WORKING PAPER
United Nations Development Programme
Regional Bureau for Africa

WP 2012-015: January 2012

The Importance of ICTs in the Provision of Information for Improving Agricultural Productivity and Rural Incomes in Africa

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Abstract: Information and communication technologies (ICTs) developments have taken place in Africa with the significant growth over the past decade. This paper looks at the evidence on the role of emerging ICTs in the agricultural sector in Africa with lessons from Asia with respect to farmers' access to information and other services that would help improve agricultural productivity, practices, and farmer livelihoods. It suggests that countries should avoid monopoly situations and encourage pluralistic providers to induce competition for higher efficiency and lower costs to consumers.

Keywords: Information communication technology; extension; productivity; rural incomes; Africa

JEL Classification: O13, O33, D83, Q16

1. Introduction

Information and communication technologies (ICTs) generally refer to an expanding assembly of technologies that are used to handle information and aid communication. These include hardware, software, media for collection, storage, processing, transmission and presentation of information in any format (i.e., voice, data, text and image), computers, the Internet, CD-ROMs, email, telephone, radio, television, video, digital cameras etc. The advent of personal computers, the Internet and mobile telephone during the last two decades has provided a much wider choice in collection, storage, processing, transmission and presentation of information in multiple formats to meet the diverse requirement and skills of people.

ICTs are believed to bring about social and economic development by creating an enabling environment. Almost every single activity in the modern world is becoming more dependent on the application of ICTs for one use or another. The benefits of ICTs reach even those who do not themselves have first-hand access to them. Through ICTs, for example, a doctor in a rural village can get up-to-date information regarding certain diseases and can use that information to advice and treat patients; an agricultural extension worker can learn new technologies, rainfall forecasts, commodity prices, etc and use that information to advice farmers in rural villages; etc.

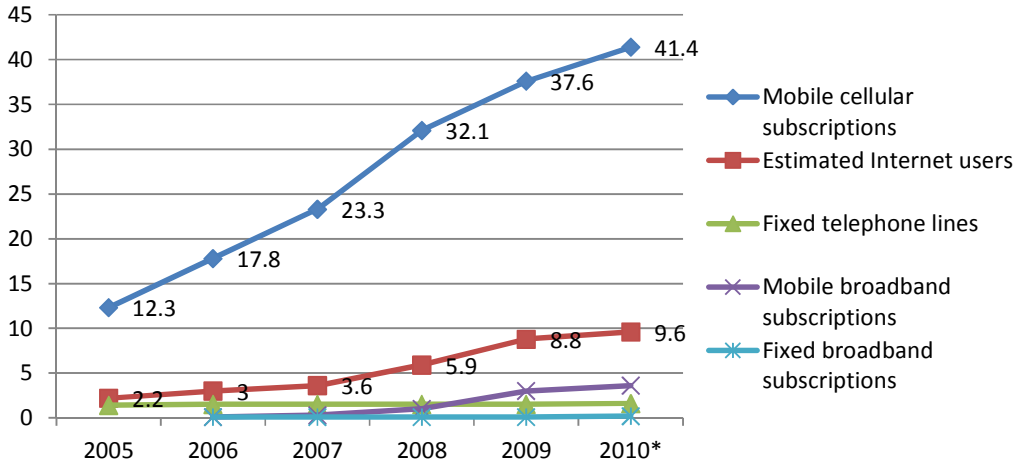
The importance of ICTs in development process was long recognized and access to ICTs was even made one of the targets of the Millennium Development Goal No. 8 (MDG 8), which emphasizes the benefits of new technologies, especially ICTs in the fight against poverty. "With 10 percent increase in high-speed internet connections, economic growth increases by 1.3 percent" observed the recent World Bank report on Information and Communication for Development (World Bank, 2009). The same report also observed "connectivity – whether the Internet or mobile phones -- is increasingly bringing market information, financial services, and health services to remote areas, and is helping to change people's lives in unprecedented ways".

Following the Millennium Declaration, key stakeholders from various sectors came together in Geneva in 2003 and again in Tunis in 2005 to discuss a broad range of subjects related to ICT for development. As a result, governments agreed on a set of commitments and actions to foster the establishment of an inclusive information society. Towards this end, ten targets were identified to be achieved by 2015 along with numerous recommendations based on different action lines (ITU, 2005). These targets range from connecting villages, schools, health centers, libraries and government agencies to developing content, incorporating ICTs in school curricula and providing broadcasting services to all people in the world. The action lines address issues related to, among others, ICT infrastructure, capacity building, cyber security, an enabling policy environment and ICT applications in agriculture, education, business or the environment. The list of the ten targets and ten core indicators on ICT infrastructure and access are provided in Appendix 1.

In recent years, important ICT developments have taken place in Africa. The rise of mobile telephony in particular and its associated applications are the most striking examples as

evidenced in Figure 1, Figure 3, and subsequent sections. The penetration rate of mobile telephone in Africa was estimated to reach 41% at the end of 2010, a growth of more than 200 percent from the 2005 levels. However, the penetration rates of other telecom services were very limited (less than 10%) leaving a significant potential for growth.

Figure 1. Trends in key telecom indicators per 100 inhabitants in Africa (2005-2010)



Source: data from ITU (2010c).
Note: *The 2010 data are estimates by ITU (2010c)

There are significant differences among Sub-Saharan African (SSA) countries in penetration of key telecom services. Five countries, for example, including Mauritius, Botswana, South Africa, Gabon, and Seychelles had the biggest penetration rates (in the range of 74 to 89 per 100 inhabitants) in terms of mobile subscription in 2007 (Figure 2). In contrast, about 13 countries had less than 10 mobile subscribers per 100 inhabitants for the same year. The majority of the countries (about 62%) had mobile penetration rate of between 10 and 50 per 100 inhabitants.

Unlike the mobile telephony, penetrations of internet and fixed telephone were very limited in SSA in 2007. For example, there were only 5 countries for internet and 3 countries for fixed telephone which had a penetration rates in the range of 10 to 40 per 100 inhabitants (Table 1). In fact, about 67% of the countries for internet and 49 % of the countries for fixed telephone line had a penetration rate of less than 2 per 100 inhabitants. The low penetration rate for fixed telephone may be due to the expanding mobile subscription.

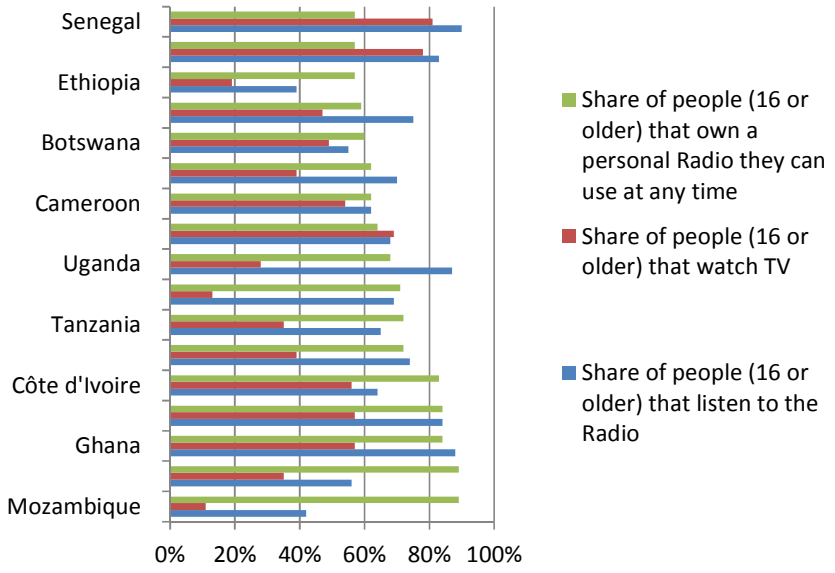
Table 1. Penetration of key telecom indicators per 100 inhabitants, SSA countries (2007)

