

**CHALLENGES AND PROSPECTS OF INFUSING INFORMATION
COMMUNICATION TECHNOLOGIES (ICTS) IN EXTENSION FOR
AGRICULTURAL AND RURAL DEVELOPMENT IN GHANA**

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Abstract

Information and Communication Technologies (ICTs) can be cost-effectively and practically employed to facilitate information delivery and knowledge sharing among farmers, extension agents and other stakeholders. This paper presents aspects of the study that sought to examine the challenges and prospects of infusing ICTs in extension for agricultural and rural development in Ghana. The study used qualitative and quantitative procedures to collect the data from 291 extension agents and ICTs service providers such as internet cafes, computer training and business centers, computer firms, and information centers in the selected districts capitals in Ghana. Means, percentages, frequencies, and standard deviation were generated to describe the general trend of the data. The study revealed that extension agents have high and positive demand for ICTs for extension. There is a prospect for involving private and public institutional sources in extension delivery. The respondents have high knowledge about the advantages of using ICTs which will probably enhance their application of the technologies in extension. However, extension agents need ICT training opportunities, infrastructure, financial resources and technical backstopping to enhance the use of ICTs in extension. The study recommends a systems approach involving major stakeholders such as training institutions, Internet service providers, research institutions, farmers, policy makers to collaborate in the use of ICTs for extension.

Introduction

About 70% of people living in rural areas in Africa are poor. The livelihoods of majority of them depend on agriculture. Revitalization of the agricultural sector will improve the welfare of such rural people and contribute to their overall development. Agricultural Extension has been at the forefront of the agricultural sector program meant to bring economic development to many developing countries, including Ghana. Agricultural Extension systems in many developing countries are responsible for diagnosis of farmers' socio-economic and agro-ecological conditions, opportunities and constraints; transfer of messages through direct contact between

extension agents and farmers or indirect contact involving intermediaries such as 'contact farmers' or voluntary organizations. Agricultural Extension also provides feedback to researchers on farmers' reactions to new technology so as to refine future research agenda. Furthermore, Agricultural Extension develops linkages with researchers, government planners, NGOs, farmers' organizations, banks, and the private commercial sector to monitor the extension system, and evaluate its performance at farm level (ODI 1994; Van den Ban and Hawkins, 1996 and Swanson, Bentz, and Sofranko, 1996).

Various strategies such as the Transfer of Technology (TOT) model (Nagel, 1997); the integrated rural approach (Ngomane, 2004), Training and Visit (T&V) system (Benor & Baxter, 1984); the Farmer Field Schools (FFS) (Owens & Simpson, 2003) and Decentralization (Work, 2002, Alex and Rivera, 2002) have been put in place over the years. These extension efforts are meant to ensure information on agricultural technologies are made available to improve the productivity of farmers and to facilitate the role extension plays in national development in many developing countries.

Despite the huge financial and human capital investments, these extension efforts have achieved some degree of success but still left extension systems facing many constraints and challenges. There is high cost involved in reaching many farmers who are located in the remotest parts of the country; the bad roads in some cases make accessibility a major problem in extension delivery. Moreover, losses of information are associated with the conventional extension information dissemination approach because information passes through many channels before reaching the final user. The major constraints and challenges have called for the need for major reforms in extension systems in sub-Saharan Africa. Driving the reforms in many developing countries is the need to make extension service more responsive to authentic needs of beneficiaries, more effective, and less costly to governments (World Bank, 2000).

The challenges of extension have opened the door to examine how Information and Communication Technologies (ICTs) can be cost-effectively and practically employed to facilitate information delivery and knowledge sharing among farmers, extension agents and other stakeholders (Kiplang'at, 1999; Richardson, 2003).

Purpose of the Paper

Information is very important for the development of appropriate technologies and communication to the farmers. The Ministry of Food and Agriculture (MOFA), the government agency responsible agricultural extension in Ghana, is committed to pursuing ICTs in agricultural extension delivery. Armed with the belief that the human resource as well as institutional structures that are expected to spearhead transformation is often ill prepared, a study was conducted from November 2004 to February 2005 to assess factors constraining the development and adoption of ICTs for extension in Ghana. This paper presents aspects of the study that sought to examine the challenges and prospects of infusing ICTs in extension for agricultural and rural development in Ghana. The specific objectives were to:

1. Identify the prospects of infusing ICTs in extension in terms of:
 - i. Demand of ICTs for Extension
 - ii. Advantages of ICTs
 - iii. Partnership/collaborations for development of ICTs among major stakeholders in agricultural knowledge system.
2. Identify the challenges of infusing ICTs in extension in terms of:
 - i. Training needs

- ii. Constraints (technology, human, policy and infrastructure).

