

**FACTORS INFLUENCING THE APPLICATION OF INFORMATION AND
COMMUNICATION TECHNOLOGY IN THE MANAGEMENT OF
AGRICULTURAL INFORMATION IN NAKURU DISTRICT, KENYA**

JUSTUS MOTURI OMBATI

**A Thesis Submitted to the Graduate School in Partial Fulfilment of the
Requirements for the Degree of Doctor of Philosophy in Agricultural Extension of
Egerton University**

EGERTON UNIVERSITY LIBRARY

EGERTON UNIVERSITY

2009

EULIB



040 611



2013/96852

f

COPYRIGHT

All rights reserved. No part of this thesis may be reproduced, stored in any retrieval system, or transmitted in any form or by any means without prior written permission of the author or Egerton University on that behalf.

© **Justus Moturi Ombati**

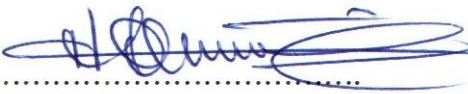
DEDICATION

This work is dedicated to my dear parents Kemunto and Ombati

DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has never been submitted in this or any other university for the award of a degree.

Signature.....

Date.....10/8/09.....

Ombati Justus Moturi

Recommendation

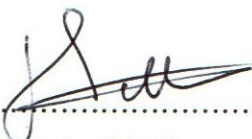
This thesis has been submitted with our approval as supervisors:

Signature.....

Date.....13/8/2009.....

Dr. Fredrick U. Ngesa (Ph.D)

Department of Agricultural Education and Extension
Egerton University.

Signature.....

Date.....17/08/2009.....

Dr. Jason M. Githeko (Ph.D)

Department of Computer Science
Egerton University.

ACKNOWLEDGEMENT

First and foremost I am grateful to the Almighty God who has blessed me abundantly and seen me through this work. He has made every day of my life a joy. Second, a number of organisations, institutions and individuals, contributed to success of this work. First to be acknowledged is the Ministry of Education, Science and Technology that granted permission for the study to be conducted. Second, the District Commissioner and the District Agricultural Officer, Nakuru District where the study was conducted were very helpful. DAAD granted me a scholarship which met the financial needs of the study. Egerton University accorded me the opportunity to study. To all of them accept my deep gratitude.

Several individuals assisted in one way or another in the course of this study. Foremost among them were my supervisors, Dr. Fredrick U. Ngesa, and Dr. Jason M. Githeko whose suggestions greatly made this work an enriching professional experience. God bless them abundantly for their support and guidance. To colleagues in the Department of Agricultural Education and Extension who provided invaluable input during the initial stages of the study, I say a big thank you. Others who deserve special mention are all the respondents in the study who took their time to fill the questionnaires. Without their responses, this study could have not been realized.

I would also like to recognise the contribution of the five enumerators who ensured that the data required for the study was collected. I sincerely appreciate their efforts to put long hours in this study. They endured rough terrains to reach some of the respondents who were in very remote areas. Their input in coding the data for analysis is equally appreciated. I wish to humbly acknowledge my wife, Wilkister, and children Linda, Cliff and Brandon who gave me moral support and accepted my long absence from home during this study. I pray to God to reward them abundantly for their understanding. To all other persons who in any way contributed towards the success of this work, I say a big thank you.

ABSTRACT

Agriculture is an important sector in the Kenyan economy. It contributes 26.6% to the GDP, creates employment to about 80% of the rural population, supplies raw materials to industries and earns the country the much-needed foreign exchange. There is need, therefore, to develop this sector. Agricultural information is one critical resource in agricultural development. It is the basis of a modern and progressive agricultural sector. This, therefore, demands that agricultural information be generated, tested, packaged and readily made available to the users. Effective use of information and communication technology (ICT) would greatly improve agricultural information management for overall development of the sector. Studies, however, indicate the use of ICT-based systems for the management of agricultural information within and between the various subsystems of the agricultural sector is limited. The overall purpose of the study was to establish the actual status of ICT usage in management of agricultural information and determine conditions inhibiting the implementation of the ICT usage. It investigated the current state of agricultural information management and determined the factors that influence the effective application of ICT-based systems in this work. It further determined and documented the requirements for implementing an ICT-based system that would interface the management of agricultural information within and between the agricultural research, extension service, training institutions and farmers in Nakuru District Kenya. A modified Delphi technique was used to obtain both qualitative and quantitative data. Respondents in the study were drawn using proportionate random sampling from research scientists, the technical extension staff, teaching staff of agricultural training institutions, and farmers in the district. Questionnaires were used to collect data. The statistical package for social sciences (SPSS) was used for data analysis. T-test at $\alpha \leq 0.05$ was used to test hypotheses, accordingly. The study established that there were low levels of information processing using ICT within and between the major subsystems of the agricultural sector in the district. Lack of resources, computer illiteracy, poor infrastructure and insufficient government initiative has been found to be major impediments on the utilization of this technology. Investment in science and technology, infrastructure development, and promotion of education are some of the measures that would enhance adoption of ICT in the management agricultural information for agricultural development.

