AGRODEP Working Paper 0035

October 2016

The Welfare Effects of ICTs in Agricultural Markets:
A Case of Selected Countries in East Africa

Mercyline Kamande
Nancy Nafula

About the Authors

Mercyline Kamande is Senior Lecturer at Mount Kenya University, Kigali Campus.

Nancy Nafula is a Policy Analyst at the Kenya Institute for Public Policy Research and Analysis.

Acknowledgement

The authors are greatly indebted to International Food Policy Research Institute (IFPRI) for providing us the research grant to carry out this study. Further, we gratefully acknowledge the support from African Growth and Development Policy Modeling Consortium (AGRODEP) Management Team in terms of training and technical support which contributed greatly to the success of this project. The valuable and helpful comments from participants at various AGRODEP and AIEN Workshops were vital in shaping this work and are much appreciated.

Our gratitude extends to the management and staff of Esoko Rwanda and KACE Kenya who were very cooperative in providing valuable information towards the completion of this project.

This research was undertaken as part of, and partially funded by, the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by IFPRI and funded by the CGIAR Fund Donors. This paper has gone through AGRODEP's peer-review procedure. The opinions expressed here belong to the authors, and do not necessarily reflect those of AGRODEP, IFPRI, PIM or CGIAR.

Table of Contents

Abstract

The use of mobile ICTs (information and communication technologies) in Africa's agricultural sector has proven to be an efficient and cost-effective method for sharing and exchanging information more widely. ICTs allow farmers to better access critical information, such as pest and disease reports, weather conditions, and market prices, and improve communications between farmers and extensions workers. This study examines the welfare effects of ICTs on both farmers and traders in Rwanda and Kenya.

The study uses a descriptive analysis and a quasi-experimental approach to examine selected ICT portals and their level of use among both farmers and traders. Our results reveal that ICTs have negative welfare effects on farmers. However, all the changes are insignificant at the 95 percent level of confidence, which makes it difficult to make a conclusive decision regarding the effects of ICTs on producer welfare in this region.

Résumé

L'utilisation des TIC mobiles (technologies de l'information et de la communication) dans le secteur agricole de l'Afrique s'est révélée être une méthode efficace et rentable pour le partage et l'échange d'informations. Les TIC permettent aux agriculteurs de mieux accéder aux informations critiques, telles que les ravageurs et les maladies, les conditions météorologiques, les prix du marché, et d'améliorer les communications entre les agriculteurs et les agents d'encadrement et de vulgarisation. Cette étude examine les effets sociaux des TIC sur le bien être des agriculteurs et des intermédiaires commerçants au Rwanda et au Kenya.

L'étude utilise une analyse descriptive et une approche quasi-expérimentale pour examiner une série de de portails des TIC et leur niveau d'utilisation chez les agriculteurs et les commerçants. Nos résultats tendent à montrer que les TIC auraient des effets sociaux négatifs sur les agriculteurs. Cependant, tous les changements sont insignifiants au niveau de 95 pour cent de confiance, ce qui rend difficile une conclusion définitive en ce qui concerne les effets des TIC sur le bien-être producteur dans cette région.

1. Introduction

Communication plays an important role in marketing, including in the agricultural sector. According to Plantwise (Plantwise website), technological innovation is becoming increasingly important in agricultural development and productivity. Mobile ICTs (information and communication technologies) are one such innovation and provide a more efficient and cost-effective method for sharing and exchanging knowledge more widely. ICTs provide farmers with access to important information, such as pest and disease reports, weather conditions, and market prices, and can also improve communication between farmers and extensions workers who are unable to visit farmers as often as both parties would like. Enhancing communication between farmers, extension workers, researchers, and policy makers is essential to the improvement of agricultural efficiency

Modern ICTs such as radio, mobile phones, computers, and internet services play an important role in transferring information (FAO, 2011). Rural households are often located in remote areas, far from urban markets (UNDP, 2010a) this creates multiple trading cycles controlled by middlemen or intermediaries, referred to as buyers (when acting in their own capacity) or buyer agents (when acting on the behalf of others), before the goods reach consumers. Another result of this situation is a scarcity of accurate and reliable market information being communicated. The net effect of these gaps results in inefficient markets with higher transaction costs, longer distribution cycles, and a lack of commercial farming due to low returns. Market Information Systems (MISs) were conceptualized to reduce information asymmetries in the agricultural value chain and to empower farmers with up-to-date market information, direct access to markets (by eliminating intermediaries), higher incomes through the informed ability to negotiate trades, and more commercialized farming activity.

The lack of proper communication channels in agricultural markets has been blamed for the emergence of middlemen (see Fafchamps and Hill, 2005) who offer very low farm-gate prices but reap very high profits. This distorts agricultural markets and in turn reduces the welfare of farmers. Research has shown that the use of ICTs to reduce this information asymmetry has a positive impact on the farmers' welfare and on the efficiency of agricultural markets in general. Parker, Ramdas, and Savva (2016) argue that fair and unbiased information can be beneficial in creating more efficient agricultural markets.

According to the ICTs in Agriculture website (2013), the role of communication in agricultural marketing encompasses two kinds of information: (1) immediate information required to determine the market's demand for specific volumes and quality of agricultural products and (2) longer-term information on market trends (also referred to as "market intelligence") required to make future plans. ICTs, especially mobile phones, have emerged as a useful tool to obtain current information and help users gradually accumulate market knowledge and insight. The most common information transmitted via ICTs is price information for various markets, which helps to enhance farmers' bargaining power. However, this information addresses only one side of the agricultural supply chain.

Many researchers have been concerned with how ICTs can be useful in linking producers (the farmer) to markets in order to eliminate exploitative middlemen (e.g. Li, 1998; Johri and Leach, 2002 and Oguoma, Nkwocha and Ibeawuchi, 2010). However, ICTs should also be viewed from consumers' and traders' perspectives. Such an expanded perspective would link the supply side and the demand side. In addition to providing price information to farmers, ICTs can also provide market demand information and market intelligence over time, which will be useful in the policymaking arena.

According to Rwanda Ministry of Agriculture (MINAGRI Website), the success of small-scale farmers in Rwanda has been greatly affected by lack of access to pricing information, with many farmers left to speculate on what crops to grow and what prices to charge at harvest. Due to this lack of information about market prices, some farmers depend on middlemen to dictate prices; in most cases, this leads to exploitative prices being offered for desperate farmers. This study seeks to evaluate the welfare effects of ICTs in agricultural markets in Rwanda and Kenya. These countries were selected because they already have ICT portals linked to agriculture - namely E-soko in Rwanda and the Kenya Agricultural Commodity Exchange (KACE) in Kenya

The main aim of this study is to evaluate the welfare effects of ICTs on both farmers and traders. Specifically, the study seeks to: provide a description of the selected ICT service providers and the nature of services they provide to both farmers and traders; determine whether the use of the ICT services provided had any effect on agricultural prices for both farmers and traders accessing the service; compare the welfare of farmers who access the ICT services with those who do not; and identify potential challenges in design and implementation of the projects in facilitating agricultural exchange between farmers and traders.

2. Literature Review

2.1 ICT solutions in Agriculture

The role of ICTs in information and knowledge management has been extensively researched. In their pilot experiment, Goswami et al. (2010) describe the work of Change Initiatives, an Indian NGO, with the application of ICTs in agricultural information management under the EU-sponsored TeleSupport Project in the Nadia district of West Bengal, India. In this project, an innovative information management mechanism was used to facilitate a two-way interaction between experts and the local community. To sustain the two-way communication system, two mobile and one fixed tele-centers were established in the project area. The project also included a web resource covering a wide range of agricultural best practices and agro-technologies. The information exchanged through the project included crop management, livestock management, and marketing. The project was successful in terms of community participation, the amount of information exchanged, and empowerment of the local community. However, the project failed in terms of sustainability for several reasons, including a lack of e-readiness, lack of appropriate resource persons among the stakeholders, absence of any explicit incentive system within the organizational context, constraints of human resources, and constraints in funds.

Aker (2011) outlines the potential mechanisms through which ICTs could facilitate agricultural adoption and the provision of extension services in developing countries. The study suggests that mobile phones can improve access to and use of information about agricultural technologies, potentially improving farmers' learning. Meera et al. (2004) examine the performance of three ICT projects in India which are concerned with improving the delivery of information to farmers and other rural populations. One project is managed by the government of Madhya Pradesh, the second project is run by sugar cooperatives (with some government support) in Maharashtra, and the third project is an experiment by a large private agricultural input supplier to provide information to farmers in Andhra Pradesh. In terms of adoption, all three projects had younger, better educated, male farmers as their primary users, but the government project in the more marginal area was fairly effective at reaching poorer and illiterate clientele. In the state government project, users most valued access to information on markets, land records, and rural development programs. In the cooperative project, question-and-answer services, accounting, and farm management information were valued most. In the private company experiment, participating farmers valued information on farm practices, management of pests and diseases, and rural development program.

Gandhi et al., (2009) analyze how the Digital Green project has been used to disseminate targeted agricultural information to small and marginal farmers in India using digital video. The project uses a participatory process for content production, a locally generated digital video database, a human-mediated instruction model for dissemination and training, and regimented sequencing to initiate new communities. In a 13-month trial involving 16 villages, the project increased the adoption of certain agriculture practices seven-fold and was shown to be ten times more effective per dollar spent. Further, the project achieved 85 percent adoption of improved technologies, compared to 11 per cent of adoption achieved by traditional extension methods. The study also reports positive social side effects.

Parmar et al. (2010) argue that despite recent efforts in the use of ICTs to bridge the information poverty gap, there is still a lack of information available for people in rural areas. This may be attributable to a mismatch between the information required by rural users and the information offered by ICT interventions, as well as the dominance of technology-centered design and deployment processes rather than user-centered approaches. The study argues that information poverty in rural India poses significant challenges for the use of ICT intervention to improve the wellbeing of rural users. Many interventions have not been successfully accepted by rural users, nor have they made a substantial contribution toward disseminating the required information. The authors further argue that instead of following a structured design process, existing ICT interventions have adopted an incomplete and sometime inconsistent development approach.

In Africa, the use of ICTs in agriculture has also been on the rise. Asenso-Okyere and Mekonnen (2012) examine the importance of ICTs in the provision of information for improving agricultural productivity and rural incomes in various African countries. Citing World Bank (2011), the study explains that ICTs enable the Ethiopian Commodity Exchange (ECX) in Addis Ababa to transmit commodity price information to farmers in real time; market data is fed directly to farmers via electronic display boards in 31 centers spread across Ethiopia, as well as on the Exchange’s website. Market data is also provided via text messaging and automatic telephone messaging.

According to Asenso-Okyere and Mekonnen (2012), the Kenya Agricultural Commodity Exchange (KACE) and the Malawi Agricultural Commodity Exchange (MACE) also provide commodity exchange services through offers and bids, which are prominently displayed on blackboards and disseminated via SMS and the Internet. Citing KACE (2011), the study explains that KACE collects, updates, analyses, and provides reliable and timely market information and intelligence on a wide range of crop and livestock commodities, targeting actors in commodity value chains and paying particular attention to smallholder farmers and small-scale agribusinesses (KACE, 2011). The KACE market information and linkage system (MILS) operates through market resource centers (MRCs), mobile phone short messaging services (SMS), interactive voice response services (IVRS), an internet database system (IDS), national radio, rural FM radio, and the KACE headquarters central hub (KCH) in Nairobi. SMS services provide market information to users, including daily wholesale buying prices for about 20 commodities, as well as offers to sell and bids to buy. IVRS uses voicemail for delivery of market price information.

Katengeza, Mangisoni and Okello (2010) examine whether the Malawi Agricultural Commodity Exchange (MACE), a market information service project, has contributed to the efficiency of rice markets in Malawi and find that the tendency of rice prices to move together in spatially separated markets has significantly increased since the implementation of MACE. The authors conclude that ICT-based market information services improve the efficiency of agricultural markets

Asenso-Okyere and Mekonnen (2012) also describe several other ICT platforms in Africa. These include Manobi in Senegal, in which staff use mobile phones to send price data to the Manobi database and farmers use their mobile phones to query the database; Market Information Systems and Traders’ Organizations of West Africa (MISTOWA), which enables traders to exchange market information, buy and sell offers, and trade contact information in real time online or through cellular phones and provides online space for producer and trader organizations to create business websites; and the Mozambique Agricultural Marketing Service (SIMA), which collects and disseminates national and provincial data on market prices, product processing, and availability through a variety of media including text messages, email, internet, national and rural radio, television, and newspapers. Other similar ICT initiatives have been developed throughout Africa to deliver market information to small-scale farmers, including a project by the Grameen Foundation in Uganda and the Integrated Cassava Project in Nigeria.

In Ghana, Esoko is a simple but powerful communication tool for businesses, government, NGOs, and other stakeholders to connect with farmers. It is a Market Information System (MIS) developed to reduce transaction and information search costs, increase transparency in the agricultural value chain, and thus increase the incomes of small-scale farmers. A fully independent business entity established in 2008, the project aims to develop local markets through the sale of subscriptions (bronze, silver, gold, and platinum) to individual and corporate customers. As explained by (UNDP, 2010a), Esoko Ghana's business comprises of four major activities - business management, monitoring and evaluation, enumeration, and marketing/business development. It allows users to electronically pull data on market prices, buyers, sellers, inventory, transport, etc. and then to push that data back via mobile phone interfaces to thousands of small-holder farmers in a wide range of produce markets. Personal use of mobile phones has also enabled rural producers to interact directly with end-user markets, traders, suppliers, extension services, and each other. The marketing/business development function engages local Esoko users; client support representatives assists customers with setup and administration; enumerators collect, verify, and publish market information; and the monitoring and evaluation assess the impact of Esoko. Individual end-users of Esoko (farmers and market traders) are the target market group of the bronze subscription. The sale of bronze subscriptions is under the purview of information agents during their price collection exercises.