Penetration rate	Internet users	Main telephone lines
Between 40 and 10	Zimbabwe, South Africa, S. Tomé & Principe, Mauritius, Seychelles	Cape Verde, Seychelles, Mauritius
Between 10 and 5	Togo, Gabon, Gambia, Cape Verde, Uganda, Senegal, Nigeria, Kenya	Namibia, Botswana, South Africa
Between 5 and 2	Eritrea, Cameroon, Guinea-Bissau, Comoros, Ghana, Lesotho, Sudan, Swaziland, Zambia, Botswana, Namibia	Senegal, Comoros, Zimbabwe, Gabon, Lesotho, Swaziland, Nigeria, Gambia, S. Tomé & Principe
Less than 2	Sierra Leone, Niger, Central African Rep., Ethiopia, D.R. Congo, Guinea, Madagascar, Burkina Faso, Chad, Angola, Burundi, Mali, Mozambique, Mauritania, Tanzania, Malawi, Rwanda, Somalia, Djibouti, Equatorial Guinea, Côte d'Ivoire, Benin, Congo	D.R. Congo, Chad, Niger, Rwanda, Guinea-Bissau, Central African Rep., Guinea, Mozambique, Congo, Burundi, Uganda, Tanzania, Angola, Madagascar, Mali, Burkina Faso, Kenya, Zambia, Cameroon, Eritrea, Sudan, Ethiopia, Mauritania, Somalia, Benin, Malawi, Togo, Côte d'Ivoire, Djibouti, Ghana, Equatorial Guinea

Source: based on data from ITU World Telecommunication/ICT Indicators Database (2008).

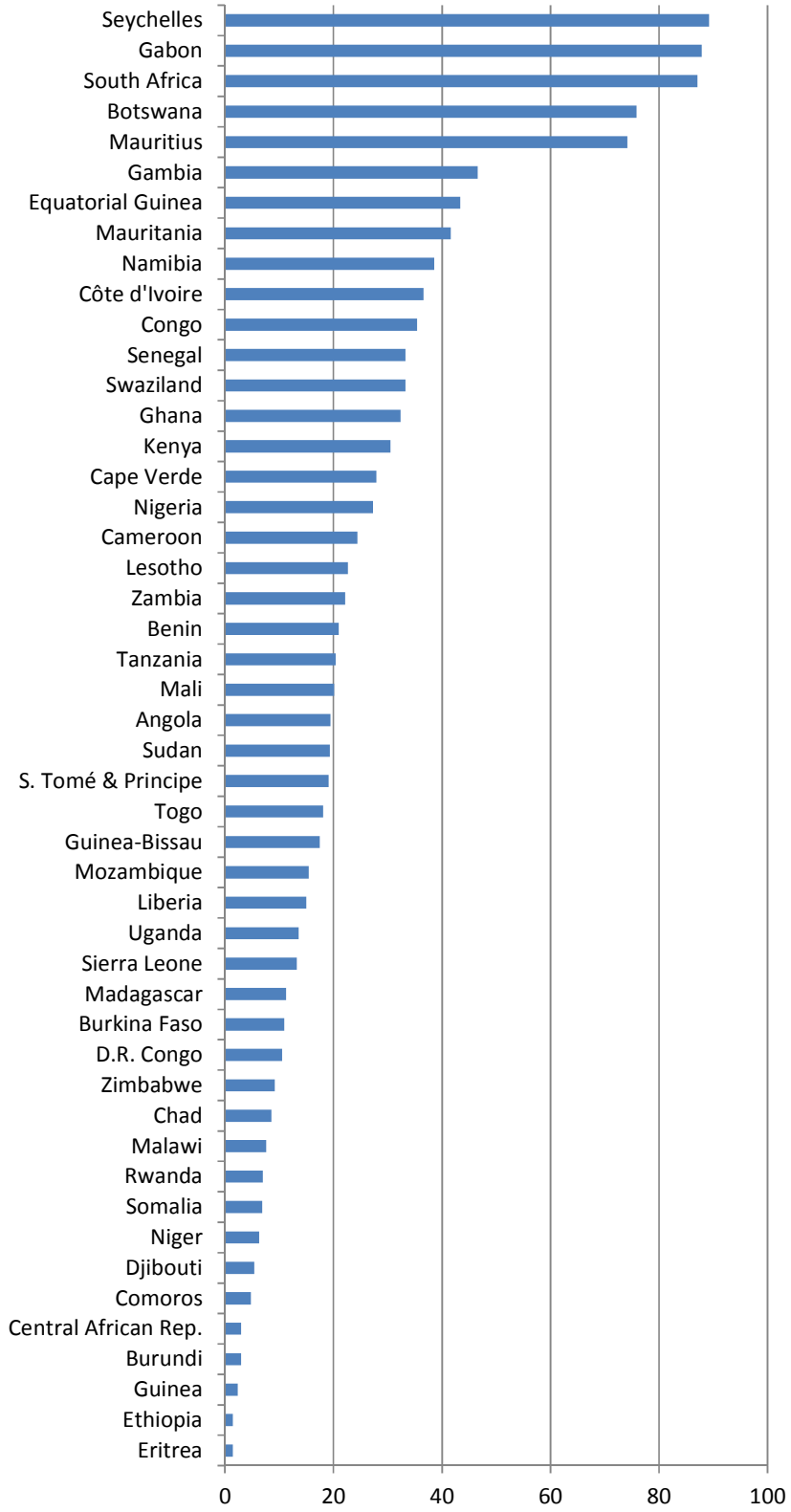
On the other hand, despite significant growth in the penetration of emerging ICTs, the more traditional ones, radios and to some extent TVs, remain popular in Africa, particularly in rural areas (Gillwald et. al., 2010). Based on sample data collected in 17 SSA countries in 2007, Gillwald et. al. found that the share of households who owned a radio was in the range of 57% to 89%. Countries including Ethiopia, Nigeria, and Senegal were on the lower end while Mozambique and Zambia had the highest percentages of households owning a radio (Figure 2). It is also interesting to note from Figure 2 that the percentage of people who listened to radio was greater than percentage of people who actually owned a radio in about 8 of the 17 countries studied. This perhaps could be indicating the potential (multiplier effect) that ICTs have in reaching many in agricultural extension.

Figure 2. Radio and TV access and usage, 17 SSA countries (2007)



Source: based on data from Gillwald et. al. (2010)

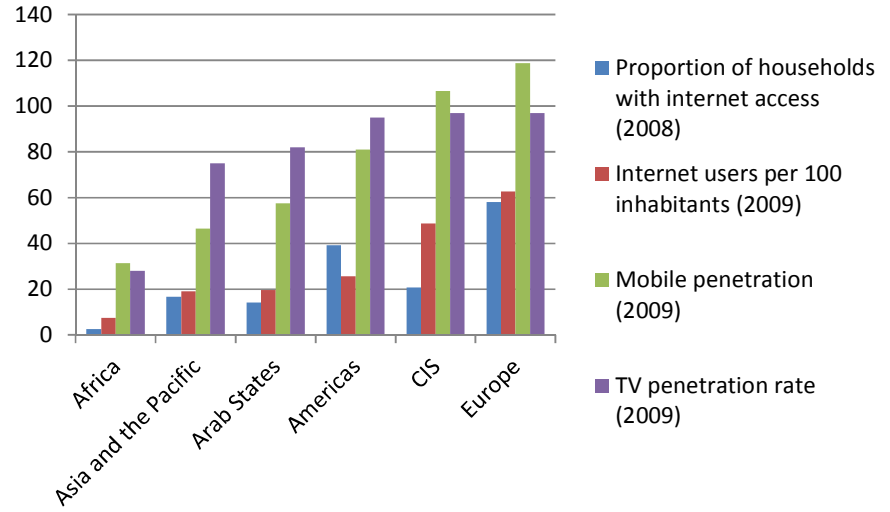
Figure 3. Mobile subscribers per 100 inhabitants, SSA countries (2007)



Source: data from ITU World Telecommunication/ICT Indicators Database (2008).

