MANAGING INDIGENOUS AND EXOGENOUS KNOWLEDGE THROUGH INFORMATION AND COMMUNICATION TECHNOLOGIES FOR AGRICULTURAL DEVELOPMENT AND ACHIEVEMENT OF THE UN MILLENNIUM DEVELOPMENT GOALS IN TANZANIA

Edda Tandi Lwoga
and
Patrick Ngulube

Abstract

Approximately 1.2 billion people in the world live in extreme poverty. In that light, the first United Nations – Millennium Development Goal (UN-MDG) targeted eradicating extreme poverty and halving hunger by the year 2015. In support of the UN efforts, Tanzania set itself a goal to halve extreme poverty by 2010 and eradicate it by 2025. Poverty is principally a rural phenomenon and agriculture is the main economic activity for the rural population, therefore the reduction of hunger and poverty significantly depend on agricultural development. The expertise and knowledge to improve agricultural productivity and to reduce poverty are there. However, Tanzania's farmers are not only deprived from accessing global knowledge on agriculture, but they also lack opportunities to share their own indigenous knowledge. Information and communications technologies (ICTs) provide a possibility for rural farmers to share and preserve their own knowledge and use external information and knowledge. This paper addresses the extent to which ICTs can appropriately be used to manage agricultural indigenous knowledge to reduce extreme poverty and hunger in the rural areas of Tanzania. It also discusses ways that ICTs can be used to disseminate exogenous knowledge in the local communities in order to attain the first UN-MDG of reducing extreme poverty and halving hunger by the year 2015. Recommendations are given on how IK can be effectively managed using ICTs by citing examples from Tanzania.

Keywords: indigenous knowledge, information and communication technologies, agriculture

1. Introduction

About 1.2 billion of world's population lives in extreme poverty (World Bank 2007b:1). The majority of these world's poor are in developing countries, they are rural based and derive their livelihoods mainly from agriculture (Academy for Educational Development and Winrock International 2003). To address the challenges faced by the poor, governments worldwide committed themselves to the United Nations Millennium Development Goals (UN-MDGs). The first UN-MDG aims at eradicating extreme poverty and halving hunger by the year 2015 (United Nations Development Programme (UNDP) 2005). In line with UN-MDGs, Tanzania set itself the goal to halve extreme poverty by 2010 and eradicate it by 2025 (United Republic of Tanzania (URT) 2001). The National Strategy for Growth and Reduction of Poverty (NSGRP) also focused on poverty reduction in the country (URT 2005a).

Despite the efforts made to address the food insecurity and poverty, the number of rural poor in sub-Saharan Africa (SSA) has continued to rise (World Bank 2007a). Consequently, the highest incidence of under- nourishment is in SSA where one in every three persons suffers from chronic hunger. In Tanzania, poverty levels have also remained high and poverty reduction during the past decade has taken place mainly in urban areas, while rural areas have seen relatively little changes. The aggregate poverty level in 2000/01 was 35.7 percent compared to 38.6 percent in 1991/2, and it is highest in rural areas, where 39.9 percent of households are below the basic needs poverty line (URT 2006a). While such progress shows that Tanzania can achieve the UN-MDGs with political commitment, good policies and increased resources, still several challenges remain. Rural areas continue to be marginalized. Poverty is still concentrated in rural areas in Tanzania, and agriculture is the major source of livelihood for rural population. That means that the sustained reduction in hunger and poverty mainly hinges on agricultural development.

Agricultural information and knowledge to improve agricultural production and linking increased production to remunerative markets do exist in developing countries. Local communities possess a wide range of indigenous knowledge (IK) that has significantly contributed to the improvement of agricultural systems in relation to production techniques and post harvest techniques (Koda 2000:21). The integration of exogenous knowledge into indigenous knowledge systems has also allowed better results on farming activities in many developing countries including Tanzania (Kilongozi, Kengera and Leshongo 2005). However, many African farmers are not only deprived from accessing global knowl-

edge on agriculture, but they also lack opportunities to share their own local knowledge. If the UN-MDG of reducing poverty by half by 2015 is to be achieved, intervention must take place to revive the processes of managing agricultural IK and integrating exogenous knowledge into indigenous knowledge systems (IKS) to enhance agricultural productivity.