Theoretical Base

Agricultural extension is an information and knowledge support system for rural people. The success of rural development programmes depends largely on decisions by rural people on questions such as what to grow, where to sell, how to maintain soil fertility, and how to manage common resources (Rivera & Alex, 2002). The stakeholders involved in agricultural and rural development need to communicate, negotiate and arrive at decisions that can be communicated in order to achieve results. The failures associated with numerous extension efforts are largely as a result of extension's inability to deal with communication concerns. According to Rölöng (1988), extension workers are often ineffective in their communication with farmer because they lack training in the scientific principles and methods of communication. They often have technical, but not communication orientation (Rölöng and Engel, 1991).

Communication must be interactive, an exchange of ideas, emphasizing dialogue and joint participation, creating the opportunity to understand various points of view, and providing audience-oriented feedback (Moemeka, 1994). Many authors have defined extension to include communication so as to highlight the importance of communication in extension delivery. For example, Rölöngs (1988) defines extension as professional communication intervention deployed by an institution to induce change in a voluntary behaviour with a presumed public or collective utility. Extension involves conscious use of communication of information to help people form sound opinions and make good decisions (Van den Ban & Hawkins, 1996). Leeuwis (2003) depicts extension as a series of embedded communicative interventions that are meant, among others, to develop and /or induce innovations which supposedly help to resolve (usually multi-actor) problematic situations.

The search for effective strategies to deal with communication concerns of extension agents continues. Bagchee (1994) notes that to effectively serve small farmers, extension workers must not only learn to communicate effectively, but see their role as facilitation of development. The advocates for the concept of communication for development or development communication have explained the role of communication in development. In the words of Thyagarajan (2002), development communication is interplay of communication and development processes. It involves the use of the process of exchange of ideas to achieve the objectives of development. It attempts to create an atmosphere conducive for genuine dialogue that would ensure that the members of the benefiting social system understand the rationale for the development programs, accept the need for change and fully participate in the planning and execution of the development programmes (Moemeka, 2000).

Communication for development thrives on access and flow of information among development agents and benefiting society. As a tool, Information Communication Technologies (ICTs) can provide the forum to provide access to information and training of development workers on communication. ICTs consist of electronic and digital means of capturing, processing, sharing, storing and retrieving information for broadcasting using radio and television; and transmission of speeches, data and images using telephones, faxes, e-mail and Internet through fixed, wireless and/or satellite networks (Zappacosta, 2001). CTA (1999) has demonstrated that, electronic mail is the most commonly used among the ICTs for interaction and to bring about change. The second most significant ICT is the World Wide Web, which enables people to access information from millions of other computers.

The cravings for ICTs for extension are due to their characteristics that have the potential to positively influence the extension systems. According to Colle and Roman (2003) ICTs hold the key to rural development as they are capable of reaching many people simultaneously, overcoming geographic boundaries, providing frequency and repetition of contact, storage of information on-demand access, capturing the reality of events by depicting them geographically and in real time, and greater efficiency (lower costs) in sending and receiving information. The overall development of rural areas is expanding in new directions as ‘traditional societies’ are being transformed into ‘knowledge societies’ all over the world (Meera, Jhamtani, & Rao, 2004). The link between development and the increased use of ICTs in development is based on two assumptions: that a new kind of economy is emerging – an information economy; and secondly, that the main constraint to development is knowledge or information gaps (Bedi, 1999). Agricultural extension, whether public or private, cannot properly function without a continuous flow of appropriate innovations from a variety of sources (local and foreign). The assertion that a knowledge gap is an important determinant of persistent poverty and that many developed countries already possess the knowledge required to assure a universally adequate standard of living, suggests the need for policies which encourage greater communication and information flows within and between countries (World Bank, 1998). ICTs have actually been applied in many development efforts to bridge the information gap. ICTs have been used as tools and a source to provide knowledge and information to service providers (extension professionals), reach a wider audience (farmers), and to solve rural development problems (Ramírez, 1999). Moreover, ICTs have been used to provide relevant information to farmers to improve their productivity, increase yields, and obtain better prices for their produce (Bhatnagar & Schware, 2002). The most significant ICT applications are providing efficient access to useful information; securing adequate feedback for learning; providing tailor made advice; exchanging of similar experiences of people elsewhere; and providing inventory and/evaluation of opinions (Leeuwis, 2003).

