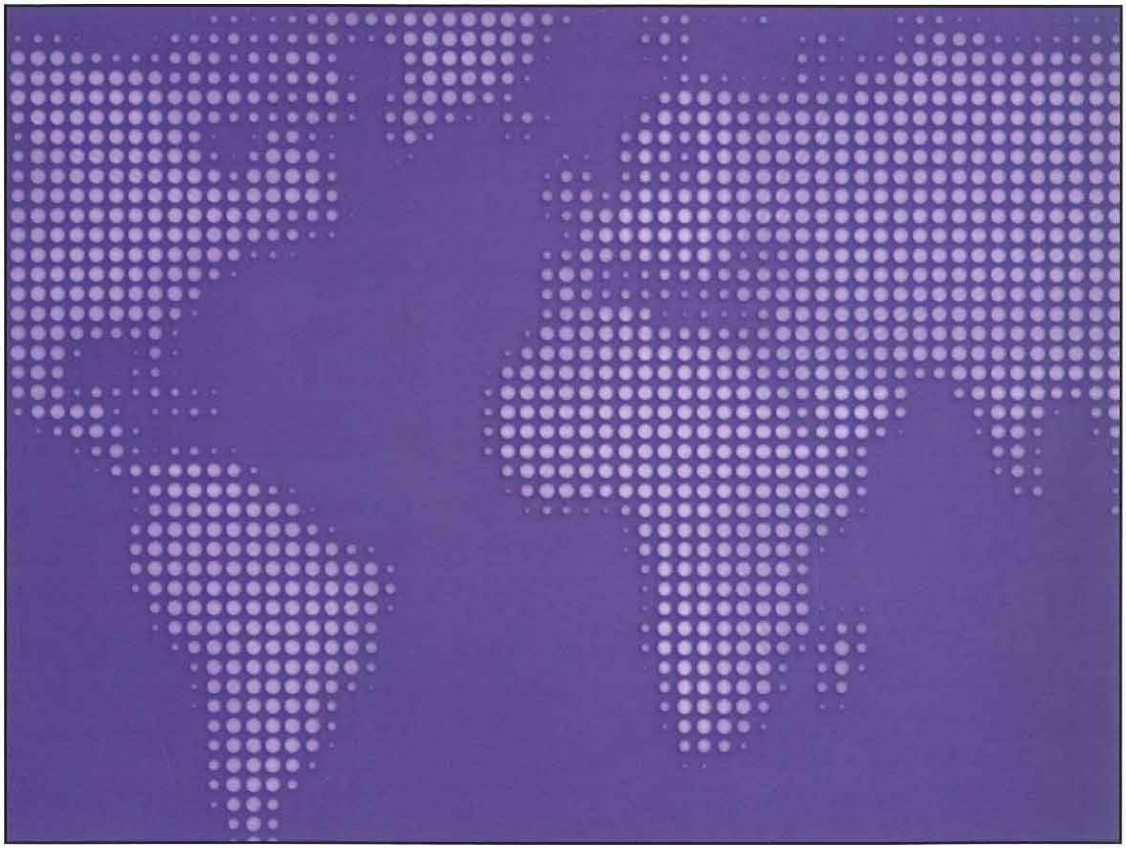
Vol. 1, No. 1
January - March 2010

An official publication of
the Information Resources
Management Association

INTERNATIONAL JOURNAL OF

ICT Research and Development in Africa



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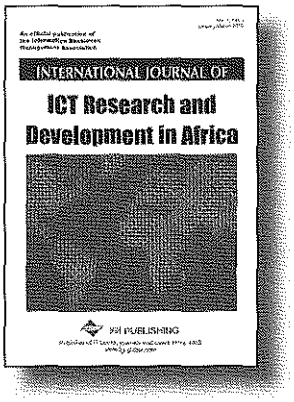

ISSN 1947-3419
eISSN 1947-3427
Published quarterly

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International Journal of ICT Research and Development in Africa

January-March 2010, Vol. 1, No. 1

Table of Contents

EDITORIAL PREFACE

The Role of Information and Communication Technology in Agriculture and Rural Development

Blessing Mukabeta Maumbe, Editor-in-Chief, Eastern Kentucky University, USA

The Information and Communication Technology (ICT) revolution has brought about unprecedented new opportunities in agriculture and rural development in developing countries. The use of ICT in agriculture has made significant contributions towards improvements in agricultural production, food security, and better access to input and product markets. It has also improved the performance of rural agribusinesses, income earning opportunities, and agricultural policy development, coordination and implementation. As farmers' use of ICT increase, additional benefits arise from better and improved access to food and agricultural market information, knowledge networks, expansion of employment opportunities, and more efficient communication channels between farmers, input suppliers, food processing and marketing firms, and rural entrepreneurs in Sub-Saharan Africa (SSA), Asia and Latin America. The widespread use of ICT facilitates and strengthens farmers' linkages with key stakeholders through backward and vertical integration with input suppliers and food marketing firms respectively. In addition, to promoting better linkages and coordination along the food and agricultural value chain, new communication channels with government policy makers and extension workers enhance on-farm production efficiencies and the profitability of rural farm enterprises and household incomes.

The world is undergoing tremendous changes and agriculture is at the heart of numerous forces that will reshape and reorganize the food production and marketing landscape especially in developing countries. These forces include globalization, climate change, biotechnology, bio-fuels, information communication technology (ICT) and the current global financial crisis among others. Although each of these global trends is reshaping our world today, the use of ICT to promote socio-economic development and uplift the living standards of the poor stands out as one of the most significant changes in the history of mankind. With Africa and Asia leading the world in growth rates of mobile ICT adoption, the use of these modern tools to drive economic growth and alleviate the scourge of hunger and poverty presents immense opportunities whose full potential remains largely untapped in the 21st century.

The ICT momentum has transformed the way governments, agribusinesses, agricultural communities and civil society in general conduct their transactions. The central role of ICT use is set to explode in all economic sectors. Agriculture is one of those key economic sectors likely to benefit from prudent applications of ICT that could result in the transformation of livelihoods of millions of poor people. Specifically, ICT have been deployed in agriculture in numerous ways including input procurement, on-farm production and storage management, enhancing access to local, regional and food global markets, and improving rural farmer's access to key health and financial services among others. The advent of ICT has provided new avenues to resolve the problems of information asymmetry and information poverty that characterize rural areas in Africa, Asia and elsewhere. Today, farmers are able to receive real time information on input and product prices, weather conditions, pest infestation, and related farm management extension advice. According to the United Nations, ICT are being deployed in innovative ways to fight global climate change. Despite the current global financial crisis, one of the key benefits arising from the integration of global financial markets is the fact that poor farmers and rural traders are able to receive financial remittances from family members working in urban areas or in other countries. Social grants destined for disadvantaged members of the community are now being delivered through mobile commerce and other innovative ways. Mobile commerce has exploded in developing countries giving poor farmers and previously neglected people access to "banking" services. Some of the successful mobile money transfer services include M-PESA in Kenya, WIZZIT in South Africa, and Celpay in Zambia among others. In the field of telemedicine, poor countries that do not afford large investments in the health sector are teaming up with medical experts in developed countries such as United States and other European countries to provide long distance diagnosis and healthcare that benefit mostly agricultural communities in remote regions of SSA, Asia and Latin America.

Despite the limited penetration of the Internet in poor countries coupled with the false starts experienced during the dot.com era, new forms of ICT have evolved and their capability and functionality have improved tremendously over time. Consequently, ICT are now considered as critical tools for social and economic empowerment of the majority poor and underserved communities in developing countries. Generally, most farm workers, agricultural producers and rural agribusiness entrepreneurs in SSA can operate multitude of ICT ranging from ordinary mobile phones to the relatively more sophisticated smart phones. Rural agribusiness enterprises, agricultural producer organizations and non-governmental organizations have shown an increasing affinity to use ICT such as mobile phones, lap-tops, email, net-books, video conferencing, webinars, and high definition digital televisions as forms of communication with their employees and clients. The full potential of ICT remains largely untapped, and as more advances are unleashed on the global market, more tangible uses that contribute towards improving living conditions of the poor people in developing countries will arise.

Most governments have seized the opportunities presented by ICT by developing electronic government (e-government) and mobile government (m-government) programs with the aim to transform the delivery of existing public services to better meet increasing citizen demands for new and improved services. In SSA and Asia, rural communities have witnessed the development of high quality e-education, e-health and e-agriculture programs that are designed to use both the Internet and mobile phones as major technology platforms for public service delivery. Therefore, ICT have unleashed a new development paradigm, engendered democratic participation by civil society, expanded communication possibilities, and extended economic opportunities to previously neglected marginalized communities.

As a result of the foregoing developments that revolve around ICT, academic researchers, non-governmental organizations, and govern-

ment policy makers are showing increasing interest in studies that investigate the household, community, and national level impacts of using ICT, and measuring the extent to which the livelihoods of ordinary people have been changed as a result. In some African countries, institutions to support ICT policy development are lagging behind and research studies that focus on ICT development frameworks, policy and strategy issues, and best practices are of vital importance for institutional development. In contrast, in other African countries (e.g., South Africa, Tunisia, Kenya, Mozambique, etc.) governments have made tremendous strides in ICT investments and policy development. In such countries, ample opportunities exist to learn from each other's successes and failures. This journal is an attempt to systematically document early empirical studies on ICT applications in agriculture and rural development in SSA and other developing countries, highlight the socio-economic benefits of ICT use and key challenges, and provide essential lessons and insights for those governments that are still grappling with ICT policy development issues on the continent and elsewhere.

The papers selected in this inaugural journal edition provide important insights on key developments in ICT applications in agriculture including some of the challenges confronting countries with early ICT adopters. The papers selected in this special edition were initially chosen as part of a mini-symposium entitled "Role of ICT in linking smallholder farmers to markets: What do we know?" that was conducted at the XXVII International Association of Agricultural Economists (IAAE) Conference held 16th-22nd August, 2009, at the Beijing International Convention Conference, held in Beijing, China. The papers were then subjected to an additional blind-peer review process before being finally accepted for publication in this inaugural issue of this journal. The topics covered by this inaugural edition span across two continents Africa and Asia which are at the epicenter of the ICT for development revolution. Specifically, the selected case studies are drawn from South Africa, Kenya, and Sri Lanka. In summary, the first paper describes a framework for the evolution of e-government policy development in South Africa and lessons for other SSA. The second paper develops a framework that can be used to analyze the link between ICT application in smallholder agriculture and household commercialization and food security. The third paper describes an ICT-based intervention (known as the DrumNet project) that has succeeded in integrating smallholder resource poor farmers into higher value agricultural chain. Finally, the fourth paper examines the problem of high transaction costs associated with obtaining market information among poor subsistence farmers in Sri Lanka. The paper argues that the ICT revolution has made the previously costly market information affordable to the farmers. If used appropriately, ICT can help reduce the high transaction costs associated with the acquisition of market information thereby help subsistence farmers move towards some level of commercialization.

Collectively, these papers are trail-blazing and they provide early lessons on the successes, challenges, and pitfalls experienced by those countries in SSA and Asia that have taken a leading role in ICT use in agriculture and rural development. First, those countries that have decide to become "followers" in ICT adoption will benefit from understanding what works in a given socio-economic context. Second, 'followers" will be able to benchmark the best practices from the successful experiences of those countries that are "early adopters" of ICT. Third, countries trailing behind in ICT applications in agriculture do not have to experiment with ICT that may have been proven to not work in SSA, Asia or elsewhere. Such countries will be able to save valuable time, money and other scarce resources by not embarking on programs whose outcomes are already known to be unsuccessful.

The successful implementation of ICT in agriculture and rural development will be judged in a number of ways. First, the successful application of ICT in SSA will be measured by tangible socio-economic benefits that will accrue to

various stakeholders along the agriculture value chain. Second the successful implementation will be indicated by and the effectiveness of ICT policy development process in creating an enabling environment for sustainable ICT deployment on the continent. Third, success will be attributed to broad-based economic opportunities that will potentially accrue to various other constituencies and stakeholders such as agricultural colleges and universities (i.e. through increased demand for ICT use in agriculture curriculum), ICT services providers, and the agricultural communities in general. Fourth, and more importantly, ICT initiatives that result in significant poverty alleviation especially among the marginalized communities in SSA and Asia, and the development of "knowledge societies" will calibrate success or failure of the ICT for development revolution in the long-run.

In order to promote a better understanding of ICT uses in agricultural development observed around the world, it is important to balance the early successes with the social and economic problems that still persist in some countries such as low market awareness, poor ICT functional literacy, security violations, unresolved confidentiality and privacy issues, cultural and language barriers, peddling of non-durable and defective grey-market handsets, use of mobile phones while driving, poor connectivity, lack of reform in telecommunication sector, unaffordable tariff rates, and the need to integrate indigenous knowledge in available content among others. Without doubt, the development of more sophisticated and affordable mobile devices is likely to sustain the momentum in subscriber growth rates as the smart-phones become widely available to ordinary people in developing countries. New challenges emerge that require dedicated work by researchers working in collaboration with governments and the private sector to provide practical solutions that ensure the long term success of the ICT for development revolution thereby circumvent the limitations of the previous revolutions such as the green revolution.

Research results reported in this exciting journal help both the public and private sectors develop policy interventions and management strategies that contribute toward making the ICT for development revolution one of the greatest socio-economic transformative tools in the history of mankind. As already highlighted, the potential that ICT offers to expand income earning opportunities, unleash rural entrepreneurship, enhance food security, eradicate poverty, and stimulate broad-based socio-economic development make ICT central to the human development process in the 21st century. The *International Journal of Information and Communication Technology in Research and Development in Africa* (IJICTRDA) provides a timely platform for academic researchers, government policy makers, industry experts and other esteemed scholars, to share cutting-edge research results, build a new knowledge frontier based on scientific enquiry, and develop the capacity to assess location-specific ICT costs and benefits, including related risks and challenges. Therefore, this publication provides a unique opportunity to; (i) promote informed discussion on the critical importance of ICT in socio-economic development, (ii) identify practical ICT solutions that facilitate the escape from poverty of the majority poor living in developing countries, and (iii) contribute to the debate on ICT policy development in SSA and the developing world.

Finally, I trust that the academic community, government policy makers, development specialists, industry experts, and all other interested global scholars will find this journal informative, stimulating and exciting. I am proud to have laid the foundation for a novelty academic publication that reports empirical research findings that provide vital insights, case studies, analytical frameworks, policy development lessons on ICT research in SSA and developing countries. Given that agriculture is central to the economic vitality of most developing countries, this publication captures cutting edge research on ICT applications in agriculture and rural development in the 21st century. As the ICT revolution continues

to unfold before us, now is the time to conduct research and document systematically the unprecedented socio-economic transformations that have been introduced by these modern technologies. Therefore, the articles in this journal and in subsequent volumes highlight these socio-economic benefits and costs, and the policy issues arising from ICT development and deployment in agriculture and rural development. In addition, the articles provide the readers with an opportunity to reflect on the foregone development opportunities for those countries or governments that decide to adopt a wait and see attitude. This journal publication is quite timely, and will spur global efforts to increase our understanding of the diverse socio-economic gains arising from ICT use in agriculture in Africa, Asia, and other parts of the world.

Blessing Maumbe is an associate professor in the College of Business and Technology at Eastern Kentucky University (EKU) where he is responsible for the Agribusiness Management Program. Prior to joining EKU, he was an associate professor in the Faculty of Business Informatics at Cape Peninsula University of Technology (Cape Town, South Africa). He holds a PhD in agricultural economics from Michigan State University (USA). His current research interests include e-agriculture, e-government, food and agriculture supply chain management, and rural financial service delivery. Blessing has received competitive research grants from the W.K. Kellogg Foundation and Rockefeller Foundation. He has published several research papers in international and national level journals and supervised several graduate students. He was the founding Lecturer and Coordinator of Agribusiness Studies at Africa University. Blessing has taught numerous courses in agribusiness management, marketing and economics at several Universities in South Africa, Zimbabwe, and the United States.

Uses of Information and Communication Technology (ICT) in Agriculture and Rural Development in Sub-Saharan Africa:
Experiences from South Africa and Kenya

Blessing M. Maumbe, Eastern Kentucky University, USA

Julius Okello, University of Nairobi, Kenya

ABSTRACT

This paper presents a framework of the evolution of information and communication technology (ICT) applications in agriculture and rural development based on comparative experiences of South Africa and Kenya. The framework posits that full deployment of ICT in agriculture and rural development will be a culmination of several phases of changes that starts with e-government policy design, development and implementation. The paper argues that ICT use in agriculture and rural development is a powerful instrument for improving agricultural and rural development and standards of living throughout Sub-Saharan Africa. However, success in greater application of ICT in agriculture will require addressing impediments to adoption and diffusion. Such impediments include the lack of awareness, low literacy, infrastructure deficiencies (e.g. lack of electricity to charge electronic gadgets), language and cultural barriers in ICT usage, the low e-inclusivity and the need to cater for the special needs of some users. The paper reviews successful applications of ICT in agriculture and urges greater use of ICT-based interventions in agriculture as a vehicle for spurring rural development in Africa.

Keywords: *Agriculture, Africa, Development, E-Government, Kenya, Policy, South Africa*

1.0 INTRODUCTION

The rapid growth in the use of information and communication technologies (ICT) by governments, businesses, private institutions, and civil society has led to key socio-economic developments globally. This widespread diffusion of ICT has enabled more efficient local and global linkages between governments, businesses, and ordinary citizens. It has also led to a significant

DOI: 10.4018/jictrd.2010010101

transformation of people's livelihoods and the development of "information societies" and "knowledge societies". As the modern ICT and related traditional technologies converge, both the effectiveness and efficiency in public service delivery, business performance, global communications, and citizen participation in governance and policy development issues have increased tremendously in the newly emerging information and knowledge societies.

Although developed countries have led the world in ICT use for over two decades, the past decade has seen unprecedented growth in ICT usage by developing countries. The later now boast the fastest growth in ICT penetration and related productivity growth has surpassed that of developed and transition countries (Mathur, 2009). Today, public information and services that were difficult to access a decade ago are readily available especially to rural and marginalized communities in Sub-Saharan Africa (SSA). In remote rural locations in SSA where communication would normally take several weeks to complete, the advent of mobile phones, instant short messaging system (SMS) and multi-media message system (MMS) has eliminated waiting periods to relay important decisions (Tyler et al., 1999). Modern ICT such as Internet, email, 3G and 4G mobile phones, personal digital assistants (PDAs) and social networking via u-tube, twitter, my-space, face-book, etc. have extended the communication frontiers in the 21st century reaching previously excluded communities. These modern ICT have enabled developing countries to "leap-frog" agriculture and rural development. As a result increasing attention is being focused on the role ICT could play in promoting access to markets that is critical to the achievement of agricultural commercialization, food security, and poverty alleviation in SSA.

In South Africa and Kenya, the relationship between the government, businesses and citizens changed significantly when e-governance was introduced in 2001 and 2007, respectively. Fuelled by events of the World Summit for Information Society in 2003, and a restless society frustrated by continued poor public service delivery more than a decade after Independence in 1994, the government of South Africa (GSA) adopted e-government with the aim of rectifying the way it interacts with its citizens. In Kenya, e-government was introduced to facilitate the speedier delivery of services as part of the civil service reform process to accelerate citizen's access to public services. It was also seen as a medium for reducing unofficial hurdles in accessing public services. E-government which involves the use of the Internet and World Wide Web (WWW) to deliver online public information and services, has helped a number of countries to improve the quality of their public services, by making them faster, dependable, available in real-time, and more citizen-centred.

In both Kenya and S. Africa, the introduction of e-governance has greatly increased access to government services. For instance, essential government forms and jobs announcements are freely accessible on-line, one can check the status of their applications for passport and national identification cards online, and citizens can even assess the performance of their parliamentary representatives on line. Can this relative success of the use of ICT in governance be replicated in agriculture? This paper aims at addressing this question. The main purpose of this paper is therefore to understand the existing and potential uses of ICT in agriculture and rural development in SSA. The paper examines e-government (and mobile government) developments as a medium for ICT deployment in the agricultural sectors of both Kenya and South Africa. Evidence of agribusiness industry e-agriculture initiatives is presented for both countries. It provides key insights into future prospects and significance of e-agriculture development in SSA and further aims to answer the fundamental question: What are the current and future possibilities, constraints, and challenges facing ICT applications in agriculture and rural development in SSA? The paper focuses on Kenya and S. Africa. South Africa is the most developed economy in Africa and has taken major strides in applying ICT in agriculture. Kenya, on the

other hand, is the telecommunication hub in eastern Africa and has aggressively liberalized its telecommunications sector in the last decade. The two countries therefore provide valuable and interesting cases to study.

The remainder of the paper is organized as follows; Section 2 describes the theoretical framework for e-government (and m-government) evolution and ICT deployment in the South African economy. Section 3 gives the background of the ICT development in S. Africa and Kenya. Section 4 discusses key considerations for ICT deployment in agriculture in SSA. Section 5 presents results of e-agriculture experiences in both South Africa and Kenya, and it also provides some insights into the future prospects of using ICT in promoting agriculture and rural development in SSA. Section 6 concludes the paper and makes suggestions for more strategic use of ICT to stimulate agricultural and rural development in SSA.

1.1 Socio-Economic Context of ICT Use in Sub-Saharan Africa

The benefits arising from the ICT for development revolution can be maximized in SSA through its effective deployment in agriculture, a strategic economic sector on the continent and major engine for economic growth and development. But African countries are quite diverse in terms of their socio-economic potential, ICT infrastructural endowment, ICT literacy, language and culture. Such major differences imply that the pace and pathway of ICT deployment will vary and so will the benefits derived by the respective countries (Maumbe et al., 2008). However, one of the leading areas likely to benefit from ICT is the revitalization of agriculture in poor countries in SSA. Indeed recent studies in West Africa (i.e., Niger) find that the use of ICTs especially mobile phones greatly affects the way rural markets for staple grains perform (Aker, 2008). Given that Africa comprises 53 nations, the specific benefits accruing from the use of ICT will vary depending on a country's socio-economic context which, in turn, will be driven by; (i) the ability to stimulate food and agricultural production, (ii) more efficient pest and disease surveillance (iii) better access to regional and global factor and product markets, (iv) improvements in two-way communication between key stakeholders such as policy makers, extension agents, agribusinesses, and farmers, (v) expansion in information-based technology transfers and (vi) knowledge sharing and information exchange among farmers, producer associations, agribusinesses, and the agricultural and rural communities in general. More specifically, ICT is expected to play a pivotal role in improving the timeliness of on-farm operations, facilitating input procurement transactions, overcoming rural agricultural production and market information asymmetries, transfer of rural financial remittances, and providing key agricultural data and market information such as changes in product quality, grades, output levels, food distribution, consumer preferences, prices, and demand and supply trends. In addition, ICT will enhance farmers' ability to respond to emergencies such as pest outbreaks, wild fire damage etc., assist with on-farm disease diagnosis, improve record keeping and analysis that is critical for generating decision making information (intelligence) needed to keep the farm business healthy (Davis, 2008).