2.2 Mobile Phone Solutions for Agricultural Intervention

Key among the challenges faced by rural farmers and traders in adopting ICTs is the high transaction cost associated with mobile phone usage. For instance, Furuholt and Matotay (2011) argue that high transaction costs are associated with information market failures and inefficiencies in the business environment. Other challenges include information search costs and the asymmetric relationships that govern price setting. Such high costs normally add to the market price of products and affect competitiveness (Duncombe, 2012).

Other studies have tried to examine the characteristics of early adopters of mobile technology in relation to agriculture. Kameswari et al (2011) discuss the agricultural information-seeking behavior of farmers in the state of Uttarakhand, India and find that although farmers have access to a wide range of media/sources, they mostly rely on middlemen and local and official sources for agricultural information. Further, they find that mobile phones, which were widely available in the study area, were mostly used for post-sale inquiries rather than negotiating prices, accessing market or price information, or increasing production efficiency. The study also shows relatively high adoption rates of mobile phones by poor farmers in this region.

Jensen (2007) argues that in the presence of limited or costly information, there is excess price dispersion across markets, leading to inefficient allocation of resources. He therefore argues that ICTs may improve market performance and increase welfare. The study shows that the adoption of mobile phones by fishermen and wholesalers was associated with a dramatic reduction in price dispersion, the complete elimination of waste, and near-perfect adherence to the Law of One Price in Kerala State in India. This increased both consumer and producer welfare.

Abel-Ratovo et al. (2012) examine the effect of an MIS intervention known as PPRR on the ownership and use of mobile phones by grain traders in the regions of Analanjirofo and Atsinanana, Madagascar. PPRR is a public-private market information services program. The study finds that traders in areas covered by PPRR are more likely to own mobile phones and are also very likely to use those phones for agricultural transactions. Other factors found to affect the ownership and use of mobile phones by traders include trader-specific characteristics, socio-economic factors, and environmental factors. The paper concludes that the presence of PPRR increases the likelihood of the use of mobile phones for agricultural transactions.

Fu & Akter (2011) investigate how mobile phones impact pre-existing extension networks in India. They use a randomized population and measure proxies for adoption, knowledge generation, attitude, and awareness among a sample of 698 farmers (with a 50 percent illiteracy rate), measuring differences before and after the intervention. They find a significant improvement in the amount and quality of services and the speed of delivery as a result of the mobile phone-based intervention.

In order to characterize the impact of mobile phones on agricultural price dispersions, researchers have applied different techniques and data sets, with differing results. Using market and trader data for 2001-2006 and a Difference-in-Difference approach, Aker (2010) estimates the impact of mobile phones on price dispersions across grain markets in Niger and finds that mobile phones account for between 10 and 16 percent price reductions in these markets. Aker and Fafchamps (2010) use market pair fixed effects to estimate the impact of mobile phone coverage on farmers' welfare and find that introducing mobile phone coverage reduces producer price dispersion for cowpeas by 6 percent. The effect is stronger for markets that are farther apart and for those linked by unpaved roads, but there is no strong seasonal effect. Aker and Fafchamps (2013) use a static, symmetric one period model to estimate the impact of mobile telephony on producer prices in Niger and find that mobile phone coverage reduces spatial dispersions of producer prices by 6 percent for a semiperishable good but has no impact on price dispersions for storable goods. On the other hand, Fafchamps and Minten (2010) investigate the effect of mobile phone-based price information services on the agricultural prices received by farmers in Maharashtra, India and find no effects.

While some researchers (e.g. Katengeza, Mangisoni and Okello, 2010; Aker and Fafchamps, 2013) utilize diverse econometric methods to estimate the impact of ICTs on agricultural price dispersions, such methods have been criticized because they are not able to isolate the impact of ICTs from other confounding factors.

Experimental methods are thus becoming more popular as they are seen to yield better results when it comes to isolating the impact of ICTs on such markets. Parker, Ramdas, and Savva (2016) use a natural experiment, stemming from a ban of all bulk messages throughout India in September, 2010, to estimate whether providing reliable, unbiased, and regular price information to interested parties has an impact on price dispersions reduction; the study finds positive results. Aker and Fafchamps (2010) use a quasi-experimental approach to estimate the impact of mobile phones on farm-gate agricultural price dispersion in Niger between 2001 and 2008 and conclude that mobile phones cause a 6 percent reduction in producer price dispersions

The present study also uses a quasi-experimental design to characterize the welfare effect of two ICT projects. Welfare effects are measured by two outcomes: change in farmer price and change in farmer income. While the use of income as an indicator for welfare is used widely in the literature (see, for instance, Muriithi and Matz, 2014), the use of change in price follows Aker (2010), who argues that reduced consumer grain price dispersion across markets leads to welfare gains for grain traders and consumers. The two projects examined are E-soko in Rwanda and KACE in Kenya. The E-soko project is a government project implemented by Rwanda's Ministry of Agriculture and the World Bank; the project aims to bridge the information gap in the country's agricultural markets. The KACE project is a privately run project that collaborates with both the government and various non-governmental organizations. KACE is anchored on another World Bank initiative, the digital villages known as Pasha Centres in Kenya. These are internet access centers which help to meet the government's objective of ensuring that Kenyans everywhere have access to the internet and use it to access government e-services. These two portals make use of mobile phones to send information to users; users can also access the information online from the program websites.

2.3 Overview of E-soko Project in Rwanda

The E-soko project is an initiative of the Rwandan Ministry for Agriculture. It provides local farmers and agricultural traders with information concerning the price of agricultural produce in different markets. As reported by World Bank (2011), the E-soko system provides market price information to rural farmers and cooperatives that, in the past, suffered from a lack of market price information and had thus been isolated from or deprived of communication and trade across markets, across borders, and throughout the region. The portal aims to protect farmers from exploitation by middlemen by helping them take advantage of the most current market prices available and thus maximize the value of their produce.

The E-soko project was planned to be implemented in two phases. Phase One of the project, which provided the latest agricultural and related commodity prices at all major markets in Rwanda, was implemented in January, 2010. This phase is managed from the head office located in the Ministry of Agriculture but operates through market agents located in major market centers. These agents collect daily price information for various agricultural commodities from the local markets and post the information to the E-soko website. To access the information, farmers use their mobile phones to key in the product codes and market codes provided by the portal; this allows them to access market information in real time. Farmers can also use a web-based application in which they log onto the website and get access to all the latest commodity prices in all markets, as well as monthly reports from all markets. Farmers and cooperatives can then make informed decisions regarding where it would be most profitable to sell or buy a particular commodity. By June 2014, the E-soko system database covered 87 agricultural commodities in the country's 50 markets, all accessible through SMS. The program used only the local language, Kinyarwanda, to send information to users. By October, 2011, 60,865 people had accessed the system using SNS and 9577 people had accessed it via the internet. Apart from farmers and farmer cooperatives, other organizations, such as the World Food Program, have also used the portal's information to negotiate food prices with farmers.

According to the Rwanda Ministry of Agriculture (MINAGRI website), the E-soko project has had a significant impact on farmers: by reducing the costs and stabilize the prices of basic foodstuffs; encouraging producers to invest in new products that can generate more revenue; facilitating consumer access to foodstuffs at a fair price; and contributing to the stability of prices at reasonable levels by encouraging greater competition.

By 2014, the Ministry for Agriculture was in the process of implementing the second phase of the project. Some of the features expected in Phase Two are the development of a multilingual portal that provides information in Kinyarwanda, Swahili, and English; the expansion of market price information to include minimum, model, and maximum prices; the provision crop advisory information, including the stage of the crop cycle and weather or climate changes; the facilitation of market linkages between smallholder farmers, cooperatives, traders, and processing industries; and the establishment of a mobile phone-based payment gateway (MINAGRI, 2012).

2.4 Kenya Agricultural Commodity Exchange (KACE) in Kenya

The Kenya Agricultural Commodity Exchange (KACE) is a privately owned micro, small and medium enterprise (MSME) that was established in 1997. It provides a forum through which small-scale farmers can access mainstream markets for agricultural commodities. It is the first and only national agricultural commodity exchange in Kenya, and it differentiates itself by dealing with a variety of commodities; maize and beans are the most heavily traded. KACE acts as an intermediary, empowering rural farmers with market information and providing capacity enhancement, business training, and technical training (UNDP, 2010b)

KACE was established to help address some of the challenges facing farmers, buyers, and other participants in agricultural markets in Kenya's emerging liberalized markets. The project aims to link farmers with commodity buyers and provide a source of reliable commodity market information (Mukhebi et al., 2007). Prior to the formation of KACE, smallholder farmers lacked access to national markets for agricultural produce, leaving them vulnerable to the whims of buyers. Small farm size, low education, low levels of technology adoption, lack of access to quality markets, and low levels of organization all translated into poor bargaining power for farmers. In addition, the marketing chain for any one crop involved multiple middlemen, each of whom took a portion of the farmers' margin. Some buyers squeezed prices to such an extent that the subsistence farmers at the bottom of the value chain were forced sustain losses (KACE Website)

KACE links farmers and urban buyers by collecting information on daily commodity prices in regional markets. The information includes daily wholesale buying prices for various crop and livestock products in selected main markets in the country, as well as offers to sell and bids to buy. KACE also links farmers and agribusinesses to markets through matching commodity offers and bids. Market information enhances farmers' bargaining power and helps link farmers to input and output markets more efficiently and profitably (KACE website).

Farmers can access KACE information in real time through mobile phones and personal computers. KACE provides a virtual marketplace, known as Soko hewani, in which farmers can post their offers though a simple phone call based on an interactive voice response (IVR). The rural market response centres, MRCs[1] [2], compile farmers' offers and display them on their blackboards and online on the Soko hewani website. Buyers can then purchase in bulk through the MRCs or directly from individual farmers. The Soko Hewani system connects different stakeholders in the agribusiness value chain by IVR services, mobile payments, radio broadcasting, and web technologies. KACE also provides other logistical services such as transport, food quality measurement, and warehousing (KACE Website).

2.5 Other ICT-based solutions to address information asymmetry in agricultural *markets*

The East Africa Exchange (EAX) started in January, 2013 and was officially launched in Kigali in June, 2014. It is East Africa's first commodity exchange, linking farmers and producers to agricultural and

[1] MRCs serve as sources of reliable and timely market information for farmers (e.g. current commodity prices in different markets), as well as provide market linkage through matching commodity offers and bids. There are 10 MRCs located in Western, Nyanza, Rift Valley and Eastern Provinces of Kenya (KACE Website1).

[2] Radio is a key component of Soko Hewani. KACE, in conjunction with the Kenya Broadcasting Corporation (KBC), disseminates price information on selected commodities every day except for Sundays. The information is aired both in English and in Kiswahili. The KBC radio network covers the whole country and is therefore widely followed by the public, including rural smallholder farmers (KACE Website)

financial markets (The East African July, 2014). The privately funded Exchange helps producers secure competitive prices for their goods and facilitates access to funding opportunities.

The EAX is the third largest agricultural commodity exchange market in Africa, after the South African Futures Exchange and the Ethiopia Commodity Exchange. However, the bulk of commodity trading across the continent is still conducted on an informal basis, using an intricate network of small traders. As a result, farmers and traders are denied access to competitive pricing from a broad range of potential buyers and sellers (Bariyo Oct. 3, 2014)

The EAX platform is expected to facilitate the cross-border trade of commodities within the region by providing a central marketplace and connecting buyers and sellers throughout the region. Products for sale on the Exchange are graded for quality, with the Rwanda Bureau of Standards acting as the key standard enforcer. It is expected that the Exchange will not only help regional farmers to eliminate post-harvest losses, but also improve the liquidity levels in the economy and encourage a steady supply of quality raw material needed to trigger industrialization (The East African, July, 2014).

M-farm in Kenya provides up-to-date market prices directly to farmers via a web app or SMS and connects farmers with buyers, cutting out the middlemen. Farmers can also use SMS to receive information relating to the retail price of their products; these prices are updated daily with information for 42 crops (including peas, sugar snaps, avocadoes, passion fruit, peanuts, potatoes, cassava, and mangos) sold in five markets.

M-Farm also addresses the fact that farmers produce in low volume. Many buyers are located in big cities and do not want the hassle of getting the volume they need from multiple different farmers. To solve this problem, M-farm gets farmers to team up to bring their produce to certain drop-off points. They then use the system's SMS services to promote what the group has sell. Thus, farmers are able to pool their resources and negotiate better prices for farm inputs like fertilizer. Transactions are handled by an integrated mobile money transfer system, Mpesa, and can also be plugged into people's bank accounts

3. Data and Methodology

3.1 Sampling Technique and External Validity

Our study targeted farmers and traders who had knowledge of the ICT portals either through their own use or through information spillover. We used different techniques to identify the target population since the implementation for each portal was different.

For E-soko, the portal registers different markets and engages agents to collect price information from those markets. Program management then uses different media sources to teach farmers and other users how to access the portal for information. The assumption is that farmers and traders who are in the neighborhood of E-soko registered markets have access to E- soko information through local leaders or media promotion.

For KACE, contact with users comes through the program's Market Resource Centres (MRCs). Farmers and traders are able to access information from the centers or the KACE website. The assumption is that farmers and traders who are in the neighborhood of MRCs have access to KACE information from the centers themselves or through media promotion. The population is considered to be homogeneous in terms of information accessibility which justifies the use of random sampling techniques.