Communication planners have argue for ICTs and policies that encourage the participation of intended beneficiaries in the planning and implementation of communication development projects to promote an effective transition in an information society (Heffzallah, 1999). Melody (1996) has suggested that development of ICT services and applications must be demand-driven. The frequency of use of various sources of information depends on the users’ characteristics, access and interests (Mundy, 1992). Therefore, an analysis of the users’ needs and consideration of factors that may exclude them from participating in the design and implementation of technological applications are essential (Mansell & Wehn, 1995). The lack of awareness, underdeveloped legal framework for information sharing, infrastructure problems, poor connectivity to global networks, maintenance problems, weak research and development and high taxes are constraining factors limiting the utilization of ICTs (Adam & Wood, 1999). Material resources and economic capacity play central roles in determining (i) whether people use ICTs and (ii) the nature and subsequent patterns of that use (Murdock, Hartmann, & Gray, 1996). The negative attitudes towards ICTs, lack of confidence and self-esteem are a barrier to ICT adoption (Cullen, 2001; Katz and Aspeden, 1997). Low-income earners are unable to afford equipment costs, access costs and telephone costs incurred in the access and use of ICTs (Selwyn, 2002). Fortier (2003) found that community ownership and relevance, finance, technology, organization and management, and regulatory issues are important obstacles that persist against development and adoption of ICTs. Burkett (2000) indicated that the productive use of ICT services requires at least the attainment of basic literacy levels because illiteracy is an

enormous barrier to accessing ICTs despite the development of user-friendly interfaces based mainly on pictographic and audio-video information.

Methods and Data Sources

The study used qualitative and quantitative procedures to collect the data to describe the challenges and prospects of infusing ICTs in extension for agricultural and rural development in Ghana. The qualitative approach included observations, informal discussions and on-site visits to individuals and institutions involved in the provision of ICTs services such as internet cafes, computer training and business centers, computer firms, and information centers in the selected districts capitals in Ghana. The quantitative procedure involved the use of questionnaire to collect data from selected agricultural extension agents nationally in Ghana. The questionnaire targeted agricultural extension agents because they are representatives of Government agency responsible for rural development at the regional, district and local levels in Ghana. Extension agents use various sources of information to communicate new and emerging technologies to farmers and are expected to play major roles if the development and adoption of ICTs for agricultural extension is to succeed in Ghana.

The face and content validity were established by a team of experts who were familiar with ICTs and agricultural development. Likert type questions on a five-point scale with 1 = very lowly important 2 = lowly important; 3 = averagely important; 4 = highly important; and 5 = very highly important were used to measure attitude of extension agent towards importance of ICTs for extension. Likert type questions on a five-point scale with 1 = not a major constraint; 2 = not a constraint; 3 = somewhat a constraint; 4 = A constraint; and 5 = A major constraint were used to measure attitude of extension agent towards constraints to infusing ICTs for extension. Similarly, a 5 point Likert scale type questions were used to measure extension agents' perceived ICT resources needed to perform duties. The scale ranged from 1 = strongly disagree, 2 = disagree, 3 = somewhat agree, 4 = agree, 5 = strongly agree. A pilot test was conducted using the instrument on twenty-five respondents who were not part of the study. The data collected from the pilot study were entered into the SPSS data file for computer analysis to generate alpha coefficients for the sub-scales of constructs on importance, constraints and needs of ICTs. The Cronbach's alpha coefficients were 0.81 for perceived need sub-scale, 0.97 for perceived importance sub-scale and 0.92 for the constraints sub-scale. This shows that the items on the subscales were internally consistent when compared to the minimum of 0.50 suggested by Nunnally (1967).

A stratified random sampling procedure was used to select six out of the ten regions, two each from the southern, middle and northern zones of Ghana. Two districts were selected from each of the six regions. The list of extension agents totalling 388 was compiled from the offices of extension agents out of which 291 returned the questionnaire at the time of preparation of questionnaire for data entry. The 75% response rate obtained for the study was considered adequate for a survey research (Ary Jacobs, & Razavieh, 2002). The questionnaires collected were screened for their usability and then entered into Statistical Package for Social Sciences (SPSS 13 for windows, 2004) to for analysis. Means, percentages, frequencies, and standard deviation were generated to describe the general trend of the data.