TABLE OF CONTENTS

COPYRIGHT.....	i
DEDICATION.....	ii
DECLARATION AND RECOMMENDATION.....	iii
ACKNOWLEDGEMENT.....	iv
ABSTRACT.....	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES.....	ix
LIST OF FIGURES.....	xiii
CHAPTER ONE	
INTRODUCTION.....	1
1.1 Background Information.....	1
1.2 Statement of the Problem.....	4
1.3 Purpose of the Study.....	5
1.4 Objectives of the Study.....	5
1.5 Hypotheses of the Study.....	6
1.6 Significance of the Study.....	6
1.7 Assumptions of the Study.....	7
1.8 Limitation of the Study.....	7
1.9 Definitions of Terms.....	8
CHAPTER TWO	
REVIEW OF LITERATURE.....	10
2.1 Introduction	10
2.2 The Role of Information in Agricultural Development.....	10
2.3 Information and Communication Technology and Agricultural Development.....	13

2.4	Agricultural Information Management Systems in Developed Countries.....	18
2.5	Agricultural Information Management System in Kenya.....	23
2.6	The Subsystems of the Agricultural Sector in Kenya.....	25
2.7	Conceptual Framework.....	44

CHAPTER THREE

METHODOLOGY.....	50
3.1 Introduction.....	50
3.2 Research Design.....	51
3.3 Location of the Study.....	51
3.4 Population.....	52
3.5 Sampling.....	52
3.6 Instrumentation.....	54
3.7 Data Collection.....	55
3.8 Data Analysis.....	56

CHAPTER FOUR

RESULTS AND DISCUSSION.....	58
4.1 Introduction.....	58
4.2 Current State of Agricultural Information Management in the Agricultural Subsystems	60
4.3 Management of Agricultural Information in the Agricultural Research.....	60
4.4 Management of Agricultural Information in the Agricultural Extension	72
4.5 Management of Agricultural Information in the Agricultural Training Institutions.....	82
4.6 Farmers' Awareness, Attitudes and Ability to Use Information and Communication Technology To Access Agricultural Information	92

4.7	Summary of the Findings.....	104
-----	------------------------------	-----

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS.....	106
---	------------

5.1	Introduction.....	106
5.2	Summary.....	106
5.3	Conclusions.....	108
5.4	Implications.....	110
5.5	Recommendations.....	111

REFERENCES.....	115
------------------------	------------

APPENDICES.....	133
------------------------	------------

A. –	Agricultural Extension Staff Questionnaire.....	133
B.	Agricultural Research Staff Questionnaire.....	141
C.	Agricultural Training Instituiton Staff Questionnaire.....	149
D.	Farmers Questionnaire.....	157
E.	Letter of Approval.....	162

LIST OF TABLES

Table 1:	Determining Appropriate sample Size (S) from a Finite Population (N).....	54
Table 2:	Appropriate Sample Size for the Study.....	54
Table 3:	Statistical Procedures used in Data Analysis.....	57
Table 4:	Educational Attainment of Agricultural Research Staff.....	61
Table 5:	Methods of Processing Agricultural Information by Research Staff.....	62
Table 6:	Current Use of Conventional Paper-Based Method Compared to When Research Staff First Began Work.....	63
Table 7:	Chi-Square Results Showing the Relationship between Preformed Attitude towards ICT and Level of Education of Research Staff.....	64
Table 8:	Chi-Square Results Showing the Relationship Between Level of Confidence in Using ICT and Level of Education of Research Staff.....	64
Table 9:	Emphasis Given to Computer Application in Processing Agricultural Information during Pre-service Training of Agricultural Research Staff.....	65
Table 10:	Pearson Product-Moment Correlation of Selected Characteristics of Agricultural Research Staff and Willingness to Use ICT-based System in Processing Agricultural Information.....	66
Table 11:	Level of Satisfaction Expressed by Researchers, Extension Agents and Agricultural Training Institution Staff with ICT Resources and Initiatives.....	67
Table 12:	Chi-Square Results Showing the Relationship Between Preformed Attitude Towards Use of ICT-based Agricultural information Systems and Occupation.....	68
Table 13:	Reasons Reported by Research Staff for Low Usage ICT- based Systems in Management of Agricultural Information.....	69

Table 14:	Test for Differences between Mean Scores on Computer Application Skills for Management of Agricultural Information Needed and Possessed by Agricultural Research Staff.....	70
Table 15:	Educational Attainment of Agricultural Extension Staff.....	73
Table 16:	Methods of Processing Agricultural Information by Extension Staff.....	74
Table 17:	Current Use of Conventional Paper-Based Method Compared to When Extension Staff First Began Work.....	74
Table 18:	Chi-Square Results Showing the Relationship between Level of Confidence in using ICT and Level of Education of Extension Staff.....	75
Table 19:	Chi-Square Results showing the Relationship between Preformed Attitude towards ICT and Education Level of Agricultural Extension Staff.....	76
Table 20:	Emphasis Given to Computer Application in Processing Agricultural Information during Pre-service Training of Agricultural Extension Staff.....	77
Table 21:	Pearson Product-Moment Correlation of Selected Characteristics of Extension Staff and Willingness to Use ICT in Extension Work.....	78
Table 22:	Reasons Reported by Extension Staff for Not Using Computers for Processing Agricultural Information.....	79
Table 23:	Test for Differences between Mean Scores on Computer Application Skills for Management of Agricultural Information Needed and Possessed by Agricultural Extension Staff.....	80
Table 24:	Agricultural Training Institution Staff Sample Breakdown.....	83
Table 25:	Educational Attainment of Agricultural Institutions Training Staff.....	83
Table 26:	Methods of Processing Agricultural Information by Agricultural Training Teaching Staff.....	84
Table 27:	Current Use of Conventional Paper-Based Method Compared to When Agricultural Training Institution Teaching Staff First Began Work.....	85