There are eight MRCs located in the Western, Rift Valley, and Eastern regions of Kenya. These include the Machakos MRC, Makeuni MRC, Chwele MRC, Mumias MRC, Eldoret MRC, Kitale MRC, Cheptais MRC, and Bungoma MRC. In order to take into account any geographical diversity, a multi-stage sampling technique was used to select participants. A list of the eight MRCs was separated into two regions: one list for the Western and Rift Valley provinces and the second list for the Eastern province. The lists were arranged in terms of performance and period of existence the first named MRC was picked from each list. These centers are Chwele MRC in Bungoma County in the Western/Rift Valley region, which was established in 2003, and Machakos MRC in Machakos county in the Eastern region, established in 2004. For each of the two MRCs sampled, a list of farmers and traders who had visited the MRC at least once was obtained. These participants were clustered according to their geographical locations, from which a random sample was obtained using a simple random technique.

Sampling for the E-soko users was done based on the vicinity with E-soko registered markets. Rwanda has five provinces; given that E-soko is a government service, all provinces have their main markets registered in the program. The Eastern and Southern provinces were chosen systematically based on their agricultural productivity. A list of districts with markets registered in the E-soko platform in each province was obtained from the E-soko website and one district in each province was selected using simple random sampling. These are Nyamagabe in Southern Region and Rwamagana in the Eastern Region. A multi-stage sampling technique was used in which two cells were selected in each district and farmers were selected through systematic sampling. For traders, a random sample of traders was selected using simple random sampling.

The external validity was assured by a large, random sample of farmers and traders drawn from the selected regions. To encourage participation, every participating farmer and trader was given a bar of soap. A semi-structured questionnaire was used to collect data from individual respondents.

It was anticipated that the refusal rate would be low given that the issues under study are not too sensitive. This low refusal rate was one of the factors contributing to the survey's cost effectiveness. The research team was also keen to ensure that the survey tools used were neutrally worded to avoid influencing participants' responses. Given these precautions, it is possible to generalize the cause and effects outcomes of the study.

3.2 Sample Size and Power

This study applied a quasi-experimental approach with matched comparison groups which compared outcomes for individual farmers receiving program activities with outcomes for a similar group of individuals not receiving program activities. To determine the sample size of farmers, we utilized power calculations.

In an earlier survey among potato farmers in Musanze in Rwanda by Kamande (2016), the price that farmers receive from the markets was found to be USD 0.171. The amount that traders fetch in the same markets is USD 0.223 with a standard deviation of 0.03. This study also established that despite the large differences in these two prices, farmers and traders sell to the same markets; these price differences are associated with information asymmetries. It is therefore logical to use these prices to estimate the sample size for this study. Assuming a design effect of 2 and an intra-class correlation of 0.05, we calculate the number of participants per cluster at 0.05 precision level and 80 percent power to be 21. Using STATA, we calculate the required sample size for one sample t-test to be 282, with the minimum clusters being 14. Thus the total sample size in each region was 282.

Farmers were assigned to a treatment and comparison group non-randomly using propensity score matching. In the areas where the projects are in operation, it is expected that there are both adopters and non-adopters of the relevant ICT technology. In this study, the adopters are considered to be farmers who frequently use the ICT portals to obtain price information. The data for treatment and comparison group was obtained from KACE farmers in Kenya. The non-adopters are considered to be farmers who share similar characteristics with adopters but do not use the ICT portals to obtain price information. The matching was conducted using results from a logistic regression of farmers, both adopters and non-adopters, from the assignment to treatment and control groups. The study adopts a post-test only quasi-experimental design.

Preliminary information obtained through interviews with KACE in Kenya indicates that in terms of access to the portal, 50 percent of users are farmers and the other 50 percent are traders. Using this proportion and Cochran's (1963) sample determination formulae cited by Israel (2009) and 90 percent confidence level, the sample size for traders in each region was 96.

3.3 Data and Variables

The study targeted ICT projects in East Africa, namely E-soko in Rwanda and KACE in Kenya. In Rwanda, the sample was drawn from two districts: Nyamagabe district in Southern province and Rwamagana district in Eastern province. A total of 403 questionnaires were administered among E-soko users comprising 302 farmers; 152 were farmers in the Kigabiro sector of Rwamagana district and 150 were farmers in the Tare sector of Nyamagabe district. Among the traders, 101 questionnaires were administered; 50 were traders in

Rwamagana and 51 were traders in Nyamagabe district. In Kenya, the study was carried out in two counties: Bungoma County in the Western region and Machakos county in the Eastern region. A total of 315 questionnaires were administered in Kenya. Out of these, 147 were farmers in Bungoma county, 100 were farmers in Machakos district, and 68 were traders (29 traders from Bungoma and 39 from Machakos).

The treatment variable is defined by the use of the ICT portals for price information; the treatment group is comprised of the adopters (those who have used the ICT portal at least once) and the control group is comprised of non-adopters (those who never used the ICT portal). There are two dependent variables measuring producer welfare: change in income and change in price. In the absence of a baseline, participants were required to report the figures before using KACE and after using KACE, with the assumption of perfect recall. These two figures were used to calculate change in the dependent variables. The confounders are those variables that tend to influence the use of the portal; these include age, age-squared, education, gender, marital status, type of business, and method of access to the portal. Other variables used as confounders are total land size, farming land size, and cost of transport to the nearest market.

3.4 Empirical Model

The study adopts a propensity-score matching (PSM) method to estimate the average treatment effects. The advantage of using PSM is that it reduces the selection bias that may be present in non-experimental data.

We assume a true propensity score bounded away from 0 and 1, which is specified as:

$$0 < Pr\ (T_i = 1\ |Xi = x) < 1 \text{ for any } x\ s\ X \qquad (1)$$

where T_i is a binary treatment and Xi is a vector of pre-treatment covariates

Given the true propensity score, the treatment assignment is ignorable, which implies that the unconfoundedness assumption specified as {Y(1), Y(0)} 1 T_i | n(X_i) and the overlap assumption specified as 0 < n(Xi) < 1 are both satisfied.

Y (1) is the potential outcome for the treatment group and Y(0) the potential outcome for the control group and n(Xi) are the propensity scores. The propensity scores are estimated through a logistic model specified as

$$n(Xi) = \frac{exp\ (X,\ ft)}{1 + exp\ (Xi\ ft)} \qquad (2)$$

To estimate the average treatment effect on the treated (ATT), the model is specified as ATT (Ti, Xi) = E(Y1 | Ti = 1) - E(Y0 | T, = 1).

E(Y1 | Ti = 1) is estimated from the data E(Y0 | T, = 1) is the counterfactual and thus unobserved in the target population and cannot be estimated.

However, assuming the ignorable treatment assignment and overlap assumptions hold (Rosenbaum and Rubin, 1983), the ATE can be specified as

$$ATT\ (Ti, Xi\ ) = E(Y1 \mid Ti = 1) - |E(Y0 \mid (T, = 1\ |X, = x, T, = 0) \qquad (3)$$

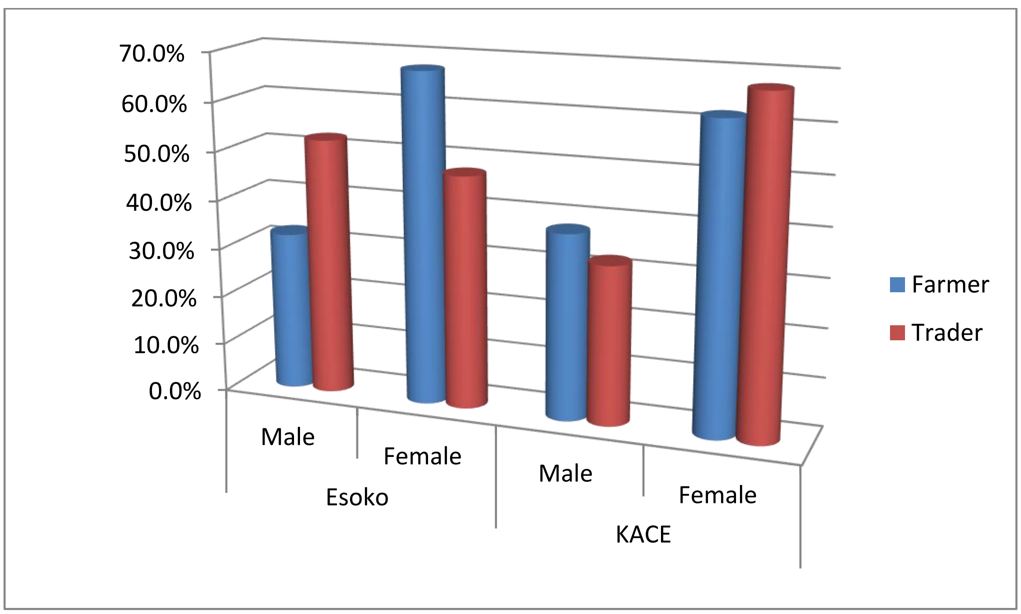
4. Results and Discussions

The first sub-section here provides the demographic characteristics of the respondents for both E-soko and KACE users. The second and third subsections describe the farmers' and traders' behavior, respectively. The fourth subsection provides a description of the selected ICT projects and the services they provide to both farmers and traders, and the fifth subsection gives a descriptive analysis of the benefits of the two portals to both farmers and traders. The sixth and seventh sections present the analysis of the welfare effect of the ICT projects on KACE farmers, comparing the users and non-users and the results of the PSM model. Finally, we present a description of potential challenges in the design and implementation of the projects in facilitating agricultural exchange between farmers and traders.

4.1 Demographic characteristics of respondents

The sample for both farmers and traders included both genders. Figure 1 presents the gender of respondents by project and by type of occupation.

Figure 1: Gender of respondents by ICT service provider



Source: survey data

In both cases, there were more female than male farmers: 67.5 percent female and 32.5 percent male for E-soko users and 62.1 percent female and 37.9 percent male for KACE users. There were more male traders using E-soko (52.5 percent) as opposed to 47.5 percent, while for KACE users, there were more female traders (67.6 percent) than male traders (32.4 percent).

Looking at the age of the respondents for both E-soko and KACE users, it is evident that most respondent are middle-aged, as shown in Table 1.

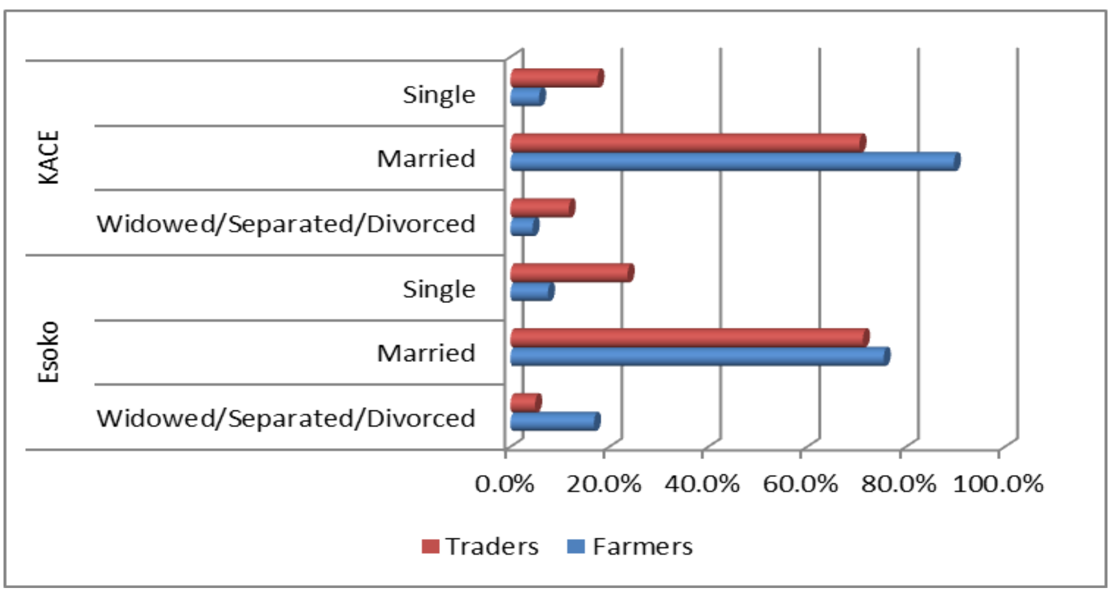
Table 1: Age of respondents by ICT service provider

Variable	E-soko		KACE	
	Farmer	**Trader**	**Farmer**	**Trader**
Mean	42	34	46	37
Std. Deviation	14.6	10.9	13.2	12.4
Minimum	18	18	20	17
Maximum	93	80	85	85

Source: Survey data

The age brackets in both regions were similar. The mean age for E-soko farmers was 42 years and that of traders was 34. For KACE users, the mean age for farmers was 46 and the mean age of traders was 37 years. In both cases, farmers were generally older than traders. The oldest farmer from E-soko was 93 years old, which is nine years older than the oldest farmer from KACE. Both the younger and older members of societies participate in farming and trading activities in both countries.