Despite the significant growth over the past decade, particularly the mobile market, Africa still lags behind other regions (see Figure 4) both in terms of the percentage of people with access to the full range of communications services and the amounts and manner in which they can be used (ITU, 2010b). Various reasons are given which will be discussed in later part of the study.

Figure 4. Penetration rate of selected ICTs by region



Source: ITU (2010b)
Note: CIS – Commonwealth of Independent States

This paper looks at the evidence on the role of emerging ICTs in the agricultural sector in Africa with lessons from Asia with respect to farmers' access to information and other services that would help improve agricultural productivity, practices, and farmer livelihoods. It also reviews available literature on the effect of existing ICTs in extension services, and assesses impediments for better application of the technology for extension and advisory services.

2. Agricultural extension and ICTs in Africa

In Africa, agriculture provides a livelihood for most of the 75 percent of the people who live in rural areas. Unfortunately, the rural areas in Africa have the largest concentration of poverty and food insecurity. One of the causes of the low incomes in rural Africa is the low productivity of agriculture. Therefore, any attempt to reduce poverty should pay particular attention to transforming the agricultural sector, especially sustained improvement of land and labor productivity in the sector, facilitated by remunerative markets. Lack of technological and market information has been given as the major reason for the low productivity in African agriculture

Knowledge and information have become the major drivers of social and economic transformation in the world. Knowledge and information are now as important, if not more, factors in development, and this trend is set to intensify. Agricultural education and extension can play a critical role in the transformation process to transfer technology, support learning, assist farmers in problem-solving, and enable farmers to become more

actively embedded in the agricultural knowledge and information system (Christoplos & Kidd, 2000). However many farmers have complained about the unavailability of extension staff in their locality for consultation or advice. In connection with this, a Malawian female farmer, during a dialogue session in Chimphedzu, asked the local District Agriculture Development Officer *"we no longer have agricultural extension workers based in our communities, and visiting us every day, so how do you expect smallholder farmers like us to learn new farming technologies or to learn how to improve our agricultural enterprises?"* (FANRPAN, 2011). Even when they are available many women do not get access to extension officers because many of them are men and there may be cultural inhibitions for their interaction with women farmers.

With almost one billion small-scale farmers worldwide, extension is urgently seeking for the best ways to support these farmers in terms of information, technology, advice, and empowerment. There has been an emergence of innovative extension approaches including: fee-for-service in New Zealand and Denmark; inclusive village level public extension service in China; market-driven empowerment through farmer groups and privatization in Uganda; farmer field schools in Asia and more recently in East Africa; farmer training centers and specialized extension agents in Ethiopia; client-oriented agricultural extension in Latin America and the Caribbean; and more recently, ICT-based agricultural extension and advisory services in Asia and Africa (Davis and Asenso-Okyere, 2010).

One promising area to do agricultural extension to reach large number of farmers is using information communication technologies (ICTs): mobile telephony, innovative community radio and television programs, mobile phones in combination with radio, video shows, information kiosks, web portals, rural tele-centers, farmer call centers, video-conference, offline multimedia CDs, open distance learning, etc. ICT-based agricultural extension brings incredible opportunities and has the potential of enabling the empowerment of farming communities. With the availability of ICTs the proposition for an increasing number of extension staff may no longer be wholly valid. Moreover, the use of ICTs to improve information flow and to connect people within the rural areas has proved that illiteracy of farming communities may no longer be an excuse to deny some form of extension system.

The social systems and/or networks in Africa also aid in the sharing of knowledge. The availability of a few mobile phones to start with can quickly spread a message from an authentic source to clan members, solidarity association members, and other members of the community. Mobile telephony in combination with radio enables messages to be given to a large number of listeners. The use of knowledge management web portals with pertinent production and marketing information has even been tried in some communities in Asia and Africa with some challenges which are not insurmountable. Evidences also suggest that the technology is being effectively used in some countries in Africa with remarkable success on market price information, weather forecasts, transport information, information on storage facilities and information related to crop and livestock diseases and general advice related to agriculture (Gakuru et al., 2009).

Yet, while use of ICTs in extension provides for several key benefits in relation to traditional media, ICT projects also come with a range of challenges including: technological

dependence; lack of accessible telecommunication infrastructure in many rural and remote areas; capital cost of technologies, high cost of on-going access and support; inherent need for capacity building; often difficulty in integrating with existing media, and local communication methods and traditions; and, often lack of involvement of all stakeholders in planning, especially women and youth (Richardson, 2009).

3. ICT-based extension services

3.1 Market information

The contribution of information and knowledge in bringing about social and economic development has been well recognized globally. Availability of markets and market information gives farmers the potential to bargain and improve their incomes, to seize market opportunities through the adjustment of production plans and better allocation of production factors, and also to use the information to make choices about marketing. The development and use of ICTs are playing a critical role in this regard.

ICT enables the novel Ethiopian Commodity Exchange (ECX) to transmit commodity price information to farmers in real time - within two minutes of a deal being made at ECX from Addis Ababa. According to the World Bank (2011), market data feeds 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 to interested mobile phone users. ECX also provides market data in four local languages via automatic telephone messaging. According to the executive director of ECX, on average, about 20,000 calls are made daily via a toll free number seeking for price information World Bank (2011). The Kenya Agricultural Commodity Exchange (KACE) and the Malawi Agricultural Commodity Exchange (MACE) also have commodity exchange service through offers and bids, which are prominently displayed on blackboard and which are disseminated via SMS and Internet.

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, with particular attention to smallholder farmers and small scale agribusinesses (KACE, 2011). The KACE market information and linkage system (MILS) involves harnessing the power and advantages of modern ICTs for information collection, processing and delivery. The components of the KACE MILS are: market resource centres (MRCs), mobile phone short messaging service (SMS), interactive voice response service (IVRS), internet database system (IDS), national radio, rural FM radio and the KACE headquarters central hub (KCH) in Nairobi. MRCs are information kiosks located in rural markets and serve as sources of KACE market information for farmers and agribusinesses, as well as providing market linkage through matching commodity offers and bids. There are 5 MRCs located in Western, Rift Valley and Eastern Provinces of Kenya. SMS service applies mobile telephony for market information delivery to users. The market information currently available through SMS includes daily wholesale buying prices for about 20 commodities, as well as offers to sell and bids to buy. IVRS uses voice mail for delivery of market price information. In this platform, a user dials a special phone number to access the information through simple menu steps, with a choice of language between the local Kiswahili and English. IDS is a system where updated market information is sent daily to

subscribers in the database as email messages. KCH in Nairobi receives, processes, manages, updates, disseminates and coordinates market information services through the MILS, using the channels described above (KACE, 2011).