The aforementioned benefits envisaged from ICT will not be automatic but will require diligence in the generation of innovative ideas and the deployment of ICT initiatives in new areas of application. It will require a clear understanding of the socio-economic context of the target country for ICT deployment. ICT will therefore not be a "magic bullet" or the "panacea" for all the development problems confronting SSA (Spence, 2003). Instead, the success of ICT use in agriculture and rural development will depend on the nature of the technology, functional literacy of end users, and the ability to exchange and share quality farm decision-making information on a timely basis (Okello et al., 2009). Agricultural communities understand their risks, have a wealth of indigenous knowledge that they use to make daily livelihood decisions, and integrating that knowledge into the design of new ICT will

increase the likelihood of success. Historically, information-based technologies provided via extension programs have failed because of an inability to appreciate the value of local information networks and failure to use it as a basis for improving farmer's circumstances (Chapman & Slaymaker, 2002; GKP, 2005).

2.0 A FRAMEWORK FOR UNDERSTANDING THE EVOLUTION OF E-GOVERNANCE AND ICT USE IN AGRICULTURE

In both S. Africa and Kenya, the deployment of ICT in agriculture is taking place under the overall umbrella of e-government evolution. We, therefore, develop the conceptual framework for the e-agriculture in S. Africa and Kenya in the broader context of e-government. Several things are, however, worth noting in relation to the framework we develop below. First, we do not assume that the different phases or the activities within each identified phase are independent or sequential. Second, the e-government (and ICT deployment) phases or the elements contained within each phase are assumed to be distinct or practically verifiable. Third, the implementation of activities within and across the different phases is assumed to be interdependent or interactive depending on the specific activity. Events or activities in a given phase can occur simultaneously as the information society develops. Essentially, the phases depict the "steps" or the pathway along which e-government has evolved in both countries, albeit with minor differences. We however caution that the e-government process is more complex, influenced by many context-specific factors and is definitely not necessarily linear or isolated.

The way the e-government programs have evolved in S. Africa and Kenya differs. Nonetheless, the evolution can be divided into four main phases namely, (i) e-government and m-government policy development process, (ii) Liberalization and convergence of ICT sector, (iii) e-value creation, (iv) e-government market awareness and ICT deployment in rural development, (v) Achieving the goal of "knowledge society" through mobile government implementation, broad-based community participation, and indigenous e-content and knowledge integration. The final phase marks the transformation of a country from an "information society" to a "knowledge-based society" characterized by universal access to ICT, ubiquitous availability of ICT-based public information and services, socioeconomic development, and poverty alleviation. In the section below, we describe in greater detail the phases through which e-government has evolved in the both countries.

Phase 1: E-Government and M-Government Policy Development

Driven by the dawn of the information society, the governments in the S. Africa and Kenya adopted policies to promote the deployment of e-government services. The limited nature of Internet penetration in the so-called "second economy" provided the impetus for the governments to consider alternative delivery modes based on wireless and mobile technology. In S. Africa, the Information Society Summit laid the foundation for governments around the world to transform the traditional "face to face" service delivery and offer more efficient, "online services." In Kenya, on the other hand, the efforts to formulate an ICT policy started in 1991 but did not gain momentum until the early to mid 2000s following pressure on the government by private sector lobbying. In both countries, new ICT policies and e-strategies were crafted during the period 2000-2005 laying the framework for the liberalization of the telecommunication sector growth. In S. Africa, the Cape Gateway Portal became the leading e-government program and it received global accolades for its

ground-breaking work in reaching more citizens through better e-service delivery.

Phase 2: Liberalization of the Telecommunication Sector

The liberalization of the telecommunication sector in S. Africa, Kenya and other countries in SSA has lagged behind. For decades, these countries had a single service network operator (SNO). The market entry by mobile phone companies such as Vodacom, MTN, Cell C and Virgin Mobile (in S. Africa) and Vodacom and Celtel (in Kenya) into the telecommunications landscape increased the momentum towards market liberalization. The cell-phone companies now play a critical role in the provision of m-government services at competitive tariff rates. South Africa is on course to having a second network operator although it might still rely on TELCOM the national telecommunication operator for infrastructure. In reality whether Phase 2 comes before phase 1 is essentially dependent on the degree of liberalization of telecommunication prior to e-government. In Kenya, on the other hand, the national telecommunications operator (Telkom Kenya Ltd) has already been liberalized. As already highlighted, liberalization is necessary condition for e-government service delivery and the success of ICT deployment in agriculture. The passing of the Electronic Communication Act in 2005 in S. Africa and the repealing of Kenya Communications Act of 1998 created an enabling environment to enhance the competitiveness of the ICT industry.

Phase 3: E-Value Creation in E-Government and E-Agriculture

The future success of ICT use to spur rural development will require that policymakers pay closer attention to demand driven technologies that bring meaningful transformations in people's lives. Value-addition, or e-service quality improvements, is a critical part of ICT diffusion and adoption. As rural problems change, the problem-solving capacity of the ICT must also evolve if their adoption level is to reach critical mass. E-value creation takes various formats including (i) the promotion of e-trust in e-government and m-government service delivery, (ii) integration of e-security into the various ICT uses, (iii) preservation of farmer-client privacy, and (iv) the increase in features that add confidentiality in financial and other transactions conducted using modern ICT. That is, any new developments that add speed, reliability, efficiency, ease of use, confidentiality, and versatility will contribute to e-value creation in ICT use in agriculture and rural development. Rural communities may not necessarily be articulate in demanding high service qualities or versatility partly because of their unfamiliarity with some of the ICT in the short-term. However, this situation will change in the long-run as farmers become familiar with technological capabilities and related vulnerabilities. Therefore, it is important to be proactive in delivering e-value solutions as farmers will not adopt technologies with high vulnerability to theft, manipulation, privacy infringements, or other forms of social and economic ills.

Maumbe et al. (2005) identified three prime movers for e-value creation in government namely, internal factors (i.e. content development, ICT literacy, ethics, etc.), external factors (national culture, trust and confidentiality, indigenous knowledge, usability, etc.), and technical factors (open source, e-security, transactional capabilities, etc). Trust reduces opportunistic behaviours between contracting parties and hence lowers the need for monitoring and controlling the other party or the need to take precautionary measures (Sartorious & Kirsten, 2007). In South Africa, the integration of e-trust in government service delivery is based on the philosophy of *Ubuntu* which basically means humanity (see Table 1). Embedded in the philosophy of *Ubuntu* as part of building trust in e-government are values such as transparency, courtesy, access, best value, and high service standards which are collectively referred to as the *Batho Pele* Principles.

Table 1. Summary of the Batho Pele principles and the IT house of values in South Africa, 2009

Batho-Pele (People first)	IT House of values
Transparency	Cost efficiency
Redress	Increased productivity
Best value	Improved service delivery
Consultation	Economics of scale
Service standards	Security
Courtesy	Eliminate duplication
Access	Interoperability
Information	Access by historically disadvantage

Source: South Africa Information Technology Agency (www.sita.co.za)

Ubuntu is therefore considered as a value-based, people-centred, and people-driven public service delivery that is framed on a code of ethics. Government's effort to increase citizen participation in ICT-based agriculture and rural development projects and programs, government administrative affairs, and governance issues is a critical dimension for e-value creation through the promotion of e- inclusivity, equity, e-accessibility and socio-economic prosperity.

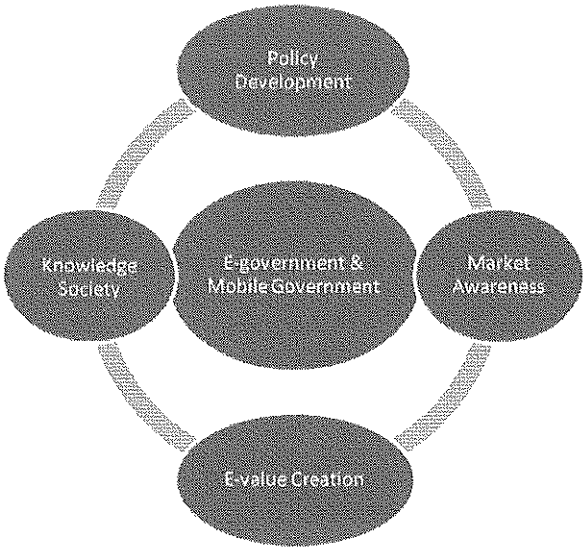
Phase 4: Market Awareness and Applications of ICT to Agriculture and Rural Development

South Africa's Cape Gateway Project (CGP) provides a classic example of the importance of creating awareness in ICT application in agriculture. The CGP was established in 2000 and has been South Africa's e-government flagship program. The project uses a portal to deliver government services in the Western Cape Province. With less than 50% of South Africa's households having access to landline, the project faced the challenge of excluding more than half of the target population. It therefore adopted aggressive marketing and awareness campaigns to bring on board the people that risked being excluded. The city of Cape Town, at the same time, launched its own parallel e-government awareness program called the Cape Access Initiative. The initiative supplemented, at grassroots, the government's national campaign aimed at sensitizing citizens about the availability of public information and services online. However, such awareness creation efforts have tended to be hampered by weak coordination, poor strategy development, high staff turnover, and budgetary problems. Even more problematic has been the difficulty of selling information and communication products to marginalized communities facing serious poverty conditions. Such communities would rather receive basic needs to survive instead of a computer or phone. Linking opportunities created by ICT in terms of job creations, job searches and reduction of communication and transportation costs to poverty alleviation will be crucial to positioning ICT as tools for agriculture, rural development, and socioeconomic transformation in SSA.

Phase 5: Achieving the Goal of Developing a "Knowledge Society" in Rural Areas

The ultimate aim of S. Africa and Kenya governments is to provide universal access to ICT to all citizens regardless of race, income, age, gender, educational or geographic location. The latter is particularly important given the digital

Figure 1. E-government evolution in South Africa, 2009



divide problems in SSA attributed to poor rural infrastructure such as lack of electricity grids and telephone towers to support transmission of mobile phone signals. The goal of ubiquitous e-government, which basically means anytime, anywhere access to public e-services will be made easier by investments in mobile phones which relies on wireless and mobile technologies such WIFI and WIMAX.

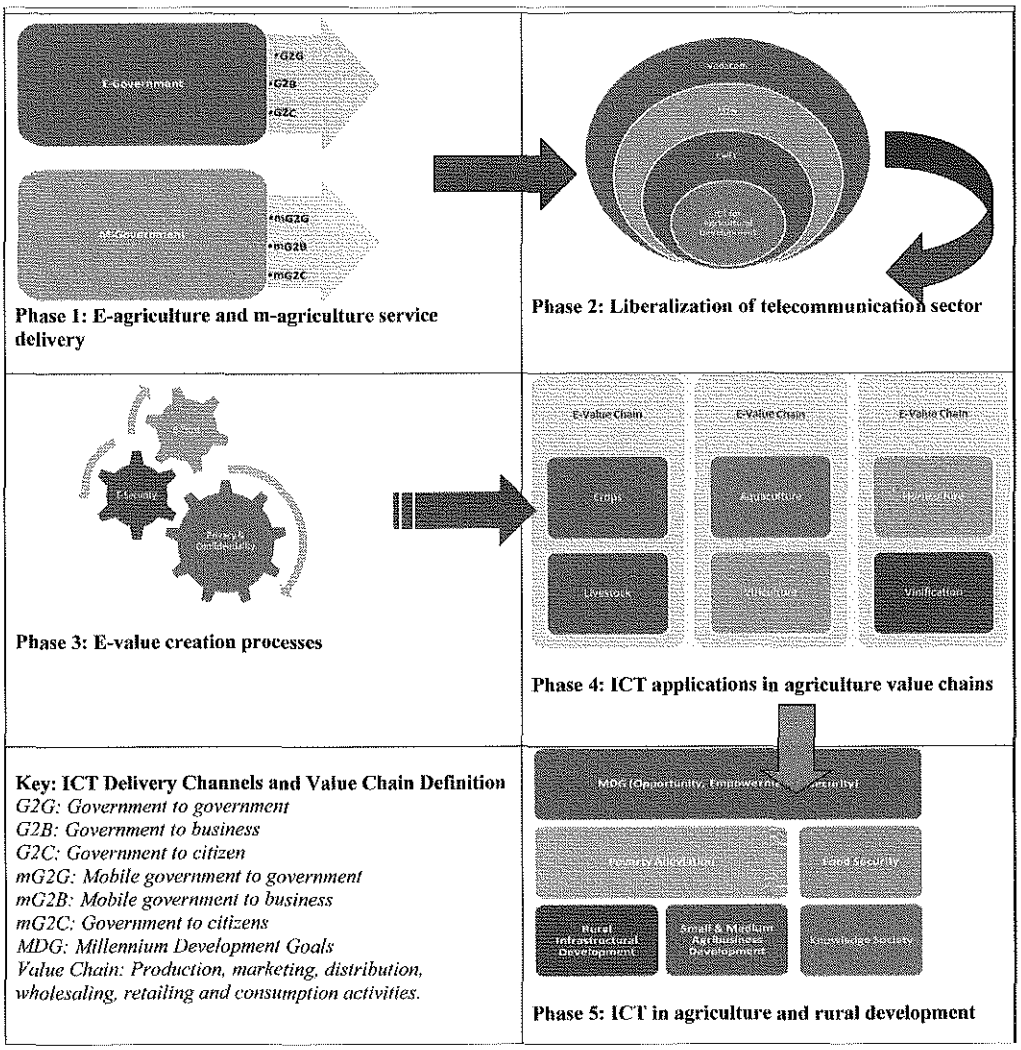
An important aspect of achieving the goal of knowledge society is the issue of e-content development. Content development is both an e-value aspect and a key ingredient in promoting the development of a knowledge society. The population of S. Africa and Kenya is quite diverse and speak different languages. Increasing citizen participation in government debates and promoting universal access to information and services will therefore require e-content that uses languages that are familiar to the majority of the agricultural communities. Open source content offers opportunities to achieve this as it can be adapted to different languages in order to increase citizen participation and build a shared knowledge society. More importantly, tapping into local indigenous knowledge systems within a given rural community will increase ICT usage by making its benefits relevant to the local context. In the long run, on-going NEPAD efforts such as the e-school initiative will be pivotal in empowering local communities in their ability to use ICT-based agricultural and rural development services. The introduction of e-agriculture curriculum into colleges and Universities will provide the necessary foundation for the k-society in South Africa. Figures 1 and 2 summarize these phases and illustrate the inter-linkages that exist between and among the various phases.

As depicted in Figure 2, with empowerment of society, individuals will secure income earning opportunities and thereby lower vulnerability to food insecurity and poverty. Knowledge becomes a key asset in provision of sustainable livelihoods, food security, and rural economic growth and development.

3.0 HISTORY OF ICT INDUSTRY DEVELOPMENT IN S. AFRICA AND KENYA

The use of ICT has brought about tremendous opportunities to improve agriculture and

Figure 2. Phases for e-agriculture development in South Africa, 2009



Phase 1: E-agriculture and m-agriculture service delivery

Phase 2: Liberalization of telecommunication sector

Phase 3: E-value creation processes

Phase 4: ICT applications in agriculture value chains

Key: ICT Delivery Channels and Value Chain Definition
G2G: Government to government
G2B: Government to business
G2C: Government to citizen
mG2G: Mobile government to government
mG2B: Mobile government to business
mG2C: Government to citizens
MDG: Millennium Development Goals
Value Chain: Production, marketing, distribution, wholesaling, retailing and consumption activities.

Phase 5: ICT in agriculture and rural development

standards of living in SSA. The entire SSA population could benefit from increased food and agriculture production, improvements in inventory management, more efficient shipping and distribution networks, better knowledge about the operations of local and global markets, rural employment creation, food security, and rural poverty alleviation (Nyamai-Kisia et al., 2007). As the ICT revolution gains momentum, numerous governments around the world have established e-agriculture and e-government programs and projects. The use of ICT to promote socio-economic development based on the upsurge of e-agriculture led by growing m-government implementation has gained greater momentum especially in SSA. The use of ICT to stimulate food and agricultural production and enhance the efficient operations of domestic, regional and global markets has provided immense opportunities for employment creation, economic growth, creation of new wealth, and poverty reduction in SSA.

Different countries are at different stages of ICT diffusion and adoption within their economies. In SSA, only a few countries stand out as having made major strides in ICT utilization; South Africa and Kenya are among these nations. A number of SSA countries have however adopted a "wait and see attitude". For such countries, there are ample lessons of missed opportunities, trade-offs, risks and challenges that can be drawn from past technological revolutions (Atkins Bowler, 2001). Sharing experiences of successful cases can therefore help countries lagging behind to use best practices to design and benchmark their own programs.

Although Kenya and South Africa rank in the top ten of Africa's competitiveness rankings, they are still grappling with problems of inequalities and poverty as shown by the relatively high gini-coefficients and a large proportion of their society living under the poverty datum line (Table 2). Investments in ICT offer opportunities for employment creation, empowerment, and reduction of some of these economic disparities.

3.1 Global Developments in ICT Industry

A recent study released at the World Information Technology and Services Alliance (WITSA) indicates that the global ICT market was worth approximately $370 billion in 2008 (Digital Planet, 2008). The study further reports that the communications technology sector of the ICT industry continued to dominate ICT spending, comprising more than 57% (or $1.9 trillion) of all ICT spending in 2007. The consumer market comprised nearly 29% of ICT products and services in 2007, with $993.8 billion in spending, while spending by businesses and governments accounted for 71%, or $2.4 trillion. These figures indicate an industry that is on unprecedented growth path, one that will impact the livelihoods of millions around the world, including developing countries who may not necessarily be top spenders on ICT to date.

3.2 The Development of ICT Policy Initiatives in South Africa 2000-2010

The government of South Africa (GSA) is among the few countries in SSA that moved

Table 2. Comparison of key economic indicators in South Africa and Kenya, 2009

Economic Indicator	South Africa	Kenya
Population (million)	49	39
Gross Domestic Product [GDP] (Billion Rands)	282	29.3
IBM/EIU E-readiness 2009 Ranking (out of 70 countries) (Economist Intelligence Unit, 2008)	41	--
Estimated Unemployment (%)	24	40
Human Development Index (HDI)	0.674	0.521
Inflation Rate (%)	8	25
Africa Competiveness Ranking (2009)	2	9
Below Poverty Datum Line (%)	40	50
Global Competitiveness Ranking (2008/09) (Schwab & Porter, 2008)	45	93
Gini-Coefficient	0.58	0.45

swiftly to launch e-government supported by a robust ICT sector. To begin with, the GSA assembled three task forces to spear-head the deployment of ICT as tool for socioeconomic development in South Africa. The first taskforce, the *Presidential International Taskforce on Information Society,* was assigned the responsibility of global ICT markets and initiatives. The second taskforce, *The National Information Technology (IT) Taskforce*, dealt with local and national ICT initiatives. The third taskforce, *The IT Council,* was responsible for provincial and for local government (i.e. municipal) information technology functions (Digital Opportunity Initiative, 2001, p. 13). The formation of specific task forces then led to the development of a number of strategy papers designed to systematically guide the process of e-government policy development in South Africa. Some of the key policy papers developed by the GSA dealt with online teaching and e-learning, (e.g., White Paper on e-Education, 2004), e-business and e-commerce development, (E-Commerce Green Paper, 2001), e-governance and e-service delivery (e.g., Electronic Government, the Digital Future: A Public Service IT Policy Framework, *Batho Pele* White Paper on Transforming Public Service Delivery, 1997), and the liberalization of telecommunication sector (e.g., Telecommunication Liberalization Policy White Paper of 1996, Open Source Software Strategy and Policy, the South African Information Technology Industry Strategy). The "Info 2025 Vision" (i.e. targets building ICT infrastructure) and the "ICT for All Strategy" are considered as the centre-pivot for e-service delivery in South Africa given its segregated past which in turn makes the goal of reaching every citizen by pursing e-inclusion and e-accessibility strategies a top priority.

The various task forces and e-strategy papers were designed to (i) develop a number of ICT policies that would effectively transform the ICT sector, (ii) create a viable environment for ICT diffusion, (iii) use ICT to alleviate poverty and improve the socio-economic conditions of its people, and (iv) reduce the digital divide problem. The ultimate goal was to create conditions that allow for universal access to ICT at affordable rates by all the citizens of South Africa. To date, the GSA has managed to put in place specific policies backed by Acts of Parliament that cover a wide spectrum of issues from information access rights, liberalization of telecommunications, promotion of electronic transactions, information security, and value-based public information and service delivery (see Table 3). South Africa is therefore pursuing an e-government and m-government policy development pathway that is designed to transform the country from an information-based into a knowledge-based society with the ultimate goal of building a value-based knowledge society with universal access for all (Maumbe et al., 2007).

South Africa has three tiers of government namely, national, provincial and municipal. One of the things that is masked by the national policy development process are the various initiatives at the provincial, municipal, and the grassroots level that promote e-government services and ICT deployment generally. The Cape Gateway Project and the Cape Access Project are examples of leading provincial government e-service delivery initiatives. The later is referred to as the *Ikapa Elihlumayo* (meaning The Growing Cape Initiative) which is an integral part of the Provincial Growth and Development Strategy for the Western Cape. The green paper on "Preparing the Western Cape for the Knowledge Economy of the 21st Century" laid the foundation for launching e-government services in the Western Cape Province. The Cape IT Initiative (CITI) is also a key player in the Western Cape ICT sector responsible for marketing and developing new ICT businesses, ICT skills training, and influencing ICT policy discourse (Cape IT Initiative, 2002). At the municipal level, the Smart Cape Initiative drives the e-service delivery frontier. In addition, the GSA established more than 100 community telecentres in all its nine provinces to position ICT-based public information services within the reach of marginalized rural communities (Snyman & Snyman, 2003, p. 96; Esselaar, Gillwald, & Stork, 2006, p. 46). Additional key

Table 3. Chronology of ICT Policy Development in South Africa, 2000-2007

Year: National Government Policy	Policy Description & Focus
2000: Promotion of Access to Information Act	Information access rights, avoid abuse of power and related human rights violations
2002: State Information Technology Agency Amendment Act	Government technology service provision
2002: Electronic Communications Security Private Limited Act	Information security for electronic transactions
2002: Electronic Communications and Transactions Act	Facilitates & regulates e-government, electronic communications, and transactions
2003: World Summit for Information Society	Development of an information society
2004: Telecommunications Act	Facilitates interconnection & facility leasing
2004: Provincial Growth and Development Strategies	The "IKapa Elihlumayo" -The Growing Cape broad-based provincial economic development initiative, e.g., Cape Access Project etc.
2005: Electronic Communications Act	Convergence of broadcasting and communications
2007: Joint Initiative on Priority Skills Acquisition (JIPSA)	Collaborative skills development, by businesses, government and labor organizations in South Africa
2007: Accelerated Shared Growth Initiative for South Africa (ASGISA)	Enhance growth and poverty reduction among the marginalized communities

Source: Adopted from Maumbe et al., *2007*

players involved in providing ICT services to disadvantaged rural communities include Vodacom (i.e. South African cell-phone company) phone shops, Multi-purpose Community Centres (i.e. for community computer use and ICT literacy training), the Universal Service Agency (USA) telecentres, and Public Information Terminals (PIT) in Post Offices across South Africa. All these fore-going initiatives are aimed at providing citizen-centred public information that helps improve the quality of both the day to day decision making process, and standards of living of poor South Africans.

