INFORMATION AND COMMUNICATION TECHNOLOGIES AND AGRICULTURAL DEVELOPMENT IN SUB-SAHARAN AFRICA: TRANSFORMATION AND EMPLOYMENT GENERATION

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GLOSSARY

ARD	Agricultural Research and Development
ANI	African Networking Initiative
ASTI	Agricultural Science and Technology Innovation
B2B	business to business
B2C	business to consumer
CABECA	Capacity Building for Electronic Communication in Africa
CAD	Computer-Assisted Design
CARIS	Current Agricultural Research Information System
FAO	Food and Agriculture Organisation
FFV	Fresh Fruit and Vegetables
GDP	Gross Domestic Product
GM	Genetically Modified
GNP	Gross National Product
GPS	Global Positioning Systems
ICT	Information and Communication Technologies
IDAs	International Development Agencies
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IICD	International Institute for Communication and Development
IMF	International Monetary Fund
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ITU	International Telecommunications Union
JIC	Just in Case
JWN	Just What is Needed
NePAD	New Partnership for African Development
NGO	Non-Government Organisation
NICs	Newly Industrialised Countries
PADIS	Pan African Development Information System
PDA	Personal Digital Assistant
PRSP	Poverty Reduction Strategy Paper
PTA	Preferential Trade Agreements
RFID	Radio Frequency Identity
SEWA	Self-Employed Women's Association
SME	Small and Medium Enterprises
SMS	Short Message Service
SPS	Sanitary and Phytosanitary
SSA	Sub-Saharan Africa
UNDP	United Nations Development Program
VITA	Volunteers in Technical Assistance
VOIP	Voice over Internet Protocol
VSAT	Very Small Aperture Terminal
Wi-Fi	Wireless-Fidelity
WLL	Wireless Local Loop
WTO	World Trade Organisation
WWW	World Wide Web

1 Introduction

In an era of globalization accompanied by rapid technology change, a country's competitiveness and relevance in the global economy is increasingly determined by its capacity to effectively use information for design, production and marketing (Dzidonu, 2002). A growing mode of delivery in this environment is by Information and Communication Technologies (ICT) that capture and store digitally encoded data, manipulate and transform these data, and then transmit and share the results. The importance of ICT for innovation and economic growth has been widely recognised, prompting the Economic Intelligence Unit of the well-known Economist magazine to introduce an annual 'e-Readiness' ranking in 2000 to guide governments and investors (EIU, 2006:1).

The concern of this paper is how ICT impact on development, transformation and employment creation in the agricultural sector in sub-Saharan Africa (SSA). For policy makers who must prioritise the allocation of public resources, the following questions are of concern:

i) What is the critical level of investment in ICT to optimize impact in the agricultural sector;

ii) What is the role of public investments to ensure optimum application of ICT in the agricultural sector and agrarian economy more broadly; and

iii) How can those actors in the sector who would be disadvantaged be compensated, given the distributional implications of the use of ICT?

These issues are particularly relevant in SSA in which the uptake of mobile telephony and the attendant investment in ICT has been the most rapid in the world since 2000 (Coyle 2005:3; MIT, 2007). As a result of this, the number of mobile subscribers in SSA had already exceeded the number fixed lines by 2001. To begin to answer the questions that arise from this spectacular growth, and the broader issue of ICT's impact on the agriculture sector in SSA, this paper uses secondary information to give an overview of applications of ICT for economic change in the agricultural sector, as well as for the socio-economic transformation of the wider agrarian economy. Its objective in doing this is to identify the elements of an appropriate framework for assessing the impact of ICT on agricultural development, transformation, and employment generation. The paper will review international experience with emphasis placed on SSA. The link between ICT and development will be discussed more generally before describing the components of the ICT system, providing examples from the agricultural sector where ICT are adopted. The challenges encountered with policy for ICT application in agriculture in SSA are then identified along with key research questions. The paper concludes by proposing a research project that will make use of a commodity chain approach to explore nine sector-based case studies to be undertaken in 12 SSA countries. In addition, two cross-cutting studies are proposed that will synthesise this information, providing answers to the three policy questions just proposed.

2 ICT and Development

There has been rapid development of information technologies internationally in the last two decades. Studies from Newly Industrialised Countries (NICs) and the developed world have shown that ICT can positively contribute to economic growth and development (Hamelink, 1997).[2] It is further argued that ICT have the potential to reduce poverty and improve livelihoods by empowering users with timely knowledge, reducing transaction costs, and appropriate skills for increasing productivity (Kenny, 2000). The dynamism of ICT is thought to promise fundamental change in all aspects of life, including knowledge dissemination, social networking, economic and business practices, political engagement, education, health, leisure, and entertainment. It is also believed that ICT are useful either as tangible goods in their own right or as value-adding services and they therefore assist the development efforts made by governments (Marker et al, 2001; Stiglitz, 1989; World Bank, 1998).

Research designed to provide empirical evidence of this relationship has most often adopted a broad macro approach in its analysis. As a result, such studies have tended to make rather general statements drawing attention to the high correlations between higher levels of economic output and intensities of ICT access (Sridhar and Sridhar, 2004; UNDP, 2003). Other research has studied the correlation between the level of socio-economic development and use of information or the size of the information sector (Jeong, 1990; Menou, 1985). Reference is often made to the contribution of information to development at a global, national or regional level. In the context of developing countries, ICT are sometimes identified as being central in efforts to escape poverty arising from their potential benefits for increasing incomes of the poor and enhancing overall national social and economic growth (Adhikari, 2002; Kenny, 2001; UNDPa, 2005). Attempting to quantify this aspect, the UNDP (2005b) examines the role accorded to ICT in the Poverty Reduction Strategy Paper (PRSP) process being followed in many countries.[3] In 13 of the 21 countries surveyed ICT were mentioned as being of specific importance to rural and agrarian development, and in 4 additional countries, as being central to wider poverty reduction efforts.

A shortcoming of much of this research is that it avoids discussion of the potential benefits, costs, trade-offs and conflicts that arise at the level of individuals, households, enterprises and communities (Menou, 1993). Torero's (2000) household study of the effects of access to telephone services on poverty in Peru is an early exception to this and gives some insight as to how these hoped for benefits might actually take place. He argues that such services are pre-condition to information and telecommunication technologies and are the basis for the development of the full range of information

[2]/ Slater and Tacchi (2004) see ICT as encompassing "…a full range of information and communication technologies, which include radio, television, the press, physical notice boards, computers and the Internet." In addition to this illustrative list, this paper specifically includes technology and software for bar-coding, wireless technologies and internet based software.

[3]/ In September 1999, the World Bank and the International Monetary Fund (IMF) introduced the PRSPs as a new approach designed to focus loan operations on poverty reduction. The approach places emphasis on the preparation of a planning document that describes the macroeconomic, structural and social policies and programs of affected countries expected to promote growth and poverty reduction over a multi-year time horizon.

technologies. However, his econometric analysis of household data shows that while access to a telephone does explain why some households remain in a poor or non-poor category, and is positively associated with transitions from poor to non-poor status (and negatively associated with the reverse), the latter results are not significant (Torero, 2000:17). As a result, the study concludes that changes in human capital status, other assets and family size are more important causes of pathways into or out of poverty than is access to telephony. The implication is that increased access to and usage of ICT may be an outcome, rather than a determinant, of poverty reduction initiatives in developing countries.

In an enterprise level study, Matambalya and Wolf (2001) noting the paucity of studies analyzing the effect of ICT on Small and Medium Enterprises (SME), use a sample of 300 SME in Kenya and Tanzania to explore whether use of ICT can enable SME to improve their competitiveness and performance. This survey finds a positive correlation between average enterprise size and use of advanced ICT, which is rising over time. Besides lowering transactions costs, reducing uncertainties and other positive effects well-addressed by most information-theoretic analyses, the paper concludes that use of ICT can additionally increase competitiveness of SME by facilitating information flows and reducing transaction costs. The authors also offer some important caveats to understanding of the relationship between ICT and firm productivity which is not found to be significant. They note firstly, that there may be a substantial time lag between ICT investments and their payoffs. Secondly, they argue that ICT should not be regarded in isolation because it is at best one factor among others that contribute to improved firm performance.

From this it is evident that more detailed sectoral studies are required that examine the use, costs and benefits of ICT at the level of households, communities and enterprises. These studies need to be able to distinguish the direction of causality (do ICT improve economic well-being, or does economic well-being result in increased ICT usage) as well as the distribution of usage patterns, costs and benefits within the unit being examined. Given its diversity and specificity, in-depth research will be required for specific activities within the agricultural sector and it is recommended that a commodity- or value-chain approach be adopted.

3 Conceptualising Agriculture and ICT

Before proceeding to the specific case of ICT usage in agriculture, it is first useful to present an overview of agricultural production in Africa and then a conceptual framework through which agriculture can be analysed.

3.1 Agricultural Production in Africa

Although the contribution of agriculture to the Gross Domestic Product (GDP) of the sub-Saharan Africa has been declining over the past two decades, this sector continues to be a major source of employment in most of the countries in the region. The importance of agricultural production, excluding agri-processing is evident from Table 1 which shows the population, Gross National Income (GNI) of the region's countries, the percentage of GDP that is contributed by agricultural production and the average contribution of agriculture to total exports.

Table 1: Population, Economy and Contribution of Agriculture in SSA

Country	Population (2007 est)	GNI per capita, (2005 US$)	Agric as % of GDP (2005)	Agric as % of exports (1999-2004 average)
Angola	13,313,553	1,410	7.2	..
Benin	7,714,766	510	32.2	73.4
Botswana	1,893,526	5,590	2.3	3.4
Burkina Faso	12,318,213	400	30.6	80
Burundi	8,075,188	100	34.9	77.2
Cameroon	17,775,743	1,000	41.1	44.2
Cape Verde	494,034	1,930	..	5.6
Central African Republic	3,307,622	350	53.9	29.4
Chad	8,915,381	400	22.7	..
Comoros	681,800	650	51	73.6
Congo, Democratic Republic	60,226,717	120	46	9.3
Congo, Republic	3,774,537	950	5.6	..
Cote d'Ivoire	20,169,352	870	22.8	67.9
Equatorial Guinea	1,120,061	..	..	..
Eritrea	4,254,498	170	22.6	70.9
Ethiopia	73,872,056	160	47.7	87
Gabon	1,461,679	5,010	7.7	16.3
Gambia, The	1,508,727	290	32.7	74.5
Ghana	21,801,662	450	37.5	51.2
Guinea	8,171,096	420	24.7	4.6
Guinea-Bissau	1,492,189	180	60.3	99.8
Kenya	35,062,192	540	27	60.8
Lesotho	2,513,076	950	17.3	11.4
Liberia	3,146,406	130	63.6	..
Madagascar	18,996,075	290	27.9	58.8
Malawi	11,553,163	160	34.7	88.6
Mali	10,914,989	380	36.6	50.8
Mauritania	2,959,592	580	23.7	52.4
Mauritius	1,292,309	5,250	6.1	26.2
Mozambique	20,356,242	310	22.3	35.4
Namibia	2,083,405	2,990	9.9	38.1
Niger	12,533,242	240	..	36.2
Nigeria	162,082,868	560	23.4	0.7
Rwanda	8,959,095	230	42.3	68.8
Sao Tome and Principe	173,942	440	14.9	97.1
Senegal	11,069,755	700	17.9	29.3
Seychelles	84,927	8,180	2.7	60.9
Sierra Leone	5,159,619	220	46.1	92.4
Somalia	12,448,179	..	..	..
South Africa	49,660,502	4,770	2.6	12.5
Sudan	36,618,745	640	33.7	35.2
Swaziland	1,173,758	2,280	11.5	39.4
Tanzania	38,870,348	340	44.5	62.6
Togo	5,527,332	350	41.8	40.3
Uganda	28,574,909	280	32.7	80.9
Zambia	11,486,812	500	18.5	12.1
Zimbabwe	12,398,897	350	18.1	54.1

Source: World Development Indicators database, http://devdata.worldbank.org/data-query/, accessed 21 May, 2007; http://stats.unctad.org/Handbook/, accessed 23 May, 2007.

In 2007 there are some 778 million people in SSA, of whom 152 million are mobile phone users and 20 million are internet users (MIT, 2007; Internet World Statistics, 2007). However, with a few outliers, the majority of the economies in SSA have per capita GNIs that are below $1000 per annum, with Burundi, the DRC and Liberia being the least wealthy, and South Africa, Gabon, Mauritius, Botswana and the Seychelles having per capita GNI that are more than 50 times higher that the poorest economy in the region. [4] The economic contribution made by agriculture also varies by country, with Botswana South Africa and the Seychelles below 3 percent and Comoros, Central African Republic, Guinea-Bissau and Liberia over 50 percent. Overall, some 17 percent of the GDP of the region is directly attributable to agricultural production. However this statistic underestimates the potential of agriculture in the regions development in a number of ways.