Figure 2: Marital Status by ICT service provider

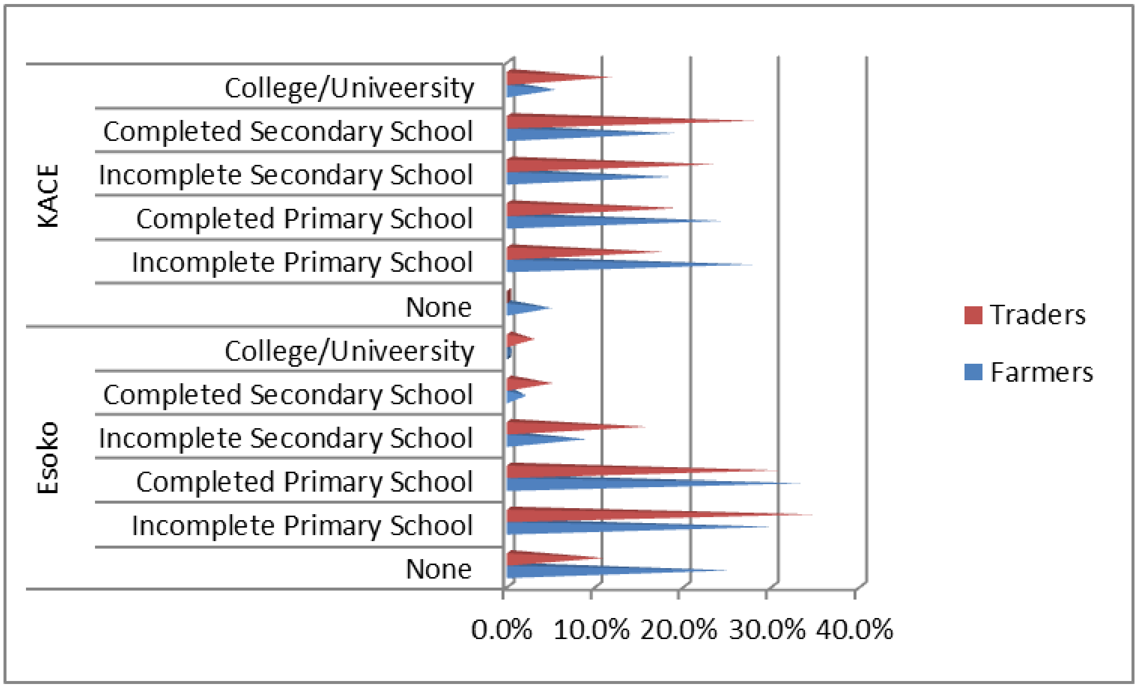


Source: survey data

Examining the distribution of respondents in terms of marital status, Figure 2 shows that the majority of respondents were married. However, there were more single traders than single farmers, which signifies that the younger generation is more eager to engage in business activities than farming activities. This trend is uniform for both E-soko and KACE users.

Given the nature of the two projects which use the ICT platforms, it is important to examine the distribution of the respondents in terms of education level. This is presented in Figure 3.

Figure 3: Education level by ICT service provider



Source: survey data

These results show that traders are more educated than farmers. Most of the farmers have attained only primary education and below, while the traders have attained secondary education and above. It is also observed that KACE traders are more educated than E-soko traders; 39.7 percent of KACE traders have secondary education and above (only 17.6 percent have lower than complete primary education) compared to 24.9 percent of E-soko traders (45.6 percent have lower than complete primary education).

Similarly, KACE farmers are more educated than E-soko farmers. Twenty-five percent of E-soko farmers had no education while only 4 percent of KACE farmers reported no education; 30 percent of E-soko farmers had incomplete primary education compared to 27.7 percent of KACE farmers; and 33.4 percent of E-soko had completed primary school compared to 24.4 percent of KACE farmers. More KACE farmers had completed secondary education and college compared to E-soko farmers. These differences in education levels can be explained by the differences in educational attainment levels for the two nations.

4.2 Farmers' behavior

The two ICT projects under study were designed to bridge information gaps for agricultural products for both farmers and traders. Empowering farmers with market information is an important channel through which to improve their welfare. It is therefore important to understand the farming behavior of respondents. Table 2 presents the type of farming practiced by the farmers in this sample, both under E-soko and KACE.

Table 2: Percent of farmers practicing farming by ICT service provider

Variable	E-soko Farmers	KACE Farmers
Farmers who do crop farming	53.6%	28.4%
Farmers who do mixed farming	46.4%	70.8%
Farmers who do subsistence farming	64.6%	21.4%
Farmers who do cash crop farming	3.4%	14.8%
Farmers who do both subsistence and cash crop farming	31.5%	62.6%

Source: Survey data

On farming behavior, the study found out that majority (53.6 percent) of E-soko farmers engaged in crop farming as opposed to mixed farming (46.4 percent). For KACE, most farmers practice mixed farming (70.8 percent) as opposed to crop farming (28.4 percent)

In terms of the scale of farming, E-soko farmers are predominantly subsistence farmers (64.6 percent); only 31.5 percent engage in both subsistence and cash crop farming. However, KACE farmers are predominantly both subsistence and cash crop farmers (62.6 percent), with only 21.4 percent engaging in only subsistence farming. This is also evidenced by the types of crops grown, as presented in Table 3

The study established that the most dominant crop grown among E- soko farmers is beans (grown by 38.4 percent), followed by maize and corn (22.8 percent), sweet potato (16.2 percent), bananas (6.3 percent), sorghum (5.3 percent), cassava (4.0 percent), and potatoes (2.6 percent). For KACE farmers, the major crop is maize and corn (39.9 percent) followed by pigeon peas (37.4 percent) and sugar cane (7 percent).

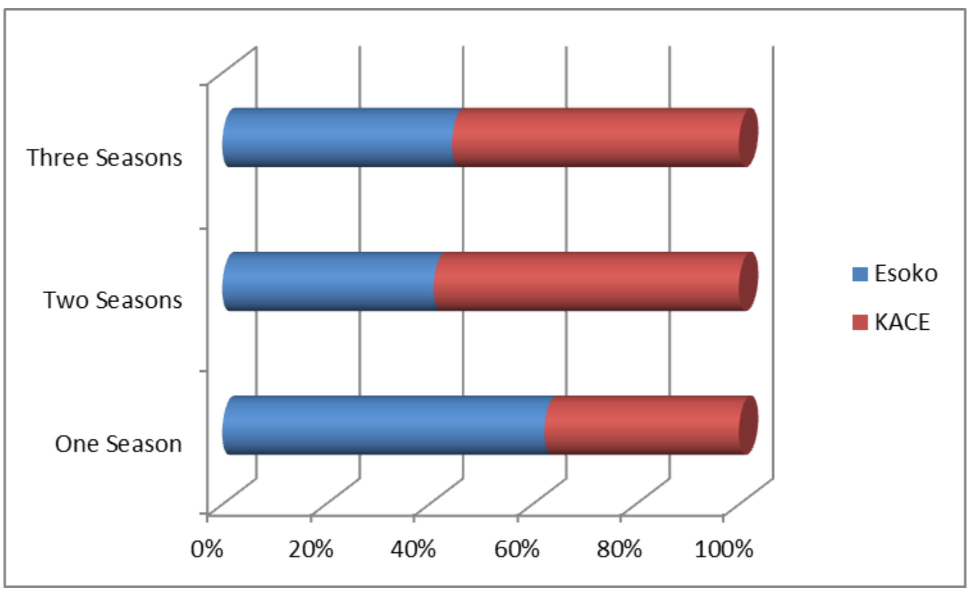
Table 3: Percent of farmers by Type of crops grown and ICT provider

Crop	E-soko Farmers	KACE Farmers
Beans	38.4%	0.8%
Maize/Corn	22.8%	39.9%
Pigeon Peas	1.3%	37.4%
Potatoes	2.6%	0.0%
Bananas	6.3%	0.2%
Sweet Potato	16.2%	0.5%
Sugarcane	0.0%	7.0%
Cassava	4.0%	0.8%
Sorghum	5.3%	0.0%
Fruits And Vegetables	1.3%	4.5%
Other Crops	1.3%	0.8%

Source: Survey data

Agricultural production is also determined by the number of planting seasons in which farming is done. Figure 4 presents farming seasons for both KACE and E-soko farmers

Figure 4: Number of planting seasons by Country



Source: survey data

The majority of E-soko farmers (54.5 percent) had one planting season; 43.6 percent reported two planting seasons. For KACE farmers, the majority (63 percent) had two planting seasons while 32.9 percent had one planting season. Very few farmers in either sample had three seasons.

It is also important to understand how farmers market their crops. The study therefore sought to determine the marketing channels used by both E-soko and KACE farmers (Table 4).

Table 4: Percent of farmers' marketing channels by ICT service provider

Variable	E-soko Farmers	KACE Farmers
Farmers who sell their produce directly to market	51.3%	48.6%
Farmers who sell their produce to walk-in customers at farm gate	1.3%	12.8%
Farmers who sell their produce to retail traders	14.6%	12.3%
Farmers who sell their produce to whole sale traders	28.5%	4.1%
Farmers who are retail traders	25.8%	49.3%
Farmers who are wholesale traders	69.8%	11.8%
Farmers who are both wholesale and retail traders	4.4%	10.5%
Farmers who use bicycle and Motorbikes as the means of transport	29.6%	49.8%
Farmers who use vehicle as the means of transport	2.5%	12.3%
Farmers who use head load as the means of transport	53.5%	6.2%
Farmers who use animals as the means of transport	0.6%	3.7%
Farmers who use other transport means	13.8%	7.4%

Source: Survey Data

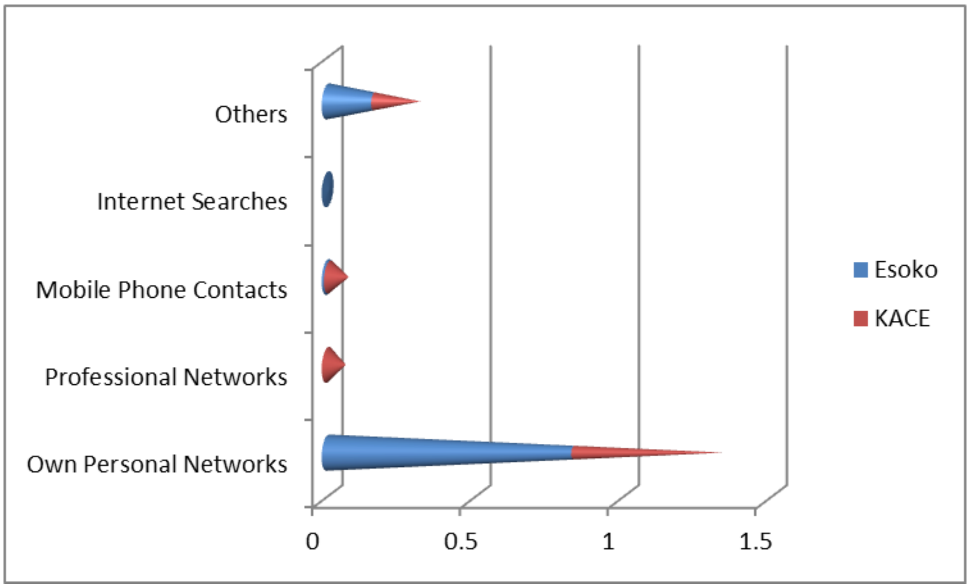
The majority of E-soko farmers (51.3 percent) sold their produce directly to the market as opposed to selling to customers and traders at farm gate. Of the 44.4 percent who sold to traders at farm gate, most sold to wholesale traders (28.5 percent) as opposed to retail traders and walk-in customers. Of KACE farmers, 48.6 percent sold their produce directly to the market as opposed to selling to traders at farm gate (29.2 percent). Those who sold at farm gate mainly sold to walk-in customers (12.8 percent) or retail traders (12.3 percent) as opposed to wholesale traders.

Further analysis shows that most of the respondents practice agribusiness. Of E-soko farmers, 25.8 percent are retail traders while 69.8 percent are wholesale traders, which confirms the earlier analysis that most E-soko farmers sell to wholesale traders. Of KACE farmers, however, 49.3 percent are retail traders, again confirming that most Kace farmers sell to walk-in customers and retail traders. Among KACE farmers, bicycles and motorbikes are the predominant means of transport to market, while for E-soko farmers, the predominant means of transport is head loads (53.5 percent).

Given that most of the farmers in this sample engage in some agribusiness, it is important to assess their source of price information. This information is presented in Figure 5.

An overwhelming majority (83 percent) of E-soko farmers used their own personal networks to obtain price information compared with 50.6 percent of KACE farmers. It was found out that 6.6 percent of KACE farmers used mobile phone contacts as opposed to 0.6 percent of E-soko farmers. The number of farmers who used internet searches to obtain price information was negligible in both cases; 6.2 percent of KACE farmers used professional networks and 15.6 percent and 15.7 percent used other methods to source for price information for KACE and E-soko farmers, respectively.