3.3 The Development of ICT Policy in Kenya: 1964 to Date

During much of the colonial era and the early independence years, the ICT industry was dominated by the government. The development of ICT policy in Kenya took a long time due mainly to the lack of political will and leadership and the ineffective coordination between different government departments and agencies with ICT responsibilities.

ICT matters were, during the colonial era, covered under Cable & Wireless Company (CWC) which provided telecommunication services to all British colonies (Tyler et al., 1999). Upon attainment of independence in 1964, the control of these services was taken over by the East African Posts and Telecommunications Corporation (AEP&TC) and the East African External Telecommunications Company Ltd (EXTELCOMS). The former handled domestic and regional calls under the East African Corporation (EAC) while the latter handled the international communications, still under CWC. In 1974, Kenya bought 40% shares owned by CWC and renamed the entity KENEXTEL (Tyler et al., 1999, p. 88). Meanwhile

the EAC collapsed in 1977 causing Kenya to form its own internal communications system known as Kenya Posts & Telecommunications Corporation (KP&TC). KENEXTEL was later (in 1984) merged into KP&TC. The telecommunications system thrived in the post EAC era contrary to expectations. Indeed Kenya, in 1994, became a member of Regional African Satellite Communications Systems Corporation whose goal was to launch a dedicated African satellite system. All these happened under the regulatory environment that was defined under the Communications Act of 1977. This act formed the KP&TC. The telecommunications policy followed the European monopoly policy until the 1980s when a wave of change in favour of competition set in. However, the actual push for liberalization of the industry did not start in earnest until 1991. However, this was followed by a long lull and it is only recently (1997) that the government yielded to pressure for the liberalization of telecommunications industry by publishing the *Telecommunications and Postal Policy Guidelines.* This resulted in the enactment of the Kenya Communications Act of 1998. The Act also established the Communications Commission of Kenya (CCK) which is the industry watchdog.

However, ICT issues continued to be based on various legislations namely *The Science and Technology Act Cap 250 of 1977, The Kenya Broadcasting Corporation Act of 1988* and the *Kenya Communications Act of 1998.* These legislations, however, proved inadequate in dealing with the issues of convergence, e-commerce and e-government. Consequently, a number of civil society organizations (CSOs) and private sector and media groups, in Kenya, maintained the pressure on the government to develop an ICT regulatory framework and policy. The initial focus of the lobby targeted the removal of the monopoly in telecommunications service provision (especially with regard to wireless communications) and the integration of telecommunications into national economic development programming. As a result of these efforts the first draft national ICT policy was released in late 2003, just prior to World Summit on the Information Society (WSIS) in Geneva. The draft did not however reach public domain and may have simply been intended for use by the government at the WSIS.

In 2004, additional impetus for the development ICT policy in Kenya came from Kenya ICT Policy project (KIP) funded by the Canada's International Development Research Centre (IDRC). This was followed by the 2005 ICT Convention organized by a lobby group The Kenya ICT Action. The convention focused on evaluating progress of Kenya's national ICT policy process. Eventually, in January 2006, the government published its ICT policy named the National Information and Communications Technology (ICT) policy.

4.0 ICT APPLICATION IN SUB-SAHARAN AFRICAN AGRICULTURE

ICT development, diffusion and adoption will impact many facets of African agriculture. As ICT utilization becomes widespread, so will be the areas of applications and benefits derived from the technology. The emergence, growth, and maturity of ICT use will depend on several factors including literacy, affordability, policy and relevance of the technology (Okello et al., 2009). Sustainable use of ICT in agriculture will also depend on the relative obsolescence of the new technology, user satisfaction and versatility of the technology. With time, more uses or benefits will be identified. The effective deployment of ICT requires a greater understanding of socioeconomic conditions as well as the political and cultural forces in the target areas (Maumbe et al., 2008; Chapman & Slaymaker, 2002). ICT use in agriculture can drive agricultural rural development programs and projects. It can facilitate information storage capacity, processing power and speed, cataloguing, commodity exchange, networking among farmers, extension agents, policymakers and other stakeholders, and faster communication. Hence effective farmer organization increases bargaining power and representation of group

interests in negotiating favourable terms of trade (Kolhs & Uhl, 2004). Decentralization of information technology systems reduces dependencies, lowers holdup costs, and promotes transparency in governance of the rural markets and economy. New demand for information by rural dwellers arises from changes in market and other institutional arrangements induced by structural adjustment programs and market liberalization policies (Chapman & Slaymaker, 2002).

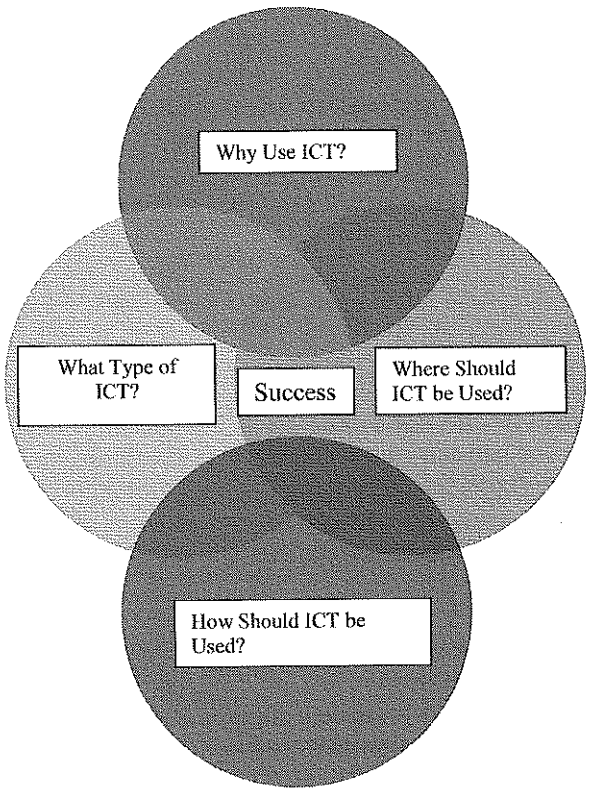
The application of ICT in key agricultural and rural development arena will affect the performance of agricultural value chain, rural employment opportunities, human relations, social capital, collaborations, and community development. A series of transformations in agriculture will be induced by ICT applications across the value chain including; 1) improved management techniques, 2) timeliness in scheduling field operations, 3) better access to both local and regional markets, 4) better market coordination through faster communication, 5) new methods of research and extension service delivery, 6) better diseases and pest surveillance, and 7) participatory policy development. The effect of ICT in Africa cuts across individual and community decision making in areas of food and fibre production, distribution, marketing, research, extension, environment, regulatory policies, e-value creation and sustainable agriculture development.

4.1 Key Considerations for ICT Applications in Sub-Saharan African Agriculture

Although the deployment of ICT in agriculture should not be treated as a separate mission from the rest of the ICT-led economic development agenda, there are unique aspects of agriculture that qualifies it for special attention in order to maximize benefits and enhance opportunities for success. First, agriculture is unique in that it is subject to risk and uncertainty. Second, deployment of agricultural technology in SSA has been characterized by failures such as the green revolution and there is need for caution when considering future technology use in this sector. Third, agricultural communities in SSA and elsewhere are endowed with indigenous knowledge that should be integrated into the design of ICT initiatives for agriculture. Finally, since majority of the farmers are poor, the issue of affordability and e-inclusivity in ICT use is central to its future success and sustainability (Chigona, 2009).

Information is not the same thing as knowledge or data. Providing information that is not usable or one that is irrelevant for decision-making can lower the economic value of ICT adoption. However, providing raw data that can easily be processed into useable information is vital for ICT penetration. Figure 3 identifies some fundamental questions that need to form part of any ICT design and deployment strategy in SSA. Simple questions about what, when, why, where and how of ICT applications in agriculture deserve attention from both the technology supply and demand side. The "what" question deals with the types of ICT tools or communication channels (platforms) and should consider the capacity of the agricultural community in terms of usage and access (i.e., cost). The "when" question addresses the timing of making ICT available and accessible. It especially addresses the issue of the level of commercialization and, hence ICT user's demand for ICT-mediated production or marketing information. The "why" question probes whether or not there is a rational case for ICT deployment. The "where" question addresses the areas, along the food and agriculture value chain, that require/deserve deployment of ICT. Finally, the "how" question deals with the process, procedures and means that are being utilized in ICT application for agricultural development. In order to answer the foregoing fundamental questions, serious considerations ought to be given to the "push" and 'pull' factors such as cost, usability, relevance, literacy level of the targeted users, user satisfaction, and value-addition derived from these modern technologies. In addition, success or otherwise of the application of ICT in agriculture will depend on the infrastructural development, in

Figure 3. Critical questions for ICT deployment in agriculture and rural development, 2009



particular the availability of network and access to electricity hook-ups, of target areas. A critical consideration of these confounding (or external factors), and demand (internal factors) is required in order to realize long-term sustainable ICT-led agricultural development.

The tendency to use ICT for the sake of doing so is overwhelming in the knowledge society, and this fallacy should be avoided if possible (Maumbe et al., 2008). There is evidence that majority of farmers use ICT technologies, especially mobile phones, mainly for social purposes such as contacting friends and family (Okello et al., 2009). Farmers can thus choose to participate in ICT initiative in agriculture merely to get access to the ICT technology which is then used for the unintended purposes. The policymakers in SSA have a responsibility to assess the rationale behind ICT investments and to balance the benefits and costs of such projects. When ICT-based agricultural projects are selected on clear benefit cost analysis basis, resulting information will drive agricultural productivity, promote better access to markets, promote more efficient product distribution, and yield fewer false starts in ICT deployment efforts.

The deployment of appropriate and relevant ICT application in agriculture is critical to its successful uptake by rural communities in SSA. It is common knowledge that most technologies that work in developed countries do not necessarily work or succeed at the same rate when deployed in SSA or in other developing countries. The availability of different ICT creates opportunities for farmers in different

agro-ecological zones and facing different socio-economic circumstances to select ICT that are appropriate to their ecological and economic situations. Technologies that are suitable for dry-land sedentary farmers may be unsuitable for fishermen or nomadic pastoralists. The question of making the *right ICT* available to the *right farmers* at the *right time* is paramount. A crucial ingredient for success is the identification of the most appropriate use for ICT in agriculture. It is possible that ICT can easily find more than one use in agricultural production system. The question becomes whether or not the identified use is the most profitable use that the technology can be applied to. Asking this question during the design process is vital because it will help maximize the profitable opportunities derived from ICT applications in various agricultural enterprises. It is therefore unreasonable to assume that effectiveness of ICT use in crop production is the same as in marketing or livestock production management. Applications along different stages of the agricultural value chain are bound to generate different payoffs to farmers.

Understanding the conditions under which ICT are being deployed is also paramount. The rationale for ICT use in agriculture may be unquestionable, its use may be suitable to the farming system, its application may be the most profitable route, but it may fail simply because conditioning factors such as literacy, service providers, language or content issues have not been addressed. Paying close attention to the penetration strategies adopted and the timing of ICT deployment are critical because it makes the technology not only relevant, but appropriate to the socioeconomic, competency levels, cultural and other factors that may be unique to the African farmers. Ignoring some of these cultural factors may inhibit the uptake of certain technology. This can especially be the case when there is poor targeting of members within the household with the technology. Poor targeting can occur when an ICT technology for use in crop marketing targets men when, in fact, the activity is usually undertaken by female household members. Understanding the conditions that make it possible for farmers to utilize technology is as equally important as identifying the problem and whether or not ICT will make a difference, selecting the right technology, and deploying it in the right enterprise. The question of selecting the right ICT, for the right conditions, for the right farmer and the right purpose is extremely important for sustainability and success.

The other key factors for consideration in the use of ICT in agriculture in SSA involve the degree and depth of ICT infrastructural development, the relative willingness of farmers to adopt the new technologies to aid their decision making, satisfaction derived from adopting the technologies and the affordability of these technologies among others. African agriculture has tended to be very risky, being characterised by rational but resource-poor smallholder farmers, and therefore requires extreme caution and better understanding of the conditions prior to introducing the technologies. Nonetheless, Africa has an advantage in that it is leading developing countries in the uptake of mobile technology that are most amenable for use in agriculture and rural development. Hence successful application of mobile phone in agriculture and rural development is highly likely. The same cannot, however, be said for computers as the cost makes it extremely difficult for majority farmers to afford.

5.0. APPLICATION OF ICT IN AGRICULTURE: REVIEW OF CASES

In this section, we highlight some of the cases of application of ICT in agriculture. Similar case studies have been reported in a number of African and Asian countries demonstrating the importance of ICT penetration in these regions of the world and the opportunities for poverty alleviation that they present.

5.1. Evidence of ICT Use in South Africa and Kenya's Agriculture

South Africa and Kenya has witnessed a surge in the number of ICT applications in agricultural sector over the past decade. For instance the number of ICT applications focusing on agriculture in Kenya was 37 in 2008. This increased use of ICT in S African and Kenyan agriculture and rural development sector has been driven by both public and private sector investments in ICT. To date ICT applications are found in almost every stage of the agricultural value chain in S. Africa and their usage in Kenyan agriculture is expanding. ICT applications are being used to perform various functions in input procurement, production, processing, distribution, and marketing of the agricultural produce. Investments in rural infrastructure (e.g. telecenters, multi-purpose community centres, information kiosks, phone shops, information bulletin boards, etc) to support the deployment of ICT has also led to new job opportunities, computer literacy training programs for the community, and the revitalization of agro-based rural economy (Munyua, 2000). Communities in remote rural small towns are experiencing revitalization of their rural economy through ICT applications in agriculture. The resulting multiplier effects from ICT investments and widespread ICT adoption is expected to stimulate economic growth especially during the current global recession.

The technologies that are currently driving ICT applications in South African and Kenyan agricultural sector are computers, email, Internet, mobile phones, personal digital assistants, telephones, and faxes (TemBo & Maumbe, 2009). These ICT technologies are being used to collect, record, analyze, and disseminate agricultural information necessary to control, monitor, evaluate and implement managerial decisions in agricultural production, distribution and marketing. Examples of the main sub-sectors that have made huge strides are wine production and marketing industry, fruits and vegetable industry, rural mobile banking, managing food banks, fast food industry, contracting with supermarkets (such as ShopRite, Pick 'n Pay, Uchumi, and Woolworth) and agri-tourism. In the following section we describe some of the specific ICT uses in South Africa and Kenya. In depth analysis of the application of ICT in agriculture is presented elsewhere in this volume by De Silva and Okello et al.

ICT Application in Precision Farming

A growing area of ICT applications lies in arable crop production or precision farming. In precision farming, crop production is managed using site specific information-based technologies. It identifies analyses and manages site-specific spatial and temporal soil variability within a field for optimum yield, profitability, sustainability and protection of the environment (Rilwan and Ikhuoria, 2006). It uses sensors, digital application controllers, communication links, global positioning systems, computers and innovative software solutions to automatically match agricultural inputs and practices to variable local conditions. Technologies used in precision farming allow farmers to vary inputs, such as fertilizers, pesticides and seeding rates throughout fields based on management zones. Automatic guidance systems assist equipment operators in running equipment in the fields (Adrian et al, 2005). The benefits of precision agriculture include (i) reduction in crop production costs, (ii) reduction in the environmental risks from uncontrolled agrochemical uses, (iii) use of more accurate information in managing inputs and soil conditions, (iv) improved environmental stewardship and (v) significant improvement in agricultural yields (Covey, 1999).

ICT Application in Irrigated Crop Production

A growing area of ICT application in crop production is computerised monitoring and controlling of irrigation systems (Miranda et al., 2005). Computerized irrigation uses a network of sensors that are laid underneath the soil in the irrigated fields with radio links to a central processor. The central processor automatically allocates water to each field based on the needs of the crop in each field. The application of

ICT in semi-arid crop production has led to improvements in water use efficiency in irrigation by a margin of up to 50%, increased per unit yields, and expansion of planted acreage harvested (Sne, 2005, p. 9). In South Africa computerized irrigation system is being used in the mango and tomato farming areas in Mpumalanga Province (Tembo & Maumbe, 2009). Similarly, the major flower and fresh vegetable exporters in the Rift Valley and Central Kenya (including Home-grown, Vegpro and Sian) use sophisticated computerized irrigation systems. The farmers installed a computerised private irrigation network that also uses short message system (SMS) to notify the operators of water pressures that are too high or low (Information for Development, 2005, p. 23)

Supply Chain Product Traceability

A number of established tracing and tracking technologies are in use in the meat industry (Mousavi & Sarhadi, 2002, p. 10), dairy industry (Gygax et al., 2007, p. 25), horticulture industry and food supply chain (Kelepouris et al., 2007, p. 183) in the two countries. Product traceability uses bar codes, voice recognition systems, radio frequency tags and transponders. Modern computers and electronic devices are also being used in computerized animal feeding, tracking systems, reproduction and disease control. Traceability comes in two forms, depending on the direction in which information is moving in the chain. *Backward traceability* or tracing is the ability, at every point of the supply chain, to find the origin and characteristics of a product from one or several given criteria. *Forward traceability* or tracking is the ability, at every point of the supply chain to find the locality of products from one or several given criteria (Kelepouris et al., 2007). In order to comply with the new regulatory requirements and procedures of the European Union (EU) and the concern for food safety, it is mandatory that all agricultural products entering the EU should be tracked back to the farm of origin (ICT Update, 2006b).

Global Agricultural Export Marketing

Fruit farmers in the Western Cape (S. Africa) and fresh vegetable farmers in central and eastern Kenya who are selling their produce to Tesco, Sainsbury's, Waitrose, and Mark & Spencer supermarkets in the United Kingdom (UK) are required to use traceability systems for their fruits and vegetables to be accepted in Europe. According to the South African wine industry, all wine exported to EU requires that that each player in the supply chain is able to identify any person or business dealt with one step forward and one step back along the supply chain (Matthee, 2004). In Fort Beaufort in the Eastern Cape Province, citrus farmers use computerised bar code system to track each farmer's produce in the supply chain back to the orchard where the fruit was picked. The same process is used to trace supply sources by major horticultural exporters in Kenya. Some of the advantages of traceability include (i) assurance of compliance with regulatory or industry requirements, (ii) enhance effective quality management, food safety and support and (iii) improved supply chain efficiency and trading partner collaboration.

Computerized National Livestock Database Management System

ICT has become an integral part of South Africa's Agricultural Research Council Animal Improvement Institute (ARC-AII)'s activities and the national livestock sector as a whole. Many commercial farmers use a personal computer-based recording and management system that monitors farm business performance and helps with diagnostics of farm level problems. South Africa uses a centralized Integrated Registration and Genetic Information System (INTERGIS) for livestock production and management which helps in determining livestock productivity benchmarks, and provides key decision making information to both the farmers and the policy makers.

Table 4. Potential ICT applications in agriculture and rural development, 2009

ICT Application in Agriculture	ICT Application in Agriculture
Production and Inventory Management • *Input procurement* • *Record keeping & management* • *Production scheduling* • *Inventory management systems* • *Product storage management* • *Computerised irrigation* • *Weather reporting*	**Market Access and Development** • *Input marketing services* • *Product shipping & distribution* • *Electronic marketing services* • *Vertical market integration* • *Horizontal market integration* • *Value chain coordination*
Research and Development • *Information storage and retrieval* • *Information dissemination and sharing* • *Real-time information acquisition* • *Extension advisory services* • *Agro-portal*	**Development of Financial Services** • *Rural financial remittances* • *Account balance management* • *Inter-account transfers* • *ATM Credit and debit cards* • *Rural mobile banking* • *E-taxation*
Development of New Innovations • *E-value creation* • *Best practices benchmarking* • *E-trust, ethics and standards* • *E-infrastructure* • *E-security*	**Agricultural Policy Development** • *Production e-policies and e-strategies* • *Marketing e-policies and e-strategies* • *ICT policies and strategies* • *Regulatory policies* • *e-petitions and e-strategies*
Human Capital Development • *ICT Literacy* • *Social capital building* • *Social networks, facebook, myspace, etc* • *E-collaboration, SMS, MMS Skype, teleconferencing etc.*	**Retailing and Wholesaling** • *e-supply chain coordination* • *e-ordering* • *Product identity preservation* • *e-Tagging of livestock* • *E-packaging*

ICT Applications in the Fast Food Industry in South Africa

The fast food industry offers tremendous opportunities for e-commerce adoption. South Africa has a vibrant fast food industry. Most of these fast foods operate as franchises and have recently expanded their base to Kenya. Examples of S. African fast food companies currently operating in Kenya include Nandos, Galitos and Steers. The product shipments from various producers are managed through centralized wholesalers. The procurement of food products and beverages at various fast food outlets across the country from geographically dispersed suppliers is conducted by using e-commerce. E-procurement of supplies is done using e-mail, faxes, mobile phones to track delivery trucks and computer based data interchanges help maintain the rapid pace of product flows that underpin this industry. Table 4 provides a summary of the numerous innovative ways in which ICT are being applied in agriculture and development and other areas.

ICT Applications in Mobile Banking Services in South Africa and Kenya

The development of Wizzit, M-PESA and ZAP mobile banking services has enabled some rural farmers and farm workers in South Africa and Kenya to access banking services for the first time. In South Africa, rural communities form the majority of the previously excluded and marginalized people or so called "under-banked" segment of the society. Mobile banking has provided diverse financial services such as checking bank balances, bank transfers, and mobile payments, among others, to this segment

of the society. Currently the mobile banking market in S. Africa comprises of MTN-Banking a joint venture with Standard Bank and Wizzit which is an independent initiative. In Kenya, Safaricom and Zain provide the M-PESA and ZAP mobile banking services respectively. MTN has teamed up with Fundamo, a specialized mobile banking and payment software solution to provide its "mobile-money" services. Fundamo's Mobile Wallet solution has a subscriber base in more than 20 countries in SSA and Middle East region. Mobile banking services have introduced immense opportunities for inexpensive transfer of funds to family members in rural areas without incurring any transportation costs. How much of the money being transferred using these mobile banking services get used in agriculture is however unknown. For some farmers, the launch of the mobile banking services has eliminated long lines in banking halls thereby increasing time available to work in fields.

5.2 Future ICT Prospects in Promoting Agricultural Development in Sub-Saharan Africa

The general optimism associated with ICT applications in improving food security and access to agricultural services is not shared by pessimists. The later believe that ICT will further create disparities between the "information rich" and "information poor". The optimist believe that, ICT will "leap-frog" agricultural development in SSA, and in the long-run, lead to greater commercialization of smallholder agriculture as the ICT technologies become cheaper, more accessible and useable by majority poor farmers, thereby closing the digital divide. ICT uses multiple devices (i.e. technology platforms) and multiple media (i.e. delivery channels) hence have the potential for wider outreach than past and current methods of communicating agricultural information to farming communities. Given that agriculture is the engine of economic growth and development in SSA, improved performance of agricultural sector brought about by ICT use in the sector will therefore contribute significantly towards enhancing the living standards of the majority people.