Table 28:	Chi-Square Results Showing the Relationship between Preformed Attitude towards use of ICT and Education Level of Training Institution Staff.....	85
Table 29:	Chi-Square Results Showing the Relationship between Level of Confidence in using ICT and Level of Education of Agricultural Training Institution Teaching Staff.....	86
Table 30:	Emphasis Given to Computer Application in Processing Agricultural Information during Pre-service Training of Agricultural Teaching Staff.....	86
Table 31:	Pearson Product-Moment Correlation of Selected Characteristics of Agricultural Training Staff and Willingness to Use ICT in Processing Agricultural Information.....	88
Table 32:	Reasons Reported by Agricultural Training Institution Teaching Staff for Not Using Computers for Process Agricultural Information.....	89
Table 33:	Test for Differences between Mean Scores on Computer Application Skills for Management of Agricultural Information Needed and Possessed by Agricultural Training Institution Teaching Staff.....	90
Table 34:	Gender and Education Level of Respondent Farmers.....	93
Table 35:	Most Important Problems Reported by Farmers during the Three Preceding Farming Seasons.....	95
Table 36:	Most Preferred Means of Obtaining Information on Agricultural Innovations by Farmers.....	96
Table 37:	Farmers' Preferences for Sources of Agricultural Information Against their Level of Education.....	97
Table 38:	Chi-Square Results Showing the Respective Relationship between Participation in Seeking Agricultural Information and Scale of Operation of Farmers.....	99

Table 39: Means, Standard Deviations and R-Test Analysis for the Relationship between the Scale of Operation and Agricultural Information Acquisition Tendencies..... 100

Table 40: Description, Summary Statistics and Hypothesized Direction of Influence of the Variables Specified..... 101

LIST OF FIGURES

Figure 1: The Dutch Agricultural Information System..... 20

Figure 2: Extension –Research- Farmer Triangle..... 46

Figure 3: Agricultural information Flow among the Agricultural
Subsystems..... 47

Figure 4: Factors Influencing the Application of ICT in the Management
of Agricultural Information..... 49

Figure 5: Farmers Level of Schooling and Basic Reading..... 93

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Information and Communication Technology (ICT) has been the primary impetus of the current globalization process. ICT application has enabled countries make gigantic improvements in both productivity and quality in agriculture, manufacturing, infrastructure, public administration, and in services such as trade, distribution, marketing, education and health. Trends in a number of transition economies such as India, Costa Rica, and Mauritius indicate that one of the major forces spurring development in their various sectors is the appropriate application of ICT. ICT streamlines and automates processes, thus improving essential services while reducing unnecessary costs and inefficiencies (Michael, 1991; Republic of Kenya, 2001).

The potential role of ICT and Information Communication Management (ICM) in improving effectiveness of agricultural productivity has given rise to wide-ranging initiatives to address the digital divide between developed and developing countries (Eponou, 1994). At the global level, the Global Forum for Agricultural Research (GFAR) contributes to bridge the ICT adoption gap through a global alliance of regional agricultural information systems, also known as GLOBAL RAIS (Stoop, 1988; Metcalfe, 1994). At the regional level, the Forum for Agricultural Research in Africa (FARA) has promoted the development of a regional strategy through workshops held in April 2004, with the objective of analyzing the strengths and weaknesses of national agricultural information systems in the region with the aim of using the outputs to develop a regional strategy (RAIN, 2007). Locally, the National Extension Task Force (NETF) has pointed out the value of ICT and called for its adoption in the management of agricultural information (NETF, 2007).

The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), an association of the National Agricultural Research Institutes of ten Eastern and Central African (ECA) countries, including Burundi, Democratic Republic of Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania, and Uganda aims to promote economic growth, food security and export competitiveness through productive and sustainable agriculture. It carries out its activities through seventeen regional

Networks, Programmes and Projects (NPPs). The Regional Agricultural Information Network (RAIN) is one of these NPPs and is spearheading the enhancement of ICT/ICM capabilities of national agricultural research systems (NARS) in the ASARECA countries. Its mission is to promote the provision and sustainable management of client-oriented agricultural information. Particular emphasis is on strengthening regional capacities to access, generate, exchange, package disseminate and use this information for agricultural research and development in ways that contribute to ASARECA's goals and objectives.

The regional efforts to spur agricultural development during this information age are an opportunity for Kenya to strategically position herself to benefit from the global economy (Kenya, 2002). Every subsystem in the agricultural information business is rapidly becoming part of a 'global' system, and none of the players (agricultural research, agricultural extension, agricultural training institutions, end-users and other stakeholders) can any longer operate in isolation. The rapid advances in computing and telecommunications are forcing all parties in the agricultural information chain to consider what role they may be playing now and in the near future. The conventional boundaries between agricultural information providers and users are being broken down (Kinara, 1984; Hussey, 1985; Clarke, 1991; Agbamu, 2000; Kamau, 2006). The country however needs to undertake a priority-setting exercise to give guidance and standards on where to focus attention to fast track adoption of ICT in the management of agricultural information for agricultural development. The information and communication technology is one of the fastest growing sectors in the country. Computer usage has been rising rapidly over the years while their cost has been falling. The range and diversity of computer applications in day-to-day activities has increased substantially (Republic of Kenya, 2001). This would be expected to infuse efficiency in the delivery of services by making information more readily and widely available.

The Kenya National ICT Policy (2005) and ICT Strategy for Economic Growth (2006) publications represent the nations vision of the information age. The preparation of the two documents was guided by the aspirations set out in Kenya's key socio-economic development framework documents including: The Economic Recovery Strategy for Wealth Creation and Employment 2003-2007; Poverty Reduction Strategy Paper, 2001; and Sessional Paper No.2 of 2005 on Development of Micro and Small Enterprise for Wealth and Employment Creation for Poverty Reduction. The imminent upgrading of the

ICT sector in Kenya through the formulation of a National ICT Policy and Strategy is significant because it has the potential to simultaneously develop the ICT sector and use the ICTs for employment creation, as well as, a broad-based enabler for economic recovery and achievement of national development goals.