Firstly, trade in agricultural commodities has expanded at a faster rate than overall agricultural output, while the value of agricultural exports grew though-out the 1990's and after a brief decline, appears to be expanding once again (FAO, 2005: 13-14). In particular, after declining for almost four decades prior to the mid 1990s, the share of agricultural exports from developing countries has begun to grow once more. This can be seen in the figures for the average contribution of agriculture to exports which generally exceed those of the contribution to GDP. For SSA, of particular importance has been the increasing tendency for regional trade with 20 percent of the region's agricultural exports being traded within SSA in 2003 compared to 8 percent in 1985 (FAO, 2005: 23).

Related to this, a substantial component of manufacturing income is derived from downstream agri-processing. Estimates of this contribution are not yet available for the region as a whole, although Wilkinson and Rocha (2006:9) show that the contribution of food processing increases with per capita income reaching an average of 2.4 percent of GDP for upper middle income countries which would include South Africa, compared to 1.9 percent for low income countries such as Ethiopia. Upstream agri-inputs (fertilisers, pesticides, packaging) will further increase the value of agricultural production in an economy.

Finally, agriculture besides representing an important source of revenue for producers and processors in developing countries, agriculture remains an important source of livelihood for both the rural and urban populations, especially for women, and as such, represents an important option for the reduction of poverty. Unfortunately, no region wide statistics are available to estimate the numbers of people employed in agriculture, with the limited data that do exist suggesting that about 12 percent of South Africa's economically active population are employed in this sector, 20 percent in Kenya and 22 percent in Botswana (UNDP, 2006). These figures are likely to underestimate such employment by excluding self employment in subsistence agriculture and represent countries with a comparatively well-developed non-agricultural sector.

This brief review suggests that improvements in the productivity of agriculture and agri-processing represent a significant opportunity for economic growth and poverty

[4]/ Gross National Income equals the total value of goods and services produced within a country (GDP) plus income received from other countries less payments made to other countries. Such income or payments include interest, dividends and remittances.

reduction. Conceptualising agricultural production in a broader way requires that analysis extends beyond simply the activity of crop production or the raising of livestock to include the inputs that are used, the processing of the commodities that are produced, and eventually the marketing and end use of the commodity. An appropriate framework for analysis is thus required.

3.2 Agriculture as a Commodity Chain

This paper will make use of the notion of agriculture as a commodity chain. Also referred to as supply chains, pipelines, value chains or as *'filières'*, this approach examines commodities and the routes that they take moving from production through to consumption.[5] The approach is especially relevant to agricultural production in which the items being produced are usually spatially and economically distant from the end consumer. Indeed this is increasingly so, with production taking place in the developing countries of 'the South', and then following a route that is often challenging in terms of logistics and regulations to reach consumers in the developed countries of 'the North'. There is case for also considering domestic markets. Indeed for many African countries, where small scale agriculture dominates, domestic markets might be more important, and as has already been mentioned, in SSA regional trade in agricultural produce appears to be growing. The case is even stronger given the many trade barriers faced by African agricultural products into markets in 'the North'. In these chains, commodity brokers, supermarket corporations, international financiers and brand managers are often stronger determinants of the operation of the chain than the farmers who grow the vegetables, fruit and other crops, or raise the livestock being consumed, as well the national government of the countries in which production is occurring. The literature on commodity chains goes on to distinguish 'producer-driven' from 'buyer-driven' types of chain governance. 'Producer-driven' chains are found usually in sectors with high technological and capital requirements, where capital and proprietary know-how constitute the main barriers to entry. In these chains, producers tend to keep control of capital-intensive operations and sub-contract labour-intensive functions. 'Buyer-driven' chains are found in more labour-intensive sectors, where market information, product design and marketing/advertising costs form the major barriers to entry. In these chains, production functions are usually out-sourced and key actors concentrate on branding, design, and marketing functions.[6]

As Gibbon and Ponte (2005) point out, recognising the production and consumption of agricultural commodities as a chain takes account of the numerous and powerful institutions that influence production decisions, include international bodies such as the World Trade Organisation (WTO) the European Union's Lomé Convention, and a plethora of Preferential Trade Agreements (PTAs) as well as the multinational corporations who eventually sell the commodities being produced. In addition to direct regulation, these institutions also govern other activities that have become part of the agricultural chain: agreements on intellectual property rights; trade in services and the regulation of Sanitary and Phytosanitary (SPS) measures. Each of these places new demands on producers if they are to remain competitive. Access to ICT in this

[5]/ See Bernstein and Campling (2006a, 2006b) for a detailed review of the analytical frameworks adopted by what they and others refer to as commodity studies.
[6]/ Agricultural commodities are likely to fall into the latter group.

environment becomes a critical way in which producers can remain part of this globalised production chain and on what terms.

ICT provide a mechanism through information (and instructions) can be obtained on markets, opportunities, regulations and constraints. In addition, ICT are potentially a way in which producers in developing countries can improve their share of the value being generated by the production and consumption of agricultural commodities through what Gibbon and Ponte (2005:92) call 'upgrading': "…improving what they are doing and or how they are doing it." Examples might be moving into niche specialisations such as organic produce, fair-trade, packaging (e.g. stir-fry or salad mix; baby vegetables; peeled, podded or sliced vegetables) and use of improved production methods (e.g. Genetically Modified; water-wise; free-range; grain-fed). Equally though, ICT are a way in which the costs of production can be reduced, potentially reducing the share captured by producers, reducing their numbers by concentrating production into larger, more capital intensive enterprises or reducing their capacity for independent action. A commodity chain approach to the use of ICT in agricultural production would need to take account of both the positive and negative outcomes and consider who might be the winners and losers from technology change and the reasons for this. As an example, the adoption of ICT may well squeeze out smaller scale producers reliant upon local markets through competition from larger producers marketed by supermarket chains. Alternatively ICT may assist small producers by providing access to market prices strengthening their ability to negotiate with wholesalers.

3.3 ICT as a System

Moving on to how best to conceptualise ICT, the term itself pertains to a myriad of stand-alone media, including telephone and mobile telephony, radio, television, video, tele-text, voice information systems and fax, as well as computer-mediated networks that link a personal computer though a modem to the Internet (Warren, 2002). ICT can be thought of as an integrated system that incorporates the technology and infrastructure required to store, manipulate, deliver and transmit information, the legal and economic institutions required to regulate ICT access and usage, and the social and inter-personal structures which allow information to be shared, facilitate access to the ICT infrastructure, and through which innovation takes place. Thus the resources needed for the deployment and exploitation of ICT in the economy and society together make up the ICT landscape, opening (and closing off) opportunities for their use. Identifying what these are, and how they interact, highlights the research questions that require our attention (Dzidonu, 2002).

As already mentioned, three broad sub-systems make up the ICT system, each of which comprise further sub-systems: technology and infrastructure; institutions and social structures. Thus while ICT might be constrained by bandwidth (meaning the amount and speed with which information is transmitted), data processing technologies might be constrained by storage capacity and the speed with which information can be processed, and both will be subject to the constraints of economic and legal institutions and social and inter-personal processes. The discussion below examines these sub-systems in more detail providing specific examples from the agricultural sector.

3.4 Technology and Infrastructure

This sub-system comprises two components each with distinct technologies and infrastructural requirements: communication and data processing. Communication technologies include the equipment required for encoding the message (microphones, keyboards, barcode readers, scanners, digital cameras) decoding the message (screens, earphones, printers) as well as for transmitting it (fibre-optic and other cables, broadcasters, satellites). Data processing technologies include the memory and processing chips inside (or outside) computers, Personal Digital Assistants (PDA) and similar equipment, as well as the software which is needed to actually transform and manipulate the data. These technologies can be brought together through the modem equipped computer, telephones equipped with memory chips or digital interactive television. For rural areas, an ever expanding range of technological advances are providing new opportunities to expand ICT infrastructure. Examples include low-cost Very Small Aperture Terminals (VSAT) that provide data and voice at a fixed cost and other innovative 'last mile solutions' such as Wi-Fi and Wireless Local Loop (WLL) linked to telecentres and community radio.

However, the technology and infrastructure component of the ICT system does not only concern hardware, transmitters and cabling. A host of supporting equipment and concepts enable the effective usage of this component, including the text, graphic, audio, video and animation files in which information is communicated. For example, an important element of an ICT system is the way in which items or events can be tagged, traced and identified. Simple forms of identification can include cards with magnetic strips or micro-chips that identify the holder/operator. Barcodes have become one of the most common ways in which this is done and have had a significant impact on the agricultural sector in many countries.

3.5 Institutions

As with technology and infrastructure, there are two components to the institutional sub-system of ICT: the legal and the economic. Governments and the attendant judicial system are central stakeholders in the legal sphere, although obviously the private sector is also important. Governments are active in terms of their regulatory roles as providers, licensers, monitors of content, costs and mode of delivery, as well as through the judiciary in terms of protecting rights and enforcing responsibilities. Government can also hold back ICT usage through inappropriate pricing policies as well as by directly limiting access. An example is Laos in which a 'One Gateway System' controlled and maintained by the government may hinder competition and uptake (Song, 2003). Different levels of government are also important, as providers of basic services to farmers (water, electricity, roads), as providers of specialist services such as agricultural extension and research, regulation and safety assurance. However governments also provide specific technical infrastructure, resources and investments necessary for ICT, as well as undertake research and develop public policy affecting the use to which ICT is put. This role requires capacity and commitment from the appropriate agency of the state (such as the ministries of communication) charged with advancing and protecting the appropriate ICT policy goals. Clear and public commitment has been identified as an important part of national telecommunications regulatory bodies whereby policy goals

may be induced by the rules of engagement in each domestic market. Linked to government, educational and research institutions play an important role in undertaking research and disseminating results and ultimately contributing towards increases in the economic and social benefits of ICT. Legal intuitions are also important for the protection of intellectual property rights, license agreements of various kinds and as well as providing oversight for leasing and maintenance obligations.

Economic institutions can include concrete structures such as user and producer groups, financial institutions that provide capital as well as financial services that facilitate e-commerce.[7] Billing systems through which usage is charged and paid for as well as payment systems such as pre-payment, service contracts and vouchers are an example of this component of the institutional system. International institutions and structures are frequently important stakeholders in this sub-system. Multinational service providers are by far the most influential in this respect, providing foreign direct investment, equipment and expertise. Bi-lateral and multilateral assistance, and international development agencies (IDAs) have been somewhat less involved in ICT development, and some developing countries have initiated services with little or no external advisory support, most have engaged with IDAs and international NGOs in strengthening local ICT services and infrastructure.

In addition to those just listed, economic institutions also include the planning structures used by government and the private sector when introducing ICT. The importance of these structures is illustrated by Braathen (2004) who finds that appropriate planning structures facilitate the speed with which new technologies are assimilated and used by beneficiaries, whether these are enterprises or households. Comparing telecommunication sectors in Mozambique and Zimbabwe, he finds that 'managerial-engineering' experience was a significant factor in determining both the speed of the digital roll-out, and its effectiveness, and notes that this applies both to the public and private sectors.

3.6 Social Structures

The third component of the ICT system is the social structures and processes that influence ICT usage and the inter-personal links that facilitate the transfer of information. These occupied and used by the stakeholders that are providers and beneficiaries of ICT access and who include individual users and the communities in which they live; the private sector including international business and the finance sector; officials in local, national and international governments; and finally, civil society, social movements and NGOs

Illustrating this using the agricultural sector as an example, central to ICT-led development in agriculture are farmers and the rural communities in which they live. Of equal importance, but often overlooked, are the urban consumers of agricultural produce. Both require information: the farmers on production and marketing opportunities, consumers on availability, price and safety. Consumers might also require information

[7]/ For the purposes of this paper, e-commerce encompasses all electronically facilitated business processes, including data transfer among buyers, sellers and various supply chain entities. E-commerce can be business to business (B2B) or business to consumer (B2C).

on other dimensions of the commodity that they wish to consume which might include ethical considerations (organic, fair-trade, free-range and so forth) as well as taste (corn-fed, heirloom, single vineyard). Standing between the farmer and the urban consumer are the private sector enterprises that provide inputs to the farmer, transport, package and process the output, and distribute and market to the consumer. In some cases these enterprises may be vertically integrated multinationals, in others, horizontally integrated commodity chains. In many cases, 'middle-men' are seen as potential exploiters of farming communities who conceal or manipulate prices, and are a favourite target of ICT programs.

Farmers are a social group that is especially prone to the costs associated with information asymmetries, lacking data on prices, market conditions, regulations and new opportunities (Greenwald and Stiglitz, 1986). It should be recognized through that the same is true of the urban consumers and agri-business sector that may also lack information with which to make decisions. Farmers who are the direct sources of this information are often located in relatively remote communities resulting in delays in the transmission of important data in both directions. This information is potentially useful to farmers themselves, their organisations and communities, as well as various other stakeholders interested in the improvement of farmers' well-being. For example, the role played by farmers who agree to cooperate in agricultural development via the provision of information can be crucial in modernising the agricultural sector using information and communication technologies. It should also be recalled that many farmers in developing countries are women, and ICT access can potentially fulfil an important gender-empowerment role through providing women farmers access to communication and information on issues beyond agriculture (Gurumurthy, 2004; Hafkin, 2002; Hafkin and Odame, 2003).