Information and communications technologies (ICTs) provide a window of opportunity for developing countries to harness and utilize IK and exogenous knowledge. In particular, ICTs can address the essential information, knowledge and communications dimensions of persistent poverty and low agricultural growth in developing countries since they can enable rapid and efficient exchange of information and knowledge across distance (McNamara 2003).

2. Indigenous knowledge

IK may be used to solve local problems, to help grow more and better food, to maintain healthy lives, to prevent conflict, to manage local affairs (Mkapa 2004:1-2), to reduce poverty, decrease environmental degradation, and enhance equity which may lead to sustainable development (Henning 2004). Despite its importance to sustainable and equitable development, IK has largely been marginalized, neglected and suppressed due to ignorance and arrogance (Ocholla and Onyancha 2005:248). Nevertheless, there is a renewed interest on IKS due to its important role for sustainable development and rational resource use (Brokensha, Warren and Werner 1980). For instance, an informetric analysis of eight indigenous knowledge databases hosted by EBSCOHost and SABINET revealed a significant growth of IK documents from 1997 – 2002 (Ocholla and Onyancha 2005).

Notwithstanding the increased interest in IK and support for IK research, IK is threatened by what Chisenga (2002) termed "modernisation, urbanisation and globalization". It is estimated by Food and Agriculture Organization (FAO) that 30% of animal genetic resources are at high risk of loss due to negligence of IK in favour of conventional scientific findings (Muyungi and Tillya 2003). Thus, there is an urgent need to document and preserve IK so that it can be available for developmental initiatives before much of it is completely lost.

3. Poverty and agricultural sector

Agriculture may contribute to poverty reduction and is a source of livelihood and a provider of environmental services in many developing countries (World

Bank 2007a). In Tanzania, the agriculture sector accounts for 45 percent of the GDP, provides 85% of exports and employs about 85% of the total work force (Central Intelligence Agency 2007). The importance of agriculture in enhancing poverty reduction is well supported by key development policies and strategies in Tanzania. The Agricultural Sector Development Strategy (ASDS) of 2001 is in resonance with the poverty reduction objectives of the NSGRP and the Tanzania Development Vision (TDV) 2025 (URT 2006b).

Despite the importance of agricultural production for poverty reduction, low agricultural growth has been a major factor in the Tanzania's slow progress towards poverty reduction. For instance, the agricultural sector in Tanzania grew by 4.1 percent despite the projected growth of 5 percent in 2006, and the actual growth rate of 5.1 percent in 2005 (Ngasongwa 2007). Considering that the overall GDP growth target for halving abject poverty by 2010 is in the range of 6-7 percent, this performance falls short of the needed growth (URT 2005b).

Regardless of the fact that agricultural yields continue to decline in SSA including Tanzania, previous studies show that agriculture growth in Africa remains fundamental to poverty reduction on the continent. Cross-country estimates show that for the poorest half of a country's population, GDP growth originating in agriculture has an impact on household expenditure that is on average four times larger than growth outside agriculture. Agriculture thus offers a great opportunity for reducing hunger and poverty. Although, the knowledge and resources to improve agricultural productivity and reduce poverty are there, their utilisation is limited, especially in Tanzania. The poor lack access to knowledge and information, the primary source of economic opportunity and political empowerment. That renders them vulnerable and prey to social exclusion (United Nations (UN) 2004).

4. Potential of indigenous and exogenous knowledge for agricultural development and poverty reduction

The potential of IK in improving agricultural performance is widely recognized (Hart and Mouton 2005; Ocholla and Onyancha 2005). For ages, farmers particularly in developing countries have planned agricultural production and conserved natural resources by using their IK. IK is an important aspect for agricultural development and poverty reduction because it is the social capital of the poor and a basis for their decision making. It provides local solutions to development challenges facing poor communities, and building on IK and leveraging other knowledge can help to alleviate poverty jointly with the poor (Gorjestani 2005).