The ICT Strategy for Economic Growth is being implemented through rolling plans initiated by intersectoral Task Groups working under the oversight of an ICT National Steering Committee. With the right sets of action plans it is possible for Kenya to embark on alternative system of agricultural information management and gain competitiveness in this key sector. A competitive sector is one which is able to utilize resources efficiently. Agricultural information is one emerging critical resource that needs to be harnessed and utilized efficiently to thrust forward the agricultural sector. It is on the basis of this information that decisions are made, and it is from such decisions that actions are taken that impact on the performance of the entire sector (Babu, et. al., 1997; Muyepa, 2002).

Building electronic links between the various subsystems of the agricultural sector represents the next step for the government that promises huge gains in productivity and speed. With appropriate ICT application, agricultural information would be transformed into a commodity created, manipulated and distributed to users effectively (Kenya, 2002; Ochieng, 2004). Equally it would be possible to maintain high quality and constantly accessible databases that surpass catalogues, reports and even manuals that contain full text information. This technology would solve transport and distance problems, provide accurate and relevant information on a timely basis, help put in place early warning systems, and ensure preparedness for response to emergencies.

Efficient management of agricultural information manifests itself in the way things are done, actions accomplished and results achieved. Some countries have digitized their agricultural information management and substantially improved their agricultural information management systems hence there is need for Kenya to move in the same direction to edge closer to world competitiveness (Sheng, 2000; Xu, 2001). Despite the potential of ICT to make the management of agricultural information more efficient, responsive and effective, the Kenyan agricultural sector is yet to become part of the information society now enjoying the digital revolution (Kenya, 2002). Much of agricultural information processing is still done manually through paper and human

movement with all its attendant problems. Without the agricultural sector in the country embracing ICT it will be further marginalized in a new economic dispensation.

This study examined the current state of agricultural information management using Nakuru District as the point of focus. It determined the extent of ICT application in the management of agricultural information and identified the factors that have hindered the use of this technology in the same. On the basis of the results, the study finally recommends viable mechanisms for deploying ICT-based agricultural information management systems to interface management of agricultural information between the research, extension service and training institutions, and farmers.

1.2 Statement of the Problem

The agricultural sector has various subsystems that are interdependent and often share and exchange agricultural information. Agricultural information is a critical resource for agricultural development because it empowers people to make informed choices in the process of improving their livelihoods. The importance of access to and use of information in rural areas for transforming agriculture has been demonstrated in some of the economically rapidly growing economies such as China (Xu, 2001). In Tanzania, Mchombu (2003) demonstrated the positive impact of information services on agricultural practices. Likewise agricultural information bottlenecks were identified among causes of low agricultural productivity in Malawi, contributing to deepening poverty (Muyepa, 2002).

Use of information and communication technology (ICT) would enhance and improve the agricultural information management processes within and between the agricultural subsystems. However in Kenya, the sector lacks an effective ICT-based agricultural information management system that is efficient and more responsive to the changing trends in the overall agricultural development process (Ngesa, 1991; ISNAR, 1999; Kenya, 2002; Ochieng', 2004; Kamau, 2006; NETF, 2007). To put in place such a system, there is need to determine the personal and institutional factors that influence the application of information and communication technology in the management of agricultural information in order to put benchmarks and subsequently set targets and objectives. Very few empirical studies relating to these factors have however been carried

out. Without knowledge from such studies it will continue to be difficult to improve the management of agricultural information using ICT-based systems. This study was intended to provide this knowledge.

1.3 Purpose of the Study

The overall purpose of the study was to establish the actual status of ICT usage in management of agricultural information and determine conditions inhibiting the implementation of the ICT usage. It investigated the current state of agricultural information management and determined the factors that influence the effective application of ICT-based systems in this work. It further determined and documented the requirements for implementing an ICT-based system that would interface the management of agricultural information within and between the agricultural research, extension service, training institutions and farmers in Nakuru district Kenya. The study thus identified the requisite interventions that would enhance effective ICT usage in the management of agricultural information as one way of contributing towards improved performance of the agricultural sector.

1.4 Objectives of the Study

The specific objectives of the study were:

- (i) to identify and document the approaches currently being used in the management of agricultural information within and between the agricultural research station, the extension services, the training institutions and farmers.
- (ii). to determine and document the institutional factors that influence the application of information and communication technology in the management of agricultural information.
- (iii) to determine and document the personal factors that influence the application of information and communication technology in the management of agricultural information.

- (iv) to determine the disincentives to the use of ICT-based systems in the management of agricultural information within and between the agricultural research, extension and the training institutions.
- (v) to determine the extent of preparedness in training of the agricultural research, extension service and training institution teaching staff in the use of ICT-based agricultural information management systems.
- (vi) to assess farmers' awareness, attitudes, and abilities to use ICT to access agricultural information.