Officials in the different levels of government are also part of the social structure and have the potential to significantly influence the rate at which ICT are adopted as well as the way in which these are used. The accountability of officials can be strengthened through ICT usage and there is ample evidence linking ICT usage to improved governance practice. Related to this are the civil society organisations that work with farmers that have an important role to play in sustained debate, substantial advocacy and continued grassroots work to promote an ICT and agricultural development agenda and by playing a watchdog role. Furthermore, civil society could play an important role in helping farmers with information systems development by linking farmers to other stakeholders such as academics. Other options include establishing the extent to which electronic networking takes place, identifying agricultural information network systems through which agricultural research can be executed, and promoting community development programmes, communication, partnerships with government, the private sector and with international organisations. Overall, through the use of ICT, accountability and citizen input can be strengthened as way of ensuring that national regulatory commissions are beholden to their clients, the carriers and their associated portal players. Along with the larger agencies working in this field, there are several NGOs, research organisations, governments and educational institutions that specialize in providing ICT media and associated technical services in developing and developed countries. These NGOs and their roles are discussed further in the section on expanding telecommunications in Africa.

4 ICT and Agriculture

Having outlined and described the components of the ICT system, we can now turn to a more detailed analysis of the agricultural sector building on the examples already provided. As with other economic sectors, effective agricultural development requires access to information on all aspects of agricultural production, processing and marketing and it seems likely that if anything this need is increasing (Jones, 1997). ICT is already showing the potential to play an important role in the delivery of this information to this sector in both developed and developing countries (Zijp, 1994). In most cases the base technology is universal, rather than being specific to agriculture (Warren, 2002), and hence usage evolves from existing designs and practices. The FAO distinguishes five broad categories through which ICT are used in the agricultural sector. These are technical and economic development for agricultural producers; community development; research and education; small and medium enterprise (SME) development; and media networks (FAO, 2006).

4.1 Technical and Economic Development for Agricultural Producers

As with any change in technology, the economic impact of ICT occurs through improvements in efficiency and increasing productivity. This can take place in different ways including improving efficiency in resource allocation, reducing transaction costs, and technical improvements that result in an outward shifting of the production function (Wolf, 2002). In particular, through the provision of information from a source that is relative affordable, accessible and broadly available, ICT can contribute to the reduction of uncertainty in activities and transactions, reduce the extent to which markets are thin, missing or incomplete, and reduce the extent to which information asymmetries can be exploited by the relatively informed to extract rent when transacting with the relatively uninformed.

There are numerous instances where improved production and market information is important to farmers who are often a particularly vulnerable group. These might include extension and research on adoption of new crop varieties, mechanization, pests and weed control, processing and the care of livestock. As the FAO (2006) observed, technology and what can be accomplished with it has implications for rural communities and producers of all sizes, whether these are larger commercial producers who need to understand global market situations that affect them or subsistence producers concerned with local input markets (FAO, 2006). This is particularly relevant in the agriculture sector which is an activity that is often highly dependent on externally determined requirements. Government, parastatals and private sector agri-business frequently regulate commercial agricultural production by placing requirements on quality, safety, logistical arrangements and even quotas. Inputs to the agricultural sector may be similarly affected, including seed, fertilizers, pesticides and herbicides as well as livestock feed and veterinary services.

ICT systems can potentially facilitate the delivery of business and government services and assist with adherence to quality and other requirements. Institutional structures and procedures needed for this infrastructural development might include the regulation of grades and standards, packaging and marketing, logistical planning, information availability, transparency in local governance, public rural finance, adherence to taxes

and tariffs, and the establishment and operation of farmer organizations. An interesting example is provided by IICD (2006:33) for the certification of produce as being organic in Bolivia and Zambia. This requires the timely filing of detailed information on production methods and land use that has been facilitated by ICT including the use of Global Positioning Systems (GPS).

An example of how the development of agricultural producers can be enhanced by using ICT is though what is known as site-specific management, also called precision agriculture. This refers to a knowledge intensive management strategy that involves the application of information technology to crop production. The literature provides many examples of ICT applications in this domain, including uses in the application of chemical samples, application of fertilizers, application of herbicides, application of liquid fertilizers, application of pesticides, and so forth, as well as activities for efficient resource management such as livestock movement regulations (Bouma et al, 1999; FAO, 2006). Pathways of development can include crop expansion and increased production where basic crop production is the dominant activity, and similar management strategies can be used in livestock farming. The use of feed supplements, specialised veterinary services and breeding services are other examples. A key aspect of precision farming relates to what Sonka (nd) describes as a move from Just in Case (JIC) procurement and utilisation of agricultural inputs to production based on Just What is Needed (JWN).

As a mechanism for data collection, the benefits of having readily accessible information to small farmers include being able to obtain location-specific weather, crop and livestock disease forecasts and the flexibility to "…quickly change crop choices, obtaining information on current market prices and develop products for small niche markets and even market directly to the consumer or commodity brokers in distant areas, so called e-commerce" (FAO, 2006). Further, unlike most other sources of information, ICT allow information to be accessed at any time during the week or day. At the level of agribusiness, the value to a business of having access to ICT is potentially immeasurable. Warren (2003), cites as some of the possible benefits to small farmers and those in agribusiness arising from adoption of ICT. These include faster, easier access to records and accounts; help with complex decisions through decision-support systems; cheaper (in running costs) communication with others via the swift transmission of information in electronic form; and rapid access to a vast store of information through decision-support systems. Indeed it is notable that Neven (2005: 109) includes a cellular phone in a list of assets owned by farmers who supply supermarket chains in Kenya along with more usual assets such as an irrigation system, refrigerator trucks and a packing shed.

4.2 Community Development

In addition to ICT usage that might be of direct use to agricultural production, rural communities in developing countries frequently are in need of more broad-based development than the interventions just described. Such areas are often removed from important services and resources and hence have urgent infrastructural investment priorities needed, as well as a need for community-based institutions to deliver services. Confirming the need for appropriate ICT intervention, one common finding from Ureta's four country study of Albania, Mexico, Nepal and South Africa is that, controlling for income level, expenditure on communication is consistently lower in rural areas (Ureta,

2005) although anecdotal evidence suggests that network supplies have been surprised that uptake of mobile telephony in rural areas has been more rapid than anticipated.

Some of the priority areas for ICT and rural community development include lowering the cost of communication, universal access, and the development of human resources, including health and education. ICT have the potential to encourage greater inclusion of individuals within the network due to their immediacy and reach, which promote faster and efficient data, thereby overcoming the barriers of physical distance (Torero and von Braun, 2005). An example cited by Warnock (2001) is of women's clubs in rural Zambia who were able to negotiate for a range of community resources with local politicians through the call-in radio stations. In addition to services such as water and improved health care, in this example, these benefits included productive infrastructure in the form of a grain shed and oil press. More direct forms of ICT usage for human development include the use of PDAs in the provision of health services whereby confidential information can be collected, stored and processed using special designed software packages such as Epi-Handy.

The close linkages between the use of information and communication technology and community driven development and community empowerment has been established in a number of studies (*c.f* Premkumar and Roberts, 1999). Torero and von Braun, (2005:1) argue: "…the development and proliferation of ICT has accelerated economic and social change across all areas of human activity", and go on to specifically note the opportunities for distributing information on farming technologies. This need not be only through conventional trainer-farmer mechanisms, and through the encouragement of collaborative initiatives between farmers, ICT can be used to set up a system of information exchange that facilitates communication between different communities regarding such issues as agricultural production and commercialization.

Media centres are an important innovation in this regard and provide a central place where the public can receive and make use of information. This can include information on the services that government, the private sector, civil society and others provide and how to access this support. This might include assistance for small businesses, how to access social grants, advice on health or education, employment opportunities and even constitutional rights. These centres are equipped with ICT such as telephones, fax and computers with access to various kinds of information (Falch and Anyimadu, 2003). Two kinds of media centres have been commonly implemented: multi-purpose community centres that are usually organized by governments; and telecentres. The latter which initially subsidized, offer Internet connection 24 hours a-day, usually take on the form of small businesses and these are supposed function independently, owned by the local community and are then supposed to be self-sustainable (South African Ministry of Communications 2004). Telecentres are important not only because these are a way of empowering communities but also as a way of facilitating the expansion of ICT to more areas, promoting greater awareness of ICT and their use, and thereby empowering local communities. Such centres offer a way to assist people at all levels of society who need to be able to access information and to be able to communicate. This communication and information access can be crucial in the socio-economic development of communities and participatory development fully depends upon this information and communication sharing process.

However, getting agricultural sector participants to computer networking and become users of ICT requires some minimum level of expertise, and this has often been cited as one of the major constraints (Warren 2003a). There is also a need to assess how effective are multi-purpose community centres and the telecentres which have been set up by governments in giving people access to ICT. This requires some level of investigation via proper research methods and education into ICT for agricultural development.

As another form of community development, ICT can have an impact through enhancing participation and knowledge sharing among the poor. ICT have been argued to have empowered poor communities, overcoming social and economic exclusion, and make commerce, knowledge and information more accessible. Other processes that are also important include promoting the culture of human rights, the rule of law, gender equality and open electoral processes (UNHCHR, 2002). Checking enrolment on voter's rolls is a practical example provided by Dossani et al (2005:2) who also report that e-Governance was the most commonly used service at nine ICT projects in rural India that they investigate. Interestingly, and perhaps not surprisingly, they also report resistance by government officials to e-Governances as a potential problem (Dossani et al, 2005: 6).

Although not analysed in sufficient detail, ICT, including radio, also offer an opportunity for more effective disaster management (Kenny et al, 2000: 8). Poor communities, and rural communities in general, are susceptible to many natural and human made disasters. These might be wide-spread, such as drought or flooding, or household specific such as death or stock loss, but in each case, improved communication may be a way in which assistance can be obtained, whether from the government or from family. Reducing the susceptibility of rural communities to disaster and improving their ability to recover from disasters once these occur represents a particularly effective policy for poverty reduction. The resources required can be extremely modest, especially when compared to those that must be deployed when disasters do take place Hafkin and Odame (2002:22) note that the Self-Employed Women's Association (SEWA) in India includes this activity in their promotion of ICT usage for women along with the more conventional micro-enterprise and training activities.

Finally, activism is a perhaps unanticipated but significant use of ICT. Kelles-Viitanen (2003) documents the example of small-scale fisherman in Honduras who documented the destruction of mangrove swamps by commercial farmers and disseminated this information internationally. Johansson (2006) documents the fascinating account of farmers and fishers in the Niger delta who, faced with oil spills and gas flaring, have resorted to a mix of digital video, the Internet and an SMS gateway to expose their situation and the negligence of oil companies and the Nigerian government. The eighth largest oil producing area in the world, weak government structures and powerful oil companies have resulted in this region also becoming one of the most polluted regions in the world. Oil spills, toxic gases and acid rain have combined to destroy crops and marine resources. Using an approach described as Participatory Video, film clips have been recorded of the impact of this pollution as experienced by the farmers and fishers who have been affected. Once edited, the video material will be uploaded onto the Internet using a free video hosting website such as YouTube.com and will integrate an SMS gateway to the internet site. Through these ICT, the hope is that international NGOS can place pressure on the multi-nationals while simultaneously a dialogue can be opened

with the national government. In Bolivia, IICD (2006: 35) document how the Confederation of Indigenous People of Bolivia make use of ICT in their struggle to establish land rights, both as a way of gathering information, and to raise public awareness of their situation. Examining the emergence of ethical trade, Dolan (2005: 372) documents how the Internet and television have been used to expose poor labour practices in agriculture in the USA, Chile, Kenya and Zimbabwe. However, there is a risk that this potential role played by ICT may be muted by government intervention since there is some evidence that the Internet is used less where political and civil freedom is lower (ILO 2001).

4.3 Research and Education

The third use of ICT relates to its potential to bring about transformation in agricultural through the enhancement of education and research though the Agricultural Science and Technology Innovation (ASTI) System. Perhaps the most straight-forward way in which this can occur is through the conventional agricultural extension system. Traditional Training and Visit extension is a comparatively costly approach requiring the preparation, printing and dissemination of training material, large numbers of trained extension officers who carry the messages to be conveyed, and the risk that messages may become distorted when they are eventually conveyed. Extension officers who are connected through ICT will be better able to update their knowledge on a continuous basis than in the past, avoiding the criticism that the information provided by these services is often irrelevant or out-of-date. This approach does not require any ICT capacity on the part of the farmer, and as a result, may be relatively simple to implement in many countries. However when farmers are digitally literate a range of new opportunities become available. For example, email conference systems are a way in which new agricultural technologies can be disseminated as is cyber-extension using exciting new developments such as internet telephone/Voice over Internet Protocol/VOIP which would permit live Question and Answer sessions. In the rural context, ICT research and education range from enterprise management information systems to text message census and survey data in remote areas. In this way ICT can be used for agricultural research surveys and censuses completing a 'virtuous circle' of information exchange. ICT can also be used to build what have been termed Knowledge Digital Libraries which can include the collection of indigenous knowledge about crops and cultivation practices specific to local contexts. Hafkin and Odame (2002: 18) reference a project in Kenya where this has been done using voice and video recordings to capture the information and the Internet to disseminate the final results. In India, they describe the Honey Bee Network which has been collecting information on indigenous innovations on pest control, livestock care and farm implements. In Bolivia, Agrecol Andes have assisted local communities in the use of presentation software. This means that digital pictures, graphs, text and oral testimonies can be collected and used to document traditional practices. These presentations can then be used to disseminate information to other communities as a farmer-to-farmer exchange who prefer this medium of learning as it is compatible with an oral tradition of information generation and communication (IIDC, 2006: 32). A similar approach is being followed by the Ndere Troupe in Uganda, a theatre organisation that uses ICT assisted drama to transmit development messages to rural communities (IICD, 2006: 33). As Meera et al (2004) comment, these examples show that ICT can actually

facilitate a bridge between modern and traditional knowledge systems.