In Tanzania, the potential of IK for reducing hunger and poverty can be gauged by the "*matengo* pits" practiced in Ruvuma region, the Ufipa mound system, the traditional terracing systems of the Iraqw and the rotational farming systems in Mufindi District in Tanzania. These systems demonstrate how the local communities, through their IK can reduce land degradation (especially soil erosion), maintain soil fertility and increase crop production (Kauzeni and Madulu 2003).

However, in Tanzania, a specific policy that deals with IK has not been formulated. Instead, IK is covered in various national strategies and sectoral policies. Among others, the National Strategy for Growth and Reduction Poverty (NSGRP) acknowledges the usage of IK for agricultural development and wildlife management (URT 2005a). A sectoral policy, such as the Agriculture and Livestock Policy of 1997 emphasizes the importance of integrating IK and conventional scientific knowledge in agricultural research (URT 1997). There is thus a need to develop the policy, strategies and action plans on the development and management of IK in Tanzania in order to reduce poverty and hunger.

It is also important to integrate IKS with exogenous knowledge since local farming systems at times face challenges that farmers are unlikely to be able to address without access to exogenous knowledge and information. Exogenous knowledge refers to the information made available to the rural community from the sources outside its boundaries as part of the information transfer process to support modernization (Mchombu 1995:124). The importance of improving the existing agricultural IK by integrating it with exogenous knowledge is well documented (Hart and Mouton 2005; Madukwe 2006). The integration adds value to local knowledge, innovations and practices rather than replacing them. For example, Dove (2000) found out that the successful production of rubber resulted from the confluence of indigenous and exogenous knowledge in Southeast Asia.

It is obvious from the aforesaid that not only indigenous knowledge is significant for reducing hunger and poverty but also exogenous knowledge is important too. However, poor people lack access to exogenous knowledge and information, as well as opportunities to share their own knowledge.

5. The poverty-reducing potential of ICTs in the agriculture sector

Previous studies indicate that ICTs can positively enhance access to relevant information and knowledge to reduce poverty among poor farmers in developing countries (Gerster and Zimmerman 2003; Souter *et al* 2005; Soriano 2007; Wa-

verman, Meschi and Fuss 2005). Access to ICTs has been growing rapidly and developing countries have embraced them in order to enhance socio-economic development and reduce poverty. Despite the rapid growth of ICT access and usage, the rural poor and vulnerable populations may have little opportunity or capacity to use or benefit from ICTs due to the digital divide. Uneven growth rates of ICTs access exist in many developing countries. For example, three quarters of all Africa's fixed lines are found in just 6 of the continent's 55 countries (World Summit on the Information Society 2005).

Similar divides are also found within individual countries, where rural areas tend to be marginalized in terms of access and use of ICTs. Although 19 telecentres have been introduced into some of the rural areas in Tanzania, access of the Internet and email services has remained predominantly confined to the urban areas (Tanzania Commission for Science and Technology 2005a). However, the major challenge is not only to increase the quantity and accessibility of ICTs in the rural areas but also to improve the access to relevant knowledge for local development.

5. 1 Approaches towards the application of ICTs in poverty reduction

Experiences from Tanzania and other developing countries will be discussed on the basis of the Sustainable Livelihoods Framework (SLF) of the Department for International Development (2001). SLF has widely been used to examine the contribution of ICT for poverty reduction in developing countries (Arun, Heeks and Morgan 2004; Soriano 2007; Souter *et al* 2005). The approach has also been adopted by the FAO's ICT programmes, for the reason that linking ICTs to sustainable rural livelihoods enables the poor to share knowledge and information that is significant to develop appropriate livelihood strategies and empower poor communities to participate in decision-making processes (Batchelor and O'Farrell 2003).