Figure 5: Source of Price Information for farmers by Country

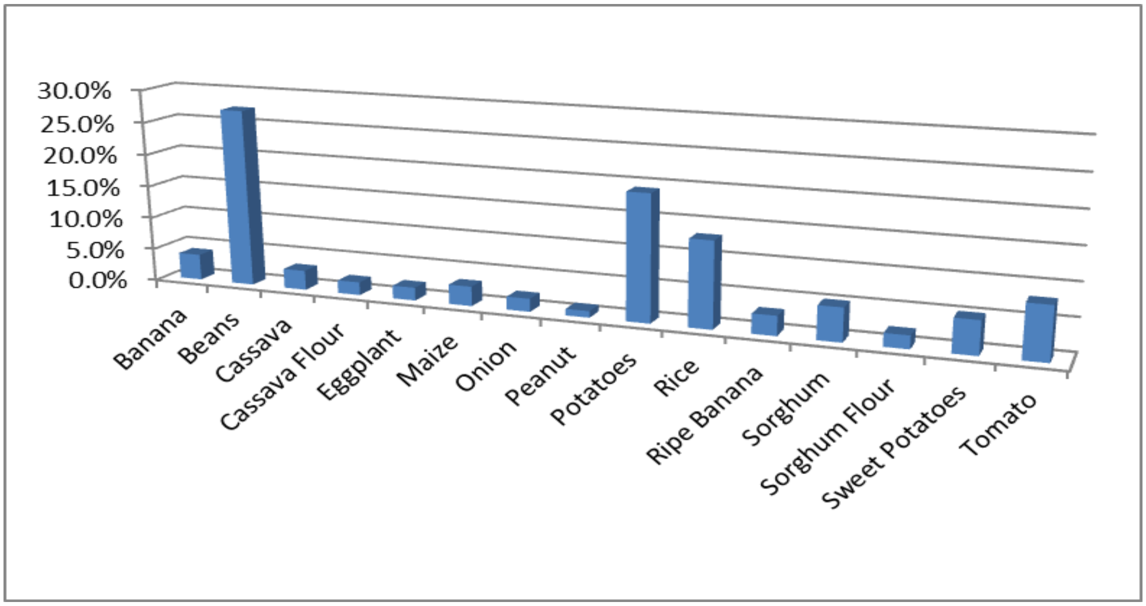


Source: survey data

4.3 Traders' Behavior

From the foregoing analysis, it is evident that most of the farmers sampled in this study interact with traders either at the market or at the farm gate. Previous studies have shown that one of the things that limits the welfare of farmers is exploitation by middlemen who put large mark-ups on the prices they offer to farmers in order to maximize their profits at the expense of the farmers. It is therefore important to understand the behavior of trader respondents. Figure 6 and Figure 7 present the main crops sold by traders under both E-soko and KACE.

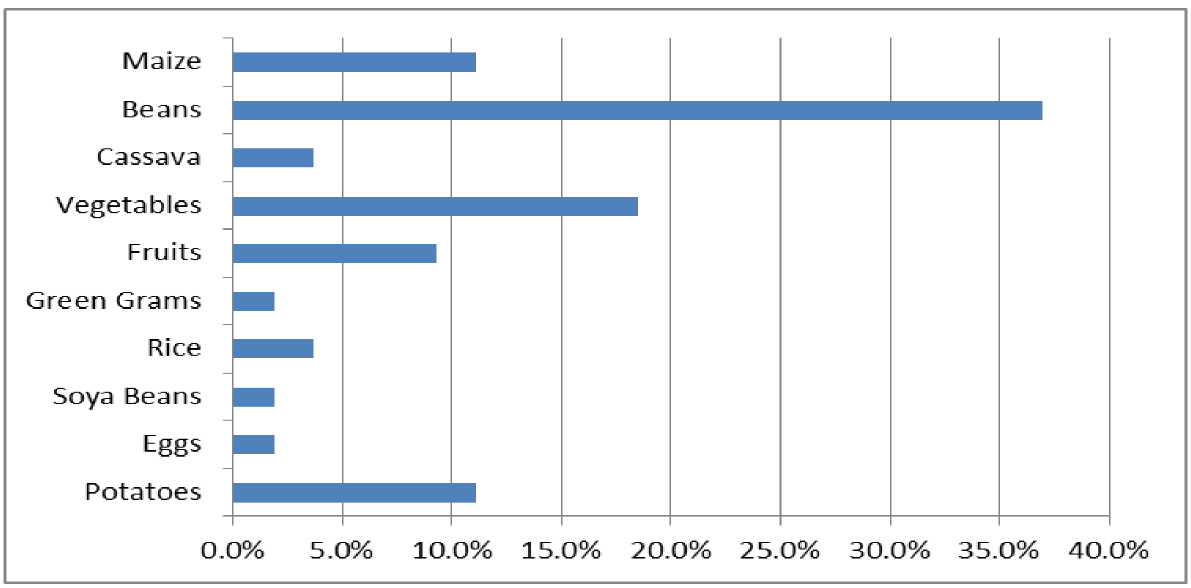
Figure 6: Main crop sold by Esoko traders



Source: survey data

From Figure 6, we observe that the main crops sold by Esoko traders include beans (27.3 percent), potato (19.2 percent), rice (13.1 percent), and tomatoes (8.1 percent)

Figure 7: Main crop sold by KACE traders

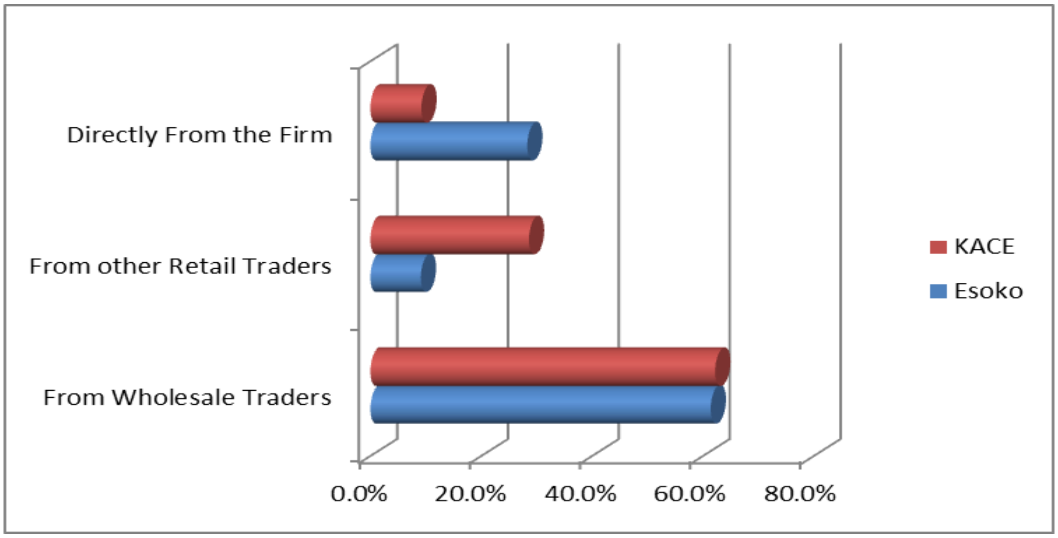


Source: survey data

For KACE traders, the main crops sold include beans (37 percent), vegetables (18.5 percent), maize (11.1 percent), and potatoes (11.1 percent).

Looking at the source of produce that traders sell presented in Figure 8, it is clear that most traders in the sample in both KACE and E-soko bought produce from wholesale traders. There were more traders buying products at farm gate among E-soko farmers (28.3 percent) compared to KACE (9.2 percent).

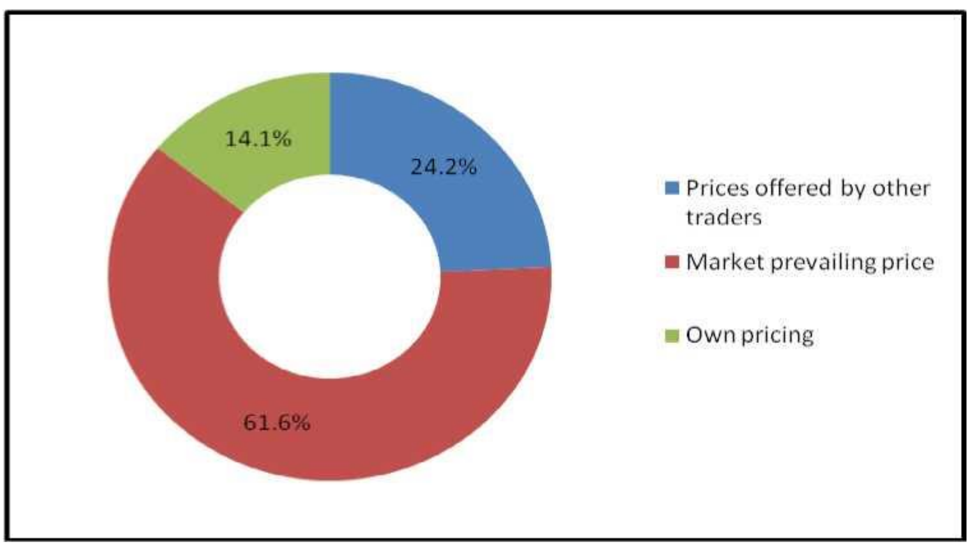
Figure 8: Source of produce for traders by ICT service provider



Source: survey data

More KACE traders bought from retail traders (28.6 percent), opposed to 9.1 percent for E- soko farmers. The study also sought to establish the source of traders' price information (Figure 9).

Figure 9: Source of price information for traders



Source: survey data

The majority (61.6 percent) of traders sought their price information from the market prevailing price, 24.2 percent from prices offered by other traders, and 14.1 percent from their own pricing.

4.4 Description of the Selected ICT Projects and the Services Provided

The two ICT projects are built on a similar platform. The E-soko portal can be accessed from the country's 30 TeleCentres or Business Development Centres (BDCs), which are set up in each district to empower farmers to make more informed market pricing decisions. These centers offer other services as well, such as training on new crop production methods and high-yielding varieties, basic ICT training, and business plan writing. The market price information is available for all the common crops in Rwanda including cabbages, cassava, maize, and bananas.

Farmers can access information using mobile phones; for farmers without mobile phones, village phones can also be used to access prices. The field staff employed by MINAGRI collect information via their smartphones, after which the pricing information is entered in the e- Soko database.

The KACE portals allows farmers to access information through mobile phone handsets and personal computers. KACE provides a virtual marketplace, known as Soko hewani, in which farmers can post their offers though a simple phone call based on an interactive voice response (IVR). There are also rural market response centres (MRCs) similar to E-soko's Business Development centres. The MRCs compile farmers' offers and display them on their blackboards and online on the Soko hewani website. The information includes daily wholesale buying prices for various crop and livestock products in selected main markets in the country, as well as commodity offers to sell and bids to buy. KACE also links farmers and agribusinesses to markets through matching commodity offers and bids.

Mobile phones are a key component in the operations of each of these projects. Table 5 provides information of mobile phone ownership and usage for both E-soko and KACE respondents

Table 5: Percent of Mobile Phone Ownership and Usage among respondents by Service provider

Variable	**E-soko**	**KACE**
Farmers who own mobile phones	64.6%	87.7%
Traders who own mobile phones	86.1%	97.1%
Farmers who use mobile phones to make and receive calls only	95.9%	86.0%
Traders who use mobile phones to make and receive calls only	92.0%	76.0%
Farmers who use mobile phones to make and receive calls only and surf internet	4.1%	7.0%
Traders who use mobile phones to make and receive calls only and surf internet	8.0%	23.0%

Source: Survey Data

For the distribution of Mobile Phone Ownership and Usage, on average, mobile phone ownership among farmers is high: more than 60 percent for both E-soko and KACE respondents. This is supported by the high level of mobile phone penetration in both Rwanda and Kenya. According to the Integrated Survey on

Life Conditions (NISR, 2012), the percentage of households with at least one mobile phone in Rwanda was 45.2 percent among the general population in 2010-2011. In Kenya, the Communication Commission of Kenya final quarterly report for 2012-2013 reported mobile phone penetration of 77.9 percent (Biztech Africa, 2013)

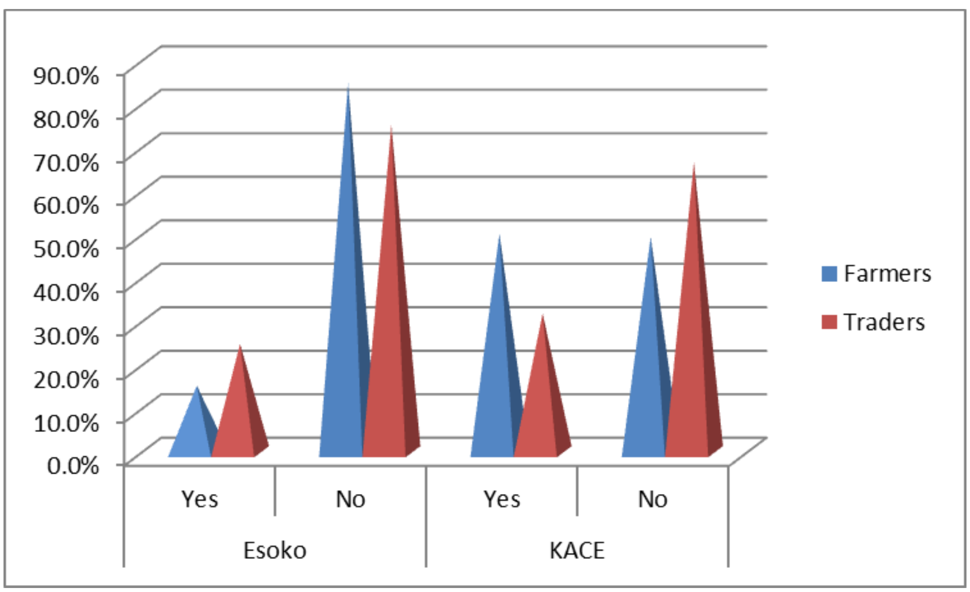
It is evident that mobile phone ownership is higher among traders than among farmers. Comparing mobile ownership among KACE and E-soko respondents, more KACE farmers owned mobile phones (87.7 percent) than E-soko farmers (64.6 percent). Similarly, more KACE traders owned mobile phones (97.1 percent) than E-soko traders (86.1 percent).