The globalization process and the resulting interconnectedness of the world economies will also benefit significantly from ICT use in agriculture. ICT applications in agriculture and other economic sectors will influence success of both regional and global economic integration of SSA economies. Successful deployment of ICT in agricultural sector in SSA is likely to stimulate growth in productivity of the trading countries as it reduces the cost of doing business. The improvement in productivity will on the other hand spur growth at the micro and meso levels. It is also likely to provide additional benefits to agricultural communities through empowerment, security, and new opportunities for distant trade (Aker, 2007). ICT use among and by rural communities can therefore alleviate poverty and spur economic development (Kenny et al., 2000).

Long term success of the deployment of ICT in agriculture will emerge from clear understanding of how the new ICT work, which requires improvements in functional literacy, and the socio-economic conditions under which the ICT will be deployed. It is expected that socio-economic and cultural conditions will vary from country to country and among communities (Klass & Maumbe, 2009; Shivute, 2007). Therefore understanding the ICT-based knowledge users (including the poorest groups in the agricultural communities), the socio-economic conditions and their knowledge requirements is paramount to the long-term success of ICT use in agriculture (Chapman & Slaymaker, 2002). Further, while ICT has overcome the challenge of distance, it is unclear if it will also transcend cultural and language barriers especially in and among non-English speaking rural communities characterized by multiplicity of languages. Clearly, the potential of ICT to spur pro-poor agricultural development will be determined by, among others, its ability to resolve long-standing rural information availability and access constraints unique

to smallholder farmers and the extent to which it is able to integrate farmers into the agricultural value chains. It will also depend on the degree to which it informs and strengthens the decision-making capacity of the rural (poor) farmers and institutions that represent them. As ICT act as catalyst for greater information flows, exchange and sharing among such farmers, market access will be improved, productivity growth spurred, and livelihoods improved.

The slow pace of liberalizing telecommunication in most SSA countries is likely to affect the progress and potential of ICT utilization in agriculture and other sectors. The slow reform of the legal and regulatory framework will therefore delay the bridging up of the digital divide, resulting in information poverty for some segments of society. Deeper reforms that unleash the private sector investment in telecommunications is one of the best strategies to harness the full potential of ICT (Chapman & Slaymaker, 2002) in SSA. Aligning ICT to rural development priorities, especially agricultural development, and user preferences will be pivotal to its sustainable use in SSA.

6.0 CONCLUSION

This paper examines ICT deployment in SSA in the context of South Africa and Kenya. The two countries present interesting cases to study because of a number of reasons. First South Africa with a long history of segregation attributed to apartheid still faces huge service delivery challenges more than a decade after independence in 1994. Second, Kenya is a typical African country which confronts huge political and economic challenges with major implications for public service delivery. Third, both countries are struggling with public sector corruption and bureaucracy, digital divide, poverty, and yet they possess immense economic potential and a capital-endowed and skilled private sector that can easily be unleashed by effective deployment of ICT in agriculture and rural development.

The paper presents a framework of evolution of ICT application in agriculture and rural development in the broader context of e-governance. The framework posits that full deployment of ICT in agriculture and rural development will be a culmination of several phases of changes that starts with e-government policy development. The paper then argues that ICT use in agriculture and rural development is a powerful instrument for improving agricultural and rural development and standards of living throughout SSA. With effective deployment of ICT, rural communities are likely to benefit from improved food production capacity, better access to markets, elimination of information asymmetries, employment creation, and enhanced communication capabilities among other socio-economic opportunities. In reality, the ICT revolution has ushered in a new agricultural and rural development paradigm, and more modern ways of conducting agricultural business even among the most remote rural villages in SSA. Although Kenya and South Africa are relatively affluent countries with relatively stronger ICT infrastructure, majority of African nations face major challenges in ICT use and most rural communities are long ways off from being fully integrated in the global information and knowledge societies.

As a signatory to the World Summit on Information Society (WSIS) Plan of Action, South Africa and Kenya are set to expand their use of ICT for agriculture and rural development. Already, ICT has been successfully deployed in wine production and marketing, fast food industry, export horticulture sector, irrigation, food banks, e-filling of taxes by farmers, among others. In Kenya, ICT are being used in improving market linkages for rural farmers, fishermen, and nomadic livestock herder (the Maasai). The fruit and vegetable marketing is key beneficiary as ICT has brought about increased efficiency in managing the cold chain linking farmers, Nairobi airport terminal, and supermarkets in Europe.

Several constraints will have to be overcome by both providers and users of ICT in agricultural development in order to exploit the

full potential of ICT. Some of the constraints that are common to Kenya and South and Africa include, on the technology supply side, (i) dilapidated rural infrastructure (ii) development of locally and culturally relevant e-agriculture content (iii) policy and institutional development to support the widespread use of ICT by rural communities. On the other hand, ICT applications in agriculture are relatively new and key constraints for potential users include (i) lack of awareness (ii) low literacy and (iii) infrastructure deficiencies e.g. lack of electricity to charge electronic gadgets (iv) language and cultural barriers in ICT usage, (v) negative image problem and lack of trust in the government due to years of poor service delivery and (vi) low e-inclusivity and the need to cater for the special needs of some users (e.g., disabled, old people, and the marginalized poor people who live in informal settlements) .

South Africa's *Batho Pele* principle which is based on the notion of *ubuntu* (meaning putting people first in public service delivery) provides a useful example to emulate in designing effective ICT applications for agriculture. The principle of *ubuntu* captures the government's desire to build a citizen-centered information society initially and ultimately a knowledge society. The values of *ubuntu*, e-trust, e-security are all aimed at developing a value-based knowledge society in South Africa. These values are applicable in Kenya and the rest of SSA. ICT deployment in agriculture is therefore bound to be successful if farmers can be made to feel that their values are respected and indigenous knowledge is not despised but rather incorporated in the design of the ICT interventions.

Although the path to full exploitation of the benefits ICT application in agriculture and rural development is fraught with major challenges and barriers, understanding what technologies are appropriate for SSA farmers and agricultural communities, how and why they should be deployed, and making them affordable, reliable, and relevant to socio-economic context will make a huge difference between future success and failure. Demand-driven approaches that encourage the integration of indigenous knowledge, use of local languages, growth in ICT functional literacy coupled with policy makers dedicated to improving competitiveness of ICT providers, and the promotion of public investments in broadband infrastructure will result in sustainable ICT use in agriculture. Demand and market-driven exploitation of ICT application such as the cases highlighted in the paper (e.g., precision agriculture, traceability, mobile banking, etc.) is likely to continue to drive development and deployment of ICT applications in both the commercial and smallholder African agriculture sectors in the future.

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Using ICT to Integrate Smallholder Farmers into Agricultural Value Chain:
The Case of DrumNet Project in Kenya

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ABSTRACT

This article examines an ICT-based intervention (known as the DrumNet project) that has succeeded in integrating smallholder-resource and poor farmers into a higher value agricultural chain. The article assesses the design of the project, and how it resolves the smallholder farmers' idiosyncratic market failures and examines member-farmers' marketing margins. The article finds that the design of the DrumNet project resolves smallholder farmers' credit, insurance and information market failures and enables them to overcome organizational failure. The article concludes that successful ICT-based interventions for integrating farmers into higher value agricultural value chains require an integrated approach to tackling smallholder farmers' constraints. The findings have implications for the design of future ICT-based interventions in agriculture.

Keywords: *Agricultural Value Chain Integration, Idiosyncratic Market Failure, Kenya, Project Design, Smallholder Farmers, Sunflower Production*

1. INTRODUCTION

Linking smallholder farmers to markets remains a major challenge in Africa and is associated with the lack of smallholder commercialization in the continent (Poulton et al., 2005; Barrett, 2008). A number of factors contribute to this problem. First, smallholder farmers are usually price-takers and deal with traders who often are more informed about input and output markets. Second, majority of smallholders lack the information on quality and quantity parameters used by traders in the selling process. Lack of information prevents farmers from adopting profitable production alternatives and also keeps them supplying low-paying marketing outlets (Ashraf et al., 2009). Third, seasonal variations in prices often expose smallholder

DOI: 10.4018/jictrd.2010010102

farmers to greater price risks than the larger farmers, causing the former to dispose of their produce soon after harvest. Fourth, smallholder farmers trade in small village markets with long and fragmented value chains.

In addition to the above market-based (incentive) factors, smallholder farmers also encounter a number of capacity-based constraints. The majority of smallholder farmers are asset-poor (Barrett, 2008). They lack financial capital needed to acquire the inputs required to commercialize production, the human skills (capital) needed to function in better-paying but competitive markets and the social capital that is instrumental in organizing production (Doward et al., 2003). In addition, smallholder farmers often face poor infrastructure in the form of roads, telecommunication and electricity that impede their market access. Further, smallholder farmers, given their geographical dispersion tend to be characterized by organizational failure (Rich & Narrod, 2005). That is, majority of smallholder farmers are often unable to mobilize themselves into farmer organizations and take advantage of benefits of collective marketing such as economies of scale and collective bargaining power.

Information and asset poverty make the cost of doing business (i.e., transaction costs) unaffordable to majority of smallholder farmers (Shiferaw et al., 2007). Consequently, such farmers prefer selling their produce in nearby village markets or at the farm rather than travelling to the market where they could get better prices (Fafchamps & Hill, 2005). Such village markets however tend to offer low prices and are characterized by significant price variation (Aker, 2008).

For many African countries, commercializing smallholder agriculture provides the only engine for agrarian and rural development. However, commercializing the smallscale farm sector requires efficient markets which in turn require access to market information, transparent and profitable pricing system, and capital (especially credit and better production practices). Where market information is not readily available and accessible, opportunistic behavior (by traders and other market actors) tends to develop. One such behavior is the cheating on quality and quantity (especially scale) which in turn results into the failure of traders to establish long-term business relations in Africa (Fafchamps & Gabre-Madhin, 2006). Due to the opportunistic behavior between buyers (traders) and sellers (farmers), transactions tend to be relational (i.e., selling only to those previously known and hence trusted), are in small volumes and are based on visual inspection. The tendency for transactions to involve visual inspection precludes long distance, non-personal transactions and typically increases the cost of trade (since actors must travel long distances to verify quality of traded commodity during the buying process). It also retards expansion of trade between regional and distant market actors.

The above imperfections in the markets for smallholder farmers have led to a search for alternative models of integrating such farmers into better paying commodity value chains. Such models attempt to resolve some of the farmer-specific (idiosyncratic) constraints that impede smallholder farmers' access to production technology, market information and better paying markets. The search for better ways of linking farmers to markets in order to promote smallholder commercialization has given rise to a number of NGO or donor funded projects and programs. Notable examples include projects/programs that: mobilize farmers into producer organization to enable them achieve economies of scale (Wambugu, 2008); provide market access by facilitating linkages with buyers; provide technical (production) and market information; and those that provide a combination of these services.

In recent years, some of the projects/programs intended to promote commercialization of smallholder agriculture have included ICT components in their activities. Examples include the use of mobile phones to transmit real time price information to farmers, the use of computer/electronic screens to display market information (Okello et al., 2009), and the use of radio and TV to disseminate market information

(de Silva, 2008; Jensen, 2007). A recent survey of the literature on the application of ICT in agriculture found 34 agricultural projects with ICT components in Kenya alone (Munyua, 2007). The major goal of the majority of these ICT-based projects is to integrate farmers into the market in order to promote their transition from subsistence to commercial agriculture. Have these ICT-based projects been able to integrate smallholder farmers into the agricultural value chains? If so, with what outcomes? This article attempts to address these questions by examining one such project in Kenya. It uses the project to assess:

i. The design of a successful ICT-based projects (and small farmer constraints they target)
ii. The effect of such projects on smallholder farmers' marketing margins

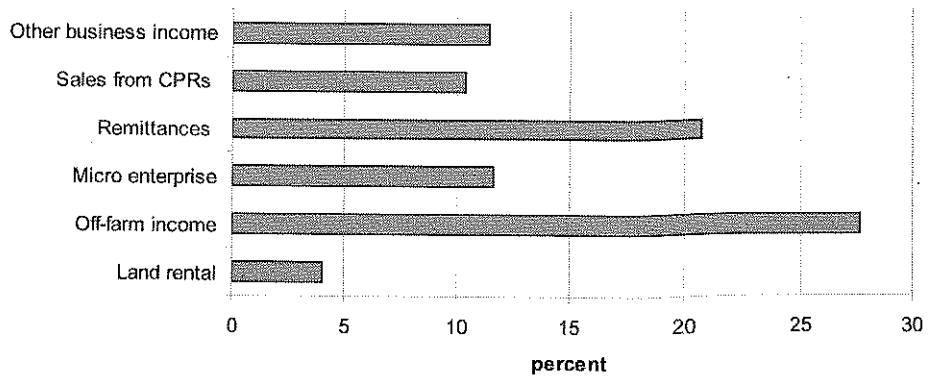
The article focuses on an integrated project known as DrumNet implemented by Pride Africa, an NGO, funded by the Canadian International Development Research Center (IDRC). The DrumNet project sought to resolve some of the idiosyncratic market failures that smallholder farmers face in the production and marketing of higher value crops using mobile phone-based platform. The project was located in western province of Kenya and targeted the commercialization of smallholder production of sunflowers, a major oil crop in Kenya. At the time of implementation most smallholder farmers in the province had abandoned the production of sunflowers due to poor access to inputs and lack of market for output. The rest of this article is organized as follows. Section 2 presents the study context while Section 3 discusses the conceptual framework. Section 4 presents the DrumNet project design and discusses the smallholder constraints it has resolved. Section 5 presents the effect of the DrumNet project on farmer's margins. Section 6 concludes.

2. THE STUDY CONTEXT

Western province is one of the major producers of sunflowers in Kenya. However, the area is characterized by high population that has reduced farm sizes significantly. The average farm size of smallholder farmers in the province is 1.4 acres (Dose, 2007; Okello et al., 2009). The major cash grown by both small and large scale farmers is sugarcane. However several food crops (maize, beans, cassava, peanuts, sweet potatoes and vegetables) are also grown.

Farming is the main occupation in the province and major source of income. However, farmers earn income from a variety of other sources (Figure 1). The other sources of

Figure 1. Major non farm sources of income in western Kenya, 2009 (Source: Okello, 2009)



income include off-farm small business and remittances from family members living away from home.

Majority of smallholder farmers practice semi-subsistence agriculture, characterized by production of small surpluses for sale to meet petty cash needs. All households produce most of their food needs and only use markets to supplement shortfalls in household food needs. Consequently, land is allocated to the production of cash crops, such as sunflower, only when the household feels that it has planted sufficient amount of food crops.

Smallholders farmers typically sell their produce in small village markets that take place once a week. The markets trade in small volumes usually ranging between 2kg – 10kg, in case of maize— a major food staple. Transactions in these markets are personalized. Most buyers physically inspect the produce when buying because there are no well-defined quality grades and standards in such markets. This system of exchange characterizes transactions involving the sale of cash crops such as sunflower and groundnuts in the province. The trade in small volumes in these village markets has given rise to thriving business for intermediaries. The rural assemblers (usually referred to as village broker) collect and bulk produce from smallholder farmers and sell to rural brokers based at the markets who then sell on to urban brokers. The urban broker trades in truck loads of 3-7 tons. They sell to urban traders who could be urban wholesaler or retailer. Thus the chain tends to be long and is often fragmented.

Most farmers in the province know and have grown sunflowers before. However, majority abandoned sunflower production due to lack of reliable market. Past attempts by cooking-oil refiners to develop the sunflower industry in the province have often failed leaving smallholder farmers discouraged. Therefore sunflower is grown much as a hobby by the smallholder farmers who harvest and sell small volumes. The farmers sell to rural assemblers who in turn sell to larger (urban-type) brokers. The larger brokers sell directly to a cooking-oil refiner or sometimes to agents who eventually sell to the refiner.

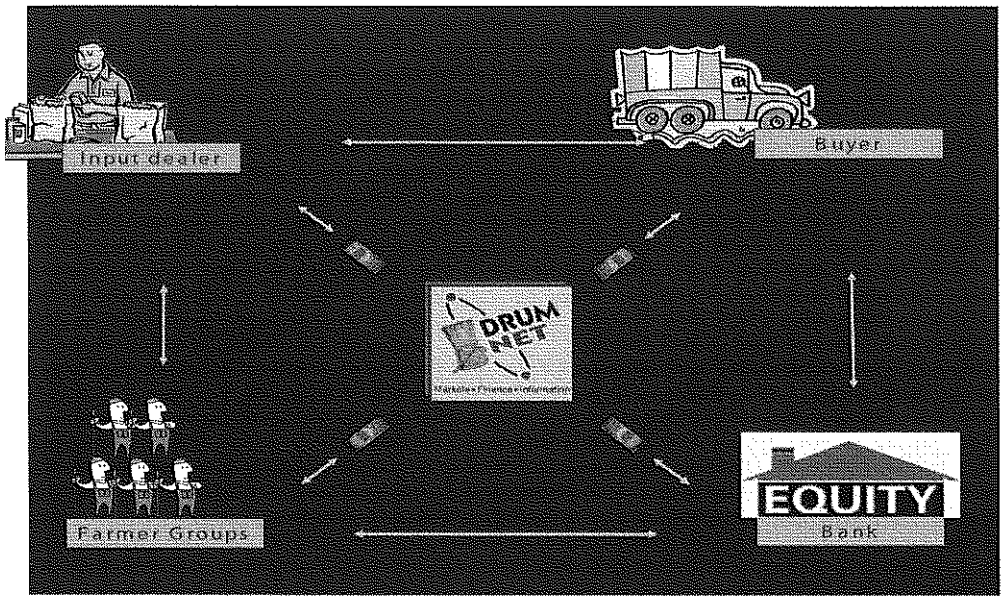
Apart from the difficulties of selling their sunflowers, smallholder farmers also face difficulties accessing inputs and the appropriate technical information needed to meet the quality specifications of buyers. Getting good quality seed on time for planting is usually a problem causing many farmers to use saved seed (i.e., seed selected from previous harvest). At the same time, majority of the farmers lack the information on the right field and post-harvest practices needed to realize the weight, oil content and size required by the refiners. In other areas, where soils are poor, farmers continue to grow crops without fertilizer because they cannot afford the cost of fertilizer or access the credit from the formal lenders.

The goal of the DrumNet project was to resolve these problems by shortening sunflower value chain. It specifically aimed at providing "one-stop shop" where farmers and oil refiner(s) can transact the selling business while also intermediating the access by smallholder farmers to technical information and financial services using an ICT (mobile phone)-based platform. It essentially connected the smallholder farmers with the various actors in the value chain (namely the service providers and buyers) thus forging a network of linkages (partnerships) that integrated the smallholder farmers into the sunflower value chain (see Figure 2). As shown, mobile phones played a crucial role in networking the partners under the DrumNet project. How did the project effect the linkages and with what outcome? Before we address this question, we present the conceptual framework with which we analyze the DrumNet case.

3. CONCEPTUAL FRAMEWORK

This article draws from the value chain analysis and the new institutional economics theory to examine the role of ICT in integrating smallholder farmers into the commodity value chains. The value chain analysis addresses the issue of who controls the commodity trade,

Figure 2. DrumNet's network of linkages



how they do so and with what consequences (for a comprehensive discussion see Gereffi, 1994, 1999; Daviron & Gibbon, 2002). The institutional economics theory differentiates between spot- and contract-based market transactions and non-market based transactions (e.g. hierarchies and vertical integration) that are used by exchange parties to minimize the costs of exchange.

Gereffi (1994, 1999) distinguishes between buyer-driven and producer-driven supply chains. In a producer-driven supply chain, the producer makes decisions on what to produce, how much to produce, and how to produce it. In contrast, the buyer-driven chain is governed by the needs of the buyers and retailers. In such cases, buyers and retailers not only wield considerable influence on the chain, but also develop their own brands with the aim of competing with others (Reardon & Farina, 2002). At the same time, retailers develop sophisticated logistical systems for sourcing produce from various suppliers. Due to the immense influence of the downstream actors (i.e., buyers and retailers) on the chain, the producer is often reduced to a price-taker (Reardon & Farina, 2002). This would especially be the case where producers are small and numerous, and lack the ability to organize themselves into a collective voice as commonly occurs among smallholder farmers (including sunflower growers) in Kenya.

Dolan and Humphrey (2002) identify a number of ways that downstream chain actors can influence the value chain, including requiring: 1) that the products be customized to meet their specified parameters; and 2) various grades of a given product. The product parameters often sought by such actors may depend on physical or credence attributes. In the former, the parameters include size, shape, spotlessness, and color. In the latter, the attributes are not detectable visually and include taste, safety, and other invisible attributes such as chemical content. In the case of oil crops such as sunflower, the credence attributes often sought after by the buyers is the oil content.

Three factors help entrench buyer control of the chain, especially in developing countries (Dolan & Humphrey, 2005). First, the buyer may be forced to control the production process

to align production parameters to its demands (which reflect consumer requirements). Second, a buyer may have a better understanding of the market than the producer. The buyer then interprets the needs of the market and informs the producer what is required. In both cases, the buyer develops the parameters (production protocols, grades and/or standards) to be followed by the producer. Third, it may be necessary for the buyer to enact logistical parameters or modify existing logistical arrangements to facilitate delivery of products with the specified parameters. In most developing countries (and especially in Kenya), a buyer's specification of production parameters is driven by three factors: i) lack of existing suitable standard for governing/regulating particular process parameters (Reardon & Farina, 2002); ii) the buyer's regard of the existing standard as being insufficiently credible; and iii) the buyer's deliberate design of a standard that differentiates its brand from that of competitors. All these three factors come to play in Kenya's sunflower industry.

Specification of production and logistical parameters may reduce the buyer's transaction costs, but requires additional coordination of such activities (Fulponi, 2005). The value chain literature identifies two types of strategies used for coordinating transactions, namely vertical integration and vertical disintegration (Sturgeon, 2001). Vertical integration entails bringing activities at various levels of the marketing system under the control of a single body, and may require (for example) the merging of production and processing. This single body could be an intermediary (such as DrumNet) or final user such as a processor in the case of oil crops. Vertical disintegration is the formation of relationships that are geared at meeting market requirements through the activity of independent firms. In both cases, the chain actor (intermediary or processor) may choose to work through networks of inter-relationships, often through the use of producer organizations (Wambugu, 2008).

Dolan and Humphrey (2002) discuss two types of global commodity chain networks: 1) those that bring together firms with different competencies (traditionally called "networks"), and 2) those that bring together firms showing a marked asymmetry in competence and power, wherein a lead firm specifies what is produced, how it is produced and provides the necessary monitoring (called a "quasi-hierarchy"). The nature of the product and its market determines the type of coordination necessary for delivering produce meeting the buyer's specifications. The nature of the network coordination, on the other hand, affects the type of supply chain chosen by the producer, which in turn affects the nature and extent of adjustments (investments) the producer must make to meet buyer requirements. Such investments may be the in form of specialized skills for meeting the technical parameters of products needed under the transaction.