Results

Background of extension agents

Many of the extension agents (84.2%) work at the district level. Male agents (81.4%) outnumbered their female counterparts (18.6%) at the regional and metropolitan and district

levels. Majority of extension agents (65.6%) have worked for over 10 years. Although there were young agents (36.4%), most of agents were above 40 years. More than half of the respondents (50.9%) have received education up to tertiary or university level.

Prospects of infusing ICTs in extension

The attitudes of users of ICTs are important to their adoption. The lack of acceptance of ICTs is a major barrier to ICTs adoption and use (Revenaugh, 2000). To examine the prospect of infusing ICTs in extension, the study examined the importance of ICTs in extension as perceived by extension agents. The results presented in Table 1 show that extension agents generally perceived the importance of the adoption of ICTs for agricultural extension. Among the technologies, computer hardware (mean = 4.08, s.d =0.95), audio-visual (mean = 4.03, s.d =0.98) and telecommunication facilities were found to be highly important for adoption for extension delivery. They also perceived the adoption of computer networks and computer software to be important. The negative attitudes towards ICTs serve as barriers to ICT adoption (Cullen, 2001; Katz and Aspeden, 1997). On the contrary, the study revealed that extension agents have high and positive demand for ICTs for extension. This implies that any efforts to provide these technologies will contribute to their adoption.

Table 1. Importance of adoption of ICTs for Extension (N=291).

ICTs Technology	Mean	S.d
Computer hardware (eg personal computer, printer, CD ROM)	4.08	0.95
Audio-visual systems (eg Camera, video camera/decks, speakers, Television sets, radio)	4.03	0.98
Telecommunication facilities(Telephone, satellite, Facsimile, radio and TV transmitters)	4.01	1.00
Computer Electronic communication/networks (e.g. Internet, e-mail, teleconferencing, e-commerce)	3.73	1.01
Computer software (word processors, presentation, multimedia, spreadsheets)	3.65	1.10

Means were calculated based on a scale of 1= very lowly important 2 = lowly important; 3 = averagely important; 4 = highly important; and 5 = very highly important.

The results presented in Table 2 shed light on the prospect for involving private and public institutional sources in extension delivery. One hundred and twenty respondents, representing 41.2%, use ICT at the office. On the other hand, few extension agents (7.9%) indicated they use ICTs at the library. Less than a quarter (23.4%) of the respondents personally owned and use computer and accessories at home. However, more than two thirds of the respondents owned the traditional ICTs such as telephone, television, radio and video decks.

Foley, Ximena, & Shazad, (2002) have predicted the possibility of equality of use being achieved only when and if every individual from every socio-economic group has access from home. Research shows that communications technologies allow many information workers to bring work home rather than transport themselves to their jobs (Williams, 1982).

Table 2. Information on ownership, place of use and training on ICTs.

Item	Frequency	Percent
Ownership of personal computer	68	23.4
Ownership of television set	266	91.4

Ownership of radio	278	95.5
Ownership of telephone	177	60.8
Ownership of video deck	197	67.7
Use of ICT at office	120	41.2
Use of ICT at business centre (community learning centre, Internet Café or computer school)	82	28.2
Use of ICT at library	23	7.9
Attendance of professional course on ICTs	69	23.7
Dependents in household with ICT knowledge and use	117	40.2
Informal training in ICT at business centre (community learning centre, Internet café or computer school)	85	29.2

Less than one-third (28.2%) use ICTs at private business centres such as community learning centres, Internet Cafés or computer schools (Table 2). Foley, Ximena, & Shazad, (2002) have further indicated that, access and use through public access points may help bridge the digital divide although there is the possibility that access in public will restrict the way in which socially excluded groups and others use ICTs at public access points.

As low as 23.7% have attended professional courses on ICTs but close to a third of the respondents (29.2%) have received ICT training on their own at business centres such as community learning centres, internet cafés or computer training school. A sizeable number, 117 (40.2%) said that dependants in their households possess knowledge and can use ICTs. The dependents can be a source for informal training extension agents at home (Table 2).