Much as in the telecentres model, research into ICT that aims to bridge the contrasts in agricultural prosperity as ICT adoption has been correlated with variables such as per capita income and geographic concentration, has to be user-oriented. This means that bottom-up participatory research approaches play an important role in ICT development that focus on the end-user rather than the data and information from organisations that have a vested interest in promoting ICT. Such research should assess community readiness for ICT as well as assess the developments and prospects for e-commerce in the agricultural sector. In an interesting illustration of this, Akiiki's case study of Busoga, Uganda, ICT are effectively used to complement and transmit local knowledge garnered though Participatory Research techniques demonstrating the importance of the social systems associated with ICT (Akiiki, 2006). Through participatory research strategies that place farmers and rural residents at the centre of the research process, a network for small scale development projects can foster the exchange of information, experiences, expertise and solutions to technical problems and adapt the often generic nature of information accessed by ICT to local conditions. Such appropriately supported ICT strategies have the potential to enhance access to information and information technologies as well as access to channels and other modes of communication.

4.4 Media Networks

Marketing systems absorb surpluses through e-commerce, improving the efficiency of agricultural products in circulation. Through agricultural e-commerce, the transactional capabilities of this innovation include allowing customers to submit and modify orders on-line, pay on-line, and automatic notification of order status. Companies can also provide useful information to suppliers on its own website, such as customer feedback, inventory information, production schedules, product demand information (actual and forecasted) on-line. An example of a similar model is provided by a South West England project that links rural business people via a personal computer and an ISDN[8] line with a central information hub. In Africa, Kenny et al (2000:6) provide an example of a handicraft enterprise, the Naushad Trading Company that experienced a 200 percent growth in turnover over the first two years after using online marketing. This kind of electronic networking is used media networks and consists of information exchange between two or more computers through any of several methods of interconnection (Warren, 2002). These require critical mass, in other words, that large enough numbers of consumers adopt the technology to make the investment financially viable and technically feasible. The Internet in this instance can be used for purchasing goods and services and selling, as well as for help in diagnosing health problems.

At less direct level, simply being able to pool knowledge with other producers through email correspondence could be an invaluable route for the transmission of information and innovation. In a similar vein, in several countries in Africa radio listening clubs have emerged as a new form of association for women having the double benefit of receiving information and building supportive linkages (Hafkin and Odame, 2002: 27). In recent

[8] ISDN stands for Integrated Services Digital Network and is a way to move data over conventional phone lines. As with a telephone call, ISDN can be used to connect to many different locations, one at a time, as long as the other location also has ISDN.

literature, such forms of interaction have become known as a component of social capital and are regarded as an important asset in the development process (Knack and Keefer, 1997; Wall, et al, 1998). This interaction can itself become commoditised through the the resale of information itself. Neven (2005:92) provides an example of the Kenya Agricultural Commodity Exchange (KACE) which is a private sector company that facilitates the exchange of information between sellers and buyers of agricultural commodities. KACE generates revenue by selling market price information, using SMS text as one avenue whereby this information is delivered.

5 International Experience

Having described the components of the ICT system, and reviewed a categorisation of the uses to which ICT can be put in the agricultural sector, in this section we will now review ICT and agricultural initiatives in the Developed Countries, South America, Asia and sub-Saharan Africa.

5.1 e-Commerce in the Developed World

ICT stand out as the leading source of information in most of the developed world, and high levels of adoption and ICT use are evident in agribusiness in crop producing and livestock raising farms. Unlike SSA, e-literacy is not a barrier to users in most of these countries from either the supply or demand sides. The high adoption rates among producers are reported by Warren (2003).

Table 2: Computer Usage among Farm Enterprises in Developed Countries

Country	Using computer for business	With Internet access
USA	30	48
Canada (Ottawa)	43	33
New Zealand	61	49
Germany	56	46
Finland	76	69
UK*	33	27

*In this survey, 66 percent of farm businesses had *access* to a computer

Source: Warren (2003)

It emerges from literature that the personal computer along with the Internet is a major force in agricultural development processes in the developed world, particularly in agribusiness. As depicted in the Table, computers are used in agribusiness by 43 percent of farms in Ottawa, Canada and 33 percent of farmers use the Internet in the United Kingdom (Warren 2003). There are high adoption rates in the United States of America as well, as might be expected, with 30 percent of farmers there utilizing this technology for their farm businesses. Communication technologies are also used by English farmer businesses for information (e.g. browsing), sales/purchases on-line, other financial information (e.g. banking), completion of government forms, surveys on-line, completion of other forms, surveys on-line and marketing (e.g. own website). The other three countries of New Zealand, Germany and Finland being the highest, also fare high in their respective adoption rates of 61, 56 and 76 percent. The same is also apparent on the demand side for agricultural produce. As Kupiec and Revell (1998) show reporting on the

results of a survey of those who visit and purchase from speciality foods sites on the Internet, consumers are in the middle age range (median age 37), comparatively wealthy (median income $58 000) and well educated.

In most of these developed countries, multi-lingual portals function as a way to enable their farmers, field officers, policy-makers and government to communicate and access relevant and useful agricultural information through their agricultural information networks. However, in some cases, farmers prefer to use familiar media to conduct their farming activities and business perceiving these to be more reliable than digital methods. In the United Kingdom for example, in another survey of media use in agribusiness, Warren 2002) found that farmers felt more comfortable and confident using ICT media such as fax machines where the proof of a transaction is a physical entity, as opposed to the virtual, 'unreal' nature of cyberspace.

An important channel through which ICT impact on agriculture is by enhancing the efficiency of the different enterprises involved in agricultural production, processing and marketing. The use of computers and computers with Internet connection has long since been the order of the agribusiness day for farmers in developed economies in the USA, Canada, Germany, Finland and New Zealand (Warren 2003). In North America, rural food producers use the Internet to sell a wide variety of products including perishables while in England, the use of fax, mobile telephony and using Short Message Service (SMS) texting to seeking and relay information. Agricultural e-commerce is emerging as an opportunity that can used by many small scale farm businesses and ICT are viewed as a way in which entrepreneurship can be stimulated (FAO 2006; Warren 2003; World Bank, 1999). Indeed, farm businesses have much to gain from the use of ICT, especially given their spatial dispersion and remote geographic location, as well as their typical small scale nature.

Discussing the future of quality food in Europe, Gilg and Battershill (1998) are enthusiastic about the possible consequences of ICT for agricultural markets. They suggest that ICT allow consumers and farmers to be more easily linked than systems based on advertising and mail-order. This would facilitate matching demand more closely with supply, thus making markets more efficient. Examples that they provide on the demand side are consumers who are concerned with animal welfare, the environment, labour practices and so forth could identify by producers who can provide information on how crops or livestock are raised, or how food is treated when processed. Examples that they provide on the supply side include farmers who analyse market trends from the patterns of consumer demand expressed and diversify or add value in order to satisfy new demands. Finally, they note that transaction costs could be reduced through the travel and energy use that is reduced when food travels to customers more directly.

Finally, the extensive usage made of ICT in developed countries has meant that there is more research available on the impact of ICT, some of which is of concern to ICT policy for developing countries. Examining non-farm enterprises, Pilat (2004) describes a 'productivity paradox' whereby firm level ICT usage is found to be beneficial to firm performance, but only in specific circumstances. These vary from sector to sector, and are most affected by the context within which production is occurring.

5.2 Communication for Development in South America

ICT for agricultural development have a comparatively long history in South America and have been used for a wide range of developmental purposes. In Chile an initiative using computers with Internet and electronic email was established through the Food and Agriculture Organisation's (FAO) Communication for Development in Latin America project. The objective of this project was to conduct participatory research into the development of the Internet information and communication networks. This project works with farmer organisations of small scale producers throughout the country in an effort to establish a computer-based communication system for both horizontal and vertical communication. ICT media usage for the network includes the use of Internet and email in order to provide farmer organisations data on crops and international crop status. This network also provides information on market timing, prices and regional, national and international market conditions. The network further provides small scale farmers organisations with weather and technical information, information about technical training information, as well as information about the various organisations that support their work.

The Chilean network was established through first conducting a needs assessment on the information that is required by farmers to be used in the network. Through participatory research approaches, farmers and their organisations were surveyed in order to determine what they wanted in terms of the communication system, i.e. their information needs, as well as how the system was to be managed and a strategy proposed by the farmers themselves on how this was to take shape, particularly for an Internet based communication system. This was done with the intention of helping farmers understand the value of the system and its applications, as well as to lead farmers' decision to take ownership of the infrastructure and network development (Kenny et al, 2000; FAO 2006). Furthermore, most of equipment used for the project was purchased and owned by the farmers' organisations.

The project methodology was structured such that a local private technical university provided preliminary technical support to the farmers. This institution was identified since it had already been engaged in offering commercial and non-profit Internet services in the region. Moreover, for the first couple of months of the project, a communication development expert provided initial logistical coordination and technical backstopping (FAO 2006). Other facilities provided in the network were a computer network server that was installed at the university. This provided each of the farmer organisations with technical support by way of issuing an account for dial-in access to modems connected to the server, thereby connecting farmers to use the system for their own identified needs as well as through making several World Wide Web (WWW) information services available to them. Research undertaken by the FAO concludes that: "…It was estimated that transmitting price and market information this way cost 40 percent less than using traditional methods. In addition, the information was timelier, reaching farmers much faster while prior to ICT access, the publication and distribution of a printed bulletin took 45 days" (Bali 1998:4).

Although the project is currently underway, the results of this initiative have been positive in meeting their developmental ends with farmers making use of email on a daily basis, farmers submitting daily reports on irrigation quotas and their planning activities to

the local irrigation water authority. Farmers also post their organisations' newsletters on the homepage to provide easy access to locally relevant market and weather information. Other links also expand access to the communication network's market information bulletin and places this bulletin information on a server for access throughout Chile and the world.

In other ICT-led developments and communication technologies in South America, Mexico has launched similar initiatives that pertain to Internet services for farm organisations. This is in an endeavour to create a system which helps with developing an electronic trading system for agricultural products and services that farmers and their organisations have to offer, as well as fostering communication for development (FAO 2006). In much the same way as in the Chilean networking system, the Mexican initiative uses Internet-based communication systems using email and several World Wide Web information services that are available. In some of the applications, farmers use the services to submit daily reports and planning activities to the local responsible authority, and this has reduced the need for publications in hard copy. In turn, farmers can obtain a directory of each farmer organisation on the network, its membership, its agricultural activities and production figures, and information about local conditions (FAO 2006). ICT media used for this initiative are not solely restricted to computers with Internet services however phones, faxes and radio are also used. Other examples include the Lilec-Tant network of Bolivia and the Infodons initiative in Peru.

Also in Bolivia, the IICD (2006: 17) provide an interesting case study in which mixed mode ICT are used to disseminate price information to farmers. In this example, a researcher visits the markets each morning to obtain the going prices for various commodities. These are then sent by email to a rural information centre some 500 kilometres away where they are broadcast on a community radio to reach an estimated 60 000 producers. The information received can then be used when negotiating with middlemen. At a more complex level, the export promotion centre of Bolivia (CEPROBOL) provides a platform from which small and medium producers can enter the export market (IICD, 2006: 31). The South American experience reveals how ICT have made the geographic location and distances of small businesses in rural communities largely irrelevant (Premkumar and Roberts, 1999) as new markets open up and rural businesses can now compete with their urban counterparts in the same market. IICD (2006: 34) provide a case study from Bolivia in which ICT access has enabled small milk producers to identify tender opportunities, prepare bids and win tenders to supply milk consumers including government institutions in rural communities.

5.3 Innovation and Entrepreneurship in Asia

Outside the developed countries, ICT usage in the agricultural sector has perhaps advanced most in Asia and this brief review cannot do justice to the numerous examples of innovation. However some examples have been selected that seem particularly pertinent to ICT and agricultural production in Africa. Supported by government, development agencies, the private sector and research institutions such as the M.S. Swaminathan Research Foundation, some interesting cases are noteworthy with experience in Asia showing that ICT can be a cost-effective way of providing extension. In India for example, (Sasidhar and Sharma, 2006: 13) report that over 20 pilot projects

have specifically targeted rural communities and agricultural producers and propose the establishment of a Rupee 3 600 million national agricultural extension project based on ICT that will build on the lessons learnt.