The major principles of the SLF approach include capital assets, vulnerabilities context, processes and livelihoods outcomes that are all related to poor livelihoods. The fight against poverty partly depends on access and use of five capital assets. The five major capital assets include (Batchelor and Scott 2001):

- natural capital: natural resource stocks used directly for production, or necessary to sustain life;
- social capital: social resources on which people draw in pursuit of livelihoods i.e. relationships, membership of networks;

- human capital: skills, knowledge, ability to work, good health which enable people to pursue different livelihood strategies;
- physical capital: basic infrastructure for the supply of energy, shelter, water, transport and communications, production equipment, markets; and
- financial capital: financial resources available which provide livelihood options, for example savings, credit, remittances, pensions.

This article uses the SLF framework to discuss the role of ICTs in managing IK and exogenous knowledge. Access to more livelihood resources/assets may help to reduce the poor's vulnerabilities and improve their agricultural livelihoods.

6. Role of ICTs for managing indigenous knowledge for poverty reduction

The usage of ICT to manage IK within and across local communities can improve cross-cultural understanding, enhance their well being and sustain their agricultural practices which they depend upon. In addition, IK management may lead to economic gain (access to markets, job creation, improved livelihoods); empowerment of communities; wide application of indigenous technologies; and promotion of community conservation of biodiversity (FAO and Vetaid Tz 2000). Experiences from Tanzania indicate that ICTs can be used to manage IK that may contribute to the reduction of hunger and poverty. The rural poor have been using ICTs available to them to acquire human capital in order to generate livelihood outcomes.

Tanzanians' farmers have been able to access knowledge and skills on the effective agricultural indigenous production methods through ICTs. For example, the Tanzania Development Gateway has enabled the rural poor to access agricultural indigenous production techniques in the local language "Swahili" (Tanzania Development Gateway 2007). Similar project have been set up in India (Traditional Knowledge Digital Libraries) to disseminate various types of IK and to prevent international companies from patenting the Indian IK (Traditional Knowledge Digital Library 2007). Other international agencies, such as the World Bank, CAB International, FAO LinKS project and Canadian International Development Agency (CIDA) have established research centers and websites to preserve and share IK (CIDA 2002; FAO 2007; World Bank 2007a). However, the impact of these national and international databases in managing IK of the rural poor is negligible due to the language barrier (most of the IK information is in English language), inappropriate packaging, poor ICT infrastructure in the rural areas, and low ICT literacy.

On the other hand, telecenters have contributed to the management of IK in the rural areas with reasonable success. For example, the Sengerema telecenters in western Tanzania has recruited several sectoral experts to collect local content in various fields. The experts gather information on issues such as indigenous chicken farming, use of organic manure and share this knowledge through the community radio and a website (Tanzania Commission for Science and Technology 2005b).

7. Role of ICTs for disseminating exogenous knowledge for agricultural development and poverty reduction

Apart from having limited ways to manage their IK, the poor also lack access to knowledge and information from the policy makers, researchers and business community which may be fundamental to reducing hunger and poverty. ICTs can improve access to exogenous knowledge and information that may meet the location specific information needs of the farmers (FAO 1998). ICTs can improve access to prices, markets and agricultural production information and knowledge (International Institute for Communication and Development (IICD) 2006:29) that may increase access and the use of capital assets such as social, human and financial within the SLF framework discussed above.

ICTs have contributed enormously to building and promoting social capital in Tanzania. ICTs have enabled farmers to interact with other communities at regional and national levels, thus reducing their social isolation. For instance, the experience from the Sengerema telecenter shows that the local community not only uses Internet communication but constantly communicate through the community radio instead of travelling long distances on bicycle and on foot (Tanzania Commission for Science and Technology 2005b). Studies done in India, Mozambique and Tanzania also indicate that telephones were largely used for social networking, particularly within the family (Souter *et al.,* 2005).

When it comes to financial capital, ICTs have been effective in raising the income levels of the poor communities and families in many developing countries. In Tanzania, the CROMABU telecenter and price information services are examples of how small-scale farmers have been able to increase their income through access to best market prices for their produce, as well as securing direct buyers from abroad through the Internet, especially when prices were low in Tanzania (Menda 2005). Apart from income gains, ICTs have also been influential in improving food security as demonstrated by the CROMABU telecenter and price information services in Tanzania (Menda 2005).