The majority of respondents for both E-soko and KACE used mobile phones to make and receive calls. The percentage of farmers and traders who used mobile phones to make and receive calls and to surf the internet was low, especially for E- soko respondents; however, the percentage of traders using mobile phones to make calls and surf the internet was relatively high (23 percent) among KACE respondents.

From these statistics, there is no indication that the high penetration of mobile phones in both regions and among the respondents translates into the use of those phones for business reasons. However, high mobile ownership does present an opportunity for phone users to benefit from the ICT portals.

The study next examined whether the respondents knew about the existence of the ICT portals results which are presented in figure 10.

Figure 10: Knowledge about Esoko and KACE Portals.



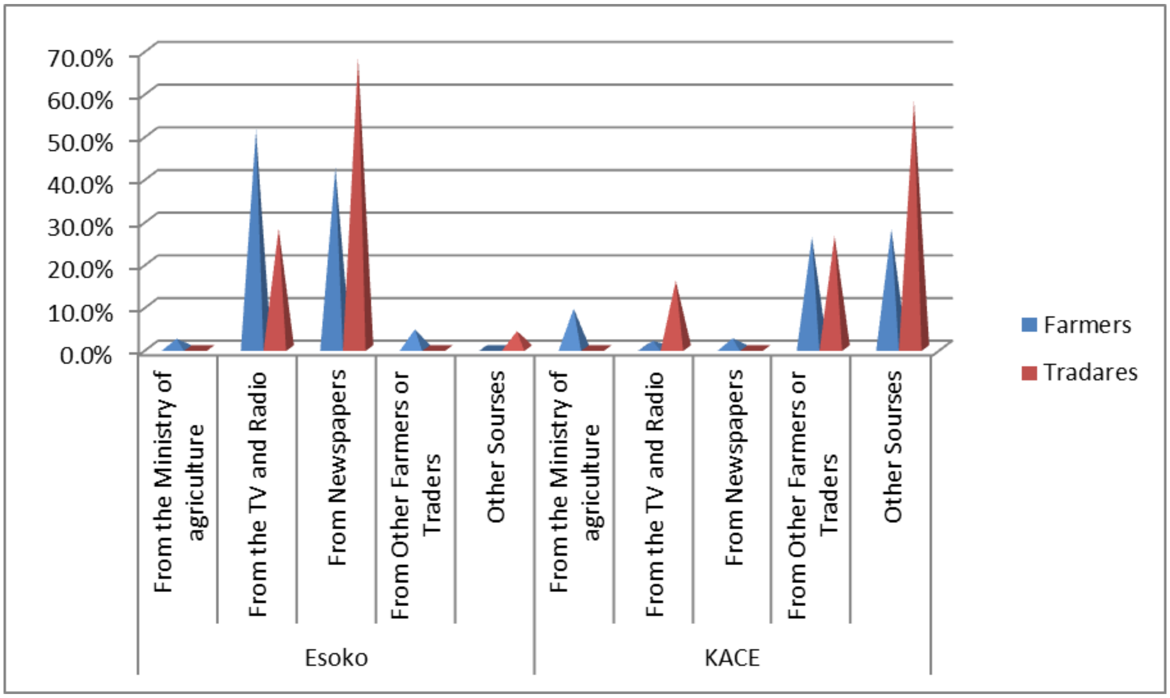
Source: survey data

The findings reveal that the majority of E-soko farmers (84.8 percent) and traders (75.2 percent) did not have knowledge about the E-Soko portal; only 24.8 percent of traders and 15.2 percent of farmers indicated that they were aware of the E-Soko platform.

The findings for KACE were more encouraging: 50.2 percent of farmers were aware of the platform. However, only 31.8 percent of traders knew about the KACE platform.

Traders and farmers were asked how they knew about E-Soko and KACE; the results are:

Figure 11: Source of E-soko and KACE information



Source: survey data

The majority (68 percent) of traders knew about E-Soko through newspapers, while majority of farmers (51.1 percent) knew about E-Soko through the Radio. For KACE, 26.3 percent of traders got their information from other traders and 26.1 percent of farmers received their information through other farmers and traders. In addition, 9.3 percent of farmers got information on the KACE platform through the Kenyan Ministry of Agriculture; in contrast, only 2.2 percent of E-soko farmers got information through Rwanda's Ministry of Agriculture.

Knowledge of E-soko is very low, which affected the knowledge of how to obtain information from the platform. However, knowledge of how to access information from KACE yielded some positive responses; this can be explained by the fact that a considerable number of KACE farmers had heard about the platform. Table 6 presents these results.

Table 6: Mode of information access on KACE Portal

Variable	Percentage
Farmers who access information from KACE through mobile phone	34.2%
Traders who access information from KACE through mobile phone	38.5%
Farmers who access information from KACE through website	0.7%
Farmers who access information from KACE through both mobile phone and Website	1.3%
Farmers who access information from KACE through office Visit	16.8%
Traders who access information from KACE through office Visit	61.5%

Source: Survey Data

For the KACE portal, the majority of traders (61.5 percent) accessed information from KACE during an office visit, compared to 16.8 percent of farmers who accessed information through an office visit. On the other hand, 38.5 percent of traders and 34.2 percent of farmers accessed information from KACE through mobile phones. Very few farmers accessed information from KACE through the website.

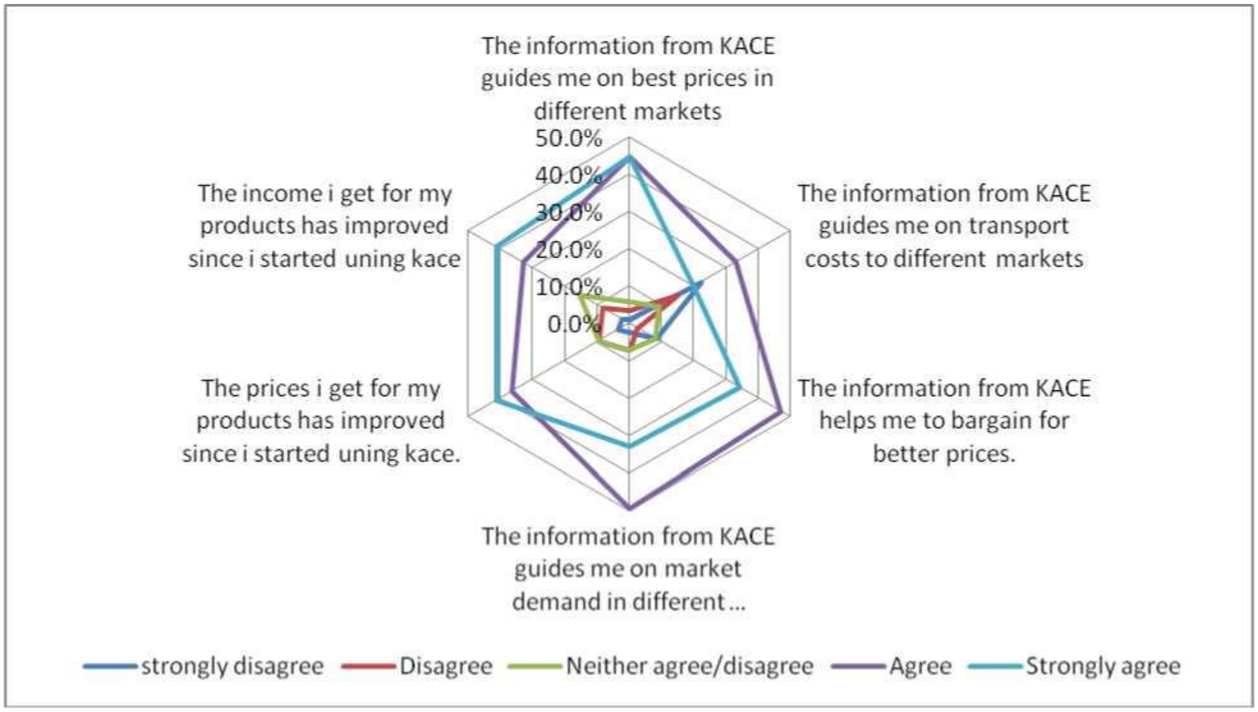
4.5 Benefit from E-soko and KACE

Regarding the various benefits of E-Soko, farmers and traders reported that they could get reliable prices information through the platform. One farmer said *"I can know my benefits based on the fixed price".* In addition, respondents said that the platform had also helped them to sell products outside their areas. As one farmer put it, *"it helped me to know who I can sell my product to".* Farmers also said that they could get good prices for their produce through the use of the platform rather than being exploited by middlemen

For KACE farmers and traders, the benefit of using the platform included creating awareness on market prices; the platform helps them locate commodity prices from various markets in the county and helps them to sell their products. As one farmer put it *"I get to know about other products available in the market*." Another said that KACE "*taught on farming techniques and got informed on market prices"* KACE also provides farmers with phones for business use and connects them to buyers. The program also offered training, marketing support, manure decomposition techniques, and information on weather patterns.

In Figure 12, we see that 89 percent of KACE users agreed or strongly agreed that the information from KACE guides them on best prices in different markets; 82 percent agreed or strongly agreed that the information guides them on market demand in different markets; 81 percent agreed or strongly agreed that the information helps them to bargain for better prices, and 52 percent agreed or strongly agreed that the information guides them on transport costs to different markets

Figure 12: Benefits from KACE



These results agree with respondents' answers as to what has changed since they started using KACE. Seventy-eight percent of KACE agreed or strongly agreed that the prices they got for their products had improved, while 74 percent indicated that the income they got from their products had improved.

4.6 Analysis of the Welfare effects of the ICT projects

The objective of this study is to estimate the causal effect of the use of ICT portals. As outlined earlier, we used a propensity score matching model, which is a quasi-experimental approach. This requires an analysis of change in income and change in price as a result of using an ICT portal. The changes in the treatment group are compared with changes for the non-users for the same period.

The sample is divided into treatment and control groups depending on the use of information from KACE. The respondents who have used the information are taken as the treatment group, while those who have not used the information are the control group. As explained earlier, this is done only for the Kenyan sample where the use of the ICT portal was found to be significant.

While all the respondents in the sample have a mobile phone, the treatment indicator is defined by the use or non-use of information from KACE; all 65 respondents in the treatment group have used the information, while the 87 in the control group have never used the information. It is assumed that the probability of treatment is positively correlated with age and education level and that the two are positively correlated with the dependent variable. Other variables assumed to influence change in income and change in price include type of business, method of access to the portal, total land size, farming land size, and cost of transport to the nearest market.

4.6.1 Two sample t-test

The estimation of the model starts by a comparison of the mean change in agricultural prices for the treated and control groups. The change in price is obtained by the difference between the price farmers got before using KACE and the price after they began using KACE platform. Two prices are considered: the average price for the main crop sold and the average price of the second main crop sold. Table 7 presents the results from a two sample t-test used to compare the means.

It can be observed that the change in price for the treatment group is higher than that of the control group, as well as that of the combined sample. Looking at the t- statistics, the difference in price change between the treatment and control is not significant at 95 percent confidence level in the case of main crop, but it is significant for the second main crop.

Table 7: Two sample t-test used to compare the means

Variable	Combined Change	Change for Treatment Group	Change for Control Group	T-Statistics
Change Price Main Crop	188.7	233.5	155.1	-1.2659
Change Price Second Main Crop	136.9	241.7	59.6	-2.4810**
Average Change Price	151.4	227.2	94.8	-2.2459**
Average Income Main Crop	3428	6284.8	897.5	-2.5154**
Average Income Second Main Crop	1942.9	4254.4	479.8	2.1472**
Average Change Income	2501.1	5097.9	553.4	-3.0579**
Change Quantity Main Crop	236.8	-155.6	458.7	1.0929
Change Quantity Second Main Crop	70.6	128.5	41.3	-1.6224
Average Change quantity	137.7	-49.1	263.9	0.9603

*Source: Estimation using Stata 14. ***,** and * denote Significance levels at 1%, 5% and 10% respectively based on t-statistics.*

Looking at the change in income, the change for the treatment group is higher than that of the control group, as well as that of the combined sample. The t-statistics are both significant 95 percent confidence level.

The observed change in quantity produced for the treatment group is lower than that of the control group, as well as that of the combined sample. Looking at the t-statistics, the difference in quantity change between the treatment and control is not significant in either case. These results are attributable to the fact that the units of measurements seemed to differ from respondent to respondent (for instance, a farmer who indicates that his production is 90 kgs of maize and another who indicates 1 bag of maize). Therefore measuring the quantity variable results in measurement errors and will not be used for welfare analysis in this study

Comparing the period before using KACE and after using KACE, there is an observable positive change in both price and income for farmers for both treatment and control groups. However, it cannot be concluded from this analysis that the changes observed are attributable to the use of KACE. Further, with the assumption that the probability of treatment is positively correlated with other covariates which may be correlated with the dependent variable, the two sample t-test approach would overestimate the effect of treatment. This calls for a more advanced method that will take care of the autocorrelation in the analysis.

4.6.2 Propensity Score Model

As outlined earlier, a propensity score model is used to measure the effects of the ICT platforms on agricultural prices and income, which are considered indicators of producer welfare. The rationale behind any matching model is that the comparison group is as similar as possible to the treatment group in terms of observable characteristics and assumes that there are no unobserved differences between the two groups.

The identifying assumption of propensity matching model is that the unconfoundedness property is satisfied, which implies that the selection into the treatment group is random and depends only on the observables. To test whether this assumption is satisfied, we estimate the average treatment effects using a conditional model for the potential outcomes. This is done for two dependent variables: change in agricultural prices and change in income. In a standard regression approach, unconfoundedness is implicitly assumed together with other functional or distributional assumptions. The results of the model are reported in Table 8.