1.5 Hypotheses of the Study

The following were the hypotheses of the study:

- Ho₁.** There is no significant difference between the extent to which agricultural research staff need ICT-based agricultural information management skills and the extent to which they possess these skills.
- Ho₂.** There is no significant difference between the extent to which extension staff need ICT-based agricultural information management skills and the extent to which they possess these skills.
- Ho₃.** There is no significant difference between the extent to which agricultural training institution teaching staff need ICT-based agricultural information management skills and the extent to which they possess these skills.
- Ho₄.** There is no significant relationship between farmers' education attainment and level of farm operation and their willingness to use ICT to access agricultural information

1.6 Significance of the Study

This research project will contribute toward creating ICT-based agricultural information management systems. It identifies the critical factors that need to be addressed before an effective ICT-based agricultural information management system within and between the agricultural research, the extension service and the agricultural training

institutions and farmers is put in place in Nakuru District, Kenya. The study would contribute to human resource capacity building by way of identifying the requisite skills to use an ICT-based agricultural information management system (AIMS) and appropriate training programmes for developing these skills. An ICT-based agricultural information management system would contribute significantly to the development of the agricultural sector. This would be by way of making the management agricultural information within and between the various subsystems more efficient and responsive to the changing trends in the development process.

The findings of the study will be made available to the Government of Kenya, voluntary agencies, educational institutions and research bodies through seminars, conferences and reports. It is expected that the Government of Kenya, which is beginning to put due emphasis on a knowledge-based economy might benefit from the findings when formulating policies towards the development of an e-based information management system in the agricultural sector. Finally, the study generates an interest in the field of use of computers in a networked agricultural information management system in Kenya so that the government and research bodies would find it prudent to support or even commission other studies in this area.

1.7 Assumptions of the Study

Staff in the agricultural research, the extension service and the training institutions are assumed to be adequately competent with regard to agricultural information management using the manual systems. The manual system of information management is however slow and inefficient. The use of an ICT-based intervention would therefore be assumed to be a significant contribution towards improving the management of agricultural information with all users benefiting from the resultant improved communication services.

1.8 Limitation of the Study

The study was conducted in Nakuru District. Ideally it should have covered the entire country but the length of study and resources would have been quite high. Therefore, caution is necessary when attempting to generalise the results.

1.9 Definition of Terms

The following are definitions of terms, which are critical to the understanding of the study.

Agricultural extension staff: The technical personnel who take agricultural innovations to the users and include those who serve at the district and divisional levels.

Agricultural information management system (AIMS): A system in which agricultural information is generated, transformed, transferred, consolidated, received and fed back in such a manner that these processes complement each other to underpin knowledge utilisation by decision-makers in the agricultural sector.

Agricultural research staff: The scientists who carry out research work at the agricultural research centres.

Agricultural training institution staff: The teaching staff in the training institution who train for the agricultural sector.

Category of staff: Staff categories in the study will be; agricultural research staff, agricultural extension staff and agricultural training institution staff.

Hardware: The physical components of the computer system for the AIMS.

Information and communication technology (ICT): A collection of hardware, software and liveware used for capturing, storing, checking, integrating, manipulating, analysing, displaying and communicating information to users.

Information management skills: Behavioural characteristics of knowledge, judgement, expertise and attitude required for the capturing, storing, checking, integrating, manipulating, analysing, displaying and communicating information to users.

Large scale farmer: One with more than 100 acres of land under agricultural production.

Liveware: Persons skilled to use the ICT-based agricultural information management system.

Level of education: The highest form of training that the staff has ever attained and includes the latest academic qualification attained.

Management of agricultural information: The process of capturing, storing, checking, integrating, manipulating, analysing, displaying and communicating information in such a way that that users can make informed decisions by use of the information.

Medium scale farmer: One with between 50 to 100 acres of land under agricultural production.

Potential of ICT: The possibility of information and communication technology being developed or used in the management of agricultural information.

Small scale farmer: One with less than 50 acres of land under agricultural production.

Work experience: The proficiency acquired by the staff as a result of working in the service and is estimated by the number of years that the staff has been in active employment with the service.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

Agricultural information is a critical resource in agricultural development. It is a major ingredient towards realizing a knowledge-based agricultural sector. Exploiting agricultural information through analysis, interpretation, packaging and efficient dissemination using advanced technology is a key driver of agricultural competitiveness. Its effective management and utilization directly influences the performance of the entire agricultural sector. Unfortunately, the management of agricultural information has not been sustained by local research and use of modern technology based methods. Literature on the practices and use of modern methods of agricultural information management continue to be insufficient both in scope and scale. What order of priority should be given to modernizing management of agricultural information? What should be developed first and what should come last?

The literature cited in the review below is a combination of original research, summaries of primary sources, and generally works that relate to agricultural information management. The first section of the review deals with the role of agricultural information in agricultural development while the second section outlines the application of ICT in agricultural development. The third section focuses on agricultural information management systems in developed countries. Emphasis here is put on how ICT-based systems have contributed to the success of their agricultural sectors. In the fourth section, literature on the Kenyan agricultural information systems is presented. Prominence is given to the limitations of the systems currently in place. The fifth section deals with the agricultural subsystems in Kenya and underscores the need for an ICT-based system that would improve and interface their agricultural information management. A summary of the literature review is given before finally developing a conceptual model of the study.

2.2 The Role of Agricultural Information in Agricultural Development

Information is a critical resource in agricultural development. Literature on agricultural development models indicates that the foundation of a modern and productive agricultural sector is the availability of appropriate and well-tested agricultural information

(Rogers, 1983; Nagel, 1980; Mowlana and Wilson, 1988; Lopez and Bruening, 2002). Agricultural information is knowledge that has been gathered, interpreted, and organised for use in decision-making by users (Haverkort and Engel, 1986; Ngesa, 1991; Mugo, 1992; Babu et al., 1997; Banu and Bode 2002; Muyepa, 2002). In many cases the information is in place and all that is needed is the recognition of its true value and utility and then disseminate it to users. There are, however, cases where information may need to be generated and tested by researchers. In all these cases, the critical element is that, for the information to have impact on agricultural production, it needs to reach the users in a form that is appropriate, useful and timely.

