Most Benefit to Rice Farmers

According to the study participants, the most beneficial ICT was mobile phones (45.8 %) followed by radio (26.0 %), Mobile/Phones/Television/Radio (20.8 %) and Internet and computers (7.3 %) as presented in Table 4.2. the study sough to determine the most beneficial ICT according to the respondents. The findings of the study show similarities to past studies. For instance, Adegbidi et al. (2012) study on determinants of ICTs use by rice farmers in Benin revealed that nearly all users (90 %) used radio program as type of media. The three most common types of media after radio program were mobile call-up (41 %), television (17 %) and mobile SMS (10 %).

According to key informants the preference for these tools was their availability, affordability and portability. Mohammad, Salleh and Hasbullah (2010) agree that radio can be useful medium to educate farmers if it appeals them with new programs having modern agricultural technologies. However, the literacy of farmers is important to understand such programs and apply them appropriately. The study also found that vernacular radio stations were the most preferred as they appealed to the farmers who had lower levels of literacy. This finding supported Haider (2014) conclusion that that local radio agricultural programs helps farmer to adopt new information and apply new methods and practices in their farms.

Table 2: ICTs Most Benefit

	Frequency	Percent
Mobile Phones	44	45.8
Mobile/Phones/Television/Radio	20	20.8
Radio	25	26.0
Internet/Computers	7	7.3
Total	**96**	**100.0**

According to a key informant, there were several ICTs adopted among Mwea Irrigation Rice farmers. These included:

> Listening to Radio programs related to farming on both vernacular stations like Inooro, Kameme and other Kiswahili programs on Radio Citizen, KBC among others. Watching programs on Television stations like Inooro TV, NTV, Citizen TV and KTN. Programs like Smart farm on Citizen, Food Friday on NTV and Farm talk on KBC. Others use the internet enabled devices like mobile phones, personal computers, laptops and others even visit cyber cafes for internet access (Key Informant 4).

4.1.3 ICT Uses among Study Participants

The study sought to determine the uses for which ICT tools were used among rice producers of Mwea Irrigation Scheme. The study required respondents to indicate the ICTs used in undertaking selected farming activities. These were: availability of inputs, quality of inputs, market prices of inputs, pest & disease management, farming system information, post-harvest information, value addition information and record keeping.

4.1.3.1 Availability of Inputs

In terms of availability of inputs, the findings show that majority used the mobile phone (30.2 %), radio (20.8 %), mobile phone/television/radio (9.4 %), internet (7.3 %), television and radio (6.3 %) as presented in Table 3

Table 3: ICTs used for Availability of Inputs

ICTs Used	Frequency	Percent
Mobile Phone	29	30.2
Television	5	5.2
Radio	20	20.8
Internet	7	7.3
Computer	3	3.1
All the Above	1	1.0

Mobile Phone/Internet	1	1.0
Mobile Phone/TV/Internet	1	1.0
Mobile Phone/TV/Radio	9	9.4
TV/Radio	6	6.3
Radio/MIAD Centre	3	3.1
Not Applicable	11	11.5
Total	**96**	**100.0**

4.1.3.2 Quality of inputs

The radio was the most used ICT tool for quality of inputs information. Table 4.4 shows 27.1 % used the radio, 16.7 % were television, 8.3 % were mobile phone, 7.3 % were internet, 6.3 % were computers and 5.2 % used television and radio.

Table 4: ICTs used for Quality of Inputs Information

ICTs Used	Frequency	Percent
Mobile Phone	8	8.3
Television	16	16.7
Radio	26	27.1
Internet	7	7.3
Computer	6	6.3
Mobile Phone/TV/Radio	2	2.1
TV/Radio	5	5.2
Radio/MIAD Centre	3	3.1
Mobile Phone/TV	1	1.0
Radio/Internet	1	1.0
TV/Internet	1	1.0
Not Applicable	20	20.8
Total	**96**	**100.0**

4.1.3.3 Input Market Prices

The radio was the most used ICT tool to acquire information on the prices of inputs. Table 4.5 shows that 33.3 % used the radio, 26.0 % used mobile phones, 14.6 % used television, 5.2 % used the internet and 3.1 used radio and MIAD Centre and television and radio.