Table 8: Regression Models Estimation Results

Variable	**Model 1** **DV = average change in price**	**Model 2** **DV = average change in income**
Constant	553.20*** (157.20)	28066.51*** (8290.79)
Treatment	-322.66*** (98.09)**	-14991.48*** (1486.2)
R2	0.077	0.061

Source: From OLS estimation using Stata 14. The figures in parentheses are the standard errors. ***, ** and * denote Significance levels at 1%, 5% and 10% respectively based on t-statistics.

From the analysis above, we conclude that the treatment effect is negative in all cases and statistically significant, implying that the use of ICTs in agriculture negatively impacts both the prices and the income of farmers for the treatment group. However, in order to ascertain whether the results were sensitive to the underlying assumption of unconfoundedness, we include all other covariates in the regression results (presented in Table 9).

It can be seen that after including these other confounders, the treatment effect is now positive for change in income but remains negative for change in price. Both are significant.

As suggested by Grilli and Rampichini (2011), using a regression model to estimate the treatment effects is not appropriate because we do not know the exact nature of dependence of the assignment on the covariates; the choice of covariates to be included in the model strongly affects the results

Table 9: Regression Models Estimation Results

Variable	Model 1 DV = average change in price	Model 2 DV = average change in income
Constant	683.17 (804.04)	80512.65 (42570.5)
Treatment	-295.67*** (105.98)	14917.2** (5611.3)
Education-CP	-266.90* (141.8)	7012.4 (7505.9)
Education-IS	66.37 (155.6)	6442.3 (8238)
Education-CS	83.30 (154.2)	19659.5 (8164,6)
Education-CU	654.59** (277.0)	535.25 (14675.6)
Gender	83.22 (118.5)	-4627.3 (6273)
Marital Status	-20.43 (92.36)	386.5 (4889.9)
Type of Business	-63.66 (73.74)	1407.3 (3904.2)
Method of information access	29.03 (31.27)	1590.1 (1655.5)
Age	-11.34 (33.88)	-2965.6 (1793.9)
Age-square	0.13 (0.37)	36.67 (19.61)
R2	0.196	0.141

Source: From estimation using Stata 14. The figures in parentheses are the standard errors. ***,** and * denote Significance levels at 1%, 5% and 10% respectively based on t-statistics.

Another condition that needs to be satisfied is the common support condition which focuses on comparison of comparable subjects. To satisfy this property, it is expected that the pre-treatment variables are balanced between treatment and control group. We therefore need to establish that the assumption of covariate balance is satisfied. This is done by estimating a logit model to predict treatment assignation and then checking the covariate balance given by the resulting propensity score. This is meant to balance covariates so that two study subjects with the same propensity score are appreciably similar in observed dimensions.

The balancing property of the propensity score ensures that observations with the same propensity score have the same distribution of observable covariates independently of treatment status and that for a given propensity score, assignment to treatment is "random" and therefore treatment and control units are observationally identical on average.

The balancing algorithm used is the nearest neighbor matching. To ensure that the treatment and control group are as close as possible, we first include as many covariates as possible and test for balance. The balance test is done for each dependent variable.

Table 10 presents the covariance balance summary for change in income.

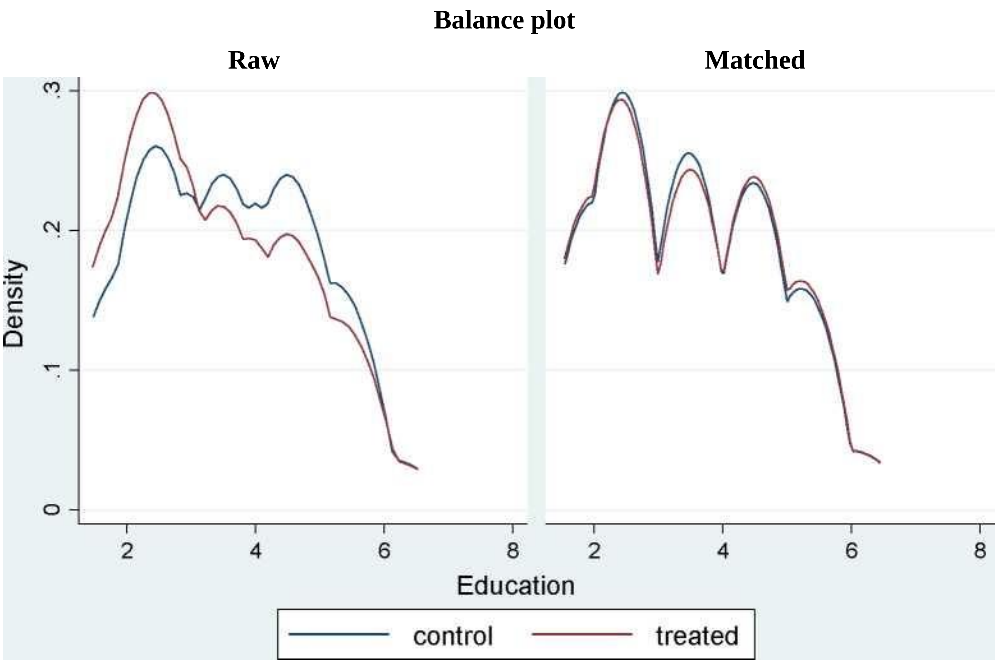
Table 10: Covariate balance summary with Change in income as dependent variable

	Standardized differences		**Variance ratio**	
	Raw	**Matched**	**Raw**	**Matched**
Education-CP	0.0945	0	1.1005	1
Education-IS	-0.1977	-0.0635	0.7285	0.9021
Education-CS	-0.0737	-0.0208	0.8918	0.9682
Education-CU	-0.0338	0	0.8661	1
Gender	-0.364	-0.3197	1.343	1.4089
Marital Status	-0.1735	-0.0865	1.1573	1.1887
Type of Business	-0.0053	-0.0126	1.0493	1.1185
Method of price information access	-0.0763	-0.0051	1.0493	1.1185
Age	-0.1709	0.0253	1.3237	1.0557
Age-square	-0.1343	0.0319	1.2275	1.0364
County	-0.1628	-0.1209	1.0976	1.0788
Total Land size	-0.0477	-0.0546	1.9265	1.6111
Farming land size	-0.5566	-0.3654	0.3654	0.4487
Transport cost to market	0.2068	0.2093	73.585	48.259

Source: From estimation using Stata 14. No. of observations: 106 - Raw (Treated = 53, Control = 53); 212 - matched (Treated = 106, Control = 106)

It is observable that after matching, most of the covariates are fairly balanced because the standard differences are closer to 0 and the variance is approximately near to 1. However, some of the covariates, such as farming land size and transport cost to the market, are not balanced. The most balanced of the covariates is education, which is observable from the table and also shown in Figure 13.

Figure 13: Covariance Balance plot for Education with change in income



Source: From estimation using Stata 14.

The balance test is repeated with change in price as the dependent variable and the covariance balance summary is presented in Table 11

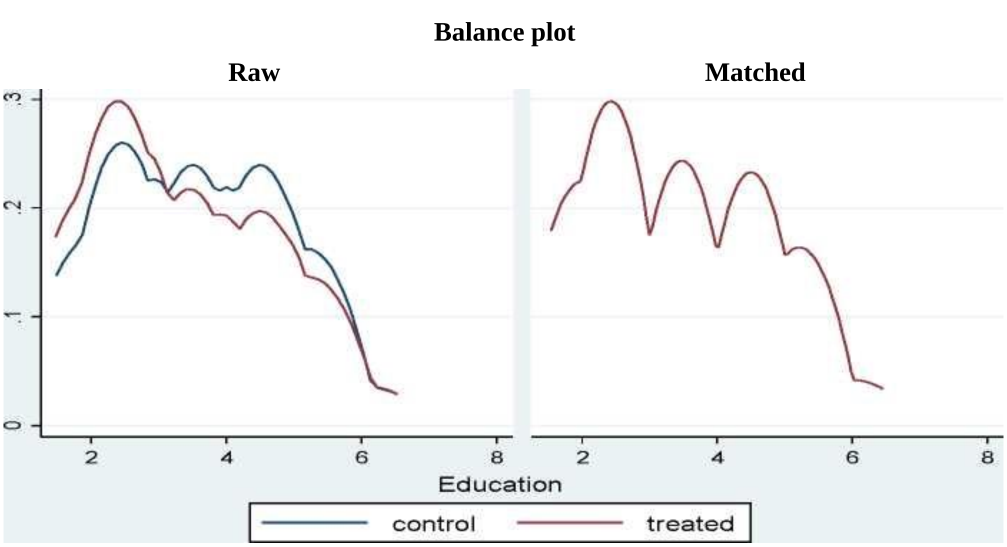
The results are similar: farming land size and transport cost to the market are the most unbalanced variables and education is the most balanced, as shown in the Figure 14.

Table 11: Covariate balance summary with Change in Price as dependent variable

	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Education-CP	0	-0.0449	1	0.9427
Education-IS	-0.0922	0	0.974	1
Education-CS	-0.0922	0.0234	0.0874	1.0353
Education-CU	0	0	1	1
Gender	-0.3246	-0.2608	1.2923	1.3496
Marital Status	-0.1475	-0.1072	1.2953	1.2228
Type of Business Method of price information	-0.1043	-0.0279	1.4399	1.6254
access	0.0106	0.1587	1.1609	1.3557
Age	-0.1802	-0.0769	1.3563	1.1311
Age-square	-0.1402	-0.0621	1.2903	1.1078
County	-0.3478	-0.3091	1.1471	1.3037
Total Land size	-0.955	-0.1308	2.0668	1.5938
Farming land size	-0.6129	-0.4733	0.4063	0.4124
Cost of Transport to market	0.255	0.1961	85.971	47.726

Source: From estimation using Stata 14. No. of observations: 106 - Raw (Treated = 53, Control = 53); 212 - matched (Treated = 106, Control = 106)

Figure 14: Covariance Balance plot for Education with change in price



4.7 Model Estimation

The matching model used is the nearest neighbor matching technique, conditioning on the common support. Given the above results from the balance test in which education gives an exact match while some of the covariates are extremely unbalanced, the treatment effect estimation is done using exact matching conditioned on education. To improve the results, the analysis is repeated using a different specification, which helps to identify observations that violate the overlap assumption.

Table 12 shows the results for both Average treatment effect (ATE) ATE, Average treatment effect on the treated (ATET) and Average treatment effect on the Control (ATC) (ATE) with exact matching

Table 12: Treatment Effect estimation with Exact Matching

Variable	**Coefficients**	**Robust Standard Errors**	**Z**	**P-Value**
Change in Income				
ATE	-3895.37	5219.83	-0.75	0.4 56
ATET	-936.92	6005.87	-0.16	0.876
ATC	-6853.81	4832.86	1.42	0.156
Change in Price				
ATE	-143.86	87.85	-1.64	0.102***
ATET	-136.44	118.15	-1.15	0.248
ATC	-151.27	80.33	-1.88	0.060***

Source: From estimation using Stata 14. ***, ** and * denote Significance levels at 1%, 5% and 10% respectively based on t-statistics. No. of Observations: 106

The average change in income for both the treatment and the control group if all farmers were to use KACE information would be 3895.37 less than the average that would occur if none of the farmers used KACE information. However, the reduction of income for the treatment group would be only 936.92 if all farmers were to use KACE information; the treatment effect on the control group is -6853.81. All the changes are not significant.

On the other hand, the average change in price for both treatment and control group if all farmers were to use KACE information would be 143.86 Kshs. less than the average that would occur if none of the farmers used KACE information. However, the reduction of income on the treated would be only 136.44 if all farmers were to use KACE information, while the treatment effect on control is -151.27.

To conclude the analysis, we also present results for a different specification which identifies the observations that violate overlap assumption in the estimation. The results are presented in Table 13

Table 13: Treatment Effect estimation with osample specification

Variable	Coefficients	Robust Standard Errors	Z	P-Value
Change in Income				
ATE	-2609.86	4398.72	-0.59	0.5 53
ATET	935.98	5032.12	0.19	0.852
Change in Price				
ATE	-115.33	90.82	-1.27	0.2 04
ATET	-107.78	116.34	-0.93	0.354

Source: From estimation using Stata 14. ***, ** and * denote Significance levels at 1%, 5% and 10% respectively based on t-statistics. No. of Observations: 106

Identifying the observations that violate overlap assumption in the estimation using the osample specification improves the results. The average change in income for both treatment and control group if all farmers were to use KACE information is now 2609.86 less than the average that would occur if none of the farmers used KACE information. However there is an increase in average change in income on the treated of 935.98. However all the changes are not significant.

The average change in price for both treatment and control group if all farmers were to use KACE information is now 115.33 less than the average that would occur if none of the farmers used KACE information. However the reduction of price for the treated is now 107.78. However all the changes are not significant.

Although farmers in the treatment group did receive higher prices and incomes than their control group counterparts, the effect of ICTs on the studied welfare indicators is negative. This is counterintuitive; however, the study by Aker and Fafchamps (2010) proposes that while the use of ICTs may affect farmers' access to information, thereby allowing them to search over more markets and negotiate better prices, ICTs may also improve traders' access to information on farm-gate prices, allowing them to search for lower purchase prices from farmers. This trader behavior may negate the welfare effect for farmers. Further, results from Aker and Tack (2010) show that increased access to information changes the search behavior of traders rather than farmers. This may partially explain our unexpected results.