There is a clear relationship between information, agriculture and progress. Information has a great impact on decision making and hence its value is closely related to the decisions that arise from its use (Lindner et al, 1982; Menou and Niang 1991; Banu and Bode 2002). It is as much about the process of communication between actors, as the design and dissemination of information products or the implementation of information services. Mugo (1993) identifies principal functions of information for agricultural development thus:

- as a knowledge tool: circulation of knowledge, innovation and experience;
- as a tool to assist decision-making: facilitating strategic choices by actors;
- as a communication process: creating links between different actors (virtually if not physically).

The main challenge in the coming years will be the capacity of various stakeholders to adapt sufficiently quickly to a context that is undergoing profound change. Information and communication are one of the essential ways of facilitating this vital change (Faylon and Acoba, 2002). For this to actually occur CTA (1996) had earlier indicated the following steps as mandatory:

- Accelerating the speed with which information circulates. Given a situation that demands frequent new economic and technical choices, any information that circulates too slowly, quickly becomes obsolete and of little value. Its value is related to those who use it, when it is used and in what situation it is used. In this sense, information is similar to other commodities.
- Encouraging the various stakeholder groups to obtain direct access to information. This is a question of efficiency and fairness. The limitations of previous systems of

disseminating information to intermediary bodies who themselves were supposed to redistribute it, have become apparent. Information must be channelled as far as its end-user.

- Diversifying the supply of information so that it can meet increasingly precise and varied information needs. There are a great many stakeholders and their needs differ. The information needs of government as the chief stakeholder in the development of agriculture is indeed phenomenal: information about trends in population, the economy, and society in general, at regional, national, and local levels; fast and correct feedback on the impact of policy measures; forecasting information for decision-support systems; impact assessment techniques to be applied to different policy options; comparative information on the results of national policies in other countries. The needs of other actors in the agricultural sector are also crucial. The ability of farmers to respond rapidly to population trends depends, in part, on the information to which they have access about changes in demand, new techniques, prices and the experiences and achievements of others. Information that is poorly targeted in its content, in its form and in the way it is disseminated, is often useless information.
- Using information as an 'observatory', enabling signs of change to be picked up, in order to understand the occurrence of evolving and dynamic situations.
- Consolidating information production and dissemination industries and networks. Through information, stakeholders can be put in touch with each other, so that they can share their knowledge, skills, experiences, expertise and opinions.

Rural producers, small enterprises, professional non-profit associations, international, national or local NGOs, local services all play an important part in agricultural development dynamics (Agbam, 2000). Their information needs are all greater in that they need it to help them in their decision-making. Their role is both to supply and to receive information (Bennel, 1989). Information in this case no longer revolves around disseminating a message formulated by "those who know", to "those who do not know". The information supply is thus becoming as multiple and as varied as demand (Eponou, 1990; Boehlje, 1998; Faylon and Acoba, 2002). It comes as much from producers as from decision-makers. This means making information accessible and available to these groups

in suitable form, in order to broaden the range of possible technical and economic choices open to them, and to help them make fully informed choices.

One main reason for low agricultural productivity is related to inadequate agricultural information dissemination (Mugo, 1993; Banu and Bode 2002; Garforth, et al.2003). It is therefore assumed that one of the priority actions to be developed in order to increase agricultural production is to define a strategy that will lead to good dissemination of technological packages and innovations to users. This would be achieved if scientific and technical information dissemination activities are strengthened and consolidated at the level of institutions involved in agricultural development, that is extension services, research institutes, training institutions, information and documentation centres and other stakeholders. There is therefore demand to design different information products (tools to aid selection rather than popularising one single technique), using varied forms of assistance, strengthening dissemination and distribution networks, and notably decentralize systems for access to agricultural information.

2.3 Information and Communication Technology and Agricultural Development

Developments in the last decade have led to the convergence of Information and Communication Technology (ICT), broadcasting and telecommunications and created the opportunity of using the technologies for communicating and sharing information on a global scale. In this regard, telecommunications and broadcasting services bridge the distance gap while IT provides the tool to develop innovative applications. Their combination in a communications value chain improves inputs to learning, production, commerce, decision-making, and other processes (Edquist and Hommen, 1999). The rapid growth in ICTs is evident from the fact that while it took the telephone close to 74 years to reach 50 million users, it took the World Wide Web four years to reach the same number. It took radio 38 years and the personal computer 16 years to reach the same number. Between 1995 and 1999, 88 million internet connections were made compared to 15 million made between 1991 and 1994, an almost six-fold increase. In 2002, over 580 million people were estimated to have access to the Internet (Temu and Msuya, 2004).

The United Nations has been at the forefront of promoting a common framework for seamless use of ICTs through appropriate policies and legislation. The UN General Assembly in resolution 40/71, paragraph 5(b), of 11 December 1985 on Legal Value of Computer Records called on governments and international organizations to take action, where appropriate to ensure legal security in the context of the widest possible use of automated data processing in international trade. Since then, many countries have enacted e-commerce laws along the UN requirements. During the plenary meeting of 16th December 1996, the UN General Assembly adopted resolution 51/162 on the Model Law on Electronic Commerce which recommended that all States give favourable consideration to the United Nations Commission on International Trade Law (UNCITRAL) Model Law on Electronic Commerce when they enact or revise their laws, in view of the need for uniformity of the law applicable to alternatives to paper-based methods of communication and storage of information (World Trade Organization, 2004).