Again in Kenya, market information is provided through SMS so that smallholders have access to daily agricultural commodity prices, extension messages and opportunities to sell or bid through text messages and/or voicemail; there are other rural-based market information points which are linked through an electronic information system that allows farmers to link with buyers in different urban centers (KBDS, 2004; Muriithi et al., 2009; Davis and Addom, 2010).
Manobi in Senegal provides access to price data on various crops, collected from different markets across the country. Manobi personnel use mobile phones to send the price data to the Manobi database using the wireless application protocol (WAP). Farmers use their mobile phones to query the database (ITU, 2010b).

Market information systems and traders' organizations of west Africa (MISTOWA) in partnership with the private sector, developed a platform (www.tradenet.biz) to exchange market information in real time on-line or through cellular phones SMS on market prices, buy and sell offers, and trader contact information for easy interpretation; and online space for producer and trader organizations to create websites for featuring business information (Davis and Addom, 2010).

In Mozambique, CTA (2006) and Jenson et al. (2004) have shown that farmers with access to market information obtain higher farm prices. The Mozambique agricultural marketing service (SIMA) collects and disseminates nation-wide and provincial data on market prices, product processing and availability through a variety of media including text messages, email, internet, national and rural radios, television and newspapers.

The Grameen Foundation developed SMS-based comprehensive system to help deliver market information to farmers in Uganda, (Pyramid Research, 2010). Having tested new uses of the Village Phone infrastructure via such programs as Application Laboratory since 2008, the Foundation launched in 2009 a group of mobile phone applications. The technology was developed with Google and MTN Uganda in the Application Lab, and leverages MTN's network of village phones and other operators of shared phones (a total of 35,000 public-phone operators) to test and deliver mobile information services to rural communities. In addition, the Grameen Foundation trained and established a network of community knowledge workers (CKWs) to become "knowledge hubs" for smallholder farmers in Uganda, giving them advice and information on how to carry out their activities. All the services are SMS-based and designed to work with basic mobile phones to reach the broadest possible audience. The new services can be accessed by existing village phone operators, who extend service to people without mobile phones. The customer sends in the query and the answer is returned later (Pyramid Research, 2010).

In Nigeria, cassava growers receive market information through a new initiative called the Integrated Cassava Project. Based on mobile phones and Internet and online marketplace Trade Net Africa, the project aims to disseminate market information using the Agri-Business Information Points (market information centers) and trade agents. These services

include prices, demand volumes and offers, trade assistance, training, SMS Alerts, and technical messages (Pyramid Research, 2010).

Natural Resource Management is another area where ICTs contributed to as was the case for a community radio in Obane rural community in the Dangme East district of Ghana. The Radio Ada followed participatory approaches in the production of broadcasts where listeners determine the content that is put on air and take turns in producing the broadcasts in villages. It took only four years of broadcast in mobilizing people to dredge a clogged 10km long river which was neglected for 40 years, providing once again the chance to channel water to the irrigation canals of riverside farms (Larweh, 2006).

In Ghana, services developed by Esoko, a local company, include placement of buy/sell orders by farmers and traders. Esoko has a network of agents that collect price information on about 20 agricultural commodities in 30 markets in the country. They have a system for providing price information to farmers and others on a subscription basis (Martiz, 2011).

The livelihood of a vast majority of people in East Africa is highly dependent on income from livestock and livestock products. Therefore, the development of reliable and timely livestock market information is vital for the development of the countries in the region and provides a basis for livestock producers and traders to make informed marketing decisions. In this context, LINKS - a livestock information network and knowledge system – was established as a sub-project within the global livestock collaborative research support program. LINKS implemented by Texas A&M University provides regular livestock prices and volume information on most of the major livestock markets in east Africa, namely Ethiopia, Kenya and Tanzania along with information on forage conditions, disease outbreak, conflict and water supply to support decision making at multiple scales. The system provides near real time market information which is available on request via SMS text message system, email, WorldSpace radio systems and on the internet (LMIS, 2011).

3.2 Other extension services

There are a number of ICT-based initiatives which cater for non-market information and extension services including financial, utilization of best agriculture practices, research, weather, climate, and distribution and supply chain management. Some of the initiatives include: KenCall Farmers Helpline, Kilimo Salama, M-PESA, and Mali Shambani - all in Kenya, Esoko, Cocoalink and Radio Ada in Ghana, and MAKWACHA in Malawi. KenCall Farmers Helpline, a for-profit call center in Kenya, is a real-time call center service staffed by agricultural experts that provide agricultural information, advice and support to smallholder farmers over the phone, using voice and voice call-back to farmers (Payne et. al., 2010a).

Mali Shambani, in Kenya, is a weekly hour-long radio program featuring agricultural news and responding to a wide range of topics, including market prices and trends, farming techniques, weather and seasonal issues, financing opportunities, inputs, land use, and quality standards. Each program also offers an interactive call-in component where farmers are given the opportunity to pose agricultural questions to a panel of experts either via phone or SMS. In addition, Farmer Voice Radio (FVR) is a radio extension service currently

operating in Kenya, Malawi, Tanzania, Mali, Ghana and Zambia that targets smallholder farmers. Extension agents of FVR provide regular, on-site extension support to a small group of pre-selected farmers, which are then documented and broadcast via radio (Payne et. al., 2010a).

Provision of agricultural insurance products to farmers through mobile phones is another innovative service being delivered in Kenya since 2010. Kilimo Salama, a product developed by UAP Insurance, the Syngenta Foundation for Sustainable Agriculture, and mobile operator Safaricom, is a 'pay as you plant' type insurance which enables smallholder farmers to insure their agricultural inputs against adverse weather conditions, such as drought or excessive rain. To be covered under the scheme, farmers only need to pay an extra 5% for a bag of seed, fertilizer or other inputs. Mobile technology plays a central role in the scheme as it is used both for registration of new policies as well as for payouts which are determined by automated weather stations that monitor the rainfall (Martiz, 2011).

Similarly, a pilot project - banana information line - ran in Kenya in 2006. The text-to-speech (TTS) telephone service provided farmers with information related to how to plant, grow, and harvest bananas, in either English or Kiswahili. This was later superseded by the national farmers information service (NAFIS) line which covers a wide range of crops and livestock where the country's farming community would receive and exchange timely news and information on agriculture, weather patterns and other related issues through their mobile phones (Gakuru et al. 2009).

In Kenya and Malawi, e-banking and especially mobile banking is another ICT-based service which has had a tremendous impact on the socio-economic status of farmers. Through innovative schemes such as M-PESA in Kenya, farmers are able to send and receive money using their mobile phones. Safaricom reported 6.18 million registered M-Pesa users as of March 2009 (ITU, 2010b). The smart-card-based MAKWACHA system in Malawi allows rural farmers to receive payments and purchase farm inputs electronically. The card can be used at any of the company's ATM terminals situated at merchant stores in rural trading centers throughout the country (Nyirenda-Jere, 2010).

In Tanzania, building on the utility of mobile phones as recording tools, listening devices, money-makers, and catalysts for dialogue, community radio stations are incorporating mobile technology into programming and it is being used for advisory services in agriculture (Gakuru et al. 2009). Information is shared in many ways. First, anyone living near the radio station can walk in to ask questions or report problems related to farming. Second, farmers can listen over the radio, a popular medium for information sharing in the area. Third, the station has evolved a system of SMS messages to both send and receive information.

Experiences from Ghana show that how mobile phones can be used by cocoa farmers to obtain production and marketing information. A pilot program called Cocoalink, launched by the Ghana Cocoa Board, provides cocoa farmers with useful information about improving farming practices, farm safety, crop disease prevention, post-harvest production, and crop marketing. In this program farmers receive information and specific

answers to questions at no charge through voice and SMS messages in their local language or English (Martiz, 2011).