Advantages of ICTs in Extension

High percentages were obtained in response to a question that sought to identify advantages of using ICTs in extension delivery in Ghana. Many of the extension agents (96.0%) believe that ICTs can provide access to update information on agricultural literature. Moreover, most of the agents (96.5%) indicated ICTs could facilitate the exchange of information among major stakeholders in agricultural system. Also, 96.2% of respondents indicated that ICTs could create opportunities to introduce new teaching approaches for training of extension agents. The high knowledge of advantages of ICTs will probably enhance their application of the technologies in extension for the lack of awareness of ICTs is a major barrier to ICTs adoption and use (Cullen, 2001).

Observations at the towns close to district and regional offices showed a host of institutions (private and public) that could collaborate with extension organizations to infuse ICTs in extension programmes. The institutions include internet cafés, computer training schools, universities and information centre of research institutions. The internet cafés provide access to telephone, fax and/or internet services such as electronic mail and the World Wide Web to people. They have facilities for word processing, spreadsheets, database management and desktop publishing. The privately owned computer training schools have been at the forefront of developing the knowledge and skills of people who have demand for such training. The universities and information centers of research institutions are strategically placed in all the ecological zones of Ghana. These institutions have achieved some high level of internet connectivity and have the requisite manpower to train extension agents in the districts.

Moreover, there were opportunities to collaborate with the private sector, donor agencies, and international institutions such as Food and Agricultural Organization (FAO), Centre

Technique de Cooperation Agricole et Rurale (CTA) and World Bank to infuse ICTs in Extension.

Challenges of Infusing ICTs in Extension

The second objective of the study sought to identify the major challenges that needed to be overcome to infuse ICTs in extension. Extension agents strongly agreed that they required training opportunities to enhance their competencies (knowledge and skills) in the use of ICTs. Moreover, the agents strongly agreed that, for them to use ICTs, they required offices equipped with ICTs (mean = 4.69, s.d. 0.66), a reliable infrastructure, financial resources to secure ICT materials and experts to train them and to secure ICT production materials (Table 3).

Table 3. Extension agents perceived ICT resources needed to Perform Duties.

ICT Resources	N	Mean	S.d	Perception (%)				
				Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
Offices equipped with ICTs	280	4.69	0.66	0.7	1.4	2.5	18.6	76.8
A reliable infrastructure (network, hardware, software) to support ICT use	280	4.54	0.70	0.7	0.4	6.4	29.5	63.0
Training opportunities	277	4.72	0.58	0.4	0.7	2.5	19.1	77.3
Financial resources for securing ICT production materials	281	4.41	0.77	1.1	0.7	8.5	35.6	45.9
Expert technical for producing ICTs	283	4.29	0.82	1.4	1.1	11.3	38.9	47.3
Expert technical assistance to ask questions	283	4.40	0.74	0.4	1.4	8.8	36.4	53.0

Means were calculated based on the following scale 1= Strongly Disagree, 2=Disagree, 3=Somewhat Agree, 4=Agree, 5 = Strongly Agree.

On the other hand extension agents perceived major constraints to infusing ICTs in extension. The constraints bordered on technology, human, policy and infrastructure (Table 4). The high cost of ICTs (mean= 4.08, s.d. 1.14) was a constraint. Other constraints identified were fear of ICTs, low economic status of users, weak communication infrastructure, and inadequate electricity supply to rural areas.

Table 4. Constraints to infusing ICTs in Extension.

Constraints	Level of Constraint		
	N	Mean	S.d
High cost of ICTs	242	4.08	1.14
<i>Inadequate electricity supply to rural areas</i>	244	4.07	1.05
<i>Weak communication infrastructure</i>	237	3.95	1.07
Location (physical distance) of ICT facilities from users	246	3.74	1.22
Profit maximization behaviour of service providers	232	3.67	1.19
Absence of rural/agricultural organisations in policy dialogues	241	3.64	1.18
Low economic status of users	243	3.54	1.31
Low educational level of users	240	3.46	1.23

Ineffective legal and regulatory framework	204	3.30	1.21
Weakness in adaptability technical information to ICTs	219	3.27	1.32
Fear of use of ICTs	230	2.55	1.29

Means were calculated based on the following scale 1 = not a major constraint; 2 = not a constraint; 3 = somewhat a constraint; 4 = A constraint; and 5 = A major constraint.