During the 85th plenary meeting held on 12th December 2001, the General Assembly through Resolution 56/80 recommended that all States give favourable consideration to the UNCITRAL Model Law on Electronic Signatures. More recently, world leaders assembled at the World Summit on Information Society in Geneva between 10th - 12th December 2003, declared their common desire and commitment to build a people-centred, inclusive and development-oriented information society (World Trade Organization, 2004).

Rapid development of Information and Communications Technologies (ICTs) accompanied by the convergence of telecommunications, broadcasting and computer technologies is creating new products and services, as well as new ways of learning, entertainment and doing business (Kaufmann and Todtling, 2001; Clark, 2002). At the same time, more commercial, social and professional opportunities are being created through the unique opportunity provided by ICTs. As a result, the world is undergoing a fundamental transformation as the industrial society that marked the 20th century rapidly gives way to the information society of the 21st century. The new society promises a fundamental change in all aspects of doing things, including knowledge dissemination, social interaction, economic and business practices and even political engagement.

The East African regional countries, Kenya included, are experiencing a high population growth rate which in many cases, exceeds growth in GDP (Green, 1996; IMF,

1999; Asiedu, 2004; World Bank, 2006). They are also facing high levels of external debt and the negative effects of the structural adjustment programmes. Growth in the agricultural production has not kept pace with population growth, and severe food deficits have become endemic in the countries, making it necessary to use available foreign exchange to import basic food items (FAO, 2003; Asiedu, 2004; World Bank, 2006). However, the national governments have now accepted the critical role of agriculture in national development. They are reviewing their agricultural policies in light of persistent food shortages to increase agricultural production through removal of price controls on farm products, strengthening extension services and reorganization and rehabilitation of agricultural research to be more in line with national priorities (FAO, 2004). In the processes of policy review and research planning, deficiencies in agricultural information systems have come sharply in focus. There is an obvious gap between known agricultural information and its dissemination and utilization by users (Carl and John, 1998; Wessler and Brinkman, 2002; Lopez and Bruening, 2002; Mchombu, 2003; Ochieng', 2004).

Improvements in agricultural information management systems are therefore, expected to play a crucial role in turning around the poor socio-economic status in the region. A major issue, especially for the small countries that cannot afford to establish large and many research infrastructures, will be access to information on technologies developed elsewhere which through inexpensive adaptation, could be used to improve agricultural productivity. On this, creation of effective linkages between the key players in the agricultural sector should be given high priority. This brings into focus the effective application of information and communication technologies for the management of agricultural information (Kenya, 2001). ICT-based agricultural information management thus becomes a major intervention tool in agricultural development.

An effective information management system in the agricultural sector would be like the nervous system in the human body: it is the link that connects all the components together and provides for better operation and survival in a competitive environment (Roling 1988; Clarke, 1991; Ahituv et al., 1994; Agbamu, 2000; Lopez and Bruening, 2002; Mchombu, 2003; NETF, 2007). It supports decisions, decisions trigger actions, and actions affect the achievement or performance of the agricultural sector. Differences in performance can therefore, be traced to the impact of information, provided that the

measurements are carefully performed, the relationships among variables are well defined, and possible effects of irrelevant factors are isolated (Ahituv et al., 1994).

The concept of ICT application in the management of agricultural information has been developed in recognition of the importance of interactions and linkages among people and institutions involved in the agricultural sector. It is based on the premise that application of ICTs in the management of agricultural information would greatly improve management of agricultural information by the major actors involved in the sector. This would lead to an improvement on the overall performance of the agricultural sector (Hurtubise, 1984; Castillo et al., 1998; Zilberman, and Sunding, 2000). These key players include the agricultural research, the agricultural training institutions, the agricultural extension and the farmers who are the end users of the technological innovations developed.

Institutional policy issues on the management of agricultural information through ICT application by these major players need to be addressed if improvement in performance of the sector is to be realized. While complexity and conflict in policy systems is not new, institutional reform in Kenya's public and industry policy systems over the last 20 years has further complicated the operating environment for agricultural industry organizations. Kenya's economic and public sector reforms, initiated in 1984 saw major changes to the machinery of the government (Kenya, 2004). They included the separation of policy, regulatory and service delivery functions of government agencies. These reforms among other things were to fundamentally change Kenya's agricultural system and the way in which agricultural policy, research and extension were to be carried out. The new system was characterized by policy-delivery and fund-provider splits, and by contestability in service delivery. Organizations responsible for developing policies were separated from those responsible for implementing them. Those responsible for funding research were separated from those responsible for doing it.

An agency, the Kenya Agricultural Research Institute (KARI) was established to administer the governments agricultural research investment. At the same time, industry organizations in the tea, pyrethrum, coffee, dairy and a number of the horticultural sectors developed, or further developed, industry-funded research portfolios and programmes (Ndiritu, 1990). These programmes were initially administered through industry producer boards existing at the time, funded either from product returns or levies. Subsequently the

Government passed legislation that enabled industry organizations to collect levies from producers, a move that allowed the funding of research and extension activities to be transparent and specifically directed at these activities.

The Government agricultural extension service is fragmented between various government ministries (Mugo, 1992; Kenya, 2004; Ochieng, 2004). The fragmented nature of agricultural extension services is compounded by poor infrastructure (roads, energy, communication), unfavorable macroeconomic factors and declining private and public investment. Under these circumstances communication between participants can be problematic and a separation of understanding between system participants can develop. There is need to put in place an improved system of communication that will ensure enhanced dissemination of information from all the players that is relevant and crucial to the development objectives of the agricultural sector. When farmers are making decisions that impact on productivity improvement, either through the adoption of new technologies or the implementation of improved management using existing technology, they are constantly gathering information from research and other sources and turning it into useful knowledge. This process is referred to as technological learning (Massey et al., 2002).