Reuters Market Light (RML) is a most highlighted example of an ICT initiative in agriculture in India. RML sends four SMS messages a day to its subscribers at an annual subscription of Indian Rupees 800 (Hardikar, 2010). Farmers receive information about the weather, crops, and current and projected commodity prices at different markets. Farmers are provided information and they are left to make their own decisions. While these approaches are ICT-driven, an approach by Digital Green also in India uses ICTs to support existing extension services provided by NGOs. Digital Green partners with NGOs to promote a video-based process for disseminating technology and agricultural practices. The videos are made with local resource people from the community and are shown to farmer groups established by the partner NGOs. Through the video farmers see what their fellow farmers have done and so it does not take much to convince them to adopt the technology or improved practice. Assessment of adoption practices in the pilot program of Digital Green shows a higher adoption rate through this video-based process than through T&V-style extension approaches (Gandhi et al. 2009).

The International Rice Research Institute launched a program called nutrient manager for rice mobile (NMRiceMobile) to provide Philippine rice farmers with advice via their mobile phone on the optimal timing, amount, and type of fertilizer to apply to their rice crop to maximize production and profit, and reduce waste. The farmers and extension workers are able to dial a toll-free number at which they can hear a voice instruction in their preferred local language which prompts them to use their keypad to answer 12 to 15 questions about their rice crop. After answering all the questions, the farmer receives a tailored fertilizer recommendation via a text message (IRRI, 2011).

Waterhole monitoring for livestock early warning is another innovative project implemented by Texas A&M University in northeastern Kenya and southwestern Ethiopia. Pastoral communities in this region heavily depend on small water bodies for domestic and livestock uses. The shortage of water has made these resources of crucial importance for survival, often leading to conflicts amongst rival communities in the region. NASA's satellite technology products are employed to develop operational waterhole monitoring for precipitation, water hole identification and watershed delineation (NASA LEWS, 2011). The satellite-based estimates used in this project are available for free on daily basis over the internet. Based on the success of this project, a similar project on mapping and monitoring water resources in the pastoral regions of Mali in west Africa was initiated (Senay, 2010).

In Kenya, mobile telephony was being used for delivery of animal health services which has reduced transactions costs and increased efficiency of animal care (Kithuka, et al. 2007). The system works with a community animal health worker, who purchases a veterinary drug kit and mobile phone at a subsidized price. Animal health assistants and veterinarians working with the project also receive mobile phones. The phone system allows the animal health care providers to update one another, share information, and conduct referrals.

ICTs are also being used in distribution and supply chain management and traceability to increase efficiency and predictability and to reduce spoilage (including recording movements along the value chain, responding to quality standard requirements, and helping large buyers track, manage, pay, and reward small producers). Examples include: dairy sector and agribusiness in Kenya; cotton supply system in Zambia; fruit and vegetable supply system in Mali and Ghana (Payne et. al., 2010b; Action for Enterprise and Payne, 2010).

When farmers are healthy then they can give in their best and increase their labor productivity. The same can happen when days lost to taking care of sick children are reduced to minimum. A variety of mobile health (m-health) projects in Africa used mobile phones for a range of activities, from monitoring child illnesses (the Pésinet project in Mali), through monitoring measles outbreaks in the Zambia, to supporting diagnosis and treatment by health workers in Mozambique, to sending health education messages in Benin, Malawi, and Uganda. The Pésinet project in Mali uses mobile technology to reduce child illness. "Agents de Pesée" (ADPs) are trained and provided with Java-enabled mobile phones to send information such as weight and symptoms about children in the community. The data are transmitted over mobile phones using the general packet radio service (GPRS) network to a database which alerts doctors to any significant symptoms. A doctor can then send an SMS to the ADPs who advise the family to bring the child to the health clinic for examination and treatment and referral if needed. In Kenya, Malawi, and South Africa, mobile phones are being used to send several reminders a day to HIV-positive patients about their anti-retroviral therapy schedule, as well as allow community health workers to send information about HIV patients' status (Aker and Mbiti, 2010).

Again, a two-year pilot project called Masiluleke, which means "lending a helping hand" in Zulu, was launched in South Africa in October 2008. The project aims to increase awareness of HIV and AIDS among South Africans through text messages. The program has two components: advertisements for the National AIDS Helpline and, TxtAlert, which targets anti-retroviral (ARV) therapy patients and aims to improve their attendance at the sessions (Pyramid Research, 2010). A similar program called My Question, My Answer was launched in Nigeria in 2007. The program has built a direct link with the population through mobile technology. My Question is an HIV counseling and education service that allows individuals to ask AIDS-related questions by sending a free SMS to a short code, calling a toll-free phone number or via email. These questions are then answered by trained counselors. My Answer is a monthly competition that engages young people by asking an AIDS/HIV-related questions, which is then answered through a mobile phone or SMS (Pyramid Research, 2010).

4. Effects of ICT-based agricultural extension and advisory services

While there exist a growing number of ICT-based initiatives to provide agricultural extension and advisory services especially in Asia and Africa, very little rigorous evidence-based impact evaluation of ICTs in agriculture has been conducted. From available literature, most studies looked at impact on markets and prices and the results are mixed. There are only few attempts which looked at the impact of these initiatives on changes in crop production practices, cropping patterns, technology adoption, productivity, etc.

Fafchamps and Minten (2011) studied the benefits that Indian farmers derive from SMS-based markets weather and crop advisory information. Using a controlled randomized experiment in 100 villages of Maharashtra, they did not find statistically significant effect of treatment on the price received by farmers, on crop losses resulting from rainstorms, or on the likelihood of changing crop varieties and cultivation practices. On the other hand, using micro-level survey data, Jensen (2007) examined the effects of mobile phones on market performance and welfare effects in the south Indian fisheries sector. Contrary to the results of Fafchamps and Minten, Jensen found 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.

Aker (2008) examined the impact that the introduction of cell phones has had on grain trade throughout Niger. Using an original dataset that combines data on prices, transport costs, rainfall and grain production, the author showed that cell phones reduce grain price dispersion across markets by a minimum of 6.5% and reduce intra-annual price variation by 10%. It was further argued that the primary mechanism by which cell phones affect market-level outcomes appears to be a reduction in search costs, as grain traders operating in markets with cell phone coverage search over a greater number of markets and sell in more markets. The results suggest that cell phones improved consumer welfare during Niger's severe food crisis of 2005, perhaps averting an even worse outcome.

Based on panel data collected between 2003 and 2005 on 856 Ugandan households in 94 communities, Muto and Yamano (2009) found that, after the expansion of the mobile phone coverage, the proportion of the farmers who sold banana increased in communities more than 20 miles away from district centers. For maize, which is another staple but less perishable crop, mobile phone coverage did not affect market participation. These results suggest that mobile phone coverage induces the market participation of farmers who are located in remote areas and produce perishable crops.

Lokanathan et. al. (2011) conducted action research to increase price transparency by leveraging an ongoing ICT-based intervention and thereby contribute to improved farmer livelihoods in Sri Lanka. Price information was made accessible to farmers via a variety of technologies including SMS, Internet, WAP, unstructured supplementary service data (USSD) as well as a dedicated call centre (accessed by dialing '977' from any dialog phone). The study was conducted over a period of ten months with a select group of farmers engaged in multi-cropping, primarily in fruit and vegetable cultivation over two crop cycles. The evidence suggests that accurate, real-time price information improves farmer livelihoods. Furthermore, the service facilitated behavioral changes that enabled farmers to improve their ability to coordinate supply and demand for agricultural produce based on price signals (Lokanathan et. al., 2011).