Networks of relationships coupled with horizontal integration are especially useful to buyers when the producers are small and geographically dispersed. In particular when farmers come together to form producer organizations (a form of horizontal integration), they enable buyers to reduce the transaction costs of sourcing from them (Okello & Swinton, 2005). Such buyers no longer incur the full search and screening costs as would one who works with individual farmers (Okello & Swinton, 2007). At the same time negotiating and completing contractual arrangement costs much less when the buyer deals with a group.

One of the major challenges smallholder farmers face outside the network of relationships is the high transaction costs of finding exchange partners. These challenges arise mainly due to information asymmetry and results in the failure of credit market to serve smallholder farmers (Besley, 1998). It also causes smallholder farmers to face information and insurance market failures (Key & Runsten, 1999). The latter relates to the failure by farmers to find and trade in reliable markets which in turn means that they face volatile prices. These problems are endemic in the smallholder production and marketing environments in developing countries including Kenya. Below we discuss how this conceptual framework guided the design

of the DrumNet project as the project sought to resolve the various market failures/challenges smallholder farmers encountered prior to the DrumNet intervention.

4. THE DRUMNET PROJECT: DESIGN AND TARGETED CONSTRAINTS

The DrumNet program facilitates smallholder farmers' market linkage by connecting them to service providers and output buyers thus enabling them overcome some of the idiosyncratic market failures identified above. Participating farmers are eligible for the full suite of DrumNet services that include financial (i.e., credit), marketing and information services. The project works only with farmers that are organized into groups known as self help groups (SHGs). However, past studies have shown that smallholder farmers face organizational failures in the form of inability to organize themselves into groups and use such groups to overcome constraints facing them (Rich & Narrod, 2005; Poulton et al., 2007). Thus the first activity the project does in initiating partnership with smallholder farmers is to mobilize farmers into groups where such groups do not exist. Where such groups exist, the project goes through a screening process in order to identify groups that are interested in participating in the project.

The process of recruiting farmers into groups has evolved over time. Initially, the project worked with other local projects/ NGOs to recruit groups. For instance, early groups recruited into the project belonged to the FAO-funded Farmer Field Schools (FFS) project. Later, however, the DrumNet project used the participating groups to recruit others, usually from among the FFS groups. This model of recruitment later changed to one in which an identified local individual mobilized smallholder farmers not belonging to any group at all, assisted them to register with government authorities as a SHG and then enrolled them into the DrumNet project. In this last case, the project resolved the organizational constraints/ failure facing smallholder farmers by facilitating their organization into groups and subsequent registration with the authorities.

Once a SHG agrees to participate in the DrumNet program it undergoes basic orientation training in which the DrumNet services are introduced, basic financial concepts described, and the basics of sunflower production explained. As part of introducing DrumNet's services, the DrumNet field staff explains to the group members how the DrumNet model works. This includes the explanation that model is based on the concept of a grameen bank, which requires that members monitor each other's activities. New members are also informed about the loan application and repayments procedures and the need to pay 25% of the line of credit they would wish to borrow, known by the project as a Transaction Insurance Fund (TIF), as extra security beside the grameen's peer pressure. Groups that successfully complete the orientation training and are judged by the DrumNet field staff as likely to succeed are enrolled into the DrumNet electronic database system. Once this is done, the system automatically generates a mobile phone text message (also known as SMS – for short messaging service) which is sent to the newly recruited group confirming successful enrolment into the project. The group is then qualified to join DrumNet's farm input credit program which provides input loans issued through a bank to enrolled farmers. The credit covers both seed and fertilizer and is strictly issued in-kind, with the needed inputs being collected from a DrumNet- approved input dealer.

Upon the completion of the enrolment process, the group applies for the input loan and pays off the mandatory 25% TIF. The application is then fed into the electronic database system. The system automatically generates another mobile phone mediated text message (referred to as E-Token) informing the group where to pick the input, the amount to collect and the date by which inputs should be collected. By this time the group has received an e-card (similar to credit/debit cards) that they must use in transacting the DrumNet credit scheme

business. Essentially, the card will have been activated with the amount of the input loan by the time the text message goes out to the group to collect the inputs from the dealer. At the same time, the participating input dealer will have received the same text message and an entry in his/her database.

A text message is sent back to DrumNet database system when the group collects the input loan from the dealer. During the collection of inputs, the group representative (known as Transaction Agent) swipes the e-card through card machine and enters the amount/value of inputs collected thus activating the system and also electronically generating the text message that goes to DrumNet database. The system also generates a back-up hard paper copy of the transaction for verification, if needed. The input dealer presents the documents generated during this transaction to the participating bank (namely, Equity Bank Ltd), which will have by this time received electronic communications and validating documents from DrumNet database system about the transactions. The dealer gets paid by the bank the value of inputs dispensed to the farmer group. Thus the smallholder farmers will essentially have received credit from Equity Bank Ltd. The DrumNet project acts as a guarantor of the input loan for the group.

One of the major constraints facing smallholder farmers is access to improved technologies (seed and fertilizer) and/or the credit with which to purchase such technologies. Smallholder farmers are often rationed out of the formal agricultural financial markets because they lack the collateral or they are perceived as higher risk borrowers (Fafchamps & Lund, 2003). At the same time, informal credit systems operating in rural areas are often unable to meet the needs of such farmers. For instance, during planting times, the individuals (usually friends and family members) that would normally lend to such farmers also need money to finance agricultural activities in their farms. Therefore the DrumNet project resolved a major constraint to smallholder farmers namely, credit market failure, by providing access to improved seed and fertilizers and/or an in-kind credit line through a formal financial organization (the bank).

Before the new group plants the seed, it enters a formal purchase contract with the buyer (in this case BIDCO Ltd). The contract is negotiated on its behalf and with their agreement by DrumNet and some of its leaders. The contract usually specified the quality parameters, the volume contracted, the expected time of collection, and the price that will be paid by the buyer. It also specified the penalties that noncompliance with quality specifications attract. Under the contract, the buyer also undertook to provide technical information (i.e., the agronomic and post-harvest practices needed to meet quality specifications) and transport services at a fixed fee. This contractual agreement is fed into the DrumNet database system to create a sale account for the group. A similar contract is signed between DrumNet and the buyer (BIDCO Ltd) and is aimed at enabling DrumNet recover its commission (of 5%) for its intermediating services from group sales.

The contract with a buyer resolves another major constraint smallholder farmers face namely, access to a reliable market for their produce. Indeed it is because of the lack of reliable market that farmers had abandoned growing sunflowers prior to the DrumNet project. The problem farmers faced in selling their produce prior to DrumNet is captured by the statement below from one farmer during a baseline a discussion with her:

"FFS came here and convinced us to plant orange-flesh potatoes and promised to buy them when ready, and we did. They urged us to put more land (acres) under potatoes, and we did because we were sure they would come and buy it all. At the time of harvest, we called them to come and buy the potatoes, but they disappeared. Everyone had lots of potatoes all around me. We couldn't sell to anybody. So we ate them, fed some to the cows and threw the rest away. Now you (DrumNet) have come with the story of sunflower. We were able to eat the

potatoes. What shall we do with the sunflowers if you don't come to buy them like FSS?"

Lack of reliable market and the resulting price volatility usually force smallholder farmers to produce low volumes of a crop and to depend on intermediaries (brokers) because the small volumes traded by the farmers have to be bulked into larger volumes to reduce the per unit transport costs for the buyer. Hence by including a formal marketing arrangement as part of the project, DrumNet resolved a major constraint ("insurance" market failure) to smallholder commercialization as well. The contractual arrangement also resolved another idiosyncratic market failure facing smallholder farmers namely, the provision of technical information.

The group receives a number of other electronically generated text messages through their mobile phones between the time they receive the input loan and the harvest time. The first text message asks whether members have planted. This is followed a few weeks later by another text message that enquires about the nature of seed germination and the health of the growing plants. This text message is especially aimed at helping DrumNet know about the crop outlook and the expected yields/volumes and is also used as a monitoring tool (Key & Runsten, 1998). The next two text messages remind the group to weed the crops (first and second weeding) and are following by another text message informing farmers to "chase" birds from the sunflower fields. A final text message in this series asks the group's TA to specify the nature of crop and is used by the DrumNet to make projections about the harvest. The series of text messages the group receives between planting and harvest provide farmers with additional information about the sunflower production practices they need to get better harvest (namely timely weeding and bird scare). They also help the buyer plan for transport logistics to avoid delayed collection and/or wastes.

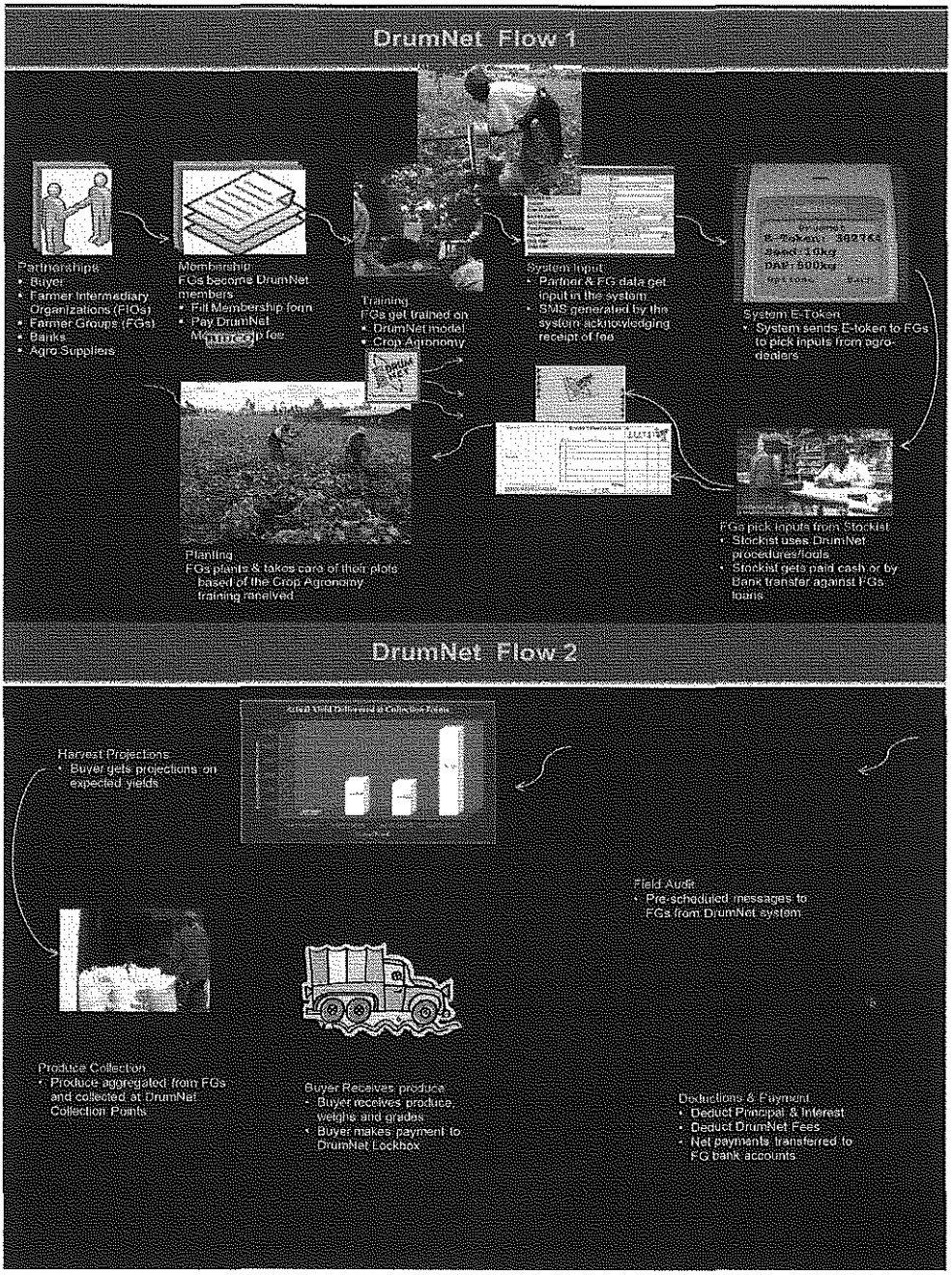
DrumNet, based on the planting date, is able to determine the harvesting date. When it is time, the groups receive a text message on their mobile phones again informing them to start harvesting and drying the crop. DrumNet later sends another text message enquiring whether the crops have been dried and assembled at the collection center. If the response is positive, DrumNet sends an electronic message to BIDCO Ltd to set a date for collection and sends another text message to the group indicating the date the produce will be collected.

Following the collection of produce by BIDCO, data on volumes by individual group member is entered into the DrumNet database and a set of bank account transfers are triggered to pay the participating farmers and the Transaction Agent. Equity Bank (on behalf of DrumNet) then deducts the principal and interest payments on loan from farmers' net returns and tracks progress toward loan repayment. It also enforces group guarantees if required. At the same time an agreed percentage of the value of group sales is deducted as payment for the Transaction Agent. The balance is transferred to the farmers' group account held by Equity Bank to complete the transaction. This marketing data and transaction details is then made available to participating group.

These transactions are represented in Figure 3 below depicting the actual flow of transaction from the formation of the partnership to the completion of group sale of crop and payment. The initial processes take a while to complete and hence needs a lead time of 3 months from the time the group is identified to the time they are able to access the credit facility.

This project differs from others in one important aspect. Unlike others, the DrumNet adopted an integrated approach to resolving the constraints facing smallholder farmers. In particular, it targeted agricultural financing (by linking the farmers to a formal bank), provision of technical information and key production inputs, and the linkage to reliable output market. Majority of past projects have tended to leave out the market linkage component. A case in point is the FAO-funded orange-flesh potato project cited above. Contrary to the FFS project case, majority of the DrumNet farmers

Figure 3. Flow of DrumNet intermediating services



developed greater confidence and trust in project especially when BIDCO Ltd actually bought up their produce and paid for it as promised. Another aspect of the project that seems to have enhanced the level of trust of farmers in DrumNet is the frequent conversation through

mobile phone text messages. While more empirical evidence needs to be collected to validate this point, discussions with some participating farmers indicated that farmers developed greater trust in DrumNet because they "felt the project kept them informed".

The project however encountered some challenges. One of the major challenges had to do with access to and the use of the mobile phone. Majority of the groups did not own mobile phones and had to depend on a phone belonging to a neighbor or a friend. In both cases, the text messages sent by DrumNet reached the group late or did not reach at all. In addition, the farmers (including the transaction agents (TA), in many instances, had difficulty reading and responding to text messages due to low literacy levels (Okello et al., 2009). These problems had little to do with the way the project was designed, which involved the participation of major stakeholders (i.e., the farmer, bank, researchers, input seller and buyer). These stakeholders participated in the development and the testing of the ICT platform used in project.

5. EFFECT OF PARTICIPATION IN THE DRUMNET PROJECT ON FARMERS MARGINS

Section 4 has discussed how the DrumNet project takes over the functions performed by various actors in the value chain namely, the rural assemblers (rural brokers), urban brokers and transporters and providers of technical/market information. It has also discussed how these services are provided by a network of partners along the shortened value chain intermediated by DrumNet using an ICT platform involving the use of a mobile phone. What is the effect of this ICT-based intermediation on participating smallholder farmers' margins? To address this question, we interviewed various actors in the sunflower value chain to determine the prices paid to farmers and the fees farmers pay/costs incurred in order to compute the marketing margins the smallholder farmers earned outside and in the DrumNet project. The interviews were conducted in January 2009 and involved farmers, rural assemblers, rural brokers, transporters, input dealers, DrumNet staff, Equity Bank and BIDCO Ltd. We gathered information on fees, costs and other charges levied by these actors during this process.

Following Mendoza (1995) we define marketing margin as the share of the final selling price captured by a farmer. However we use the price paid by BIDCO Ltd as the denominator because sunflower in unprocessed form does not have a "consumer price", only the oil extracted from it does. Thus we compute the farmer's marketing margin (FMM) as:

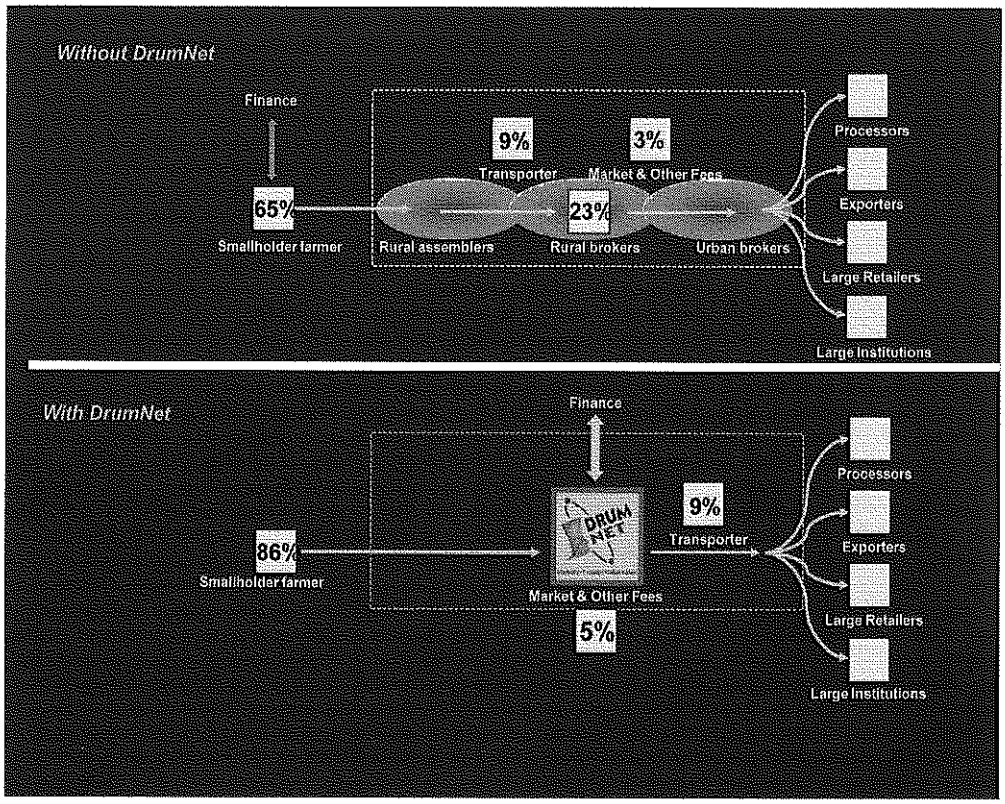
$$FMM = [(\text{BIDCO's price} - \text{Fees\&Costs})/\text{BIDCO's price}] \times 100$$

In this formulation, *Fees&Costs* represent the various fees charged by the intermediaries and the marketing costs the farmer incurs (especially transport costs). Figure 4 presents the margins earned by DrumNet and non-DrumNet smallholder farmers. Overall, a non DrumNet farmer earns only 65% of the sale price (i.e., price paid by BIDCO Ltd). The rest is taken by the various intermediaries namely transporter (9%), brokers (23%) and others (3%) go towards paying for marketing costs and fees.

By comparison, DrumNet farmers earn much higher margin. Apart from the 9% of the BIDCO price deducted (by BIDCO) for transportation, the only other cost the DrumNet farmers incur is the DrumNet commission amounting to 5% of the BIDCO price. Altogether, the DrumNet farmers earn 86% of the price paid by BIDCO.

We also investigated the prices paid by other sunflower buyers in western province and their trading practices. Apart from BIDCO Ltd which operated directly in the province, the other buyers mainly used intermediaries (i.e. rural assemblers, rural brokers and/or urban brokers) to buy from the smallholder farmers. BIDCO had a two-tier pricing scheme. It paid Ksh 21.5/kg at the farm-gate and Ksh 24.00

Figure 4. Margins earned by DrumNet and non-DrumNet farmers, 2009 (Source: Adapted from Okello et al. 2009)



for sunflower delivered to its processing plant. By comparison, the traders paid a price ranging from Kshs 5/kg to Ksh 30/kg depending on the supply situation. The price of Ksh 30/kg was paid when there is acute shortage of sunflower and the goal of the intermediary was to induce DrumNet farmers to side-sell the produce. Therefore the price was very temporary. In areas where such intermediaries succeeded in causing mass side-selling, the DrumNet project responded by withdrawing altogether forcing all farmers to sell only through intermediaries. The resulting surge in supply then made it easy for the intermediaries to reduce the price to as low as Ksh 5/kg[1]. The overwhelming response by farmers to such low price was to exit production and the pre-DrumNet situation in which farmers planted only small plots of sunflower ensued.

6. SUMMARY AND CONCLUSION

Smallholder agriculture remains the engine of growth and rural development in Africa. However, it faces a myriad of challenges arising from, among others, agricultural information, insurance and credit market failures, poor access to improved technology and, unreliable or poor access to better paying markets. Consequently commercialization of smallholder agriculture has occupied a central place in rural development dialogue as the means of integrating smallholder farmers in better-paying agricultural value chains are sought.

The search for a model of smallholder commercialization in developing countries has led to the mushrooming of projects that apply

ICT in attempts to resolve the idiosyncratic market failures that affect smallholder farmers. Several such projects have been implemented in Kenya, Uganda, Tanzania, Malawi and the West African belt. A number of these projects are using mobile phones as a platform to provide price information, technical information and to build the capacity of smallholder farmers. The interest in mobile phones arises from high penetration of mobile phones in rural Africa. Have these initiatives succeeded in integrating smallholder farmers to agricultural value chains? This article examines one ICT-based project, known as the DrumNet project, which has succeeded in integrating smallholder farmers into better-paying agricultural value chain. The project uses mobile phone to maintain a network of partnerships that enable smallholder farmers to participate in higher value agricultural value chain. This article assesses how the project is designed, the smallholder farmer's idiosyncratic market failures it resolves, and the how member-farmers benefit from it.

The article finds that the DrumNet project provides smallholder farmers with access to credit which they use to access improved production technology (i.e., seed and fertilizer) thus resolving credit market failure. The project works with farmer organizations and facilitates their formation thus resolving their organizational failure/constraint. The article also finds that the DrumNet project links the smallholder farmers to a buyer who provides the technical advice and also a reliable market for produce thus insuring farmers against market risks. At the same time the project provides logistical and other technical/production-related information hence, jointly with the buyer, resolve the smallholder farmers' market information failure. Resolution of these constraints has benefits for the participating smallholder farmers (i.e., the DrumNet farmers). The article finds that the DrumNet farmers receive 86% of the price paid by the buyer compared to their counterparts who receive only 65%.

These findings imply that ICT-based projects that focus on the various constraints facing the smallholder farmers and design an integrated intervention targeting all the constraints are likely to facilitate their inclusion in higher value agricultural value chains. The findings have implications for design of future ICT-based interventions in agriculture.