Further, access of information on market prices has empowered the local communities to make informed decisions regarding their marketing strategies. For instance, the Maasai pastoral people in northern part of Tanzania are now agreeing to sell their livestock and engage in marketing and businesses due to the Orkonerei Radio Programmes on food and nutritional security (Development Associates Ltd 2004).

Short message services (sms) are also used to effectively deliver market information through mobile phones to farmers in Tanzania. This sms project was implemented by the Ministry of Industry, Trade and Marketing, and Vodacom since 2005. Although, there has been no impact evaluation of this initiative as yet, evidence shows that many people utilize the service to request for information (Economic and Social Research Foundation 2007). Similar projects have been implemented in other African countries such as in Senegal, Benin and Zambia (Stienen, Bruinsma and Neuman 2007).

Exogenous knowledge gained from ICTs has enabled farmers to adopt new agricultural technologies that have improved their food security. For instance, the Agricultural Research Institute in northern Tanzania is an example of how a number of requests for agricultural information increased from farmers due to a weekly 15 minutes agricultural radio programme (William, Manyama and Schouten 2003:137). Further, telecenters have also been influential in equipping the local communities with the useful agricultural information. For example, the Sengerema telecenters in western Tanzania has enabled farmers and livestock keepers to search for information on agricultural chemicals (that is, herbicides and pesticides) and types of fertilizers from the Internet (Tanzania Commission for Science and Technology 2005b).

ICTs have also demonstrated greater impact on overall vulnerability in the developing countries including Tanzania. ICTs can effectively provide accurate weather forecasting and timely warning systems to lessen the effects of natural disasters, as well as improve crop yields and lessen the effects of severe weather or drought (World Bank 2007c). For example, in northern Tanzania, the broadcasts on breakouts of livestock's diseases through the Orkonerei radio station made quicker response from responsible parties possible (Development Associates Ltd 2004).

As far as livelihood outcomes are concerned, ICTs have shown a significant positive impact. ICTs have had significant positive economic impact as demonstrated by the CROMABU telecenter and price information services in Tanzania (Menda 2005). The information services it provides help farmers to effectively

utilise the existing knowledge to improve agricultural production. A study by Waverman, Meschi and Fuss (2005) examining the impact of ICTs in 92 countries (both rich and poor) revealed that ten extra phones per hundred inhabitants can lead to 0.59% extra annual GDP growth in a typical low-income country.

8. Conclusion and recommendations

ICTs are not a panacea, but they can facilitate the management of IK and the dissemination of relevant exogenous knowledge to achieve efficiency in agricultural productivity and poverty reduction. Further, ICTs can enable the rural poor to combine their assets to improve the agricultural livelihoods and expand their asset base within the SLF framework. Experiences from Tanzania indicate that the impact of ICTs for managing IK is mainly apparent in managing human and social capital (indigenous agricultural production techniques and networking knowledge sharing). On the other hand, the role of ICTs in disseminating agricultural exogenous knowledge also include financial aspects (better earnings and market prices) over and above the assets covered in the IK dimension.

Despite the fact that utilizing ICTs have the potential to reduce poverty, their effective use may be limited by the lack of relevant content, language, financial resources and ICT policies. To improve the situation, ICT strategies should be incorporated into agricultural sector policies and programmes, and the use of low cost ICTs options such as open source applications should be promoted. Pro-poor ICT investments and national budgets should be linked to poverty reduction strategy plans and specific sector plans. The dissemination of content should not be limited to the exogenous knowledge, but should also cover knowledge possessed by local people. Finally, mixed ICT options should be used such as mobile phones, radio, telecenters, television and loudspeakers to enable the local communities to effectively communicate information and improve their media literacy.

9. List of references

Academy for Educational Development and Winrock International. 2003. Future directions in agriculture and information and communication technologies (ICTs) at USAID. [Online]. Available WWW: http://www.dot-com-alliance.org/documents/AG_ICT_USAID.pdf (Accessed 20 June 2007).