Conclusions/Implications/Recommendations

This study sought to examine the prospects and challenges of infusing ICTs in extension for agricultural and rural development in Ghana. The study concludes that there are prospects to infuse ICTs in extension for agricultural and rural development. Extension agents held high perception about the importance of ICTs for extension and rural development. Some extension agents already owned ICTs and have attended professional ICT courses and could therefore assist their colleagues to acquire knowledge and skills on ICTs. There exists private and public sector institutional partnership to move ICTs forward. However, for extension to attain the full potential of application of ICTs for development, some challenges need to be addressed. Extension needs ICT training opportunities, infrastructure, financial resources and technical backstopping to enhance the use of ICTs in extension. Moreover, there are constraints relating to high cost of ICTs, weak infrastructure, absence of extension agents in ICTs policies making process and ineffective regulatory framework. The study recommends a systems approach involving major stakeholders such as training institutions, Internet service providers, research institutions, farmers, policy makers to collaborate in the use of ICTs for extension. MOFA should consider the private sector partnership to provide technical backstopping for continuous training of extension agents in the short term. Specifically, MOFA can liaise with the private Internet café operators spread in most district capitals to provide internet services to its train.

In the long run, the study recommends that MOFA makes large investment not only in terms of hardware and software procurement, but also in the accompanying training and support structures. The investments in low cost but cost effective technology options as information technologies keep changing due to advances being made each day. Moreover, MOFA should forge partnership with international development based organizations such as FAO, CTA, local private and public organization and the Ministry of Communication to translate the goals of the ICT policy for agriculture into reality. Partnership and cooperation are vital as these organizations already have such experience and resources that MOFA can use to realize its goals. Pooling resources together, such cooperation could provide training and infrastructure necessary to make ICT available throughout Ghana for extension. Other points of cooperation will be exchange of information, techniques and policies.

The universities have a major role to play in the cultivation of content for the ICT, especially, in relation to poverty alleviation and community development. In Ghana, higher education training institutions who are strategically placed offer some kind of curriculum specializing in ICTs. These can be tailored to suit the most urgent needs of extension education. There is need for research to examine the curriculum of training institutions for ICT content and capacities to provide ICT training and examine the competencies of extension staff who have received ICT training and attitude of extension directors who are who are key to facilitating development and adoption of ICTs for extension.

Moreover there should be establishment of regional communication centers to provide training workshops and ICT network/media support and monitor ICT activities and impacts in the regions.

References

- Adam, L., & Wood, F. (1999). An investigation of the impact of information and communication technology in Sub-Saharan Africa. *Journal of Information Science*. 25 (4) 307-318.
- Bagchee, A. (1994). Agricultural Extension in Africa. In Benor, D., Harrison, J.Q., & Baxter, M. (1984). *Agricultural Extension: The Training and Visit System*. Washington D.C.: The World Bank.
- Bedi, A. (1999). "The role of information and communication technologies in economic development, a partial survey", *ZEF-discussion Papers on Development Policy*. No. 7 Bonn: Center for Development Research (ZEF), .p7
- Benor, D. and M. Baxter (1984). *Training and Visit Extension*, The World Bank, Washington, DC.
- Bhatnagar, S., & Schware, R. (eds) (2002) *Information Communication Technology in Development: Cases from India New Delhi*: Sage Publications. ISBN 0-7619-9444-0.
- Burkett, I. (2000). Beyond the information-rich and poor: futures understanding of inequality in globalizing informational economies *Futures* Vol. 32, 2000 pp. 679-94
- CTA, (1999). Information and communication technologies: a remarkable revolution. *SPORE* No. 79 February 1999. pp. 4-5.
- Colle, R., & Roman, R. (2003). Content creation for ICT development projects: Integrating normative approaches and community demand. *Information Communication for Development*. (10) (2003) 85-93.
- Culle, R. (2001). Addressing the digital divide. *Online Information Review*, 25(5), pp. 311-320
- Fortier, F. (2003) *Sustainable Rural Networking Community Ownership and Appropriate Technologies*. New York: UNDP.
- Frakaren J, Sawin E and Wallen N. (1999). *Visual Statistics: A Conceptual primer*. Boston/London/Toronto/Sydney/Tokyo/Singapore Allyn and Bacon: ISBN: 0-205-28317-9. p4.
- Foley, P. Ximena, A. & Shazad, G. (2002). *The digital divide in a World city* London: London Connects & London Development Agency. June 2002. pp 1-79.
- Heffzallah, I.M. (1999). The New Technologies and Learning: Empowering Teachers To Teach And Students To Learn In *The Information Age*. Springfield: Charles Thomas.
- Katz J. and Aspen, P. (1997). Motivations for barriers to Internet usage: results of a national public opinion survey. *Internet Research: Electronic Networking Applications and Policy*, 17(3), pp. 170-188.
- Kiplang'at, J. (1999). An analysis of the opportunities for information technology in improving access, transfer and use of agricultural information in the rural areas of Kenya. *Library Management* 20(1-2) 115-127.
- Leeuwis, C. (2003). *Communication for Rural Innovation: Rethinking Agricultural Extension* (3 edition) with Contributions From Anne van den Ban. Blackwell Science Ltd, Iowa USA, and CTA, Ede , Netherlands.
- Meera, N., Jhamtani, A., & Rao, D. (2004). *Information and communication technology in agricultural development: a comparative analysis of three projects from India*. Agricultural Research & Extension Network ODI Network Paper No.135 January 2004.
- Melody, W. (1996). Toward a framework for designing information society policies. *Telecommunications Policy*. 20 (4), 243-259.
- Moemeka, A. (1994). *Communicating for Development: A New Pan-Disciplinary Perspective*. Albany, NY: State University Press.