ACKNOWLEDGMENT

The authors gratefully acknowledge funding for this study by Pride Africa through an IDRC grant

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ENDNOTES

1 Marketing literature describes this kind of conduct by marketing agents as coercive conduct.

A Framework for Analyzing the Role of ICT on Agricultural Commercialization and Household Food Security

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ABSTRACT

Lack of agricultural information has been attributed to the inability of smallholder farmers to transition from subsistence to commercial agriculture. Recent efforts to improve smallholder access to agricultural information have seen increased application of ICT technologies in developing agriculture. These efforts use ICT-based market information to reduce transaction costs of smallholder participation in markets, promote commercialization, and improve household food security. Emerging studies document the benefits of such ICT-based applications in agriculture, including increased incomes and improved performance of agricultural markets. Unfortunately these studies have been context specific and the link between provision of ICT-based market information, smallholder commercialization and household security remains unclear. This paper develops a framework that can be used to analyze the link between ICT application in smallholder agriculture, household commercialization, and food security. The paper generates testable hypotheses relating ICT application in agriculture and reduction in transactions costs, smallholder farmer commercialization, and household food security. It then provides illustrative cases where ICT application in agriculture has benefited smallholder production and improved market performance. However, more research must be done to test the generated hypotheses. The paper discusses the implications of the framework for practitioners.

Keywords: *Commercialization, Developing Country Agriculture, Food Security, ICT, Smallholder Farmers, Transaction Costs*

1.0 INTRODUCTION

One of the constraints on smallholder farmers' access to markets is lack, or asymmetry, of information (Barrett, 2008) about product, input and credit markets. Farmers rely on friends, relatives and extension agents for market information. However the usefulness of information from these sources is usually limited because the information is either unreliable or

DOI: 10.4018/jictrd.2010010103

not timely. The consequences of information asymmetry are problems of moral hazard, and opportunistic behaviour by traders and money lenders towards smallholder farmers. Studies in several African countries indicate that under such circumstances, input and output markets are thin and exchange is personalized, requiring physical presence of parties and commodities (Fafchamps & Hill, 2005; Doward et al., 2005; Fafchamps & Gabre-Madhin, 2006). The high transactions costs of such exchange process impede access to better-paying markets and entrench poverty (Barrett, 2008) because when and if they participate in markets, smallholders are often obliged to accept low prices for their produce (Shiferaw et al., 2007). Furthermore, poor roads and telecommunication networks, increase transactions costs and risks (Poulton et al., 2006) and tends to limit access of smallholder farmers, especially those in remote areas, to efficient and competitive markets.

Lack of market information exacerbates the problem of low-level equilibrium poverty trap that locks smallholder producers into subsistence production and imperfect markets where they typically trade in low volumes. Farmers may thus be unwilling to diversify out of "low value" staples into higher value crops if markets for the latter are too costly or too risky to rely on for food purchases (Fafchamps, 1992; Jayne, 1994).

The problem of farmer access to market information is an old one. Smallholder farmers were not the focus of colonial governments in many developing countries. After independence, many governments still pursued extension methods that focused on larger progressive farmers. While large-farmer bias has to some extent reduced, public agricultural extension systems in most developing countries lack the financial and human capacity to reach the large numbers of geographically dispersed smallholder farmers.

Recent attempts to resolve the problem of poor access to information by smallholder farmers have focused on promoting information transfer through ICT-based innovations (Tollens, 2006; Aker, 2008). Munyua (2007) and de Silva (2008) document the use of several ICT-based interventions in agriculture in Africa and Asia respectively. In Kenya alone, for instance, there were 34 projects that used ICT as a platform for disseminating agricultural information in 2008 (Okello & Jakinda, 2008). South Africa, Kenya, Tanzania, Uganda, Malawi, Madagascar and the whole of West African belt have ICT applications targeting the transfer of information to smallholder farmers.

Evidence of the benefits and impacts of ICT-based interventions in improving smallholder access to markets remains anecdotal. A few studies have attempted to investigate the effects of ICT-based interventions on smallholder and market performance. Examples include use of Internet-based technology to link horticultural farmers to input and output markets in Kenya (Ashraf et al., 2007); use of mobile phones to obtain real-time prices of fish in India (Jensen, 2007), synchronize production practices with export market requirements in Colombo (de Silva, 2008), and by grain traders in Niger to obtain price information in other markets (Aker, 2008). None of the past studies systematically examines the effectiveness of ICT-based market information systems on smallholder market linkage in a broader context that encompasses, among others, the different cultures, commodities, and farmer types. Therefore findings on the impact of interventions are patchy and context-specific.

This paper develops a framework that can be used to analyze the role of ICT interventions in agriculture on household commercialization and food security. It develops a set of hypotheses that can be tested empirically but uses illustrative cases to provide a flavour that there exists evidence, albeit context specific, that the hypothesized relationships might actually exist. These illustrative cases do not in any way mean that the hypothesized relations *do* exist. Such proof will require more robust studies.

1.1. The Context

The debate on how best to provide smallholder farmers with agricultural (production and mar-

ket) information has occupied academic and development practitioners and policy forums for many years (Shepherd, 1997; Eicher & Staatz, 1998). It has led to search for the best model for reaching farmers with agricultural information over the years. Early examples include the public extension model which was based on the personal contact between a trained extension agent and the farmer. There are several variants of this approach including the progressive farmer approach that targeted the better-off farmers and hoped that messages passed on to these farmers would trickle down to the rest of the farmers. However, this model had the shortcoming that the messages were not always relevant and appropriate, besides being a top down approach.

In many countries, the T&V's model of personal contacts with farmers has been modified and the training component removed. At the same time, the fortnightly visits have been removed and non-scheduled visits are made instead. In other countries, other models of communicating agricultural information are being tried namely the field day approach, on-farm trials and demonstrations, and the residential training through farmer/agricultural training schools. The farmer and community based organizations approach has also been tried, where the organization acts as an information hub. The extension officers use the organization to pass necessary agricultural information to members who are then expected to pass it on to neighbors. The effectiveness of these models of communicating agricultural information is however unknown. Nonetheless, they tend to be cheaper.

In most developing countries, agricultural extension models, such as the Training and Visit (T&V) have traditionally been supplemented by traditional mass media channels such as the radio and television. However, the messages transmitted through these channels have tended to be dated because the information gathering, processing and release takes time. Timing of delivery of information through radio and television is also a problem as most of the programmes tend to be aired when farmers are out in the fields or busy with other domestic chores (Okello et al., in press; Munyua, 2000). Governments have also attempted to address the market information gap through the provision of price information either on radio or in print media (Mangisoni, 2006)[1]. The rationale for the price information programmes is that traders would respond to significant price differentials and move commodities between low price and high price areas. However the impact of this market information initiative has been limited because it relies on limited channels of disseminating the information and the weekly dissemination of the information is too low a frequency to be of value to both farmers and traders.

The more recent applications of ICTs in smallholder market linkage projects are the mobile SMS, web/internet-based resources and telecenters. Radio and television are also used often interactively with mobile phones. The increased focus on modern ICT-based methods of information provision comes from the realization that they can be used to i) communicate knowledge and information to rural farmers on time, ii) deliver training modules to farmers at low cost, iii) improve farmers' access to markets and agricultural credit, iv) empower farmers to negotiate prices better, and v) facilitate and strengthening networking among smallholder farmers.

Proponents of the use of ICT in providing farmers with agricultural information also argue that it can greatly improve the productivity of smallholder farmers resulting in smallholder commercialization and the exit from the low equilibrium poverty trap (Barrett, 2008). Smallholder commercialization has the benefit of improving the food security status of such households. Consequently case studies are emerging that attempt to test the usefulness of ICT in smallholder farmer commercialization[2]. However, such analyses have been based on different and often uncoordinated approaches. We provide a unifying framework in which analysis of the role of ICT in stimulating smallholder commercialization can be analyzed.

The rest of this paper is organized as follows. Section 2 lays out the proposed frame-

work. Section 3 provides some illustrative cases of ICT application in agriculture and the outcomes. Section 4 concludes and presents implications for policy and further research.

2.1 TRANSACTION COSTS AND THE SMALLHOLDER FARMER

Lack of agricultural information impedes smallholder commercialization by raising their transaction costs of participating in input and output markets. Transaction cost can loosely be defined as cost of doing business or cost of exchange between two trading partners, in our case farmers and buyers. The theory has been widely used in studying agricultural markets in developing countries (Jaffee, 1995, Jaffee, 2003; Fafchamps, 2004; Fafchamp & Hill, 2005; Okello & Swinton, 2007). It posits that difficulties in economic exchange between two partners arise because of three exchange related problems namely, asymmetric information, bounded rationality and opportunism.

In small farm situation, asymmetric information arises when either the farmer or buyer lacks essential information relating to the exchange. The more informed parties therefore take advantage of the exclusively available information to benefit themselves, a situation referred to as opportunism and which has been defined by Williamson (1985, p. 45) as "self-interest seeking with guile" (Miller, 2005). In agricultural marketing in Africa, the small farmers tend to be less informed than traders/buyers. Buyers and traders therefore use the exclusively available information (about price, supply condition, or quality) to their benefit. Uncertainty of future outcomes means that the buyers, even with a priori agreement on terms of exchange can take advantage of the smallholder farmers by engaging in actions that are contrary to the specifications of the agreement (i.e. abuse the spirit of the contract), a condition known as moral hazard. Alternatively, the buyer may claim ability to meet the terms of the agreement (e.g., buy the entire commodity from the farmer) only to fail to do so due to changes in the market, a situation called adverse selection. These conditions prevail in many rural farming environments in which agricultural information is generally unavailable (Mangisoni, 2006) and has been one of the factors behind the push for ICT-based projects.

Lack of information between the seller (farmer) and the buyer makes trade more costly (Furubotn & Richter, 1997; Furubotn, 2001; Williamson, 2004). Farmers who need to sell some produce must search for buyers and screen-off unreliable or opportunistic ones thus incurring search and screening costs (Coase, 1937). Once the buyer is identified, the farmer has to negotiate the terms of sale (i.e., price, quantity, quality, time of sale, frequency of sale, etc). The farmer thus incurs costs relating to time spent and financial outlays in negotiating the terms of exchange. A farmer may then have to monitor the buyer to ensure that the latter meets the terms of exchange, and incurs monitoring costs in the process. The farmer may also have to spend time and resources getting the buyer to honor the terms of agreement and thereby incurs enforcement costs. Lastly, in long-term agreements, changes in production and market condition may dictate adjustments in the terms of exchange such as the sales volume, quality, price, and frequency or time of sale. The farmer may thus incur monetary or time costs (i.e., mal-adaptation costs) during the re-negotiation of the terms of exchange.

The four categories of transaction costs above are prevalent in both input and output markets in developing countries. Poulton et al. (2006), Fafchamps (2004), and Fafchamps and Gabre-Madhin (2006) for instance highlight some of these costs in relation to African farmers and traders. ICT-based information services reduce these transactions costs by reducing the asymmetry of information and uncertainty related to trade.

In sum, lack of market information increases the costs of exchange between the smallholder farmer and buyer. Smallholder farmers due to their geographic dispersion incur higher variable transaction costs of accessing inputs and selling their produce. The higher costs emanate

from the costs of searching for and screening of exchange partners, negotiating the sale of output or purchase of inputs, monitoring and enforcing the terms of exchange and also adjusting to changes in market environment. Farmer access to market information helps to reduce these costs of doing business and allows the farmers to increase net income. The increased income is in turn expected to provide greater incentives to smallholder farmers to participate in the market. We therefore hypothesize that:

H1: *Smallholder farmer access to market information through ICT-intervention reduces the costs of doing business.*

2.2 Transaction Costs and Performance of Spatially and Temporally Separated Markets

Studies on the performance of spatially and temporally separated markets focus mainly on the efficiency with which prices are transmitted between such markets which in turn is partly driven by the availability of and farmer/trader access to market information. Such studies have a long history dating back to von Thunen (1926) and build on studies by Samuelson (1952) and Takayama and Judge (1964). They measure the tendency for prices in two spatially or temporally separated markets to move together (i.e., integration) or of price shocks in one market to be transmitted into another (Moser et al., 2005). Recent studies of price transmission focus on the nature of relationship between price series at different levels of the value chain or at spatially separated markets (Abdulahi, 2007). Such studies use time series methods and, in some cases, use lag structures on prices to analyze the relationship between prices in spatially separated markets (see Fackler and Godwin (2001) for a review of such time series-based studies).

The speed and degree of price transmission between markets can signal presence of market failures arising from high transfer costs and the lack of market information (Abdulahi, 2007). The extent of adjustment and the speed with which price information is transmitted among various actors in the market reflects the behaviour of actors. Slow transmission of price information following a shock may be indicative of the high marketing margins, large price spreads and mark-ups and unfavourable pricing practices (i.e., opportunistic behaviour). However previous studies suggest that lack of investment in market infrastructure (especially transport and communication) can exacerbate the problem of high transfer costs and hence impede efficient transmission of prices between spatially separated markets. Good transport infrastructure is needed to lower the cost of obtaining and disseminating information in circumstances where farmers have to travel to spatially or temporally separated markets to obtain and pass information to other markets (Aker, 2008). On the other hand, good communication systems, including electronic ones, can ease the information search costs and improve the performance of spatially separated markets (Jensen, 2007).

Efficient transmission of price information between markets is important for the meso-level (i.e., inter-village/ interregional) trade to occur. Given the limiting effect of lack of information on the performance of markets, provision of such information benefits smallholder farmers by, among others, i) improving their access to markets and hence improving the price obtained, ii) improving the speed and efficiency of price adjustment between spatially separated markets through arbitrage, iii) making response to market shocks more rapid and complete and iv) making price discovery process by farmers, traders and consumers more efficient and rapid. Based on the foregoing we hypothesize that:

H2: *The provision of price information using ICT increases the efficiency or performance of spatially and temporally separated markets.*

2.3. Transaction Cost, Marketing Margins and Market Participation

The effect of information asymmetry and transaction costs at the micro and meso levels can be understood by looking at simple stylized models relating the household and market price and prices between two markets. Following Minot (1999), Larson (2006) and Barrett (2008) we argue that transaction cost at the micro level causes a wedge between the exogenous market price and the price the household receives for its produce. Transaction cost is affected by the state of infrastructure especially the condition of the roads and distances to input and output markets. In addition, we argue that smallholder farmers' cost of doing business is affected by farmer/household asset endowment including possession of physical assets such as radio, TV, mobile phone; human capital assets such as skills and experience and; social capital assets that can be in form of membership to a farmer organization. High transaction costs caused by difficulties in accessing input and/or output markets increase input costs and reduce the net price earned by farmer/household thereby depressing the household's desire to participate in input and output markets. This in turn causes the household to produce only what is enough for its subsistence needs (i.e., become subsistence oriented). Such households stay out of the market (Barrett, 2008). Similarly, poor state of infrastructure, lack of market information services and lack of needed assets can increase the costs of inter-village/inter-regional trade thus reducing or eliminating opportunities for trade between local and regional markets. The high costs of inter-regional trade can in turn cause different regions to focus on meeting food needs rather than pursuing trade.

The importance of farmer access to information is in reducing the transaction costs of exchange. ICT-based projects usually seek to provide access to agricultural information hence the presence of an ICT-based project in an area is expected to provide farmers with an easy access to market information. However, for farmers in an area with ICT-based project to benefit from the agriculture information service provided by the project, they need to be aware of the presence of the project and use the services provided by it. Undoubtedly, farmers will use the services from the project if they find it profitable to so. The use of any technology entails a cost. In the case of ICT-based market information services, the cost may include the expenses on mobile phone calls to the project center to acquire information, the cost of buying a mobile phone handset, the fees levied on Internet browsing, etc. The benefits of using market information services provided by an ICT-based project, on the other hand, include reduced cost of: finding and selecting a trading/exchange partner (i.e., search and screening costs), negotiating and monitoring the terms of exchange and, adjusting the terms of exchange. The reduction in these costs increase the margins earned by farmers and hence the revenues/income from participating in the output market. The increase in income can also be due to increase in the volume of produce sold which in turn may be caused by reduction in costs. Access to market information through ICT-based project is also expected to reduce the costs of acquiring credit and other inputs by lowering search, negotiation and monitoring costs thus increasing the margins and revenues assuming constant output price.

Theoretically, households that use market information services provided by ICT-based projects are expected to face lower production and marketing transaction costs. Such farmers are therefore expected to earn higher margins (see paper by Okello et al, in this issue that presents evidence on this). The increased revenue earned by such households is expected to spur investment in agriculture. This leads us to hypothesize that:

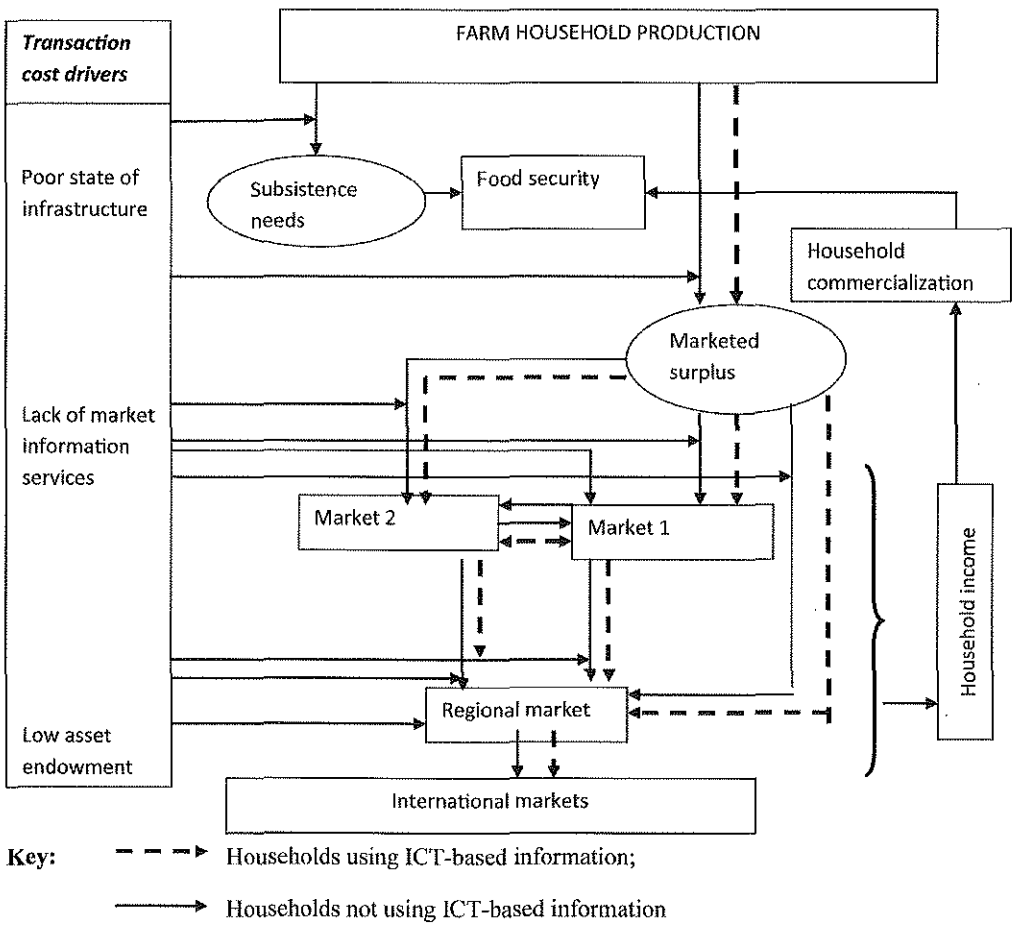
H3: *The use of ICT-based market information will promote commercialization of smallholder agriculture.*

We use Figure 1 to illustrate the pathways by which ICT-based market information will bring about commercialization of smallholder

agriculture. As shown, we anticipate that households that increase production out of use of ICT-based market information services will participate in the market through sale of surplus production to village Market 1, Market 2 or to regional markets. Trade would then occur between village markets, between village and regional markets, between regional markets (e.g., between market in two districts but one country) or between regional and international markets. We assume that households that do not use the services of ICT-based project have no or very little access to market information. Consequently, such households face higher costs of doing business both in the input and output markets. Such households therefore either stay out of the market (are purely subsistence-oriented) or sell little surplus, hence the small arrows. On the other hand, farmers/households that use ICT-based market information services produce more marketable surplus hence sell more. Increased volume of sales increases household income which spurs commercialization. Such households, represented by the bigger broken arrows in Figure 1, engage in commercial farming compared to counterparts who are constrained by high costs of doing business.

Commercialization of smallholder agriculture is further expected to generate and/or

Figure 1. The effect of transaction on market participation



strengthen backward linkages with input sector. In particular, it is expected to generate greater demand for services that will further increase agricultural productivity including ICT-mediated agricultural information. Increased revenue will also increase the demand for other agricultural inputs (e.g., in the form of increased use of such inputs as fertilizers, improved seed) and also bring about in the medium-term investments in productive assets including human, physical, financial and natural assets. The increased revenue earned by households with access to market information is also spent on meeting households needs (especially food) besides re-investment in agriculture. Indeed, most households often meet their food needs first before meeting the input needs. The increased income, by increasing the disposable income that households can spend food needs, thus contributes to the welfare of the household. Thus we hypothesize[3] that:

H4: *Access to ICT-based market information increases the food security status of household that use such information*

We illustrate in Figure 1 the pathways by which household commercialization could improve the food security status. We assume that as households commercialize, they would use the more incomes earned from sale of produce to purchase food needs. However household food security is also affected by the volume of home production for subsistence needs.

Some existing ICT-based projects provide more than just the market information services. A number of them provide the infrastructure needed to facilitate access to such information while also building capacity of farmers to produce marketed surplus. Background studies indicate that a number of ICT-based project in Africa create the necessary infrastructure needed by farmers to access market information (see Munyua, 2007). These include creation of information kiosks, Internet shops, or tele-centers and also the strategic location of such infrastructure closer to farmers, thereby increasing access. At the same time the background studies find that a number of ICT-based projects in Africa build the capacity of farmers to more effectively use the services they provide through training and/or provision of basic assets especially the mobile phone handsets on interlinked credit arrangement. Other projects mount television sets or information billboards at strategic points in the market places for use by farmers. Provision of such infrastructure and assets enhances access to market information, reduces transaction costs facing the household by reducing search, screening, negotiation and monitoring costs, and increases price earned by the household from market participation hence revenues. It also increases reigning price in spatially separated markets linked through trade. In both cases reduction in transaction costs enhances the likelihood of participation in the market due to increased margin. Indeed poor state of infrastructure and lack of assets (often referred to as asset poverty) are the major causes of poor access to market information (Barrett, 2008). Nonetheless, households face differential effects of the transaction costs (Omamo, 1998b; Key et al., 2000; Renkow et al., 2004). At the same time differences in costs of commerce may make geographic or spatially separated markets be differentially integrated (Godwin & Fackler, 2001; Barrett, 2008).