The potential to deliver information at a large scale is an important advantage of ICT for Asia. As an example, India's considerable livestock extension infrastructure comprises some 36 000 professional staff and 70 000 'para-veterinarians' operating from 51 000 veterinary institutions (Sasidhar and Sharma, 2006: 2). However, the scale of the bovine population of India means that each institution serves an average of 10 000 cattle and buffalo while milk production is second only after rice in terms of its importance in the agricultural sector. Several experiments are showing the potential of ICT in assisting the delivery of messages in the form of cyber-extension. As an illustration, Parghi (2005:22) describes an ICT based milk automation process that reaches some 1.5 million producers in 1000 locations. The system tests the milk for butter fat content, transmits and stores the results, and displays the results for the farmer's information and as way of promoting transparency and eliminates potential fraud. A similar project has seen an increase in the productivity and milk yield of cattle through the provision on information on the care of both the cattle and the milk during transportation (Digital Partners, 2002). In addition, Sasidhar and Sharma (2006:5) report that as similar system has reduced that time for payment to farmers from 10 days to 5 minutes.

In Madhya Pradesh in India Kelles-Viitanen (2003) records that in addition to market information, information on land records is important and useful data that can be accessed via ICT. She notes that the absence of land records can prevent farmers from obtaining loans or support from government agencies. Also in India Meera et al (2004) describe three projects in three different states that all offered farmer support through an ICT kiosk. Operated variously by community volunteers, entrepreneurs and project staff, these kiosks could be used by farmers to access and transmit information, for 'Ask the Expert' cyber-extension, to obtain market prices, access information on weather, inputs and even bus and train time-tables and access and complete on-line applications forms for a variety of government and private sector programs or products. The study reports favourable usage of this kiosk system by farmers in all areas, and that there was reasonable representation of poorer farmers. However men dominate: just 10 to 15 percent of the users were women (Meera et al, 2004:6). The study concludes by noting that the farmers in each of the areas are quite differentiated and groups may have different ICT needs. This extends beyond having different capacities to use ICT, but rather that different enterprises bring with them diverse information needs.

Looking at experience in other parts of Asia with radio, Sasidhar and Sharma (2006:8) comment that useful lessons for improving extension outreach can be learnt from rural radio services promoted by the Grameen Bank in Bangladesh, the community radio towers in Philippines and Nepal and local radio networks of Indonesia. Using evidence from an impact assessment of a rural telephony and text messaging service rolled out in Laos, Song (2003) finds telephone usage improves the economic performance of the rural users who are able to earn higher incomes as a result. These benefits are not confined to improved agricultural production, but also from the potential to improve the attractiveness of rural areas for non-farm investment, thereby contributing towards a broader notion of the agrarian economy. In Bangladesh for example, the International

Telecommunication Union (ITU) (1999) reports that access to ICT reduce management travel time and the direct costs associated with travel, a cost reduction that was equivalent to 13 times the investment that was made. Also in Bangladesh, the well known example of Grameen Phone has had a significant impact by providing low-income women entrepreneurs in rural areas with loans with which to offer payphone services based on cellular technology. By creating a 'phone culture' this intervention has been able to provide especially women with access to ICT. Kenny at al (2000: 32) report that the introduction of the service has allowed farmers to compare agricultural prices, challenging the power that landowners and intermediaries have held over the agrarian economy. Indeed, they note that the ICT have become an important new business sector in their own right. However, Cecchini and Scott (2003) find that mixed mode ICT are important if poorer producers are to benefit, and that the social dimension of the ICT system is particularly important. They recommend that participatory approaches be used to ensure this.

Finally ICT has also been incorporated into national policy for poverty reduction. In Cambodia for instance, the UNDP (2005) reports that ICT will be included into the PRSP as a way of developing an agricultural statistics system, while in both Cambodia and Laos, an Internet based marketing information system is seen as a way of better linking producers, wholesales and retailers. This is especially noteworthy since Laos only legalised the Internet in 1998 (Song, 2003).

5.4 Expanding ICT Networks in Africa

With the infusion of communication technologies a fairly recent development, notwithstanding the barriers associated with its diffusion and adoption, ICT take-up in agriculture in Africa has been off to a sluggish start in comparison to Asia and South America. In most of these developing countries, ICT are not only focused on the use of computers and computers with Internet however, a myriad of communication equipment technologies are used in conjunction, such as radio, television sets, phones, fax machines, scanners, digital cameras, copiers. As an example, see Akiiki, 2006 reporting on the use of radio for information dissemination in Uganda. To their credit, many African countries are developing Internet-based information tools that may be of direct benefit to small producers and rural and remote communities. One example is Pride Africa, a Kenya-based NGO that has launched a new project, DrumNet, which provides information, marketing and financial services for small-scale farmers in East Africa. DrumNet includes a credit guarantee fund and an electronic databank on the financial status of the farmers. This facilitates access to these farmers to financial facilities. Pride Africa itself has 60 branches in five countries in East Africa offering similar ICT linked support to the agricultural sector (UNCTAD, 2003). Another example can be found in a initiative similar to that already described in India, the government of Mozambique has launched a Computerised Land Register. This project is being executed by the Ministry of Agriculture and Rural Development and will establish an integrated system for the administration and management of land, accessible through the Internet, which will assist with the processing of requests related to land usage (Republic of Mozambique, 2002:61). Other projects include a market price initiative in Ghana similar to that already described for Bolivia, a project in Burkina Faso that also collects price information which is disseminated through television, and a project that combines warehousing, logistical

planning and ICT communication to ensure that higher prices can be received for coffee producers in Uganda (IICD, 2006: 26-28).

Sometimes referred to as community and/or media centres, several African countries are experimenting with telecentres as a means to decentralize communications infrastructure and the centres are created using satellite or local ISP Internet connections (Falch and Anyimadu 2003).[9] The objective of the centres is to expand telecommunications networks to previously disadvantaged people whilst taking cognizance of some of the challenges associated with ICT media use. An interesting variation of this concept is proposed by the Mozambique ICT policy which involves mobile ICT units which are expected to widen the reach of fixed telecentres, and which will provide computers, telephone access, a CD/DVD library and a low cost bidirectional satellite link. The centres are also seen as a way of providing training in more remote rural communities (Republic of Mozambique, 2002:14).

Challenges in setting up an agricultural communication network which are more pronounced in the developing world and particularly in rural communities in Africa with their remoteness, include poor telephone lines, which in turn are required for full Internet connectivity, high communication costs associated with Internet connections, fax, telephone and other conventional systems, and securing licenses and appropriate hardware needed for a well functioning communications network. In an interesting example of how to overcome some of the problems, Hafkin and Odame (2002: 23) suggest a mixed mode of ICT usage whereby information collected from the Internet through telecentres is broadcast through local radio stations in order to reach those unable to access the Internet.

In Kenya, bar-coding has been shown to facilitate the export of Fresh Fruit and Vegetables (FFV) to Europe by enhancing the tracking of perishable goods during their transportation, thereby certifying their freshness. Bar coding, and a related technology, Radio Frequency Identity (RFID), are also useful for stock control. The expansion of the FFV sector in domestic retail markets has benefited from such stock control which is of particular importance when retailing through large supermarkets which make use of centralised procurement systems. Again in Kenya, it is interesting to observe that the penetration of supermarket chains into the domestic market has been assisted by an elaborate ITC system which links stores through satellite communication which facilitates the centralised tracking of all products including FFV (Neven et al, 2005). Although this is of greater importance in the retail sector, improved stock-control can also enhance the management of inputs during agri-processing, and the shipment of the finished product. IICD (2006: 31) provides a case study of soybean oil production in Ghana which has benefited from more efficient organisation of supply and transportation resulting from information exchange facilitated by ICT. Other technologies related to both communications and data processing technologies include computer-assisted design (CAD) to improve product design, global positioning systems (GPS) for surveying and planning activities, and audio-visual equipment for training and marketing.

As there is a minimum level of ICT literacy required in order to be able to engage with

[9] ISP stands for Internet Service Provider, which are institutions that provide access to the Internet in some form, usually for a subscription fee.

this technology, and as a service and technology infrastructure provision usually by governments, media centres are a model initiative that has been adopted in several African countries, including Ghana, South Africa, Senegal, Malawi, Zambia and Zimbabwe. Whilst these are not necessarily restricted to Africa, these centres are a strategy that realizes that ICT does not mean having everybody owning individual computers and the initiatives afford people with having access to information that they want. This therefore assists in achieving universal connectivity and access, and helps (particularly rural) farmers to engage with the global market systems that affect their livelihoods (Falch and Anyimadu 2003).

Presently, technology advances, adoption and diffusion are skewed towards the computer, the Internet and phone, however with the decrease in the fixed line, there has been a high penetration of cell phones into the rural areas. While Senegal is trying to establish a reliable modern digital network, in Zambia and Zimbabwe, Internet-based market information tools, household food security information systems, famine early warning systems and other tools to assist decision makers are now being developed as part of a New Partnership for African Development (NePad) initiative on ICT infrastructure rollout project to connect Africa. Among other uses, in South Africa telecentres have been identified as providing access and links to employment opportunities through their connectivity and access to information and communication media. However, in Zambia and where other forms of ICT media have been used for communication in agriculture, the radio has been used in a project which focuses on how rural women could use radio to record their voices and then take the audio tape to a radio producer who will then put it out on air. This in itself demystifies the technology of radio and the women felt that they were empowered to produce their own programmes and to create their own meanings.

In an approach that ICT influences and information sources not only include the extension worker, another farmer or a trade journal but also the farmer's child, several other African governments are participating in a NePAD e-schools project in the hope that this will facilitate bridging the digital divide. This project endeavours to promote ICT literacy in schools and has already been launched in several countries, such as Kenya, Rwanda and Lesotho. The project aims to make access to ICT in schools cheaper by having several countries that would be procuring services, resources and infrastructure and planning together at the same time so that it makes it much cheaper in fact to provide these ICT in schools. Furthermore, South Africa, Mozambique, Ethiopia, Mauritius, Uganda, Mali and Cameroon, among others, recently signed onto the e-schools initiative and these countries also aim to equip their national primary and secondary schools with information communication and technology apparatus such as computers, radio and television sets, phones and fax machines, communication equipment, scanners, digital cameras, copiers and connect them to the Internet (NePAD web document 2006).

South Africa provides an example of the value of ICT where agribusiness has become big business since their structures have changed, with primary agricultural co-operatives and agribusiness throughout the country transforming themselves into private companies. Global companies like Microsoft have also begun advocating for people to begin to learn how to use the computer in high school and other schools because of the ever increasing necessity for people to be computer literate in order to benefit from various

developmental goals. In rural areas, people have embarked in this process and the government tries to ensure that people are computer literate and able to communicate with people all over the world. South Africa is one of several countries that have signed a protocol with countries from the West Coast of Africa towards this endeavour.

As can be seen from this review, the ICT landscape in Africa consists of diverse role players which include non-governmental organisations that specialize in the application of Internet tools and which assist in providing technical support, training and awareness building. Examples include SangoNet, the Internet Society, Volunteers in Technical Assistance (VITA), and the Pan African Development Information System (PADIS) (Richardson 1998). Bilateral financial organisations such as the World Bank and IFAD also assist in the development of locally relevant market information systems, and provide financial packages to support the development of ICT services for (rural) communities. Other agencies also assist in co-ordinating and executing ICT activities for rural and agricultural development (Richardson 1998).

In Africa, ICT adoption in agricultural development in many countries does not take on a "one-size-fits-all" approach to technical assistance and information is devolved through decision-support systems. Small and medium scale farming has been identified as a major growth area where overall employment has been on the decline because of increasing productivity (van der Brink 2006), and the development of e-commerce in the farm sector is directly linked to the adoption of ICT by farmers in micro-business. However, modern farming requires knowledge of new developments in agriculture, and marketing farm products through the ICT adoption of various media can be of benefit for advertising farm products.

As in most of the developing world, a multitude of organizations that work with farmers in agricultural development devote much time and effort to the adoption of ICT. In some countries, independent organizations work as country partners with various stakeholders in those countries to realize the goal of agricultural development. Bilateral financial organisations such as the World Bank and IFAD have assisted in the development of locally relevant market information systems, and financial packages to support the development of ICT services for (rural) communities. Other agencies have also assisted in co-ordinating and executing ICT activities for rural and agricultural development (Richardson 1998). Examples include the International Food Policy Research Institute (IFPRI) which undertakes and supports research and the International Institute for Communication and Development (IICD) which specializes in ICT as a tool for development via programmes that train their project partners in the areas that include facilitation in technical seminars, project formulation and prototyping workshops, technology based training and ICT-expertise development (IICD Research Brief, 2006). Both these organizations follow their unique but similar format of information dissemination in their engagement with their country partners. The IICD's format takes on the project process cycle which has six stages: preparation, formulation, pilot, implementation, completion and evaluation whereas IFPRI's approach follows a farmer-centred model in their research on markets, technology, the environment and infrastructure that engages directly with farmers.

Notwithstanding relative weaknesses in human and technical infrastructure, some African countries have also adopted agricultural information support systems that are anchored on

ICT. In Zambia, Zimbabwe, Senegal and Ghana for example, the benefits of adopting ICT via these media networks include access to knowledge and services, opportunity to increase trade and cut costs where the Internet represents a global storefront for SMEs, particularly for rural and remote businesses (Falch and Anyimadu 2003; Kalusopa 2005). In Senegal, mobile telephones linked to the Internet via a telecentre are used to enable women producers to obtain market prices (Hafkin and Odame, 2002: 24).