Table 5: ICTs used for Input Market Prices Information

ICTs Used	Frequency	Percent
Mobile Phone	25	26.0
Television	14	14.6
Radio	32	33.3
Internet	5	5.2
Computer	1	1.0
Mobile Phone/TV/Radio	1	1.0
TV/Radio	3	3.1
Radio/MIAD Centre	3	3.1
Not Applicable	12	12.5
Total	**96**	**100.0**

4.1.3.4 Pests and Disease Management

In terms of getting information on pests and diseases management the study found that 33.3 % used the radio, 14.6 % used the television, 12.5 % used the internet, 6.3 % used the television and radio, 5.2 % used the mobile phone, and 3.1 % used radio and MIAD Centre as depicted I Table 6.

Table 6: ICTs used for Pests and Disease Management Information

ICTs Used	Frequency	Percent
Mobile Phone	5	5.2
Television	14	14.6
Radio	32	33.3
Internet	12	12.5
Mobile Phone/TV/Internet	1	1.0
Mobile Phone/TV/Radio	1	1.0
TV/Radio	6	6.3
Radio/MIAD Centre	3	3.1
TV/Internet	1	1.0
Not Applicable	21	21.9
Total	**96**	**100.0**

4.1.3.5 Farming System Information

The radio was the most used to gather information on farming systems as cited among 30.2 % of the study participants. Other ICT tools used were mobile phones (16.7 %), television (15.6 %), internet (8.3 %), television and radio (7.3 %) and radio and MIAD centre (3.1 %) as presented in Table 7.

Table 7: ICTs used for Farming System Information

ICTs Used	Frequency	Percent
Mobile Phone	16	16.7
Television	15	15.6
Radio	29	30.2
Internet	8	8.3
Mobile Phone/TV/Internet	1	1.0
Mobile Phone/TV/Radio	1	1.0
TV/Radio	7	7.3
Radio/MIAD Centre	3	3.1
Radio/Internet	1	1.0
Mobile Phone/TV/Radio/Internet	1	1.0
Not Applicable	14	14.6
Total	**96**	**100.0**

4.1.3.6 Postharvest Information

In acquiring information on postharvest the results showed that 26.0 % used the radio, 18.8 % used mobile phone, 14.6 % used the television, 3.1 % used the radio and MIAD centres, 2.1 % used the internet, mobile phone/internet and television and radio respectively as shown in Table 8.

Table 8: ICTs used for Postharvest Information

ICTs Used	Frequency	Percent
Mobile Phone	18	18.8
Television	14	14.6
Radio	25	26.0
Internet	2	2.1
Computer	1	1.0
Mobile Phone/Internet	2	2.1
Mobile Phone/TV/Radio	1	1.0
TV/Radio	2	2.1
Radio/MIAD Centre	3	3.1
Mobile Phone/TV	1	1.0
Not Applicable	27	28.1
Total	**96**	**100.0**

4.1.3.7 Value Addition Information

Table 4.9 shows that the radio (26.0 %) was the most used ICT tool to acquire information among the respondents. Other ICT used were mobile phone (16.7 %), television (11.5 %), 6.3 % used the internet and computers, 4.2 % used the television and radio and 3.1 % used radio and MIAD Centre.

Table 9: ICTs used for Value Addition Information

ICTs Used	Frequency	Percent
Mobile Phone	16	16.7
Television	11	11.5
Radio	25	26.0
Internet	6	6.3
Computer	6	6.3
TV/Radio	4	4.2
Radio/MIAD Centre	3	3.1
TV/Internet	1	1.0
Not Applicable	24	25.0
Total	**96**	**100.0**

4.1.3.8 Record Keeping

In regards to the type of ICTs used for record keeping, the results showed that the radio (26.0 %) was the most used ICT to learn about record keeping, this was followed by the mobile phone (16.7 %) and television (11.5 5). Other ICT tools used included internet and computer (6.3 %) as shown in Table 10.

Table 10: ICTs used for and Record Keeping

ICTs Used	Frequency	Percent
Mobile Phone	16	16.7
Television	11	11.5
Radio	25	26.0
Internet	6	6.3
Computer	6	6.3

TV/Radio	4	4.2
Radio/MIAD Centre	3	3.1
TV/Internet	1	1.0
Not Applicable	24	25.0
Total	**96**	**100.0**

4.1.3.9 Other Uses of ICT

The other uses of ICTs among the study participants are shown in Table 4.11. The results revealed that the most popular use of ICTs was attending meetings and seminars (34.4 %), learning new farming technologies (18.8 %), communicate on work arrangements (15.6 %), information on input prices, marketing and planting time table (13.5 %), payment of inputs (7.3 %) and capacity building (5.2 %).