3. ILLUSTRATIVE CASE STUDIES

In this section we provide case studies that appear to lend support to some of the hypotheses generated in this paper. As intimated earlier, we do not attempt to provide proof of the hypotheses above using these cases because the cases are too context specific. At the same time studies in this field are still too few to allow careful synthesis and triangulation of evidence to test the hypotheses. Doing this would require a more carefully designed study that covers general contexts. The examples we present are from two continents (Asia and Africa) and were designed to address the problem of poor

access to market information and the ensuing high transaction costs of doing business. Both examples use mobile phones as platforms for agricultural information provision. However, while the Asia case focuses at the micro-level, the African case focuses at the meso-level.

3.1 Importance of ICT in Resolving Farm-level Information Problems: The Sri Lanka Case

The Sri Lanka case is drawn from studies by Harsha de Silva (2008) in Sri Lanka. The case is based on a study of a number of smallholder vegetable farmers producing and selling vegetables in Sri Lanka wholesale market called Dambulla Dedicated Economic Centre (DDEC). The farmers also plant maize, cowpea, mungbean, chilli, onion and rice hence have to decide which crop to plant during each season. Landholdings are typically very small averaging 0.25 hectares. As majority of the smallholder farmers, these farmers encounter a number of information problems at the production (micro-level). To produce a crop and eventually market it, they need information of what to plant, when to plant, where to obtain agricultural inputs (including seeds, fertilizer, pesticides and labor), when to harvest (in order to seize good prices in the market), when to sell, and where to sell. Searching for these different types of information entail both time and financial outlays and hence involve transaction costs related to search for information, screening potential input sellers and produce buyers, travelling to the information source, negotiating with the seller and follow-up (i.e., monitoring) the seller for payment in case the payment comes after delivery. The case study farmers therefore encountered two broad categories of information costs namely, the search transaction costs and the transportation transaction costs.

The farmers had two options for obtaining the production and marketing information namely, walk to the information source or use a mobile phone or electronic/computerized information stalls in the DDEC wholesale market. Walking to the information source involves paying visits to various stores, input sellers/markets, and traders and entails both financial and time costs. The mobile phones could instead be used to obtain information on input availability and prices and also on the timing of planting and sale of produce at the cost of airtime, usually less than the costs of travelling to the information source. The DDEC information stalls, on the other hand, provide information on selling prices only. Overall, 11% of the costs of doing business is associated with the costs of searching for information on input availability and prices. Some extra 4% of the costs of doing business resulted from transportation costs. Hence transaction costs accounted for 15% of the costs. The search costs contributed to 70% of the total transactions costs incurred by the farmers.

The study finds that most of the farmers travel to the information source to obtain needed information. A farmer makes on average 24 trips over the production season to a market and incurs on average USD 1.8 per trip giving a total of USD 52. So how would the use of mobile phone change the situation? The study estimates that if just half of the trips are replaced by a phone call, the costs of information search would drop to USD 35 over the production season. This represents 33% drop in the information search costs. These results seem to agree with our expectations as outlined in hypotheses *H1*. It proposed that the saving on information search costs will increase the net incomes earned by households that opt to use mobile phones rather travel to the market. This case study did not assess the effect of this reduction on information search costs on household incomes. However, another study conducted in Sri Lanka (Soysa, 2007) finds that use of mobile phones to obtain information on how to reduce wastage significantly increased farmers' income. Lack of income is often attributed to the failure of smallholder farmers to shift from subsistence to commercial farmers. Hence the results of these case studies suggest that the use of mobile phones can facilitate the commercialization of smallholder agriculture as hypothesized in *H3*.

3.2 ICT and Performance of Spatially Separated Markets: The Niger Case

This case study draws from studies of grain markets by Jenny Aker (see Aker, 2008 for a complete treatment of this case) focusing on the role that ICT plays in determining price transmission in spatially separated grain markets in Niger. Hence unlike the Sri Lanka case, this case is a meso-level study of how different regional markets perform. The study focuses on grain markets because of the way prices and traders behave especially during periods of short grain supply.

Grains in Niger are bought and sold through a system of traditional markets separated by distances ranging between 10km to 900km. Grain traders typically searched for price by travelling to the markets, which sometimes took several days. Traders thus incurred travelling and time costs. For instance a trader travelling from Bakin Birgi market (to the east of Niger) to Zinder (in central region) spent on average USD 20.00. The costs of information search escalated with distance to the destination. Consequently many traders simply traded in the principal markets where they know the price (usually home markets) with limited interregional trade occurring between markets. As a result prices differed greatly between markets, especially during times of grain scarcity, with low prices co-existing in different markets, even in the same region, with high prices. The prices reigning in one market did not, in many instances, differ from the prices in another by the amount of the transfer costs as suggested by the "law of one price". Famines exacerbated the price spread between some markets as speculation and hoarding occurred.

Between 2001 and 2006, mobile phone towers were introduced in most (76%) of the grain markets throughout Niger. Rather than travel to distant and other markets, traders could now simply call their contacts in such markets and get information on prices. How did this affect the performance of such markets?

Aker uses unique panel dataset comprising 395 traders in 35 markets across Niger to investigate the effect of mobile phone roll-out on grain markets. The data was collected over the period 2005-2007 and subjected to various econometric analyses. In line with our hypothesis *H2*, her study finds statistically significant association between mobile phone roll-out and the reduction in grain price dispersion in markets connected by mobile phone by 6.5-22%. In other words, mobile phone roll-out improved the performance of grain markets in Niger. How did this happen? Rather than travel to market, traders were able to obtain price information in other and distant markets using phone call for as low as USD 2.00. At the same time, unlike the pre-mobile phone era, traders in markets with mobile phones are also able to search for better prices in 26% more markets than before. Thus mobile phone roll-out increased the number of trading partners traders knew and could source price information from.

The reduction in price spread between markets had welfare implications as well. It implied that consumers paid lower prices than they would without the phones. At the same time traders secured higher profits. These findings suggest, in line with our hypothesis *H4*, that ICT can improve household food security situation. The study however does not assess the welfare gains from mobile phone roll-out on farmers and consumers.

4. CONCLUSION AND IMPLICATIONS FOR DEVELOPMENT PRACTIONERS

The application of ICT in agriculture has gained popularity because of the expectation that it can resolve the constraints facing smallholder farmers, increase their participation in markets and contribute to higher investments and food security of farm households. Hence the number of ICT applications targeting smallholder agriculture has increased. A number of studies have recently emerged that attempt to assess the impact of these ICT applications in agricul-

ture. These studies have generated interesting findings. However, they have mainly been context-specific. At the same time the analyses have usually focused on one area (i.e., farm or market) of the continuum of farm household which typically encompasses both production and marketing.

We have presented a framework for analysing the effects of ICT interventions on farm households. The channels of these effects include improved efficiency of input and output markets, improved benefits to farmers in terms of reduced costs of marketing (transactions costs) which then serve as further incentives for investment and commercialisation. Increased production arising from higher investments improves food self-sufficiency, an important step towards food security of farm households. The channels by which ICT interventions lead to commercialisation and food security are however conditional on factors such as quality of infrastructure and household asset endowment. Therefore these factors must be examined in any analysis of the benefits of improved information from ICT-based interventions. Finally, the reach of ICT-based interventions determines the level of impact they can make. Therefore factors that affect that reach, such as awareness and willingness of farmers to participate in an intervention need to be a part of any assessment of effectiveness of interventions.

The major implication to be drawn from this paper is that while there has been increased attention on the use of ICT-based projects to provide smallholder farmers with market information, conditions such as asset poverty can dampen their incentives to adopt services rendered by such projects. Asset poverty, which encompasses poor infrastructure and the lack of human, financial, social and/or physical capital, is prevalent in smallholder production system. Hence providing market information services through ICT technologies alone is not sufficient in spurring commercialization of smallholder agriculture. Investment in physical infrastructure and in providing access to inputs/assets that such farmers need to facilitate the use of such services is equally important. Indeed, evidence from the DrumNet project in Kenya (presented elsewhere in this special issue) indicate that smallholder farmers are more likely to benefit from ICT-based market information projects if such a project resolves the other idiosyncratic market failures they face.

ACKNOWLEDGMENT

The Authors gratefully acknowledge funding for this study from International Development Research Center grant.

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ENDNOTES

1 Although Mangisoni described the system in Malawi, the same system has operated in Ghana.

2 Agricultural commercialization describes the transition by farmers from subsistence farming to market oriented farming and is usually measured by the volume of household production that is marketed (Wambugu, 2008).

3 While H4 may be far reaching we hypothesize, *ceteris parbus*, that households that have access to ICT-mediated agricultural information are likely to be better off than those that don't.

ICT Policy for Agriculture Based on a Transaction Cost Approach: Some Lessons from Sri Lanka

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ABSTRACT

In Sri Lanka, the majority of farmers are generally poor, and rely on subsistence agriculture. If these farmers can even partially be made responsive to market needs, as opposed to current household needs, they could cultivate at least some income generating crops, which if sustained, can reduce their poverty. However, high transaction costs associated with obtaining market information have continued to keep poor farmers entrenched in subsistence farming. The current ICT revolution is making previously costly market information much more affordable to these farmers. Therefore, if used appropriately, ICT can help reduce the high transaction costs associated with market information thereby helping farmers move toward some level of commercialization. The question is how can a country achieve this objective. This paper considers the case of Sri Lanka and provides lessons, both positive and negative, for African policymakers.

Keywords: *Agriculture, ICT, Mobile Phones, Policy, Poverty, Sri Lanka, Transaction Costs*

1.0 BACKGROUND TO THE PROBLEM: HIGH TRANSACTION COSTS

The poverty headcount for Sri Lanka as per the 2006/07 Household Income and Expenditure Survey of the Department of Census and Statistics of Sri Lanka was 15.4%.[3] However, 21.6% of agricultural households, a much higher number than the national average, was found to be in poverty. Put in another way, as a share of all households in poverty, agricultural households accounted for as much as 45% of the poor (industry 23.2% and services 31.8%). These findings indicate the importance of fighting agricultural poverty in reducing overall poverty in Sri Lanka. The World Bank (2008) points out that growth in agriculture is on average at least twice as effective in reducing overall poverty as growth outside agriculture. The basic argument is that sustained agricultural growth through some level of commercialized farming reduces poverty directly by raising farm incomes and indirectly by generating employment and reducing food prices. However, the challenge for countries like Sri Lanka where the sector is dominated by small scale subsistence farmers is, to what extent they could move towards

DOI: 10.4018/jictrd.2010010104

becoming commercial (at least partly) to achieve such a sustained growth.

As McCollough et al. (2008) point out, becoming a commercial farmer fundamentally means that farm produce becomes responsive to market needs as opposed to household needs in a subsistence environment.[4] However transforming from subsistence to commercial agriculture, assuming the farmer is willing and able to do so, is difficult. Pingali et al. (2005) demonstrate that the biggest barrier to a successful conversion is high transaction costs associated with the process. For instance, how does a farmer decide what, when and how much to produce? How does he or she decide when and which market to sell? These are the hard questions farmers find difficult to answers, or in other words, typical transaction costs that the farmers find difficult to meet, and thus keep them in subsistence farming. It is in this context of reducing high transaction costs in the transformation from subsistence to commercial agriculture for small scale farmers that information and communication technology (ICT) become important. In this background, this brief paper considers what role ICT can play and provide some food-for-thought to consider in formulating ICT policy for agriculture.

The rest of the paper is structured as follows. Section 2 contains a short theoretical background to transaction costs in agriculture to identify the role of ICT in reducing the same; then section 3 refers to a case study of vegetable farmers in Sri Lanka to practically assess transaction costs along the selected value chain and section 4 then identifies the role ICT can play in reducing transaction costs. Having done this, section 5 looks at to what extent an ICT policy for agriculture is required and in section 6 discusses the situation with respect to Sri Lanka. Then section 7 deals with the current predicament in Sri Lanka and finally section 8 proposes some food for thought for the future in ICT for agriculture.

2.0 DEFINING TRANSACTION COSTS: INFORMATION SEARCH COSTS

Given the objective of ICT in agriculture is to reduce transaction costs for farmers it is imperative that transactions costs are understood and well defined. Interestingly however, as Singh (2008) points out, there is no standard definition of the term, and traditionally, transaction costs have broadly been interpreted as costs associated with market exchange. In the vast literature on the subject starting from the seminal work of Coarse (1937) to the recent work by Aker (2008) several specific definitions have been used. In this paper we use the definition suggested by Staal et al. (1997) where transaction costs in an economic exchange are classified into observable and unobservable costs beyond the actual cost of the product or service being exchanged. In the case of agriculture markets observable transaction costs would include tangible (and proportional) costs such as transport, handling, packaging, storage, spoilage etc. that are visible when an economic exchange takes place. Unobservable transaction costs, on the other hand, would include intangible (and mostly fixed) costs such as cost of information search, bargaining and enforcement of contracts etc. From an ICT perspective it is really the cost of information search; a subset of total transaction costs, that can potentially be reduced through the adoption of ICT.

3.0 INFORMATION SEARCH COSTS: A CASE STUDY[5]

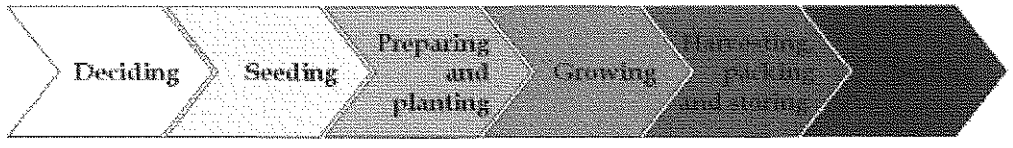
Generalizing information search cost to agriculture in Sri Lanka, or any other country for that matter, is not possible due to the heterogeneity of the sector. In the case of Sri Lanka the agriculture sector is divided into two sub-sectors; plantation and non-plantation. The plantation sector covers export cash crops; predominantly tea, rubber and coconut and holds a considerable share (37%) of

cultivated lands. The non-plantation sector on the other hand comprises crops grown mainly for domestic consumption by small farmers in small pieces of land; majority with less than one 2.5 acres of land. Rice is the major crop grown by these small farmers along with a variety of other field crops such as maize, cow-pea, mungbean, chillie, onion and vegetables (Mudannayake, 2006). The importance of these small farmers become clear when one considers the findings of the National Agriculture Census of 2002. It was found that the island's land area under agriculture consisted of some 1.5 million less-than-quarter-acre plots and another 1.8 million quarter-acre to 20-acre small holdings. In addition to these small and midsize plots some 385,000 greater-than-20-acre estates also were listed. In total almost 5 million acres were found to be under cultivation. It is obvious that transaction costs of the varying agricultural crops and holdings would be diverse and not generalizable. However given the objective of this paper on using ICT to reduce transaction costs from a poverty reduction perspective we focus our attention on the millions of small farmers with the potential of becoming at least semi-commercial farmers.

To illustrate the point we use the case study in de Silva et al (2008) of selected commercialized small holder vegetable farmers in the greater Dambulla area. De Silva et al. (2008) modeled transaction costs along the (limited) value chain (depicted in Figure 1) starting from the crop decision and ending with the sale of produce at the wholesale market using a random sample of 300 farmers growing the four most traded vegetables; namely tomatoes, onions, brinjals and chilies in the feeder are of the Dambulla Dedicated Economic Centre, the largest wholesale market for vegetables in Sri Lanka located in central Sri Lanka. The study was administered by the final year students of the main agriculture school in the area. They used a structured questionnaire, which was developed after several iterations of focus group discussions with farmers to gather information on all the farming related activities and costs incurred by selected farmers during the previous season. These costs were subsequently categorized in to direct costs, information search costs and other transaction costs.

In order to appreciate how ICT can be used to reduce the cost of information search, it is important to understand the points at which farmers actually search for information along the value chain in order to make decisions. De Silva et al (2008) found that in the first stage of 'deciding', farmers look for information to select (as far as possible) what crop to grow and how much land to allocate for (each) crop. They also seek information on arranging working capital financing at this stage. In the second stage of 'seeding' farmers were found to either purchase seeds or prepare their own seeds based on the crop they have earlier decided to grow. Here information is sought on seed availability, quality and price of such seeds. In the third stage of 'preparing and planting' farmers prepare the land using own or hired labor and (or) land preparation machinery and subsequently plant the seeds. Here farmers look for information on availability of labor and on hiring and sharing the hired equipment. In the fourth stage of 'growing', application of water, fertilizer and pesticides take place. It is during this stage that farmers actively look for

Figure 1. The limited agriculture value chain: From planting decision to sell at wholesale market (Source: De Silva et al., 2008)

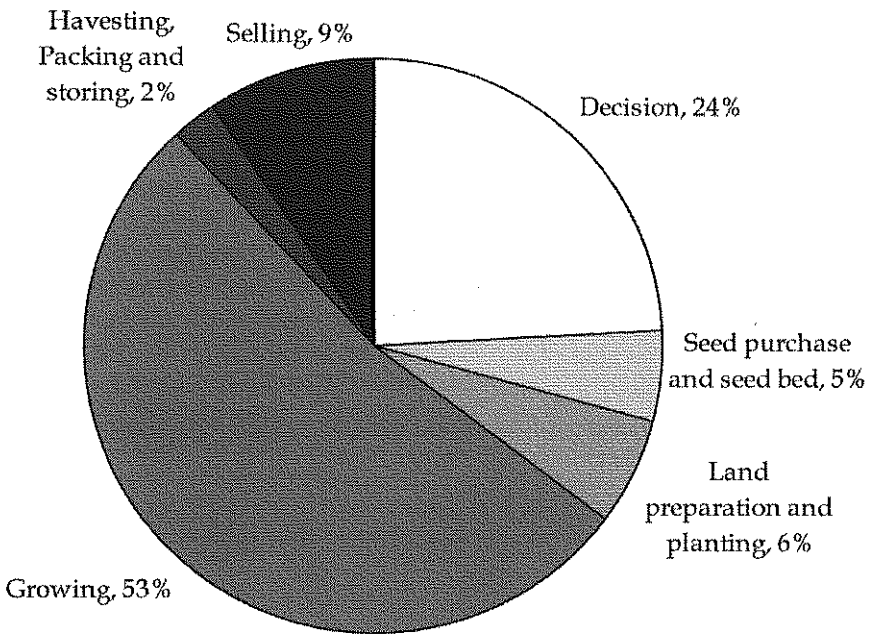


subsidized fertilizer that they are not actually eligible for; a perverse incentive that exists due to the policy of issuing low cost fertilizer for selected farmers based on crop. In this stage farmers are also in danger of diseases to crops and in such cases need information on the type of treatment and pesticides to use. In the fifth stage of 'harvesting, packing and storing' farmers were found to look for information on labor for harvesting and locations for storage (in case of being stored) and (if at all) packing. In the final stage of 'selling,' farmers were in need to ascertain prices at the various markets and also on options on transporting the produce to the selected market. If the price was not known or if it changed since it was last known, farmers, who arrive at the wholesale market (Dambulla Dedicated Economic Centre) were found to seek information on the best price from the large number of trade stalls.[6]

Based on this model de Silva et al. (2008) found that 11% of total cost, or 70% of all transaction costs, was related to information search along the value chain for the surveyed farmers. When the total information search costs in different stages of the agricultural value chain was considered, they found that the highest percentage of cost of information was incurred during the growth stage, followed by the decision stage and selling stage as depicted in Figure 2.

De Silva et al. (2008) found that the primary reason for the unusually high percentage of information search costs during the growing stage (53%) was found to be caused by the previously mentioned government procedure on fertilizer subsidy to farmers in that area besides information on pesticides. Vegetable farmers were found to visit the distribution centre multiple times before purchasing the subsidized fertilizer earmarked, not for vegetable farmers, but only for paddy farmers. The second most important stage was the decision stage (24%). Here information search costs included visits to meet farmer association officials and other neighboring farmers etc. to decide on a crop to grow. Costs of arranging finance where the farmers had to pay multiple

Figure 2. Information search costs by stage (Source: De Silva et al., 2008)



visits to banks and other rural finance institutions and finding guarantors etc. were also included. Some farmers had leased the land from others and this process had also involved substantial search for information. The selling stage was the third most important in terms of information search (9%). Here it had been found that costs of comparing prices of different markets and traders accounted for the most costs while finding transport to physically carry the produce to the selling market also incurred a fair share of information search costs. Other stages also contributed as depicted in Figure 2.

In terms of proportion of cost of information in each stage, de Silva et al. (2008) found that the decision stage was the costliest in terms of the share of information search costs with the cost of information search to total cost ratio being 3:1, followed by growing stage with a ratio of 1:4 and the selling stage with a ratio of 1:5 as depicted in Figure 3.

Another significant finding in de Silva et al. (2008), reiterating Stall (1997), is that the cost of information is relatively fixed; that is the cost incurred in obtaining information is not necessarily associated with the total cost. Stemming from this finding is that the smaller farmers have to bear a larger proportion of total costs as information search costs as shown in a plot of information search costs and total expenditure in Figure 4.

4.0 ROLE OF ICT IN REDUCING INFORMATION SEARCH COSTS

Having established the importance of information costs in agriculture using the above case study the next logical step is to ascertain how well ICT could be used to reduce such costs. De Silva et al. (2008) found that farmers mostly traveled (exclusively or combined with other needs) to meet farm association officials to obtain crop advice or to distributors looking for fertilizer or to markets looking to get a good price for their produce because they did not have prior accurate and timely information.[7] The authors calculated that if half the visits were replaced with paid phone calls that the total information search costs would reduce to by 33% without accounting for cost of time saved. In fact, several recent studies have been able to show positive results between use of ICT (mainly mobile phones) for information search and increased income among farmers and fishermen. Jensen (2007) is perhaps the most convincing thus far on the role that mobile phones can play in increasing efficiencies in markets where information is limited or costly.