Arun, S. et. al. 2004. Researching ICT-based enterprise for women in developing countries: a livelihoods perspective. [Online]. Available WWW: http://www.womenictenterprise.org (Accessed 4 June 2008).

Batchelor, S. & O'Farrell, C. 2003. Guiding principles for ICT interventions. **In:** FAO (ed.) *Revisiting the 'Magic Box': case studies in local appropriation of information and communication technologies (ICTs).* Rome: Food and Agriculture Organization, pp. 1-24.

Batchelor, S. et. al. 2001. The role of ICTs in the development of sustainable livelihoods: a set of Tables. [Online]. Available WWW: http://www.sustainableicts.org/livelihoods.htm (Accessed 12 January 2008).

Brokensha, D., Warren, D. & Werner, O. 1980. *Indigenous knowledge systems and development*. Lanham: University Press of America.

Canadian International Development Agency, (CIDA). 2002. Selected list of centers of indigenous knowledge. **In:** Handbook of CIDA Project Planning and Indigenous Traditional Knowledge. [Online]. Available WWW: http://www.kivu.com/CIDA%20Handbook/cidacentres.html (Accessed 1 March 2007).

Central Intelligence Agency. 2007.The world fact book: Tanzania. [Online]. Available WWW: https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html (Accessed 25 June 2007).

Chisenga, J. 2002. Indigenous knowledge: Africa's opportunity to contribute to global information content. *South African Journal of Library and Information Science,* 68(1): 16-20.

Department for International Development. 2001. Sustainable livelihoods guidance sheets 1-7. [Online]. Available WWW: http://www.livelihoods.org/info/info_guidancesheets.html#7 (Accessed 19 June 2007).

Development Associates Ltd. 2004. Case study Tanzania [Online]. Available WWW: http://www.tv4d.org/Tanzania_ANNEXES_final.pdf (Accessed 20 June 2007).

Dove, M.R. 2000. The life-cycle of indigenous knowledge and the case of natural rubber production. **In:** Ellen, R., Parkes, P. & Bicker, A. (eds). *Indigenous environmental knowledge and its transformations.* Amsterdam: Harwood Academic Publishers, pp. 213-254.

Economic and Social Research Foundation. 2007. Enhancing the livelihoods of the rural poor: the role of information and communication technologies (ICTs):

Tanzania country report. [Online]. Available WWW: http://topics.development gateway.org/ict/rc/filedownload.do~itemId=1117435 (Accessed 19 January 2008).

FAO. 1998. Knowledge and information for food security in Africa: from traditional media to the Internet. [Online]. Available WWW: http://www.fao.org/sd/CDdirect/CDan0017.htm (Accessed 29 November 2006).

FAO. 2007. FAO LinKS project: reports from the field. [Online]. Available WWW: http://www.fao.org/sd/LINKS/ (Accessed 13 June 2007).

FAO & Vetaid. Tz. 2000. Benefits and risks of sharing local knowledge. LinKS project gender, biodiversity and local knowledge systems for food security. [Online]. Available WWW: http://www.fao.org/sd/LINKS/documents_download/Benefits%20and%20risks%20Arusha%202000%20for%20WEB.pdf (Accessed 19 June 2007).

Gerster, R. & Zimmerman, S. 2003. *Information and communication technologies (ICTs) and poverty reduction in Sub Saharan Africa. a learning study (synthesis).* The Hague: IICD for the Building Digital Opportunities (BDO) Programme.

Gorjestani, N. 2005. Indigenous knowledge and achieving the Millennium Development Goals. Indigenous knowledge – learning from local communities global distance learning course March 28 – April 1, 2005. [Online]. Available WWW: http://worldbank.org/afr/ik/dlc/DLC%20files/Nic-new.ppt (Accessed 21 March 2007).

Hart, T. & Mouton, J. 2005. Indigenous knowledge and its relevance for agriculture: a case study in Uganda. *INDILINGA – African Journal of Indigenous Knowledge Systems,* 4 (1):249-263.

Henning, R.K. 2004. Using the Indigenous knowledge of Jatropha: the use of Jatropha curcas oil as raw material and fuel. **In:** World Bank. *Local pathways to global development: indigenous knowledge*. Washington, DC: World Bank. pp. 222-225.