Similarly, Raj et. al. (2011) conducted action research in Nagapattinam district in the state of Tamil Nadu, India using intervention of mobile technology (SMS and interactive voice response system) and individual web pages. Through this action research, a system was designed, developed and implemented at the farm level to find out whether providing customized crop cultivation and nutrient management practices to farmers could improve

livelihoods. The study showed that introduction of ICT led to change in cultivation practices among the intervention farmers and some significant reduction in the cost of cultivation. As a result, net income of the intervention farmers was 15.2% higher than that of the control group; and, spending of intervention farmers on seeds, nursery, nutrient management, and weeding was significantly less than that of control farmers. The intervention group was able to reduce costs by using the recommended quantities of seeds and inputs, and realizing better market prices as they had better information available on the inputs (Raj et. al., 2011).

In India, Rizvi (2011) studied the impact of using LifeLines, a mobile-based advisory service for farmers, in the lives of users by comparing intervention and control group experiences which were collected through sample surveys complemented by participatory rural appraisal tools such as focus group discussions. The study found that there was an increase in the yearly income of the farmers after they received information through LifeLines services. The annual average income of users of LifeLines was about 37% more than the control group. For 67% of the intervention group, there was an increase in savings and earnings because of increased productivity and disease control (Rizvi, 2011).

The e-AGRIKultura (ICT) project was implemented in 2005 and 2006 in six provinces in central and southern Philippines to provide farmers with faster access to information on agricultural and farming technologies through the internet and optical media. Barrios et. al. (2011) conducted a study of the project in 2010 to investigate the link between ICT and rural livelihood expansion. Based on survey data collected from 450 households in project and control sites, they computed the contribution of ICTs using selection models. They found evidence of a positive association between ICT, livelihood and income. With the project, for example, the expected household farm income was US$2,114 while it was about US$1,203 without the project.

In 2008, the government established a village information center in all villages in Ningxia province in China which enabled each village to have access to the internet and IPTV (internet protocol TV). Through the integration of three platforms (telecom, TV and internet), a new operational platform was created. This initiative resulted in the integration of service items of portal, 10 application systems, real time play of IPTV system and video on demand, stock information and teletext. Fengying et. al. (2011) studied the impact of this rural information project on rural livelihoods based on the livelihoods framework. The study indicated that the main overall impacts include capability building and the promotion of information awareness among farmers. According to Fengying et. al., 85 percent of farmers reported that the project had made great contributions to the quality of life and development of the local economy and society. It was also indicated that the project improved the livelihood of rural farmers mainly by strengthening human capital to increase financial capital through improved access to information on better agricultural practices and market information. For instance, due to the support of this project 72.9% of respondents had participated in distance learning and skill training initiatives while 69.3% earned more income. The research also found that farmers were eager to gain access to technology and knowledge (Fengying et. al., 2011).

Radio plays the most significant role of any communication technology in the transfer of information in African countries since spoken word on broadcast radio is the principal means of information transfer where literacy rates are low (CTA, 2006). Svensson and Yanagizawa (2008) studied the impact of agricultural price radio broadcast on the spread of market information in Uganda. Exploiting the variation across space between households with and without access to a radio, they found evidence suggesting that better informed farmers managed to bargain for higher farm-gate prices on their surplus production.

Similarly, studies conducted in selected countries in Sub-Saharan Africa (Tanzania, Malawi, Mali, Mozambique, Ghana, and South Africa) showed that rural radios with innovative programs including dramas and radio forums tailored to local communities are an effective way of communicating agricultural messages (Farm Radio International (FRI), 2008a). As a result of farm radio messages, studies in Malawi found that farmer behavioral changes have occurred in: diversification of crops to reduce overdependence on maize; engaging in soil improvement, use of compost manure, tree planting, rotation systems, micro-enterprises, small-scale irrigation, better environmental conservation, nutrition, and home economics (Chimutu, Kapyepye and Ndlhovu, 2006 and Manyozo, 2007 cited in FRI, 2008a). The study also suggested that farm radio is more effective when linked with new information and communication technologies (ICTs).

Based on data collected from 74 registered participants and 60 non-participants, Sasidhar et. al. (2011) evaluated the impact of a distance education radio program on poultry farming in India using Bennett's hierarchy. The study found that the farm school on radio with registered participants had a major impact on developing awareness, knowledge and changes in attitude and in involving end-users in outreach activities.

Finally, important as it is for economic capabilities, the provision of ICTs and ICT-related training could also bring about several social changes. The impact of a village resource center established in Thanjavur district of Tamil Nadu state in India is a typical example. Using a single course called the Microsoft potential program, this initiative provided a wide range of ICT skills to under-served people especially the youth and adult women since 2005. As a result, apart from the tangible economic benefits, several positive attitudinal and behavioral changes have occurred including: ability to make decisions, willingness of girls and women to work outside of village, eagerness to go for higher studies, tendency to explore opportunities for development and overall enhancement in self confidence. The course also helped participants expand their social network which enabled them to form healthy bonds, to mix and interact with opposite sex and develop friendship and camaraderie (Vedavalli, L. n.d.).

Table 2. The effect of ICTs - summary of selected studies

Study	Study site	Type of ICT used	Purpose of ICT used for	Effect of the intervention
Aker (2008)	Niger	Mobile phones	Market information	- Reduction in search costs - Reduced grain price dispersion across markets by a minimum of 6.5% and reduce intra-annual price variation by 10%.
Muto and Yamano (2009)	Uganda	Mobile phone	Exposed to mobile network	- Market participation of farmers who are located in remote areas and produce perishable crops
Svensson and Yanagizawa (2008)	Uganda	Radio	Market information	- Better bargaining power - Higher farm-gate prices
Chimutu, Kapyepye and Ndlhovu (2006), Manyozo (2007)	Malawi	Farm Radio	agricultural messages	- Diversification of crops - Engaging in soil improvement - Small-scale irrigation, better environmental conservation, nutrition, and home economics
Fafchamps and Minten (2011)	Maharashtra villages, India	Mobile phones (SMS)	Markets weather and crop advisory information	none
Jensen (2007)	South India	Mobile phones	Market information	- Dramatic reduction in price dispersion - Complete elimination of waste, and near-perfect adherence to the Law of One Price
Raj et. al. (2011)	Nagapattinam, India	SMS and interactive voice response system, web pages	Crop cultivation and nutrient management practices	- Significant reduction in the cost of cultivation - Net income of farmers higher by 15.2% than of control group
Rizvi (2011)	India	Mobile	Advisory service	- Annual average income of users was higher by 37% than of control group - Increased productivity and disease control
Sasidhar et. al. (2011)	India	Radio distance education	Education on poultry farming	- Knowledge and changes in attitude in involving end - Users in outreach activities

Vedavalli, L. (n.d.)	Thanjavur, India	Computer Training	Training on ICTs	- Ability to make decisions, willingness of girls and women to work outside of village, eagerness to go for higher studies, tendency to explore opportunities for development and overall enhancement in self confidence.
Lokanathan et. al. (2011)	Sri Lanka	SMS, Internet, WAP, unstructured supplementary service data (USSD), and telephone	Price information	- Farmers were able to get USD0.045–0.09 per kg higher for their produce - Behavioral changes that enabled farmers to improve their ability to coordinate supply and demand for agricultural produce based on price signals
Barrios et. al. (2011)	Southern Philippines	Internet and optical media	Information on agricultural and farming technologies	- Higher farm income - Higher living condition than of control group
Fengying et. al. (2011)	Ningxia, China	Internet, internet protocol TV, and video	Village information center	- Capability building - Improved income and livelihoods

5. Factors that affect use of ICTs for agricultural extension

The use of ICTs for agricultural extension is growing in Asia and Africa especially with the recent expansion in the use of mobile phones. Mobile phones and other ICT devices have been used to largely provide marketing information. Yet, if not supported with advice on improved agricultural practices and farmer education, marketing information alone may not necessarily lead to innovations and the desired increased productivity of smallholder agriculture. Therefore, it is imperative to harness the use of ICTs for provision of all aspects of agricultural information. However, while use of the technology seems relatively easy once in place as opposed to human-based extension service, which requires deployment of large number of extension workers, among others, doing so is not without constraints that can be summarized into three broad conditions: the policy environment; the rural setting, infrastructure and capacity problems; and, nature of local communities including their ability to use the technology to access information for their work.