6 ICT Challenges and Policy Issues

A number of specific policy areas need to be addressed by ICT policies seeking to promote agricultural development. These pertain to poverty and end-user competencies, levels of access to ICT in agriculture, knowledge management and information generation, research and development, the price of technology and the cohesion between government departments directly affecting ICT initiatives.

6.1 Poverty and the Digital Divide

Even if subsidised, ICT may be beyond the reach of many potential beneficiaries, especially in rural communities in which poverty tends to be most prevalent. The issue of connectivity for universal access comes with affordability and cost issues, especially with reference to computers with Internet. Certain factors inhibit sectors of the agricultural industry such as farm businesses, to adopt ICT services and innovations. Geographic remoteness and sparseness of communities, especially in rural areas, and Internet access (or lack thereof) are economic circumstances affecting both service providers in the agricultural industry as well as members. This said, separating technology limitations from cases where the end-user faces capacity constraints that inhibit her from engaging in the technology, such as lack of skills, confidence and motivation. As well as providing low cost (or donated) equipment, private sector bodies can assist in developing appropriate technologies to provide agricultural communities with ICT services to assist with project initiatives. Information and communication technologies provide both opportunities and threats to small businesses located in rural communities (Premkumar and Roberts, 1999). Knowledge that could not be accessible ten years ago is now more widely available and this affords the small producer with a competitive footing that comes along with information and communication access. At the same time, conventional mechanisms for obtaining information may be declining, squeezed out by new technologies and perhaps open a 'digital divide' between those that have access to technology and those that do not (Sasidhar and Sharma (2006). Indeed, Barrentes (2005) has made use of the notion of 'digital poverty' to distinguish barriers to ICT usage arising from resource and skills constraints, infrastructure and unrealized demand.

The use of this concept encompasses the lack of means with which to access ICT, the lack of skills to use the ICT and inadequate information about the usefulness of ICT. Harris (2003) usefully identifies 14 dimensions of the digital divide which have been added to and adapted in Table 3 to represent a scale of attainment rather than the rights based approach as suggested by Harris.

Table 3: Measuring Digital Poverty

Infrastructure and Service Availability	The extent to which ICT infrastructure and the services made available through the use of ICT are available to those who might wish to make use of them.
Financial accessibility	The extent to which the population can afford the full costs of ICT access and ICT services, including transportation and time.
Awareness	The extent to which the population is aware of how they might be able to use ICT for their own benefit.
Opportunity to learn and use new media	The extent to the population has the opportunity to attain (and maintain) computer literary.
Mastery of new technologies	The extent to which the population understands which ICT tools are best suited to which tasks.
Experience	The extent to which the population is able to accumulate sufficient experience with the use of ICT to enable them to fully exploit their potential.
Skills	The extent to which the population has the right skills (and is able to develop new skills as required) for performing ICT related tasks.
Support	The extent to which the population can access appropriate assistance when needed to help them make good use of ICT
Attitudes (motivation)	The extent to the population is encouraged to participate in the sharing of benefits available from equal access to ICT.
Content	The extent to which the content available is sufficient to enable the population to gain benefit from ICT
Cultural	The extent to which other dimensions are adapted as required to the cultures of all potential users.
Disability	The extent to which other dimensions are adapted as required so that disability is not a barrier to equal enjoyment of the benefits of ICT.
Linguistic	The extent to which other dimensions are adapted as required so that language is not a barrier to equal enjoyment of the benefits of ICT.
Gender	The extent to which other dimensions are adapted as required so that gender is not a barrier to equal enjoyment of the benefits of ICT.
Empowerment of civil society	The extent to which structural, political and governance factors facilitates equal enjoyment of the benefits of ICT.

Source: Adapted from Barrentes (2005) and (Harris (2003)

The different dimensions of digital poverty certainly do appear to prevail among agricultural producers. Kalusopa (2005: 421) reports that less than 20 percent of his sample of farmers reported that they did not have access to a television, while only 38 percent reported that the extension officers with whom they engaged made use of any form of ICT. An important reason given for the low usage of ICT was high tariffs. In their review of ICT projects in rural India, Dossani et al (2005: 5) find that the lack of knowledge about the usefulness of ICT is widespread and is an important reason for low usage of ICT facilities provided by the projects that they investigated.

As a result, as much as e-commerce provides the small farmer with the business opportunity to gain entrance to a global economy, there is also an accompanying threat of non-adoption of ICT. The non-adopter is at a relative disadvantage and is becomes disenfranchised as they cannot gain access to services. This can result in their business becoming less profitable and less competitive (Warren 2003). These concerns are not confined to developing countries: the Social Exclusion Unit of the Government of the United Kingdom has recently identified a 'Digital Challenge' (Government of the United Kingdom, 2005:41). These concerns are also not confined only to small scale farmers or poor communities. Reporting on a workshop held to discuss ICT and national agricultural research systems, Maru (2002:1) notes the concerns of agricultural scientists in developing countries which included the high costs of accessing research reports in prestigious journals, the costs of joining electronic libraries, and their own lack of capacity to make full use of ICTS.

Further, while inadequate skills may pose a barrier to the effective utilization of ICT, being aware of ICT does not necessarily lead to their application as there are personal characteristics, such as age or culture, that influence the decision to adopt. As an example, younger people are more likely to be technology literate and this can result in generational differences. An interesting observation by Hafkin and Odame (2002: 11) though, is that the inclusion of an ICT component into an agricultural project can increase the likelihood of participation by the youth, while ICT also allows people who may be legal minor access a range of services for entrepreneurial activities that would otherwise be denied to them.

Premkumar and Roberts (1999) argue that the decision to adopt unfolds in five stages *viz*, awareness, persuasion, decision, implementation and confirmation while Warren (2002) argues that ICT usage stems from three factors: motivation, access and competence. Building e-literacy thus requires sector policies that take these motivations into account and that are demand driven and which build up community nodes so can have farmer support. Another concern is the potential for bias towards technologically advanced and well resourced large agri-businesses to the neglect of small farmers;

Integrated strategies for expanding farmer access to electronic information services related to marketing and the development of national and international trading links need to be explored with the participation of all stakeholders and pillars of ICT, including farmers and their organisations, the government (and their national departments of agriculture, as well as other relevant government departments), academic institutions that provide technical support to farmers as well as conduct research on the impacts of various strategies, and civil society organisations that work with farmers.

Where electronic communication is adopted as the default knowledge transfer mechanism by governments, corporations and public agencies, this will further exacerbate the digital divide. Non-adopters run the risk of becoming disenfranchised and this will result in sizable pockets of relative, if not absolute, disadvantage, more so if the barriers that are inhibiting adoption in these areas are unidentified and hence not eliminated. The result may be areas, especially in rural communities, which are trapped in a 'low-use equilibrium' (Grace et al, 2001).

6.2 Barriers to Accessing and Using ICT in Agriculture

ICT face a number of unique barriers in rural communities that will have to be overcome. As Kenny at al (2000:18) observe, geography plays a very strong part in the determination of communications costs and functionality. In rural communities, where a sparse population implies that potential users live in area of low demand density, communications costs will be higher and services will be less well developed. This is due to what is known as the economics of networks. Thus ICT in rural areas cost more per line both because each connection is further from the next, and because it is not possible to achieve economies of scale in switching. The result of this can be seen in the penetration of ICT into rural areas. While not a complete indicator, tele-densities (the number of main lines per 1000 people) give some idea of the extent to which this will be a problem for farmers in rural Africa when used in combination with mobile phone densities (mobile phones per 1000 people). As Table 4 shows, tele-densities are far higher in the main urban areas than the rest of the countries of all those for which data are available. The Table also shows the percentage of households with access to a radio and television, internet access per 1000 people and a relative rural ICT score.

While radios are more accessible to the population of most countries than are telephones, of the 44 countries for which data are available, only in 9 do more than three quarters of the population have access to a radio, while in 11, less than half the population have access to a radio. In the case of television, in only three countries do more than 50 percent of households have access to a television, and in 16, less than 10 percent of households can access a television. Mobile phone access is highest in Seychelles, South Africa and Reunion at more than 700 users per 1000 people, and lowest in Ethiopia and Eritrea at less than 10 users per 1000. While there are 26.25 internet users per 1000 people in SSA as whole, this varies from over 100 per 1000 for South Africa and the Seychelles to below 3 per 1000 for Niger, Ethiopia, DRC and the Central African Republic. Finally, in terms of the Rural ICT score, Cape Verde, Cote d'Ivoire, Gabon, Kenya, Namibia, Senegal, South Africa and Sudan were ranked as having relatively high rural ICT access.[10]

[10]/ While access to a telephone, mobile phone, PC and internet would have provided a complete set of ICT indicators, these data are not available from a consistent information source or reference period for the majority of countries. The scoring system is a simple relative score whereby countries were ranked in terms of the percentage of the population with access to radios and televisions, teledensity outside the largest city and mobile phone densities. These scores were summed and again ranked into three groups: low Rural ICT access, Medium and High. Thus a country in the bottom quartile in terms of radio and television access, tele-density and mobile density would receive a score of 3 and be placed in the Low Rural ICT category. It should be emphasized that this rank is relative to the countries contained in the table and not to a global best practice.

Table 4: ICT Access in SSA

	Teledenisty per 1000 largest city (2000)	Teledensity per 1000 all other (2000)	Radio access (%) (2000)	TV access (%) (2000)	Mobile density per 1000 (2005)	Internet users per 1000 (2007)	Rural ICT Score
Angola	21.3	0.8	16	9	69	6	Low
Benin	41.1	4.1	84	18	100	55	Medium
Botswana	..	..	82	..	466	32	Medium
Burkina Faso	40.9	1.7	63	7	43	5	Low
Burundi	50.8	0.8	57	11	20	5	Low
Cameroon	35.5	3.2	53	17	138	14	Medium
Cape Verde	160.4	115.5	66	40	161	59	High
Central African Rep.	..	..	56	2	25	3	na
Chad	7.7	0.3	40	2	22	4	Low
Comoros	..	..	55	10	20	29	
Congo	..	..	30	6	123	13	na
Cote d'Ivoire	63.9	6.6	74	32	38	10	na
DRC	..	..	16	1	151	2	High
Equatorial Guinea	67.8	5.1	..	..	193	6	Low
Eritrea	43.1	2.3	55	11	9	19	Low
Ethiopia	51.9	1.6	20	2	5	2	Low
Gabon	84.6	13.2	73	51	470	46	High
Gambia	77.9	13.8	71	12	163	32	Medium
Ghana	83.3	2.7	53	22	129	18	Medium
Guinea	..	..	56	9	24	6	Na
Guinea-Bissau	112.7	2.7	27	20	50	21	Medium
Kenya	76.2	4.1	91	15	135	32	High
Lesotho	65	5.7	..	..	137	17	Medium
Liberia	..	..	..	..	49	0.3	na
Madagascar	8.7	1.3	39	7	27	5	Low
Malawi	39.8	2.6	55	1	33	5	Low
Mali	24.5	1.2	65	13	77	5	Low
Mauritania	19.6	3.6	51	19	243	7	Medium
Mauritius	375	218.6	87	87	573	232	High
Mozambique	..	..	39	4	62	7	na
Namibia	156.4	44.5	85	37	244	36	High
Niger	22.8	0.6	34	5	21	2	Low
Nigeria	11.7	3.9	62	26	141	31	Medium
Rwanada	43.7	1.1	35	2	32	6	Low
Sao Tome and Principe	54.8	14.9	40	24	77	115	Medium
Senegal	64.5	9.7	68	26	148	49	High
Seychelles	..	..	94	86	707	247	na
Sierra Leone	17.6	1.1	46	4	20	2	Low
Somalia	10.2	2.1	..	..	61	7	na
South Africa	415.2	81.8	75	55	716	103	High
Sudan	79.8	6	76	45	50	76	Medium
Swaziland	111.1	24.8	53	18	194	31	Medium
Tanzania	33.5	2.9	50	9	51	9	Low
Togo	35	2.5	80	17	72	54	Medium
Uganda	34.2	0.9	49	..	53	17	Low
Zambia	22.6	5.1	56	23	81	20	Medium
Zimbabwe	73.8	12.2	60	25	59	97	Medium

Source: ITU (2006); World Development Indicators data base, http://devdata.worldbank.org/data-query/, accessed 21/05/07; Internet World Statistics, http://www.internetworldstats.com/stats1.htm#africaand, accessed 25/05/07 and own calculations.

In many parts of Africa, an additional access issue may be the language gap, both in terms of the nature of information access through ICT as well as the medium. Dossani (2005: 4) report that as much of the information provided through ICT can be seen as lacking relevance to local conditions since it is generic in content, resulting in low usage. This is also commented on by IICD (2006: 24) who refer to earlier research on agricultural information systems that found a disjunction between the information needs of farmers and that which is provided. In addition, as English is still the dominant language used on the Internet, although not the home language of the majority of users. While access to information and communication technologies should not be bound by language, culture or distance, it is likely that ICT access of those who are poor and of women in general, may be affected by this.