IICD. 2006. *ICTs for agricultural livelihoods: impact and lessons learned from IICD supported activities.* The Hague: International Institute for Communication and Development.

Kauzeni, A.S. & Madulu, N.F. 2003. Local knowledge systems and mechanisms for benefit sharing. FAO LinKS project report 10. [Online]. Available WWW: http://www.fao.org/sd/LINKS/documents_download/Rep%2010%20Madulu.pdf (Accessed 13 June 2007).

Koda, B. 2000. Understanding local knowledge systems for agricultural and rural development: research needs for Tanzania. **In:** Mascarenhas, A *(ed.)*. *Gender, biodiversity and local knowledge systems to strengthen agricultural and rural development: the Tanzanian context.* FAO LinKS project report 2, pp. 20-37.

Kilongozi, N. et. al. 2005. The utilization of indigenous knowledge in range management and forage plants for improving livestock productivity and food security in the Maasai and Barbaig communities of Kibaha. [Online]. Available WWW: http://www.fao.org/docrep/009/a0182e/A0182E00.HTM (Accessed 6 March 2007).

Madukwe, M.C. 2006. Delivery of agricultural extension services to farmers in developing countries: issues for consideration. [Online]. Available WWW: http://knowledge.cta.int/index.php/en/content/view/full/3009 (Accessed 29 July 2007).

Mchombu, K.J. 1995. Researching rural information provision: a case study. In: Johansson, E (ed.) *Seminar on Information Provision to Rural Communities in Africa: Proceedings of the Seminar held in Gaborone, Botswana, 22-25, June 1994*. Uppsala: Uppsala University, pp. 124-130.

McNamara, K.S. 2003. Information and communication technologies, poverty and development: learning from experience. [Online]. Available WWW: http://www.infodev.org/en/Document.17.aspx (Accessed 15 November 2007).

Menda, A. 2005. ICT for improved crop marketing in rural Tanzania. [Online]. Available WWW: http://www.ftpiicd.org/iconnect/ICT4D_Livelihoods/TZ_ Livelihoods_EN.pdf (Accessed 18 June 2007).

Mkapa, B. 2004. Indigenous knowledge—a local pathway to global development. **In:** World Bank. *Local pathways to global development: indigenous knowledge.* Washington, DC*:* World Bank. pp. 1-3.

Muyungi, R. & Tillya, A.F. 2003. Appropriate institutional framework for coordination of indigenous knowledge. FAO LinKS project report 9. [Online].

Available WWW: http://www.fao.org/sd/LINKS/documents_download/Rep%209%20TILLYA.pdf (Accessed 13 June 2007).

Ngasongwa, J. 2007. The economic survey for 2006 and medium term outlook for 2007/08– 2009/10. [Online]. Available WWW: http://www.tanzania.go.tz/bspeech2007_2008.htm (Accessed 15 June 2007).

Ocholla, D.N. & Onyancha, O.B. 2005. The marginalized knowledge: an informetric analysis of indigenous knowledge publications (1990-2004). *South African Journal of Libraries and Information Science,* 71(3):247-258.

Odero, K.K. 2003. Extending the sustainable livelihoods framework. [Online]. Available WWW: http://dlc.dlib.indiana.edu/archive/00001293/01/kodero01.pdf (Accessed 11 February 2008).

Organization for Economic Cooperation and Development. 2005. Good practice paper on ICTs for economic growth and poverty reduction. World Summit on the Information Society, Geneva 2003 – Tunis 2005. [Online]. Available WWW: http://www.oecd.org/dataoecd/2/46/35284979.pdf (Accessed 18 November 2007).

Soriano, C.R.R. 2007. Exploring the ICT and rural poverty reduction link: community telecenters and rural livelihoods in Wu'an, China. *EJISDC*, 32(1):1-15.