- Moemeka, A. (2000). *Development Communication in Action: Building Understanding and Creating Participation*. Lanham: University Press of America.
- Mundy, P.G. (1992) *Information Sources Of Agricultural Extension Specialists In Indonesia*. A Thesis Submitted In Partial Fulfilment Of The Requirements For The Degree Of Doctor Of Philosophy (Mass Communications) At The University Of Wisconsin-Madison, 1992.
- Murdock, G., Hartmann, P., & Gray, P. (1996). Conceptualizing home computing: resources and practices. In: Heap N, Thomas R, Einon G, editors. *Information Technology and Society*. Mason, R and Mackay, H. London: Sage.
- Nagel, U.J. (1997), Alternative approaches to organizing extension, In B.E. Swanson, R.P. Bentz and A.J. Sofranko (eds.), *Improving Agricultural Extension: A Reference Manual*, FAO, Rome, pp. 13–20.
- Ngomane T (2004) The evolution of extension processes and practices in relation to smallholder farming in southern Africa. "New Directions for a Diverse Planet". *Proceedings of the 4th International Crop Science Congress*, 26 Sep – 1 Oct 2004, Brisbane, Australia. [www.cropscience.org.au/icsc2004/pdf](http://www.cropsscience.org.au/icsc2004/pdf)
- ODI (1994) Public Sector Agricultural Extension: Is There Life After Structural Adjustment? *Natural Resource Perspective* Number 2 Vol November 1994. London: Overseas Development Institute 1994 ISSN: 1356-9228
- Swanson, B. Bentz, R & Sofranko A. (eds) (1996) *Improving Agricultural Extension: A Reference Manual* July 30, 1996 Rome: FAO of UN.
- Ramírez, R. (1999). *Special: The first mile of connectivity. Communication: a meeting ground for sustainable development*. Ontario: University of Guelph, School of Rural Extension Studies.
- Richardson D (2003) Agricultural extension transforming ICTs? Championing universal access ICT *Observatory 2003: ICTs- transforming agricultural extension* Wageningen, 23-25 September 2003. Wageningen: CTA.
- Rivera, W., & Alex, G. (2002). National strategy and reform process: Extension and Rural Development: International Case Studies and Emerging Trends. World Bank. Washington, DC.
- Rölings, N. (1988). *Extension Science Information Systems in Agricultural Development*. Cambridge: University Press.
- Röling, N., & Engel, P. (1991). IT from a Knowledge perspective: concepts and issues. *Knowledge in Society: The Journal of Knowledge Transfer*. 3. p. 6-18.
- Selwyn, N. (2003). Apart from technology: understanding people's non-use of information and communication technologies in everyday life technology. *Society* 25 (2003) 99–116 London: Elsevier.
- Van den Ban, A. W., & Hawkins, H. S. (1996). *Agricultural Extension* (2nd ed). Cambridge, Massachusetts: Blackwell Science Ltd.
- Work R (2002) *Overview of Decentralization Worldwide: A Stepping Stone to Improved Governance and Human Development* New York: Decentralization Democratic Governance Team, IDG/BDP United Nations Development Programme.
- Williams F (1982). *The Communications Revolution*. New York: New American Library.
- Zappacosta, M. (2001). Information technologies for rural development: between promises and mirages. *Information* Volume 3 Number 6, December 2001. p521-534.