Aker and Fafchamps (2010) further suggest that the use of mobile phones to increase access to information in agricultural markets is expected to increase the number of markets over which farmers and traders search and to reduce producer price dispersion among markets. The use of ICTs in agriculture is expected to have a similar impact on producer prices, leading to a positive welfare effect for farmers. However, when the flow of information through ICT channels is strongly localized and sub-optimal, these positive welfare effects may not be realized.

Aker (2010) further suggests that mobile phone coverage is more useful for more perishable traded commodities in Niger than for crops that can be stored. The present study does not make a distinction between perishable and non-perishable crops. The main crops grown by E-soko farmers are beans, maize, and corn while for KACE farmers, the main crop is maize and corn, followed by pigeon peas.

Assessing producer welfare involves more than an analysis of changes in producer prices and income in an ex-post setting, as done in this study. The availability of baseline data would overcome the limitations of the perfect recall assumption and allow for a more comprehensive welfare analysis. We therefore argue that the counterintuitive results found in our study could be associated with this limitation. In the absence of baseline data, we can only attempt to provide a rough estimation of the welfare effect of ICT usage in agriculture.

The study also reports considerably low use of the ICT portals under study to access price information. This may be due to several factors, such as a lack of information about the existence of the portals and the benefits that they are intended to offer to farmers; localized market information offered by the portals; and difficulties in accessing the information from mobile phones, stemming from high costs as well as technical complexities.

Such results suggest that a future analysis of the welfare gains from these ICT portals will require more detailed data, a larger sample, and different agents.

5. Conclusion

From this empirical analysis, we conclude that there is a negative average treatment effect (ATE) for both the treatment and the control group, although the treatment group is better off when they use ICTs. This is the case for both measures of welfare. However, all the changes are insignificant at 95 percent level of confidence, which makes it difficult to make a conclusive decision on the producer welfare effects of ICTs on farmers in this region.

As noted earlier, these counterintuitive results are due to several factors which include strongly localized flow of information, lack of baseline data, and low usage of the portals under study to access price information. A future analysis with a larger sample and more detailed data may yield better results

5.1 Opportunity for Scale up

Finally, we were able to identify several challenges faced by ICT platform users that should be addressed in the design of future interventions. Some of the challenges identified by KACE users include: there was poor communication and no follow-up by trainers with farmers after the initial KACE training; farmers often lack technology access and money to obtain mobile services; there are fewer KACE trainers who visit farmers in the studied areas; KACE offices are too far, hence there is a high cost of transport to conduct office visits; the platform is not easy to use for people with lower levels of education; accessing price information using mobile phones is quite challenging, especially for the elderly; a radio is needed in order to listen to prices information; the services are too costly; it takes a long time for information to reach farmers and traders; and there is a lack of storage facilities.

KACE users further indicated that there are some services they would want to see in the platform. These include: regular training and advice; intensified training on commercial farming; cheaper SMS services; provision of manure, fertilizers, and treated seeds for planting; consultations for planting; help in constructing proper irrigation schemes; capital schemes for inputs; transport for ferrying produce at cheaper costs; provision of markets for the produce; provision of price information in the smaller markets and towns; provision of pesticides to spray crops; better communication between KACE and farmers; warehouses in which to store the produce until it is sold at the best prevailing prices.; and easier accessibility to KACE offices.

Clearly, one of the challenges in the two projects analyzed in this study is the lack of communication. Farmers and traders are left to scout for information from the portals by themselves, with no deliberate efforts from the platforms to reach out with information. Given that farmers are relatively less educated, this presents a technology challenge and contributes to the ineffectiveness of the ICT interventions. The other challenge is that the information available in the portals is not sufficient to empower farmers.

To scale up the use of ICTs, the study proposes the development of a mobile solution following the M-farm framework, another ICT solution in Kenya. Farmers' associations will be required to send a message to promote what they are selling, while traders and customers will send a message indicating what they need. Mobile payments will be used to transfer the money between the farmers and buyers.

REFERENCES

Abel-Ratovo H. L., N.C. Rahelizatovo, J.J. Okello, F. Rasoarahona, and J. Rasoarahona. 2012. "Ownership and use of mobile phones for agricultural transactions by traders: The case of the Analanjirofo and Atsinanana Regions – Madagascar." Journal of Agricultural Extension and Rural Development 4(10): 305-317

Aker, J.C. 2010. "Information from Markets Near and Far: The Impact of Mobile Phones on Agricultural Markets in Niger." American Economic Journal: Applied Economics. 2 (July 2010): 46–59

_______. 2011. "Dial "A" for Agriculture: A Review of Information and Communication Technologies for Agricultural Extension in Developing Countries." CGD Working Paper 269. Washington, DC: Center for Global Development.

Aker, J.C. & Fafchamps, M. 2010. How Does Mobile Phone Coverage Affect Farm-Gate Prices? Evidence from West Africa. Paper Presented at the Center for the Study of African Economies University of Oxford, March 2010

______. 2013. "Mobile Phone Coverage and Producer Markets: Evidence From West Africa." Center for the Study of African Economies WorkingPaper WPS/2013-09, University of Oxford

Aker, J. & Tack, J. B. 2011." Information and Firms' Search Behavior". Agricultural and Applied Economics Association 2011 Annual Meeting, July 24-26, 2011, Pittsburgh, Pennsylvania

Asenso-Okyere, K. and D.A. Mekonnen. 2012. "The Importance of ICTs in the Provision Information for Improving Agricultural Productivity and Rural Incomes in Africa." Working Paper WP 2012-015.

Bariyo, N. 2014. Rwanda's East Africa Exchange to Expand Commodities Trade, The Wall Street Journal, Oct. 3, 2014, 12:52 p.m. ET

Biztech Africa. 2013. "Kenya Mobile penetration passes 77%." January. 22, 2013

Duncombe, R. 2012. "Mobile Phones for Agricultural and Rural Development: A Literature Review and Future Research Directions, Development Informatics Working Paper Series, Paper No. 50, Centre for Development Informatics, University of Manchester

Fafchamps, M. and R.V. Hill. 2005. "Selling at the farm gate or traveling to the market." American Journal of Agricultural Economics 87(3): 717-734

Fafchamps, M. and B. Minten. 2011. Impact of SMS-Based Agricultural Information on Indian Farmers. Department of Economics, Oxford University

Food and Agriculture Organization. 2011. "Women in Agriculture Closing the Gender Gap for Development: The State of Food and Agriculture Report." Rome: Food and Agriculture Organization of the United Nations.

Fu, X. & Akter, S. 2011. The impact of ICT on agricultural extension services delivery: evidence from the rural e-services project in India, TMD Working Paper Series No.046, University of Oxford Department of International Development.

Furuholt, B. & Matotay, E, 2011. "The development contribution from mobile phones across the agricultural value chain in rural Africa", EJISDC 48 (7):1-16.

Gandhi, Rikin, R. Veeraraghavan, K. Toyama, and V. Ramprasad. 2009. "Digital Green: Participatory Video and Mediated instruction for Agricultural Extension." Information Technologies and International Development 5 (1): 1-15.

Goswami, R, J.G. Roy, and J. Ghose. 2000. "Telesupport Experiment for Agricultural Information Management in West Bengal, India." MPRA Paper No. 21788. Online at http://mpra.ub.uni - muenchen.de/21788

Israel, G. D. 2009. "Determining sample size." Gainesville, FL: Florida State University, Cooperative Extension Service. Retrieved 5 December, 2014 from http://edis.ifas.ufl.edu/pd006

Jensen, R. 2007. "The digital provide: information (technology), market performance, and welfare in the South Indian fisheries sector. The Quarterly Journal of Economics CXX11 (3): 879-924.

Johri, A. and Leach, J. 2002. Middlemen and the Allocation of Heterogeneous Goods. International Economic Review, Vol. 43, pp. 347-362.

Kamande, M.W. 2016. "Information As A Solution To Price Disparity In Agricultural Markets: Evidence From A Pilot Experiment Among Small Scale Irish Potato Farmers In Musanze District, Rwanda" International Journal of Development Research, 6(8): 9287-9293

Kameswari, V.L.V, D. Kishore, and V. Gupta. 2011. "ICTs for agricultural extension: a study in the Indian Himalayan region." EJISDC 48(3): 1-12.

Katengeza, S.P., J.H. Mangisoni, and J.J. Okello. 2010. "The Role of ICT-based Market Information Services in Spatial Food Market Integration: The Case of Malawi Agricultural Commodity Exchange." Paper prepared for presentation at the 3rd African Association of Agricultural Economics, AAEA/AEASA Conference, Cape Town, South Africa, 19-23 September, 2010

Kenya Agricultural Commodity Exchange (KACE), www.kacekenya.com/, accessed 15th August 2014

Li, Y. 1998. "Middlemen and Private Information." Journal of Monetary Economics 42 (1): 131–159

Meera, S.N, A. Jhamtani, A. and D.U.M. Rao. 2004. “Information and Communication Technology in Agricultural Development: A Comparative Analysis Three Projects From India.” Network Paper No. 135, Agricultural Research & Extension Network

Ministry of Agriculture and Animal Resources (MINAGRI) website: http://www.minagri.gov.rw/ Accessed on 25th August, 2014

Mukhebi A.W., Kundu J., Okolla A., Wambua M., Ochieng W. and Fwamba G., 2007. Linking farmers to markets through modern information and communication technologies in Kenya. AAAE Conference Proceedings (2007) 23-27

Muriithi, B.W. and J.A. Matz. 2014. “Welfare Effects of Vegetable Commercialization: Evidence from Smallholder Producers in Kenya.” ZEF-Discussion Papers on Development Policy No. 189. Centre for Development Research, University of Bonn

Oguoma, O.N., V.I. Nkwocha, and I.I. Ibeawuchi. 2010. “Implications of Middlemen in the Supply Chain of Agricultural Products.” Journal of Agriculture and Social Research 10 (2)

Okello, J.J., 2010. Does use of ICT-based market information services (MIS) improve welfare of smallholder farmers? Evidence from Kenya.4th ACORN-REDECOM Conference proceedings Brasilia, D.F, 2010

Parker, C., K. Ramdas, and N. Savva. 2016 “Is IT access enough? Evidence from a Natural Experiment in India’s Agriculture Market.”, Management Science, Articles in Advance , 62(9), 1-23

Parmar, V., D.Keyson, and C. de Bont. 2010. “Analyzing ICT Projects from a Design Perspective: A Case of Rural India.” International Design Conference - Design 2010 Dubrovnik - Croatia, May 17 - 20, 2010.

Plantwise, http://www.plantwise.org/, accessed in 5th March, 2014

The East African, http://www.theeastafrican.co.ke/ accessed in 25th July, 2014

United Nations Development Program. 2010a. “E-soko Networks: facilitating agriculture through technology, Growing Inclusive markets, Sub-Saharan Africa – Ghana.” Growing Inclusive Markets(GIM) Database, retrieved from http://cases.growinginclusivemarkets.org/documents/116

United Nations Development Program. 2010b. “Kenya Agricultural Commodity Exchange (KACE): Linking Small-Scale Farmers to National and Regional Markets” Growing, Inclusive Markets (GIM) Database, retrieved from http://cases.growinginclusivemarkets.org/documents/118

World-Bank. 2011. ICT in agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions. Washington, DC : The International Bank for Reconstruction and Development / The World Bank, 2011.

AGRODEP Working Paper Series

0021. An Analysis of the Fishing Industry in Namibia: The Structure, Performance, Challenges, and Prospects for Growth and Diversification. Blessing Chiripanhura and Mogos Teweldemedhin. 2016.

0022. Artificial Insemination, Livestock Productivity and Economic Growth in Senegal. François Joseph Cabral. 2016.

0023. Impacts of Health Services on Agricultural Labor Productivity of Rural Households in Burkina Faso. Omer S. Combary. 2016.

0024. Fertilizer Subsidy and Agricultural Productivity in Senegal. Abdoulaye Seck. 2016.

0025. Decision to Export among Ghanaian Manufacturing Firms: Does Export Destination Influence the Entry Sunk Cost. Francis M. Mulangu and Luke O. Olarinde. 2016.

0026. Informal Trade and the Price of Import Bans: Evidence from Nigeria. Sami Bensassi, Joachim Jarreau, and Cristina Mitaritonna. 2016.

0027. The European Union's and United States of America's Non–Tariff Measures: Impacts on African Exports. Kareem, Olayinka Idowu. 2016.

0028. An Exploration of the Determinants of Bribery in Benin's Transborder Trade. Sami Bensassi, Joachim Jarreau, and Cristina Mitaritonna. 2016.

0029. Natural Resource Curse in Africa: Dutch Disease and Institutional Explanations. Richard Mulwa and Jane Mariara. 2016.

0030. Have Migrant Remittances Influenced Self-Employment and Welfare among Recipient Households in Nigeria? Kabir Kayode Salman. 2016.

0031. Does Distance Still Matter for Agricultural Trade? Christian Ebeke and Mireille Ntsama Etoundi. 2016.

0032. Analyzing Trade Integration in North African Markets: A Border Effect Approach. Houssem Eddine Chebbi, Abdessalem Abbassi and Lota D. Tamini. 2016.

0033. Trade Performance and Potential of North African Countries: An Application of a Stochastic Frontier Gravity Model. Lota D. Tamini, Houssem Eddine Chebbi and Abdessalem Abbassi. 2016.

0034. Determinants of Cross-Border Informal Trade: The Case of Benin. Sami Bensassi, Joachim Jarreau, and Cristina Mitaritonna. 2016.

0035. The Welfare Effects of ICTs in Agricultural Markets: A Case of Selected Countries in East Africa. Mercyline Kamande and Nancy Nafula. 2016.