Figure 3. Relative cost of information by stage (Source: De Silva et al., 2008)

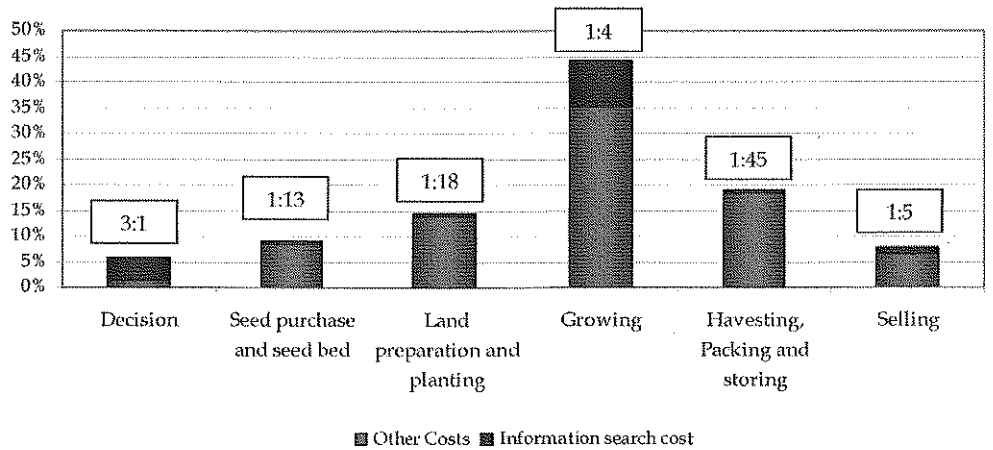
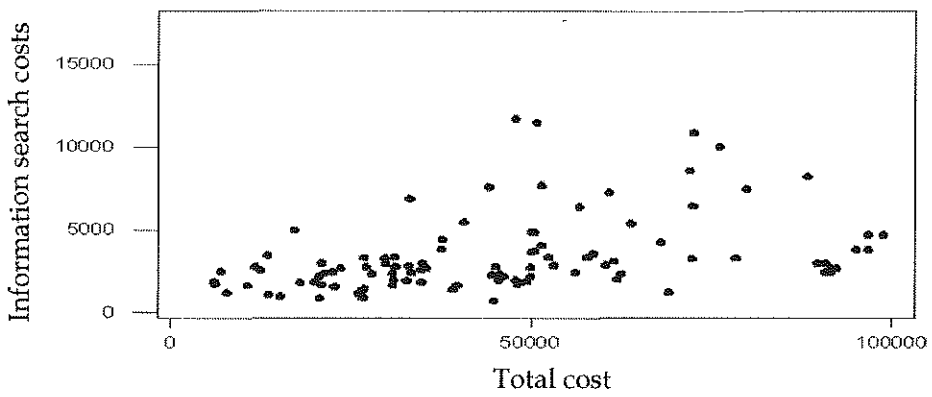


Figure 4. Information search costs vs. total cost in Sri Lanka Rupees, (LKR); Source: De Silva et al., 2008)



He presents the results of a study on fisheries markets in Kerala, India, where adoption of mobile phones by fishermen and buyers resulted in a "dramatic reduction of price dispersion, the complete elimination of waste and a near perfect adherence to the law of one price". This, Jensen (2007) shows, was because prior to the availability of mobile phones the cost of information was so high that agents were not able to engage in optimal arbitrage; before phones, fish was sold in home markets of the fishermen where they did not get the best possible price, whereas after phones, they found out the prices in nearby markets that enabled them to sell their fish at the market with the highest price. This improved the welfare of fishermen as well as fish consumers. More recently, Aker (2008) has shown that mobile phone use among grain sellers led to significant reductions in grain-price dispersion net of transport costs across markets in Niger. While all of the above were linked to 'selling' stage of the value chain considered, Soysa (2008) reporting on a case study on traceability in the agriculture value chains, shows how gherkin farmers in Sri Lanka were able to improve their incomes by using a simple mobile phone application to reduce waste through a feedback system linking 'selling' with the 'growing' stage. Here text messages were sent to the farmers on a daily basis giving details of amount of gherkins rejected at the processing centre and the reasons for same in order to take immediate action to rectify the issue (here mainly melon fly disease easily reversible in less than 3 days). The information search cost of this activity prior to the use of phones was prohibitively high and resulted in significant losses both to the processor and the farmer.

In this background many have shown that adoption of mobile phones, in particular by low income earners, greatly dependent on the perceived benefits of owning a mobile phone. Taragola et al. (2001) shows that apart from the high cost of technology and lack of technological infrastructure, lack of understanding "how to get a benefit from the use of ICT" is a main barrier for ICT adoption in horticulture. In their Technology Acceptance Model (TAM), Davis et al. (1989) argue that perceived usefulness of new technology and perceived ease-of-use of the new technology as the two main factors that drive the new technology adoption. Rice and Katz (2003) and Chabossou, Stork et al. (2009) developed statistical models to understand the mobile adoption decision and show that demographical and social characteristics impact the mobile adoption decision. More recently De Silva et al. (2009) show that apart from demographical and social characteristics, higher level of perceived social, economical

and emergency benefits contribute positively towards the mobile phone adoption decision.

Therefore an essential pre-condition for the farmers to realize economic benefits (i.e. lowering information search costs) of using ICT is the existence of accurate and timely information in order to be disseminated or picked up by phone. Some of the much discussed such market information service projects are Manobi in Senagal where price information and e-business services are provided on a mobile telephone platform to commercial farmers (Rashid & Diga, 2009; IDRC, 2005) and TradeNet in Ghana where an NGO is subsidizing text messages of current price information of various crops (Kutsoati & Bartlett, 2008). Reiterating this fact, Alenea (2008) studying the maize market in Kenya found that access to mobile phones had turned out to have positive but insignificant effects on market participation in the context of non-availability of any market information service in the study area.

Besides numerous such mobile phone based market information schemes (in addition to individually obtaining the same via simple adoption) number of complex Internet based initiatives are also available across the region and the world. For example India is overflowing with such services as explained by de Silva (2008) in a scoping study of ICT for rural livelihoods in South Asia. A typical example is Agmarknet, a government initiative providing comprehensive market information to farmers, traders and consumers with the objective of "networking 2,800 major agricultural produce wholesale markets and dissemination of daily commodity prices in major Indian languages and empowering the farmer community with the knowledge of latest market information" (Stockholm Challenge, 2006). AgriWatch is another; a private initiative that provides wide-ranging information related to spot and futures prices, news and analysis, statistics and trends, weather, crop forecasting and advice. While such portals have tremendous value in terms of reducing information search costs across the six stages of the earlier discussed limited value chain (and in an extended value chain), the crucial issue from a poverty reduction perspective is to what extent poor farmers could avail themselves to this information given the grave lack of access to the Internet in rural areas of the country. LIRNE*asia* (2009) found that only 1% of Indian households at the Bottom of the Pyramid (BOP: defined as socio-economic classifications D and E; age 15 to 60) use the Internet. This shows that existence of accurate and timely information alone is not sufficient for ICT to contribute to economic well being of the poor. The technology also plays a significant role in realizing the true potential ICTs have in reducing poverty. Simple technologies such as mobile phones, interactive voice recognition (IVR) systems and text messaging have often been proven more effective than flashy web applications.

Apart from all the above the ICT policy of a country should not be a barrier (if not conducive) for researchers and practitioners to develop and maintain ICT interventions that address information asymmetries in the markets along the agricultural value chain.

5.0 ICT POLICY FOR AGRICULTURE: USEFUL OR NOT?

If policy makers appreciate the objectives and final outcome of a policy and formulate the same to make the environment conducive for the various stakeholders towards achieving the said final outcome then a policy would be welcome. The preceding sections have made it clear that the objective of ICT in agriculture is to reduce demand-driven information search costs along the value chain so that the resulting lower transaction costs would help subsistence farmers to gradually move towards at least some level of commercially oriented sustainable farming; the expected outcome in order to promote agricultural growth and reduce agricultural poverty. To be sure, this is diametrically different to the view held by some that ICT for agriculture is the 'computerization' of supply-driven extension services currently being provided (or supposed

to be provided) by the state or developing a fancy website.

A few countries have ventured in to formulating ICT policies for agriculture. Ghana is an example. According to the Institute for Communication and Development (IICD, n.d.), Ghana with the help of IICD and based on a consultative mechanism between ICT experts and those in the agriculture sector 'mainstreamed' ICT within its ministry of agriculture and developed an e-Agriculture policy to "improve the livelihood of farmers". The objectives of the policy are said to be several-fold: to apply ICT to develop information systems for increased agricultural productivity; to apply ICT for development of effective agricultural production systems; to use ICT to develop effective marketing mechanism for agricultural products; to use ICT to promote processing, preservation and storage of agricultural products; and to apply ICT to facilitate capacity building in agriculture. While this list sounds most impressive, to what extent Ghana could apply ICT to actually reduce information search costs of Ghanian farmers (the real objective of ICT in agriculture) remains to be seen. While formulating policy is one, it needs to be adopted, implemented and evaluated before judging its level of success.

India on the other hand does not have a specific ICT for agriculture policy. However, in 1995 Indian policy makers had recommended that the Indian government set aside some 3% of its agriculture budget for 'agriculture informatics' and by 1997 an IT plan for the agriculture sector had been formulated by the ministry of agriculture leading to the earlier discussed Agmarknet portal (Sarma, 2003). However in the case of India, immaterial of policy, numerous ICT for agriculture projects have been established by the private sector and NGOs across the nation; 44 of such grassroots initiatives are listed in the IDRC scoping study by de Silva (2008). In addition to the numerous small local projects, India has several large ICT for agriculture programs that are very successful and by their sheer size and importance led the Indian government to ensure that the policy environment for their success is not disturbed. The most well known initiative is e-choupal, an initiative by Indian Tobacco Company providing (non-tobacco) farmers the opportunity for transparent price discovery and access to wider markets, farming know-how and services, timely and relevant weather information and also providing logistics support for produce transport (more than ICT), that is currently covering 40,000 villages and 4 million people with 6,200 e-choupal centres; bigger than any government initiative (Rai, 2009). Another is Reuter's MarketLight, a service that provides customized market intelligence to farmers. (Thaindian News). The other very important initiative by the private sector has been to establish electronic commodities exchanges to trade agricultural commodities. The Multi Commodity Exchange (MCX) and the National Commodities and Derivative Exchange (NCDEX) are now beginning to make its presence felt with spot and future prices being transmitted to rural farmers through middlemen (mobile phone based services) for decision making.

6.0 CASE OF SRI LANKA

Sri Lanka does not have a national ICT policy for agriculture. In this background various institutions, both state and NGO, have articulated the need for such a policy and in turn started to develop their own. Consider the state; the Ministry of Agriculture Development and Agrarian Services through the Department of Agriculture (DOA) has incorporated ICT in to their extension programs and created some effective programs to reduce farmers' information search costs as well as build capacity among them. According to the DOA, the National Agricultural Information Network or the cyber agricultural extension system is one of such key initiatives. Under this program, 45 cyber extension units are available for farmers to use some 30 user-friendly and interactive multimedia CD- ROMs on how to cultivate various crops. The DOA in their website (www.agridept.gov.lk) articulates the need for market information on agriculture in the following manner:

"The sustainability of agriculture sector can be improved by better information on knowledge of supply, demand, knowledge of buyer requirements and prices. Pre-seasonal planning will help the country to avoid over production and ultimate low prices. Considering the importance of this information, a farmer database (name of the farmer, type of crop, extent, expected yield etc.) was introduced to the network of information repository of the DOA website in early 2007. This initiative will be an attempt to solve marketing problems of the farmer as a direct link will be established between the farmer and the wholesale buyer, both local and foreign, without middlemen. The regular updating (of the) database will also give policy makers a clear insight of availability of crop at a given time, which helps them for export and import decision making."

While this is a good start to reduce the information search cost in the 'decision' stage, the initiative seem to have got lost in the grandness of the scheme. Even though the database is supposed to be all encompassing; with details to be submitted from all across the country and for 48 different types of produce, a cursory visit to the database indicated that the vast majority of the fields were empty with a only a few entries for paddy, tomatoes and banana.

Besides this database, the DOA has two other important services. One is the provision of market information from the Dambulla Dedicated Economic Centre. Here the spot price information is current and updated several times a day in association with 'Govi Gnana Seva' (GGS) a private not-for-profit initiative operating in the location (personal knowledge). The other is the '1920 Govi Sahana Sarana' service; a toll-free (first 3 minutes), short code (1920), quick advisory service provided to farmers during office hours. According to DOA some 150 to 200 calls a day were received during the early stages of the program up to May 2007. According to the DOA, the expected outcomes of this service are: demand driven agriculture extension; quick mechanism of disseminating agriculture information; strengthening of research-extension-training-farmer linkage; and maintaining of records on farmers' queries as a digital database for further action. From an information cost reduction perspective along the value chain, this service possibly could help across all segments except deciding and selling (selling information to be obtained from the market information website and deciding from the market database). While the above ICT activities are being implemented by DOA, the Ministry of Agriculture Development and Agrarian Services has under its purview, another 19 separate departments and statutory institutions which could implement their own ICT programs. However, Punchihewa et al. (2008) has noted that "Most of the institutions under the ministry have very useful information on research, product development, market enhancement information etc, but very rarely (does one) see them disseminated over the Internet for farmers use".

The other government agency with a natural interest in formulating an ICT policy for agriculture is the ICT Agency of Sri Lanka (ICTA). The ICTA, functioning under the Presidential Secretariat, has been tasked, according to their website (www.icta.lk) with implementing the e-Sri Lanka initiative; to use ICT to "develop the economy of Sri Lanka, reduce poverty and improve the quality of life of the people", a broad enough mandate to include sustained agricultural development for poverty reduction. Even though the ICTA does not have a specific ICT for agriculture program, it has undertaken several agriculture related activities. The first was funding, inter alai, the GGS pilot project in 2003. The GGS pilot, designed and developed specifically to address the information search cost problem leading to high transaction costs, has continued (with difficulty and at a scaled down version in the recent past) to collect and disseminate spot prices of vegetables on a daily basis (several times a day) via price boards, an IVR and the Internet from DDEC. Punchihewa et al. (2008) refer to the GGS as follows "The ICT agency of Sri Lanka pioneered in initiating the 'Govi Gnana System' pilot project in

Dambulla Dedicated Economic Zone. This is an important project that empowers the traders and farmers to benefit from greater access to information providing long term visibility and predictability of income and details on demand of trends for harvesting. Unfortunately however, the system's benefits were not reaped by the implementers as users have shown lack of enthusiasm towards this project." Ironically, the GGS pilot was evaluated by independent auditors at the end of the pilot period along with all other pilot projects and was found to be only one of three pilots to have scored the highest level of success: a satisfactory outcome with a substantial impact on the target audience.[8] However ICTA appeared to be neither interested nor appreciative of the solution as defined as one aimed at reducing information search cost and thereby did not contribute towards scaling up the GGS pilot.[9] Having lost valuable time in the process and having relied on private donations to continue the service, GGS has just been re-launched as a mobile-phone based commercial venture with a reach of millions of farmers across the island.[10]

Since the early days of GGS, ICTA has subsequently initiated or funded several agriculture related projects. The support to the Audio Visual Centre of the DOA to develop, inter alia, an 'agriculture wikipedia' (ww.goviya.lk) and also awarding the best government website to the DOA to encourage further innovation perhaps is the most significant. Among other large ICT for agriculture interventions funded by the ICTA are a fair number of websites to promote e-learning (sometimes referred to as 'web-based training' and 'digital content') among various groups of farmers. Besides, ICTA has also funded at least 15 smaller ICT for agriculture interventions as well. They consist mainly of training workshops, websites, developing CDs etc. aimed mainly at providing 'information to farmers' or 'establishing e-marketing centres' to farmers at a regional or local level.[11]

Besides DOA and ICTA another fairly established player in the ICT for agriculture landscape is the NGO Sarvodaya-Fusion which according to their website have launched a project called the 'Agri-Clinic' with the participation of the DOA, University of Peradeniya, ICTA, an entity by the name of CAB International of the UK, Microsoft UP and UNESCO, to according their website (www.agriclinic.fusion.lk) 'help Sri Lankan farmers increase their agricultural productivity' by gathering 'latest research findings and agricultural data' from various sources and 'transforming them into simple, farmer-friendly communication materials such as leaflets, booklets, video CDs, and e-books'. According to the ICTA website it is also developing a 'mobile-enabled platform for agriculture marketing'.

7.0 CURRENT PREDICAMENT OF ICT FOR AGRICULTURE IN SRI LANKA

Desk research and personal discussions with stakeholders indicate that, and as elaborated above, a large number of positive interventions in the ICT for agriculture space have been initiated by truly committed people and institutions within government, NGOs and some private sector parties. The work by the DOA must particularly be commended for having attempted to address almost all components of the earlier defined agriculture value chain. The small regional projects funded by the ICTA are also important from a localized perspective.

However, a most noticeable feature of these various projects is that there does not seem to be any cohesion in the approach of incorporating ICT for agriculture. There are several projects that are redundant and several that seem to be planning to provide much more than practically possible.

It is not possible to conclude that this ad-hoc nature of projects, except for the DOA, is due to the absence of an ICT policy for agriculture or due to a lack of clear appreciation of the objectives of ICT for agriculture. However it is clear that none of the existing projects have explicitly addressed the issue of using ICT to reduce the information search costs along the agriculture value chain. Unless that appreciation is made it will not be possible to link

the various projects in to one seamless ICT intervention in agriculture. For instance, the projects that are attempting to 'educate' the farmers on how to treat a particular disease must all be consolidated together. It is not possible for farmers to 'look' for this information in numerous places. The objective of 'ICT for agriculture' in this scenario would be to reduce this particular search cost or the cost of 'looking' for the information. Punchiweva et al. (2008) have proposed a 'farmer community web portal' where information will be collected from various sources and made available for farmers in the rural areas through community tele-centeres. Ironically, this seems to be the universal ICT for agriculture solution; build a fancy portal and make it available through a tele-centre. This is nothing new and numerous people and organizations have tried this and, for the most part, failed in the past. ICTA is supposed to now have several hundred tele-centers and theoretically the problem could thus be solved fairly easily. But, the practical reality is that farmers continue to be poor, stuck in subsistence farming. However knowledgeable the farmer maybe with the e-learning provided by ICT for agriculture service providers if he or she does not know what and how much to produce when and where and what price to sell, the farmer will never be able to become a commercially sustainable farmer.

8.0 THE FUTURE OF ICT IN AGRICULTURE: FORWARD MARKETS AND MOBILE PHONES

ICT cannot solve all farmer problems. It can only play a role in reducing information search costs; and that too, if and only if, the farmer adopts (not in a strict way, but loosely if he or she uses) ICT. Therefore if ICT is to help the farmer, two key questions must be answered. One; how can ICT be specifically used to reduce the information search costs of the particular farmer along his value chain? Two; how can one ensure that the farmer adopts the ICT that would help him reduce this cost?

The current assessment is that the various ICT for agriculture projects put together is still unable to provide completely satisfactory answers to these two questions. While a significant amount of work has been done in the case of compiling information on the various components of the agriculture value chain, say on seeding, growing and to some extent selling (with current prices) almost no work has been done on the most important component of 'deciding'. The only attempt by DOA in matching supply and demand using a 'farmer database' has not been successful. It is therefore imperative that a complete re-look at this critically important aspect is undertaken. The answer lies not in government officials demarcating 'one village one crop' type schemes but in a market determined mechanism of matching future supply with future demand; essentially in creating forward (or futures) markets. The relevant question then becomes one of how could ICT be utilized to create such a market for agriculture.

The second and equally important question is how one ensures that farmers adopt the particular ICT that will help him or her reduce the cost of information. There is no value in having all the crucial information in some website if the farmer has no access to the Internet. Unfortunately in Sri Lanka much of the ICT for agriculture projects, both DOA and ICTA, as discussed earlier, has a complete Internet focus with the exception of the DOA 1920 telephone service. This is clearly a mistake. Evidence shows that mobiles, not Internet PCs, have the potential to be the best vehicles for delivering services to rural areas, not just in Sri Lanka but across the emerging Asia region (LIRNEasia, 2009). This study shows the dramatic difference of access (in late 2008) with 77% of the bottom of the pyramid (BOP defined as socio-economic classifications D and E) in Sri Lanka owning a phone (personal mobile phone or household fixed phone) but with just 3% of the BOP had access to the Internet (LIRNEasia, 2009). While it is true that some of them would go to tele-centres to use the Internet, the difference between 77 and 3 is so wide that it is impossible

to justify a focus on Internet delivery of services at the present time on a mass scale.

The days of mobile phones being used only for voice are beyond us now. Text messaging, or SMS, has become equally important as voice communication with 73% of all mobile phone owners at the BOP in Sri Lanka admitting to using SMS regularly in the above survey (LIRNEasia, 2009). Thus it is clear that agriculture information, particularly frequently used information (as opposed to infrequently used information such as learning how to grow a particular crop) would be better provided by the almost ubiquitous mobile phone than at distant tele-centres with opening and closing hours (in the case of the ICTA sponsored nenaselas this is even worse with several of them being located in Buddhist temples that restricts access to women and non-Buddhist persons). Once the technical and regulatory issues of m-payments are resolved, it is likely that mobile phones will become the main mode not only of information search and recovery but also of e-payment. Then it will be possible not only to lower transaction costs along the agriculture value chain, but also complete farmer transactions via the mobile phone.

In conclusion what is important is not whether Sri Lanka has a glorified ICT policy for agriculture but whether the stakeholders are able to appreciate the role ICT can play in agriculture; that is to reduce the cost of information search leading to lower transaction costs along the agriculture value chain; be it through market prices or 'educating' farmers on crop management. The ideal future scenario would be that farmers are able to confidently decide on what, how much and when to grow based on ICT driven forward market agreements on where and what price to sell; something impossible in the current context with prohibitively high information search costs. All other costs of information search in between these two actions would also naturally be lowered by ICT interventions so that it would become possible for farmers to profitably participate in agriculture markets. However for any of this to happen policy makers must appreciate the practical ground situation on affordable ICT access at the rural farmer level. Instead of being carried away by fancy technology stakeholders must be willing to appreciate that two-way communication front-ended by the almost ubiquitous 24x7 mobile phones will be the ICT that can get the job done given the right incentive structures are in place for win-win outcomes to all parties.

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ENDNOTES

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2 Presented at the Joint National Conference on IT in Agriculture, University of Moratuwa, Sri Lanka, 16 July 2009. Comments received

therein and that of an anonymous reviewer of this version are appreciated.

3 Excludes the Northern Province and Trincomalee district in the Eastern Province due to the war. Unofficial estimates are that poverty has risen since then due to very high inflation in 2008.

4 Of course not every agricultural household will convert to commercial farming and in many cases agricultural households will continue with subsistence farming for staples while engaging in commercial agriculture with selected cash crops.

5 This section draws extensively from a previous paper by the author; de Silva et al (2008)

6 It is true that some farmers would have to sell to the particular trader who may have advanced him working capital, but if the market price is known to the farmer he is empowered to at least bargain for a better price for the produce than what is offered, if much lower than the market price.

7 Some argue that it is not possible to estimate the cost of information accurately since farmers do other things or do multiple things when they travel to town. Special attention was paid to this possibility in the survey and only the costs incurred during visits that are primarily related to the farming process were included.

8 http://www.icta.lk/Insidepages/downloadDocs/Nenasala/OutcomeEvaluation_of_PilotProjects.pdf

9 As founder of GGS and having dealt with the ICTA since the beginning of the pilot the author has had numerous interactions with the agency to have come to this conclusion. However, it remains a purely personal view.

10 http://www.tradenet.dialog.lk/tradenet.htm

11 This information was obtained through discussions with officials of the e-SDI program of the ICTA.

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Example 2: Duke-Wilson (2009) states that the value of information is recognized by most organizations.

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Example 1: Wilson (2008) states that "the value of information is realized by most organizations" (p. 45).

Example 2: In most organizations, "information resources are considered to be a major organization asset" (Duke-Wilson, 2009, pp. 35-36) and must be carefully monitored by the senior management.

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ISSN 1947-341-9

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