6.3 Improving Knowledge Management and Information Generation

Establishing the information needs and skills of farmers is a priority challenge when contemplating ICT policy for agricultural development. Meera et al (2004: 9) reporting on ICT usage from three projects in India find that marketing information was a priority need for many farmers. More specifically, farmers wanted to know the prices of the commodities that they were expecting to sell in places other than the village in which they lived. Information on land records was also seen as important, along with the ability to register plots of land (presumably when transfers are made or leases entered into). A question and answer service was valued, though this appreciation was enhanced when the service was linked to the ability to then be able to apply for support, subsidies and other forms of government assistance. Weather forecast were valued, through almost half of the respondents in their survey did not regard this type of information as being appropriate, perhaps a result of the extended drought that some of the regions had been experiencing at the time of the study. Other information needs listed by the study includes post-harvest technology, information on crop insurance, and accounting and payment systems. Also in India, Hafkin and Odame (2002) mention that ICT also facilitated reporting grievances and obtain routine official documents such as income and domicile certificates which had previously required paying bribes to local officials. In addition, Wolf (2001:21) notes that government department websites can improve the access of entrepreneurs to information regarding regulations and applications, and she comments that South Africa has made significant progress in this regard. Finally as Maru (2002:5 observes, ICT itself can be used as a way of establishing the needs of farmers.

The transformation from hard copy style of dealing with transactions and markets and trade to sophisticated and technologically advanced digital methods and standards presents its own complexities. Although ICT may provide enormous opportunities to access information, the management of this, and the generation of new information is an important concern. A starting point is the digitization of relevant literature on agriculture and the integration of searchable data bases which can then be accessed by producers. Facilitating the sharing of information will also require some minimum form of standardisation for national agricultural research systems, and Maru (2002: 3) suggests that revitalising the Current Agricultural Research Information System (CARIS) project of the FAO might be a useful starting point with which to achieve this. Improving the skills and ICT literacy of farmers is another requirement, which it likely also necessitate a more general improvement in the education levels of farmers. In Ethiopia, Weir (1999)

finds that cognitive skills improve the ability of farmers to access and use productivity-enhancing information, and to be more willing to engage in activities that might involve higher levels of risk.

Problems can arise throughout the process of creating a new knowledge economy, and as one example, Akiiki (2006) mentions information hoarding and overload as difficulties facing a farmer support project in Uganda. Differential capacity for innovation and adaptation is also an issue that can exacerbate digital poverty. It is also noteworthy that Wolf's (2001:20) study of small and medium enterprises in Kenya and Tanzania which includes the food processing sector concludes that "…access to credit, managerial and other skills, infrastructure, rule of law etc. are at least as important as information and ICT."

Apart from promotion of e-literacy for its intrinsic values of bridging the digital divide and getting everybody to participate and engage in global systems that affect them, in a sector such as agriculture that engages frequently and structurally with government, expanding ICT adoption is of instrumental benefit as well. This is through the potential of the ICT to encourage the diffusion of new ideas and information, the innovation that might result from the use of ICT, improved productivity, and hopefully the improved profitability that would follow.

Maru (2003) presents a useful way to classify countries in terms of their usage of ICT for Agriculture Research and Development (ARD). She uses four codes: A- Advanced users of ICT in ARD; B- Less advanced users of ICT in ARD; C- Rapidly developing ICT use in ARD; and, D- Slow development in ICT use in ARD. A similar exercise for African countries would be informative and could build on the data provided above. This would serve as a useful point of departure for further research on agricultural production and ICT usage.

In addition, the withdrawal of publications in hard copy and discontinuation of extension services using conventional communications such as paper application forms, face-to-face or telephonic-based trading may further disadvantage those without ICT access or skills. Managing these problems implies that a number of prerequisites are in place with regards to developing an information society and economy. The establishment an agricultural communication network that includes consumers and the private sector, as well as national agricultural information and research systems is one prerequisite. Examples already can be found in a number of countries in Sub-Saharan Africa including Ghana and Zambia (IICD, 2006: 25). Another issue is the improvement of rural infrastructure including cabling and cellular coverage. Securing licenses and appropriate hardware and the reduction of communication costs associated with fax, telephone and other conventional systems are also important. Training for the effective utilization of ICT is a basic requirement especially in the developing country context. Further effective network management practices are required that include ensuring the interactivity of networks and compatibility of technologies to local conditions. Finally, an overarching concern is improved information on the agricultural sector.

6.4 Women and ICT

A final concern relates to the implications of ICT for women. Although the potential for

ICT to serve as an empowering force for women is real, the results of Meera et al (2005) are quite worrying. The very low participation of women at the ICT kiosks that they study suggests that women may be further disadvantaged if ICT development does not consciously embody a gendered approach. Earlier research examining other technological innovation has found that the introduction of new technology may increase women's work, and that when new technologies led to improved livelihoods, these may be taken over by men (Paris et al, 2001). ICT interventions themselves run the risk of being perceived as a desirable 'modern' activity that become appropriated by men generally, as well as by the relatively wealthy or relatively literate. In addition, as Hafkin and Odame (2002: 15) observe, the work undertaken by women is frequently overlooked by development agencies. They cite two examples of projects in Senegal and Peru in which ICT access was improved by making services available to male fishers and male farmers without recognition of the roles played by women fish sellers and women farmers in each of the countries. This both limits the potential impact of the intervention and further marginalises the women involved.

6.5 Increased Control and Penetration of Markets

Finally, while much has been made of the potential of ICT to improve the access of agricultural produces in developing countries to larger markets, the reverse may be equally true. As Wolf (2001: 12) points out, ICT may well enable the penetration of larger producers into markets previously served by small and medium enterprises. If these enterprises cannot improve their competitiveness, it is likely that they would eventually close down, potentially resulting in the loss of jobs and livelihoods in rural communities. The example of the expansion of supermarkets documented by Neven et al (2006) may well have had such negative consequences. In addition, the spread of ICT will also strengthen the relative power of what Gereffi (2001) has termed "infomediary- driven" commodity chains where internet-based "informediaries" are able to control e-commerce. Examples might be PayPal, American On-Line and Yahoo! Two other possibilities are suggested by Gereffi (2001), both of which may result in still further erosion of the power held by producers. Firstly that ICT and e-commerce may accelerate the tendency to make commodity chains more buyer-driven and secondly that that e-commerce is simply captured by already established leaders in both producer-driven and buyer-driven chains.

7 Research for Agricultural Development and Agrarian Change

The country case studies reviewed above illustrate how farmers and the organisations that they form make use of ICT. This has illustrated the need to assess impact of ICT so as to make a case for public and/or private investments in ICT. Those countries that do not support development and use of ICT may not appreciate the benefits and costs of such investments, especially when weighed against other urgent/priority investments whose benefits are easily identified and, perhaps, have hidden costs. Further, those countries that do support such development may be underestimating the negative impact that ICT might have on some sectors of their economy. The positive results found in most case studies suggest that ICT have the net potential to expand the choice of farmers and to improve productivity and profitability of the agricultural sector in Africa. However there are important challenges that have to be overcome if these benefits are to be fully achieved. Of these, the potential for a 'digital divide', and the wider social consequences of such a

divide, is perhaps the most important. For countries already characterised by high levels of inequality, such as is the case for most of sub-Saharan Africa, the introduction of a relatively costly, and relatively highly skilled technology has the potential to widen social and economic gaps. The 'digitally wealthy' are better placed to take advantage of the new opportunities offered by ICT while the 'digitally poor' fall further behind, perhaps experiencing new forms of social exclusion as a consequence. This is particularly relevant to the agricultural sector. In the best of conditions rural communities often face an intrinsic 'urban bias' in terms of policy and investment and are often politically and economically marginalised with relatively low human capacity, poor infrastructure and comparatively costly services. Agriculture itself has tended to experience declining terms of trade relative to other sectors and is subject to extensive regulation by national and international governments, as well as by the private sector.

As set out in the introduction, three policy issues present themselves for investigation:

1. What are the critical priorities and level of investment required in ICT in order to optimize its impact in the agricultural sector in Africa;
2. What is the role of public investments to ensure optimum application of ICT in the agricultural sector and agrarian economy more broadly; and,
3. How can those actors in the sector who would be disadvantaged be compensated, given the distributional implications of the use of ICT?

To answer these policy issues research is needed to better describe and analyse that nature of ICT application in agriculture. These are:

1. Co-ordination and regulation by government and the private sector;
2. Managing the costs and benefits of technology change;
3. Enhancing innovation, productivity and profitability in agriculture; and finally,
4. Agrarian change and community development.

In each case, it is evident that despite the plethora of case studies of ICT usage, rigorous micro-level studies are required at the level of the household, enterprise or farm unit and placing this enterprise in the context of the commodity chain in which it is operating. Furthermore, since most of the case studies that are reported tend to be descriptive, where possible impact assessment methodologies should be followed which allow for the identification of causality. These methodologies provide a useful framework for this purpose since they permit the more precise identification of the contribution made by a specific intervention and take account of the importance of identifying the direction of causality (Baker, 2000; Ezemenari et al 1999). Such methodologies may adopt quantitative or qualitative approaches, and often may include some form of randomised intervention that affects the usage or access to a pre-identified intervention. By collecting information on the control, or counterfactual group, and often by collecting information on initial versus post-intervention conditions, impact assessments can improve understanding of the benefits, or costs for that matter, that can be directly attributed to an intervention. Even when an experimental approach is not followed, the structured research design adopted by impact assessments can be used to guide a less rigorous assessment of the costs and benefits of a development intervention.

With this in mind, a research project is proposed that will make use of a commodity chain approach to explore nine sector-based case studies to be undertaken in 11 African countries. The sectors and case studies are shown in Table 5 and discussed in more detail below.

Table 5: Proposed Research Projects on ICT and Agriculture

#	Issue	Focus	Sector	Country
1	Coordination	Export, buyer driven, high ICT	Horticulture	Kenya
2	Coordination	Export, buyer driven, low ICT	Coffee	Cote d'Ivoire
3	Coordination	Export, producer driven, high ICT	Sugar	South Africa
4	Coordination	Export, producer driven, low ICT	Sugar	Mozambique
5	Costs	Mixed, buyer driven, high ICT	Palm oil	Cameroon
6	Costs	Export, buyer driven, medium ICT	Cocoa	Ghana
7	Costs	Mixed, processor driven, high ICT	Milk products	South Africa
8	Costs	Mixed, producer driven, medium ICT	Milk products	Uganda
9	Innovation	Export, buyer driven, medium ICT	Vanilla	Uganda
10	Innovation	Export, buyer driven, low ICT	Vanilla	Madagascar
11	Innovation	Domestic, producer driven, medium ICT	Plantain	Rwanda
12	Innovation	Domestic, producer driven, low ICT	Cassava	Mozambique
13	Agrarian	Rural development	Community	Nigeria
14	Agrarian	Rural development	Community	Uganda
15	Agrarian	Poverty Reduction	PRSP	Zambia
16	Agrarian	Poverty Reduction	PRSP	Ghana

In addition to these sector studies, two cross-cutting projects are proposed. The first of these is a pilot project to assess the take up of ICT in rural areas and analyse the determinants and impact of ICT roll out. The study should make use of data on the roll-out and usage of ICT in rural communities to be obtained from government regulators and the private sector. These data should be matched with appropriately geo-referenced socio-economic and infrastructure data from censuses, Geographic Information Systems and other sources. It is suggested that this pilot study be undertaken in Kenya with the aim of developing methodologies for the compilation of the data base, analysis and interpretation. Once established, these methodologies could be applied to other countries as required. The second cross-cutting project is the preparation of a synthesis report based on the sectoral studies. This should draw the material into a single document that addresses the policy questions already identified.

Each case-study would initially comprise a desk-top review followed by in-depth key-informant interviews along the commodity chain, including regulators. These interviews should identify and assess ICT adoption in the sector. Wherever possible, local researchers should be drawn into the study as country experts.

7.1 Coordination and Regulation

7.1.1 Problem Statement

In view of the complex relationships specifically associated with ICT usage in the agricultural sector, it seems likely that all levels of government will increasingly find themselves under pressure to create an enabling environment for small farmers to access

markets, services. To some extent, as Kenny et al (2000: 28) point out, this may be no more than public sector support in order to promote ICT development in rural areas that would otherwise be unattractive to private sector investors. However the development of appropriate policy, regulations and coordination is equally important. Indeed in a 7 country assessment of ICT usage and management, Zachmann et al (2004) conclude that the absence of appropriate regulatory policies was the key factor limiting the impact of ICTS on agricultural research. A similar finding is reported by Kenny et al (2000: 11) for India where an ICT project to improve access to land records through the Ministry of Agriculture was found to have minimal impact due to the failure to address the prerequisite administrative changes that were required.

Government intervention is thus required to coordinate and regulate the efforts of the private sector, both in ICT provision and in the agricultural commodity chain. The private sector itself plays a significant role in regulating the activities of farmers through quality and supply requirements which are also affected by, and affect ICT usage. In many countries international and local agricultural development agencies are working with the different levels of government and with ICT users and their organisations to address this question of appropriate coordination. A model adopted by the IICD is to work with country partners in developing ICT strategies for the agricultural sector. There are many other international agencies[11] that work with their country partners in mostly the developing world in their quest to bring about agricultural development and help bridge the digital divide in ITCs, which follow much the same format as the IICD in their engagement with their country partners.