5.1 The policy environment

The telecommunications sector of some countries such as Ghana, Kenya, Nigeria and Senegal, are very dynamic. Yet, as shown in the introductory section, Africa as a whole continues to lag behind other regions of the world. This is primarily as a result of the high cost of services (Calandro et. al. 2010). Based on a review conducted across 17 Sub-Saharan African countries, Calandro et. al. argue that the national objectives of achieving universal and affordable access to the full range of communications services have been undermined either by poor policies constraining market entry and the competitive allocation of available resources; weak institutional arrangements with a dearth of technical capacity and competencies; and, in some instances, regressive taxes on usage. Gillwald (2010) argues that in addition to competition and open access regimes, effective regulation of other factors such as spectrum and interconnection and tariffs are required to stimulate market growth, improve access, and lower prices. This is because: many competitive markets with several players have experienced spectrum allocation problems (e.g. case of Warid telecom in Cote d'Ivoire); high cost of services as a result of retrogressive tax on mobile communications despite having an open market with several operators (case of Uganda); and expensive leased lines - generally available from incumbent operators which are mostly unregulated - contributed to the high cost of doing business and inhibited growth and employment opportunities (Gillwald, 2010).

5.2 The rural setting, infrastructure and capacity problems

Rural people mostly live sparsely and this would make provision of infrastructure and public utilities such as electric power, water, health facilities, and some devices of modern ICTs very difficult to deploy in rural areas. Private companies invest their resources in areas where they would get good returns. In addition, provision of ICT services would require electricity which is limited in most places of rural Africa. Moreover, incomes of the rural people tend to be lower as compared to urban areas, and many rural households simply cannot afford modern ICTs (such as mobile phones, computer and internet). In effect, the combination of these constraints would result in a digital divide between the urban and rural areas. The implication of the divide to the development of agriculture in particular and

rural development in general is obvious and something has to be done about it so that the rural areas do not remain marginalized forever.

The major ICT infrastructure for the provision of information in rural areas in LDCs and in Africa in particular continue to be radio followed by television (TV). In LDCs, around a third of households, on average, have a TV set, compared to two-thirds with a radio (ITU, 2010b). In Sub-Saharan Africa, a survey conducted in 2004 indicates that, of adults in rural areas with access to a telephone, 92.4% of respondents in Mozambique, and 95.6% of respondents in Tanzania used radio while television use among this rural section of the population was considerably lower, at 57.9 % (Mozambique), and 45.6 % (Tanzania) (Souter et al. 2005). Yet, ITU (2010b) argues that the broadcasting digital divide is not a pure income divide. ITU (2010b) and Gillwald and Stock (2008) further argue that although income is without doubt an important factor, particularly in LDCs, the lack of electricity and the lack of content are major barriers that governments need to tackle.

On the other hand, since commercial investments including ICTs are driven by profit motive, ICT operators may not be willing to cover the rural areas unless there are strong incentives to do so. This is because of the high cost of start-up, operating, and programming costs given the capacity of the rural people to pay for the services offered. For example, an investment of $500 per week, or $26,000 per year would be required to finance the production and broadcast of 3-6 hours per week of interactive farm radio programming (FRI, 2008b). For the establishment of "micro-station" with a broadcast range of 2.5 kilometers, a study estimated that a start-up cost of $100,000 is required on average. For a community radio of this size, its annual operating costs were in the range of $2500 to $286,000. In addition, the cost of a reporter in the field (which is a common format for agriculture and food security reporting) was $297 per program for a commercial station in Uganda, and $107 per program for a community station in Malawi (FRI, 2008b). This implies that given many rural households simply cannot afford modern ICTs, shared access could be a cost-effective means of providing rural connectivity and perhaps partly a solution to the digital divide. In fact, this was evidenced by the fact that the statistics on use of ICTs (mobile phone and television) far exceeded ownership in a case study of India, Tanzania and Mozambique (Souter et al., 2005).

In general, high cost of services is the very reason that continues to inhibit the uptake of other forms of ICT services and their usage by consumers throughout Africa. In line with this, Gillwald and Stock (2008) used a contingent valuation technique to understand the willingness and ability of individuals to pay for mobile services in 17 countries in Africa. The results confirmed that income is the main adoption barrier. Based on individual level data, the authors evaluated the number of new mobile phone users operators could expect should they offer mobiles for US$20, US$15 and US$10 respectively. The results suggest that US$20 handsets would attract about 3 million new customers in Kenya and Côte d'Ivoire, 2.6 million in South Africa, 1.4 million in Tanzania and Ethiopia, and 1.3 million in Ghana and Senegal. Furthermore, at a handset price of US$10, about 5.6 million people in Kenya, and about 4 million in Côte d'Ivoire and South Africa would subscribe for mobile services. The results also suggest that the vast majority of respondents would make more calls if connectivity prices were to come down. However, Senegal and Ethiopia are the two

exceptions where the highest share of respondents said they would use the saved money from price reduction for something else.

5.3 The nature of local communities, including their ability to use the technology to access information for their work

In addition to income, educational attainment, social and cultural constraints are other factors which affect the likelihood of an individual having the necessary e-skills to use different technologies optimally (Gillwald et. al. 2010; Hafkin and Odame, 2002; Hafkin and Taggart, 2001). Based on panel data from Uganda, Muto and Yamano (2009) found that the total value of assets and the education level of both male and female household members are directly related to possession of mobile phones.

Munyua (2008) conducted a scoping study on ICTs and small-scale agriculture in Africa and found low usage patterns and anecdotal adoptions. It was argued that ICT initiatives were scattered and uncoordinated and summarized the main challenges and factors that influence the use of ICTs as: high cost of available technologies, inadequate infrastructure and low ICT skills, poor and expensive connectivity, inappropriate ICT policies, language barriers, low bandwidth, inadequate and/or inappropriate credit facilities and systems. Moreover, the author also identified poor involvement of women and other disadvantaged groups, inappropriate local content, weak institutions and inadequate collaboration and awareness of existing ICT facilities and resources, a poor information sharing culture and low awareness of the role of ICTs in development at all levels.