Table 11: Other Uses of ICTs among Irrigated Rice Farmers

ICTs Used	Frequency	Percent
Attending meetings and seminars	33	34.4
Capacity building	5	5.2
Communicate on work arrangements	15	15.6
Comparing other farming Methods	3	3.1
Learning new farming technologies	18	18.8
Assist in water management practices	2	2.1
Information on input prices, marketing and planting time table	13	13.5
Payment of inputs	7	7.3
Total	**96**	**100.0**

The key informant interviews revealed that there were several uses for which ICTs were used among the irrigated rice farmers in Mwea Irrigation Scheme. These were:

- Checking on available paddy seed varieties.
- Checking on prices of the paddy seed and packaged rice.
- Issues related to rice from Japan and its quality
- Diseases that affect paddy fields and control measures applied across the world.
- Methods of planting, managing and harvesting paddy.
- Methods of adding value to paddy by products like the rice husk.
- Market for paddy and its by-products.
- Research related to paddy production (Key informant 2)

4.2 Barriers of ICTs use in Irrigated Rice Production in Mwea Irrigation Scheme

Table 4.12 shows a summary of some of the barriers that face irrigated rice farmers in adoption of ICTs. The mean (M) and standard deviation (SD) were used to show the highest ranked and lowest ranked barriers. The results show that the most cited barrier was lack of training (M=3.59; SD =1.34), lack of ICTs skills and inability to use (M=3.49; SD =1.41) and cost of ICTS and/or funds (M=3.20; SD =1.16). The lowest ranked barriers were Tradition and/or traditional practices (M=2.17; SD=1.20) followed by fear and/or distrust of technology (M=2.19; SD=1.18) and available ICTs unsuitable for practice or zone (M=2.28; SD=1.26).

Table 12: Barriers to ICT Adoption in Irrigated Rice Production

Constraints	No extent	Little extent	Moderate extent	To an extent	A great extent	Mean	Standard Deviation
Lack of ICTs skills and inability to use	11.5%	15.6%	21.9%	14.6%	36.5%	3.49	1.41
No perceived economic benefit	18.8%	30.2%	32.3%	14.6%	4.2%	2.55	1.08
Too hard to use	18.8%	21.9%	23.0%	17.7%	18.8%	2.95	1.38
No ICTs access and/or infrastructure	13.5%	27.1%	26.0%	10.4%	22.9%	3.02	1.36
Lack of (personal) ICTs support services	18.8%	15.6%	30.2%	10.4%	25.0%	3.04	1.41
Cost of ICTS and/or funds	6.3%	21.9%	35.4%	17.7%	18.8%	3.20	1.16
Integration, reliability, usefulness of information	10.4%	22.9%	36.5%	21.9%	8.3%	2.94	1.09
Available ICTs unsuitable for practice or zone	32.3%	34.4%	15.6%	8.3%	9.4%	2.28	1.26
Fear and/or distrust of technology	38.5%	21.9%	25.0%	10.4%	4.2%	2.19	1.18
Time limitations	24.0%	20.8%	30.2%	20.8%	4.2%	2.60	1.18
Lack of training	8.3%	14.6%	24.0%	15.6%	37.5%	3.59	1.34
Tradition and/or Traditional practices	37.5%	28.1%	17.7%	11.5%	5.2%	2.17	1.20
Don't understand value, lack awareness	10.4%	29.2%	32.3%	15.6%	12.5%	2.90	2.17
Power cuts	13.5%	19.8%	25.0%	19.8%	21.9%	3.17	1.34

The study findings showed that the major barriers to ICT adoption among irrigated rice farmers were lack of training, lack of ICTs skills and inability to use and associated cost of ICTs and/or funds. These findings support previous studies highlighted in the literature. Mwakaje (2010) found that a large number of respondents (68 %) said that they did not have money to buy the ICTs facilities or services and their running costs (8.5%) and others admitted that they did not know how to use ICTs (4 %).

Similarly, Kituyi-Kwake and Adigun (2008) study confirmed barriers to ICT use included services were unaffordable (32.0 %). Jayathilake, Jayawira and Waidayasekera (2008) conducted a study on ICTs adoption and its' implications for Agriculture in Sri Lanka. The result of their study showed that the most important limiting factor which affects the use of ICTs in agriculture is cost of technology. Lack of training and inability of farmers to use ICTs is the second factor that affects its adoption.

According to a key informant, there many challenges facing rice farmers in Mwea. Most of the farmers have only attained basic education and there are some who are not learned at all. The few farmers we have who have gone past secondary school are not directly involved in the rice farming business but rather operate from Nairobi and other parts of the country. They engage casuals to

work for them and they might know the challenges people face here to have the final crop ready for the market. Some of the challenges include:

- Illiteracy
- Lack of ICTs since most of these gadgets is very expensive.
- Most households are not connected to the national grid.
- Lack of exposure
- Over reliance on traditional methods of farming. This limits their desire to explore other options used elsewhere (Key Informant 3).