Souter, D., Scott, N., Garforth, C., Jain, R., Mascarenhas, O. & McKemey, K. 2005. *The economic impact of telecommunications on rural livelihoods and poverty reduction: a study of rural communities in India (Gujarat), Mozambique and Tanzania*. London: Commonwealth Telecommunications Organisation for UK Department for International Development.

Stienen, J. et. al. 2007. How ICT can make a difference in agricultural livelihoods. [Online]. Available WWW: http://www.iicd.org/files/ICT%20and%20agricultural%20livelihoods.pdf (Accessed 5 March 2008).

Tanzania Commission for Science and Technology. 2005a. Tanzania Commission for Science and Technology ICT projects. [Online]. Available WWW: http://www.costech.or.tz/ (Accessed 5 March 2008).

Tanzania Commission for Science and Technology. 2005b. The multi-purpose community telecentre pilot project – Sengerema Online]. Available WWW:

http://idrinfo.idrc.ca/archive/corpdocs/123705/77483.pdf (Accessed 6 March 2008).

Tanzania Development Gateway. 2007. Tanzania indigenous knowledge database. Online]. Available WWW: http://www.tanzaniagateway.org/ik/ (Accessed 13 June 2007).

Traditional Knowledge Digital Library. 2007. Traditional Knowledge Digital Library (TDCL), India. [Online]. Available WWW: http://www.slais.ubc.ca/courses/libr500/05-06-wt2/www/D_Ionson/TKDL.htm (Accessed 13 December 2007).

UN. 2004. Mainstreaming information and communication technologies for the achievement of the Millennium Development Goals. [Online]. Available WWW: http://www.apdip.net/documents/mdg/analysis/unict18112004.pdf (Accessed 10 January 2008).

UNDP. 2005. Assessing environment's contribution to poverty reduction. [Online]. Available WWW: http://www.undp.org/pei/pdfs/Indicators_Paper_Final.pdf (Accessed 18 March 2007).

United Republic of Tanzania (URT). 1997. *Agricultural and livestock policy, 1997*. Dar es Salaam: Government Printer.

URT. 2001. *Tanzania development vision 2025*. Dar es Salaam: Government Printer.

URT. 2005a. *National strategy for growth and reduction of poverty*. Dar es Salaam: Government Printer.

URT. 2005b. Tanzania national website. Online]. Available WWW: http://www.tanzania.go.tz/agriculture.html (Accessed 26 March 2007).

URT. 2006a. *Millennium development goals: progress report*. Dar es Salaam: Mkuki na Nyota Publishers Ltd.

URT. 2006b. *Agricultural sector development programme (ASDP)*. Dar es Salaam: Government Printer.

Waverman, L. et. al. (2005). The impact of telecoms on economic growth in developing countries. [Online]. Available WWW: http://web.si.umich.edu/tprc/papers/2005/450/L%20Waverman-%20Telecoms%20Growth%20in%20Dev.%20Countries.pdf (Accessed 11 February 2008).

William, M.N.M. et. al. 2003. Output production: making research results accessible and available. **In:** Lema, N. M., Schouten, C. & Schrader, T. (eds). *Managing research for agricultural development. Proceedings of the National Workshop on Client Oriented Research 27-28 May 2003, Moshi, Tanzania,* pp. 130-141. [Online]. Available WWW: http://www.kit.nl/net/KIT_Publicaties_output/showfile.aspx?e=482 (Accessed 13 June 2007).

World Bank. 2007a. World Bank: indigenous knowledge. Online]. Available WWW: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTINDKNOWLEDGE/0,,menuPK:825562~pagePK:64168427~piPK:64168435~theSitePK:825547,00.html (Accessed 20 November 2007).

World Bank. 2007b. *World development report 2008: agriculture for development.* Washington D.C: World Bank.

World Bank. 2007c. Using information and communication technologies (ICTs) to support rural livelihoods: evidence, strategies, tools. Online]. Available WWW: http://www.infodev.org/en/Document.358.aspx (Accessed 20 February 2008).

World Summit on the Information Society. 2005. The digital divide at a glance. Online]. Available WWW: http://www.itu.int/wsis/measuring-is/index.html (Accessed 20 November 2007).