Based on household and individual access and usage survey conducted across 17 African countries, Gillwald et. al. (2010) found that the diffusion of ICTs (mobile, internet, radio and television) is highly uneven, concentrated in urban areas and leaving some rural areas almost untouched. Access to these technologies is constrained by income as is usage, and as they become more complex, they are increasingly constrained by literacy and education. Further disaggregating the data by gender, the study revealed that women are not equally able to access and use even the more prevalent forms of ICTs. For example, the study indicated that between 39% (Ethiopia) and 90% (Senegal) listened to radio in 2007, with men listening to radio more often than women (see Appendix 2). The study also reported that important factors such as income, education and social position played a major role in explaining ICT access and usage. When men and women have similar backgrounds, the differences in access to ICTs and their use are less. However, due to unequal access to the factors that appear to enhance ICT access and usage – such as income and education – women generally have less access to ICTs and this increases as the technologies and services become more sophisticated and expensive, requiring greater levels of income and education to access and to operate. Moreover, GSMA (2010) shows that a woman in low and or middle income country is 21% less likely to own a mobile phone than a man. This situation is disturbing for agricultural development in Africa where more women are involved in food production than men and they need technology and market information to increase their productivity and profitability.

Similarly, by reviewing ICT initiatives in India, Sulaiman et. al. (2011) studied the role of ICTs in empowering Indian rural women. They concluded that, while most of the ICT initiatives

are disseminating new information and knowledge useful for rural women, many are not able to make use of it, due to lack of access to complementary sources of support and services (including human networks and financial support). Among the varied tools, the knowledge centers and the community radio were found to have the greatest potential in reaching women with locally relevant content.

Hafkin and Odame (2002) and Hafkin and Taggart (2001) also studied agriculture, gender and ICTs in developing countries. They identified factors that constrain women's use of telecenters and communication facilities, including: heavy workloads and multiple roles that limit the time available to use telecenters; male attitudes towards women's use of technology and to women visiting a mixed-sex public facility; opening of public facilities during evenings that may expose their safety to danger; the lower educational levels of women compared with those of men; and lack of disposable income to spend at fee-paying centers, among others.

6. Conclusion

The world is going through some changes that are triggered by demand and supply factors. The demand drivers of the changes include population, income growth, and urbanization, all of which demand increasing availability of food and fiber. The supply drivers encompass climate change, water and land scarcity, science, technology and innovation policy, investment in research, and policy and governance reform. Innovations are needed to tackle these changes. Innovation involves the extraction of economic, ecosystem and social value from knowledge. It involves putting ideas, knowledge and technology to work in a manner that brings about a significant improvement in performance. Increased mobility of knowledge has made re-cycling of knowledge easier.

H.E. Ellen Johnson Sirleaf, President of Liberia said at the Science with Africa conference (March 3-7, 2008, Addis Ababa, Ethiopia) that, "No country on earth has developed without deploying, harnessing and utilizing science and technology, whether it is through technology transfer or home grown. The African continent needs to think seriously about stepping up its efforts in using science and technology for decision support and for making a difference in the lives of ordinary people. By harnessing science and technology, African countries have a stronger chance for sustained economic growth, for addressing poverty, disease and environmental destruction. Therefore building national science and technology capacities are critical indicators of the future well-being of a country's citizens and how well a country can compete in the global market".

The development of ICTs has facilitated the dissemination of knowledge and information and it is revolutionalizing the use of technology in agricultural production and provision of market information to maximize the returns to agriculture. There is evidence that rural incomes have been increasing with the use of ICTs to access knowledge and information. However, there are challenges in making ICT platforms available to a large number of the rural population who are engaged in agriculture and these have to be tackled through public policy in the context of rural development and incentives for investments in rural areas. Expansion in the use of ICTs has to start from primary and secondary education by including computer science in the curriculum so that African countries would build the

human resource base required for "home-grown" development and use. Public policy should be used to promote the availability and use of ICT devices through tax and credit programs for inventors, adaptors and users of the technologies. Fortunately Africa is witnessing a phenomenal increase in mobile phone acquisitions and when they are combined with other ICT platforms like radio the impact on agriculture, health and other sectors can be very high. It is very important that as ICT platforms are rolled out their content or the message that is sent out is validated to ensure authenticity of the knowledge and information to sustain the interest of users. Access to the platforms can expand further if the costs of the devices and connectivity go down. One way of reducing costs is for countries to cooperate in rolling out ICT platforms in terms of equipment and content. For instance, countries in east Africa can cooperate in mobile phone infrastructure or sharing of bandwidth through a regional internet backbone; the creation of content on animal disease surveillance and treatment in local languages on radio and mobile platforms since the solutions are similar for the region. Countries should avoid monopoly situations and encourage pluralistic providers to induce competition for higher efficiency and lower costs to consumers.

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Appendix 1. World Summit on the Information Society (WSIS) targets and core indicators on ICT infrastructure and access

Targets	
1	To connect villages with ICTs and establish community access points
2	To connect universities, colleges, secondary schools and primary schools with ICTs
3	To connect scientific and research centers with ICTs
4	To connect public libraries, cultural centers, museums, post offices and archives with ICTs
5	To connect health centers and hospitals with ICTs
6	To connect all local and central government departments and establish websites and e-mail addresses
7	To adapt all primary and secondary school curricula to meet the challenges of the information society, taking into ac-
	count national circumstances
8	To ensure that all of the world's population have access to television and radio services
9	To encourage the development of content and put in place technical conditions in order to facilitate the presence and
	use of all world languages on the Internet
10	To ensure that more than half the world's inhabitants have access to ICTs within their reach.
Core indicators on ICT infrastructure and access	
1	Fixed telephone lines per 100 inhabitants
2	Mobile cellular telephone subscribers per 100 inhabitants
3	Fixed Internet subscribers per 100 inhabitants
4	Fixed broadband Internet subscribers per 100 inhabitants
5	Mobile broadband subscribers per 100 inhabitants
6	International Internet bandwidth per inhabitant (bits/second/inhabitant)
7	Percentage of population covered by a mobile cellular telephone network
8	Fixed broadband Internet access tariffs (per month), in US$, and as a percentage of monthly per capita income
9	Mobile cellular prepaid tariffs, in US$, and as a percentage of monthly per capita income
10	Percentage of localities with public Internet access centers (PIACs) by number of inhabitants

Source: ITU (2005, 2010a)

Appendix 2. Gender differences for radio access and usage – country split

	Share of people (16 or older) that listen to the radio			Share of people (16 or older) that own a personal radio they can use at any time			Share of people (16 or older) that watch TV		
	All	Male	Female	All	Male	Female	All	Male	Female
Benin	75%	76%	73%	59%	72%	45%	47%	49%	45%
Botswana	55%	66%	50%	60%	69%	55%	49%	56%	46%
Burkina Faso	74%	77%	63%	72%	81%	30%	39%	36%	49%
Cameroon	62%	65%	58%	62%	68%	54%	54%	48%	62%
Côte d'Ivoire	64%	73%	46%	83%	89%	64%	56%	56%	58%
Ethiopia	39%	41%	37%	57%	59%	55%	19%	21%	17%
Ghana	88%	91%	84%	84%	89%	78%	57%	52%	62%
Kenya	84%	88%	81%	84%	87%	82%	57%	70%	49%
Mozambique	42%	45%	37%	89%	94%	78%	11%	8%	17%
Namibia	70%	71%	70%	62%	75%	54%	39%	46%	35%
Nigeria*	83%	87%	78%	57%	64%	48%	78%	77%	80%
Rwanda	69%	73%	64%	71%	85%	57%	13%	13%	13%
Senegal	90%	92%	88%	57%	66%	50%	81%	87%	77%
South Africa	68%	73%	66%	64%	69%	60%	69%	67%	71%
Tanzania	65%	74%	60%	72%	74%	70%	35%	40%	32%
Uganda	87%	96%	78%	68%	79%	55%	28%	34%	21%
Zambia*	56%	71%	45%	89%	90%	87%	35%	48%	26%

Source: adopted from Gillwald et. al. (2010). *Also note that results for Zambia and Nigeria were extrapolations to the national level but are not nationally representative