Developing appropriate policy for both the private and public sectors, and understanding the impact of policy and how intervention actually takes place are thus important research questions for ICT usages in the agricultural sector.

7.1.2 Research Questions

The primary research question what has been the experience of policies for the regulation and coordination of the agricultural sector that have made use of ICT in their design, implementation and monitoring?

Detailed research questions include:

- Which are the existing co-ordination and regulatory structures in agricultural production, processing and marketing that can or should be involved in ICT? More specifically what have been found to be the most appropriate institutional structures for the promotion and regulation of agricultural production for ICT usage? What are current initiatives in agricultural production, processing and consumption among such institutions and what best practice can be identified?

[11]/ Some of these agencies include the World Bank and its Information for Development Programme, the International Fund for Agricultural Development (IFAD) and its project to assist the rural poor in accessing agricultural marketing information, technical information (including other initiatives via an approach that involves significant use of information technologies in South America and the Caribbean), and the United Nations Development Programme (UNDP) with its Sustainable Development Networking Project which operates in several African countries (various Internet sources).

- Which are the existing co-ordination and regulatory structures in ICT that might impact upon agricultural production, processing or consumption? More specifically what have been found to be the most appropriate institutional structures for the promotion and regulation of ICT usage for agricultural production? What are current initiatives in ICT usage among such institutions and what best practice can be identified?
- What role can the national and international private sector play in the promotion of ICT for coordination and regulation that improve agricultural production and value added activities at different points along the agricultural commodity chain?
- Are there examples of regulation or coordination which has helped to strengthen the economic hand of agricultural producers vis-à-vis other interests in the agricultural commodity chain? To what extent have these/can these be enhanced by ICT?

7.1.3 Research Design

Two case studies are proposed. The first to explore regulation in complex buyer-driven commodity chains with strong export potential. This study will examine ICT usage in the Kenyan horticulture sector and the coffee sector in Cote d'Ivoire. Both are important sectors in the countries being investigated, and both sectors involve substantial regulation by government and the private sector. While horticulture in Kenya has witnessed a sustained boom that preliminary investigation suggests has been encouraged by ICT usage, coffee production in Cote d'Ivoire has been experiencing a serious slump. In addition, while Kenya has generally experienced a rapid expansion in ICT usage, Cote d'Ivoire uptake has been comparatively sluggish (ITU, 2006).

The second case study will look at complex export orientated commodity chains in which producers have substantially more influence. This study will examine sugar production in South Africa and the Mozambique. While South Africa has a long established ICT sector with very high usage, ICT usage in Mozambique has recently expanded.

7.2 Managing the Costs and Benefits of ICT

7.2.1 Problem Statement

As this review has shown, there are many potential benefits associated with ICT usage. However effective usage of ICT media carries developmental, infrastructural and access costs. While some of these can be carried by governments, and by implication by their revenue base, a substantial portion of the costs are carried by the private sector and by users. This presents the need for the analysis of an emerging political economy of information and its usage. Pricing policy and competition between service providers is an example of the areas of concern that this might involve. An example is South Africa's Telkom in which pricing structures are higher than international standards in telecommunications and broadband, which has huge cost implications to the economy. As Kiiski and Pohjola (2001) observe, telecommunications pricing and infrastructure and internet access are complementary factors in determine ICT use and impact. Lowering the costs to communicate therefore seems a useful policy direction whether these deal with

unbundling, access to international ICT services, cable or broadband wireless.

The costs associated with ICT may well extend beyond the direct expenses associated with the provision of infrastructure and user charges. As also discussed, ICT may be used to restructure the agricultural commodity chain in a way that there are winners and losers, the smaller producers being a potentially vulnerable group. There is also evidence to suggest that specific groups may negatively affected of which women are of particular concern. Specific research questions for investigation thus include:

7.2.2 Research Questions

- How can the economic and social impact of ICT in agricultural development be assessed for important crops grown in Africa, and in Africa more generally?
- What is the impact on agricultural producers, processors and consumers of using ICT in terms of prices, profitability, choice and quality of life? Does this differ between different groups within developing countries in Africa, and if so, how and with what consequences
- What unintended consequences result from ICT usage, either to individual businesses or to society as a whole? This should include issues concerning empowerment/marginalisation and gender specifically.
- What are the costs of non-adoption at different levels (government departments, local authorities, agri-processing enterprises, farm producers of different sizes and individuals within households) and who carries these costs? Are there examples where non-adoption has been beneficial, and if so, for whom?
- What are the costs and benefits to ICT service providers, regulators and other stakeholders including the private sector and the ICT commodity chain itself?
- What has been the macro-economic impact of the ICT adoption, and how can this impact be built into national and agricultural statistics systems?
- What are the digitally dividing barriers (such as geographic concentration and urban-rural, gender, low income, age) that result in non-adoption of ICT (such as electronic communication) and how can these be reduced and/or eliminated?
- What transaction costs could potentially be reduced by ICT adoption and through what mechanism and with what government support?

7.2.3 Research Design

Two sector studies are proposed: the first will examine palm oil production in Cameroon and compare this to cocoa in Ghana. Both are buyer driven commodity chains, while palm oil has both export and domestic consumers, cocoa is an export crop. The second sector study is milk production in Uganda and South Africa. While Uganda remains relatively protected from international investment and competition, the dairy industry in South Africa has undergone substantial restructuring in the last decade. All these countries have seen comparatively rapid expansion of ICT usage although South Africa has experienced the longest growth.

7.3 Enhancing Innovation and Productivity

7.3.1 Problem Statement

For some governments, the limited resources available for the use of ICT have been justified as a lesser pressing investment priority relative to other development agendas (Torero and von Braun 2005). As such, research that sheds light more into the direct and indirect links and/or benefits between ICT and the expansion of the agricultural sector, and the macro-economic consequences that result, is an important information gap. Research is also required that is designed around the needs of the target population, rather than those of the providers of ICT and hence, it is important to engage farmers on the data and information to collect. As discussed earlier, changes to productivity and profitability can occur through-out the agricultural commodity chain through facilitating more efficient allocation of resources, by reducing the transaction costs involved in production and consumption, and by shifting outward the production function of the different enterprises on the commodity chain. To capture this, research would need to be directed at each of these elements, and at key commodity chains rather than at specific case studies. Finally, since few studies have included a time dimension, and/or have given a fully comprehensive and representative picture of the whole range of agricultural businesses in any country, little is known about the parameters of the ICT adoption curve (Warren 2002).

7.3.2 Research Questions

Questions include:

- What are the agricultural commodity chains most likely to be affected by ICT in terms of productivity and profitability and at what point in the chain would this occur? What are the possible consequences of this (job creation or loss; higher capital/labour ratios; gain or loss of control over production process)?
- What is the impact in terms on productivity and profitability of the ICT change, and what complementary changes have facilitated this such as training or other forms of investment?
- What new farm technology and innovation have improved output, productivity, safety or value added generally, for important crops grown in African, and in Africa more specifically?
- Who is, and who could assist farmers to innovate and to exploit the benefits of ICT generally and electronic commerce in particular and who can offer ICT linked agricultural research, training and skills enhancement?
- What is the percentage of farmers that have adopted or have been affected by the adoption of particular technologies?
- What is the rate of growth (measured over time) in use of ICT such as personal computers and Internet technologies as a management aid? What types of farmers use these the most, e.g., crop (arable), livestock (such as dairy)? What size farms? What are the demographics like between laggards and innovators?

- Do ICT assist emerging farmers through diversification, by opening up opportunities for marketing or are they increasingly excluded from such commodities and markets?

7.3.3 Research Design

Two case studies are proposed. The first is an examination of a high value export crop that is strongly buyer-determined. The case study of the vanilla sector in Uganda and Madagascar is recommended.[12] Currently the Coca-Cola Corporation is the world's largest customer of natural vanilla extract to the extent that changes in production have directly impacted upon economy of Madagascar. Prices have been volatile since the disbanding of Madagascar/Reunion led Vanilla Alliance in the 1980's which resulted in a substantial decline in prices and subsequently rose after the typhoon Huddah damaged production in Madagascar in 2000 (de Melo et al, 2000). This event is said to have encouraged the expansion of vanilla production in Uganda (www.ugandavanilla.com/). Uganda and Madagascar also have experienced different trajectories in terms of ICT uptake, with this sector expanding rapidly in Uganda, while uptake in Madagascar has been comparatively slow.

The second case study is of producer-driven domestic food crops. As before, two country studies are proposed. The first is the plantain sector in Rwanda, a country that has experience rapid and innovative ICT uptake and the second is cassava in Mozambique.

7.4 Agrarian Change and Rural Empowerment

7.4.1 Research Problem

So far the analysis has emphasised the market production aspect of agricultural activity. However, in many parts of Africa, agriculture serves multiple purposes that extend beyond this to include the production of food for subsistence, a source of employment and a social role that provides especially women with an independent livelihood. Agricultural is also not carried out in isolation from non-farm production, including handicrafts, retail activities and other formal and informal employment. As mentioned earlier, broad-based community development is an important concern of rural populations which indirectly impact upon the capacity of farmers to successfully engage in production through their improved health, education and participation.

A number of civil society organizations are working in the ICT sector which can affect how communities access and make use of technology. In the case of Internet, existing Internet policy and action groups include the African Networking Initiative (ANI), the International Development Research Centre (IDRC) and Bellanet, Capacity Building for Electronic Communication in Africa (CABECA), the UN Secretary General's Special Initiative on Africa (Proposal for Harnessing Information Technology for Development, and the Africa Internet Forum (Richardson 1998). Other challenges with ICT pertain to setting up systems that later become vulnerable to theft, including the cables themselves. Further, training needs to be provided on a continuous basis given the rapid technological

[12]/ Madagascar remains the world leader in vanilla production with Uganda in ninth position. Vanilla is also produced in Reunion, Malawi, Zimbabwe and Kenya.

developments. Finally economies of scale may not be realised due to the lack of necessary critical mass required for electronic networks.

7.4.2 Research Questions

Potential research questions include:

- What is the social impact of ICT: does digital networking reduces isolation and social exclusion?
- What is the role of social networks in the use and diffusion of ICT usage? Who is excluded and included, for what reason and on what terms?
- What is the extent to which the digital divide manifests itself in terms of access to ICT and geographic location, education, income and wealth?
- What is the extent to which the digital divide manifests itself in terms of acess to ICT and gender, ethnicity, disability and class?
- Who uses ICT for community development and community empowerment, for what purpose, and with what impact and with what constraints?
- Who uses rural or community telecentres, for what purpose and with what impact?
- In impact assessment evaluations using country case studies, what have been found to be the main positive impacts of ICT in most countries in the area of agricultural development and agrarian change? What potential impact assessments can be identified that provide opportunities for a satisfactory counter-factual?

7.4.3 Research Design

The two case studies are proposed. The first will compare rural community development using ICT in Nigeria and Uganda, while the second will examine poverty reduction and ICT adoption more broadly with case studies of Zambia and Ghana.

8 Conclusion

Improving the productivity of agriculture, whether for commercial production or for subsistence, is a priority for Africa. Experience elsewhere suggests that ICT can make a contribution to this and perhaps reverse the somewhat bleak picture of declining per capita production food and increasing food insecurity that has been suggested by organisations such as IFAD (2002). A substantial body of research suggests that people at all levels of society and especially the organisations that serve and represent them, need to be able to access critical information and communicate. In line with many other innovations, ideal ICT features and principles should be those that are owned by countries (governments) and driven (engaged in) by farmers, agribusiness, civil society and the private sector in order to facilitate agricultural development and employment creation. The intermediary agencies serve farmers and their communities in all their ICT initiatives with development assistance, advice, research, extension, education and training. These are the crucial elements of the networks created for information sharing purposes which in turn promote efficiency of data collection (censuses and surveys) and

ultimately result in the highly desirable situation of individual and community development and empowerment.

The role of ICT to support agricultural development has been varied in many countries, with developed countries being relatively more advanced in their technological developments and developing countries generally lagging behind. If it is said that ICT are not only of instrumental value but also have intrinsic benefit, this technological gap, also referred to as a digital divide is something that needs to be addressed if only as a matter of best practices (United Nations, 2005). The manner in which ICT have revolutionized the field of agricultural development in many countries are in a number of ways, including the area of e-commerce e-government and predictably, e-agriculture which includes cyber-extension. In Sub-Saharan Africa, some countries have a framework for national ICT policy making that includes support for the agricultural sector for example Ghana and Lesotho, while others have adopted ICT policies that specifically target rural communities such as Mozambique.

Rapid developments in technology infrastructure is such that some countries, usually in the West, now have open cities while others, usually in the South, still lag behind. The value of technology however, has both intrinsic and instrumental benefits. The instrumental value of these technological developments particularly in the field of agriculture, have implications for agricultural productivity and poverty. On the intrinsic value front, ICT literacy is something that is a must in the information society and this is something that governments should be taking up with the ICT industry. Governments must provide an enabling environment by provision of the necessary resources, infrastructure and policy framework. Governments' communications departments can also work hand-in-hand with agricultural departments and allocate costs and invest in ICT to bridge the technology divide. The effects of globalisation and the impact of the emerging information revolution cannot be ignored.

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