4.3 Influence of ICTs use in Irrigated Rice Production in Mwea Irrigation Scheme

The study had found that farmers had adopted several ICTs in rice production at the Mwea Irrigation Scheme. The study sought to establish the influence of these ICTs on irrigated rice production. Table 13 shows the respondents'' opinions on the influence of ICTs. One of the major influences was increase in rice production output (M=3.19; SD=1.31), followed by increase of farmers' skills/knowledge in rice production (M=3.08; SD=1.35), Accessing agricultural market information (M=2.95; SD=1.30).

Table 13: Influence of ICT on Irrigated Rice Production

Statements	No Effect	Very Little Effect	Moderate Effect	Little Effect	Great Effect	Mean	Standard Deviation
Increase of farmers' skills/knowledge in rice production	15.6%	16.7%	35.4%	8.3%	24.0%	3.08	1.35
Increase in rice production output	16.7%	6.3%	38.5%	17.7%	20.8%	3.19	1.31
Access to production and market information	12.5%	27.1%	31.3%	14.6%	14.6%	2.91	1.22
Enhanced access to agricultural extension services	24.0%	5.2%	40.6%	21.9%	8.3%	2.85	1.25
Accessing agricultural market information.	17.7%	15.6%	36.4%	13.5%	16.7%	2.95	1.30
Strategic partnerships with associations and organisations	21.9%	14.6%	27.1%	19.8%	16.7%	2.94	1.38

From the key informant interviews, the study revealed for those who have adopted these ICTs, there are several good results they have realised. Some of these are increased paddy yields, increased income from rice paddy and its by-products, market access, knowledge on issues related to innovations on rice paddy production and knowledge on diseases affecting paddy rice and control measures (Key Informant 1)

The findings revealed that major influence of ICTs among irrigated rice farmers were increase in rice production output (M=3.19; SD=1.31), followed by increase of farmers' skills/knowledge in

rice production (M=3.08; SD=1.35), Accessing agricultural market information. Several studies show support for this findings. Katengeza (2012) agrees that ICT based interventions have attracted attention because they are more effective in communicating knowledge to rural farmers; are more cost-effective and they facilitate access to markets. Al-Hassan, Egyir and Abakah (2013) study on ICT use in Ghana concluded that there is a latent potential for ICTs, especially the mobile phone to facilitate transactions of rural farm households, which can be realized through positive partnership between the private and the public sectors. Mwakaje (2010) study in Tanzania found that people who used ICT to access market information sold a lot more and received relatively better prices, which has a positive impact on poverty alleviation. In Kenya, Ogutu, Okelloa & Otienoa (2013) study on impact of information and communication technology-based market information services on smallholder farm input use and productivity found that there was a positive impact of ICT on productivity. In order to enhance irrigated rice farmers adoption of ICTs, the researcher asked key informants for suggestions on how this could be achieved. The two levels of government (County and Central Governments) have a huge role to play in assisting farmers in Mwea to increase rice production in the country to meet rice demands and minimise overreliance on imported rice from Japan and other countries.

5.1 Conclusion

The study concludes that there were several motivations for using ICTs. These motivations included easy availability of information, easy access to information and reduced costs in acquiring information on rice production. The study concludes that ICTs were used to source for information on available paddy seed varieties, prices of the paddy seed and packaged rice, issues related to rice from japan and its quality, diseases that affect paddy fields and control measures applied across the world, methods of planting, managing and harvesting paddy, methods of adding value to paddy by products like the rice husk, market for paddy and its by-products and conduct research related to paddy production.

The study concludes that the major barriers facing ICT adoption among irrigated rice farmers in Mwea Irrigation Scheme are lack of training, lack of ICTs skills and inability to use and cost of ICTS and/or funds. It further concluded that the major barriers of ICTs among irrigated rice producers were personal barriers. The study concludes that irrigated rice farmers' adoption of ICT was hindered by personal barriers such as illiteracy of farmers, age was also a factor that limited ICT adoption and access to funds to acquire information communication technologies and maintenance of these tools. The study concludes that the most influence of ICT adoption among rice farmers was increase in rice production output, followed by increase of farmers' skills/knowledge in rice production and accessing agricultural market information. The study concludes that key areas where ICT can help improve this is by providing up-to-date information about pest and disease control, early warning systems, new varieties, new ways to optimise production and regulations for quality control.

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