Organising the agricultural sector in a way that facilitates effective management of information is, therefore, an important input in the modernisation of agriculture. An ICT-based system becomes handy in this respect as it ensures that all the required databases that are a foundation of such a system are in place and in useful formats (Awad and Gotterer, 1992; IAC, 2005). A database in a given subject is a collection of data on that subject that observes three criteria; comprehensiveness, non-redundancy and appropriate structure. Comprehensiveness means that the data about the subject are actually present in the database. Non-redundancy means that each individual piece of data exists only once in the database. Appropriate structure means that the data are stored in such a way as to minimise the cost of expected processing (Awad and Gotterer, 1992; IAC, 2005). The idea of a large corporate database that can be flexibly shared by several applications or model bases can now be realised by means of software packages specially devised to perform such tasks (Ahituv and Riley, 1994; Swanson, 1997; Hagmann and Chuma, 2000; IAC, 2005).

To attain effective management of agricultural information, appropriate systems need to be designed and put in place. Such systems would interface the research, extension (dissemination), education and training, and user subsystems (Imboden, 1980;

Nagel, 1980; Ngesa, 1991; Roling, 1988; Agbamu, 2000; Reece et al., 2004). The research subsystem performs innovation function by developing material and knowledge-based technology (Swanson, 1997; Sumberg and Reece, 2004). It also participates in field trials and on-farm experiments. The second subsystem, the extension and education subsystem, assumes most of the farmer education responsibility by disseminating agricultural information from the agricultural research subsystem through education and training (Simpson and Owens, 2002). The Training institutions subsystem prepares agricultural personnel, who after training assume extension and research responsibilities. The final subsystem the user (farmer) subsystem consists of farmers and farm managers. All these subsystems need to be interfaced for the agricultural sector to be made more dynamic and productive (Swanson and Claar, 1983). This suggests improvements to the agricultural information management practices between the various subsystems as an important step towards sustainable agricultural development in Kenya.

2.4 Agricultural Information Management Systems in Developed Countries

Compared with Kenya, agricultural information management systems in developed countries appeared earlier, developed more quickly and their effects are easily seen. The overseas agriculture information systems have experienced three stages as follows: In 1950s and 1960s, the focal point was on agriculture data processing and agriculture database development. In 1980s and early 1990s, the research emphasis was turned to handle knowledge, develop automatic control and apply network technology. The agriculture information technology of European and American countries has now entered into the industrialization stage (CTA, 1991).

With the effective application of information and communication technology, some countries have successfully interfaced information management in the agricultural research, extension and education and the farmer subsystems to greatly improve the performance of their agricultural sector (Roling, 1990; Metcalfe, 1994; Lopez and Bruening, 2002). The Land Grant College system of extension in the United States is an example of a system that integrates the functions of teaching, training, extension, and research, all of them being the responsibility of a state university. The integration is facilitated purposefully by such devices as building an interpersonal network among extension and research faculty, often exchanging staff in these functions. From its earliest

beginnings, extension was not only seen as away to deliver new applied knowledge to farms and rural people but also to transmit their interests to the land grant university research community (Hildreth and Armbruster 1981; Lionberger and Cheng, 1982). Due to the efficient and effective flow of agricultural information between all these players, the US system has been highly successful. Networking of these stakeholders has ensured that each one of them promptly responds to changes and developments in the sector to ensure optimal performance. This is because information is delivered reliably, exhaustively, accurately, in usable form and on timely basis. Economic evaluations have since found that the land grant university research and extension efforts do make a major contribution to the rate of technical change in agriculture (Davis and Olson, 1985; Ahituv et. al., 1994; Agbamu, 2000; Faylon and Acoba, 2002).

The Dutch system of enterprise development is another significant example. This success has been attributed to the 'triad of agricultural research, extension and education', usually referred to as the core policy instruments for agricultural development (Wielinga, 1986; Boehlje, 1989; Garforth, et. al., 2003). This system is based on the theory of the triangular schema (IFAP, 1995). The theory of the triangular schema works on the perspective that links between the farmers, research and extension is a prerequisite for a healthy agriculture. That is, farmers, extension and research are closely inter-linked through a multiplicity of formal and informal contacts and working institutions. The essential aspect of the system is that it is a highly interconnected network of researchers, adaptive researchers, specialists, extension workers, teachers, agro-businessmen and farmers. Special linking roles have been created between specialists of the extension services and experiment stations and research institutes. The computer has allowed these networks to become interconnected and to exchange information effectively (Dilman, 1986; Roling, 1990; Metcalfe, 1994; Pittway et.al., 2004; IAC,2005). They have organised databases and their integration has enabled decision support systems to be put in place. These networks have enabled the Dutch system to be highly successful. Each player is sensitive to the needs and demands of the other players due to the high connectivity (Pittway et.al., 2004; IAC, 2005). The overall result is agricultural subsystems that work harmoniously and complement each other.

Figure 1 gives a highly simplified picture of the Dutch information system. It only deals with the government set-up; extension by the farmers' organisations, the

cooperatives, and agri-business is not included. In the system, there is an interesting articulation of research into (1) research institutes with a disciplinary mandate such as phytopathology, soil fertility among others, (2) experiment stations with a branch mandate such as dairy production, horticulture under glass) and (3) trial farms with a farm system level mandate. Another characteristic feature of the system is the regular transfer of staff between the institutes and the experiment stations. Farmers' organizations pay 50% of the cost of the trial farms. Experiment stations have boards in which farmers participate in key decision-making processes regarding their farming activities.

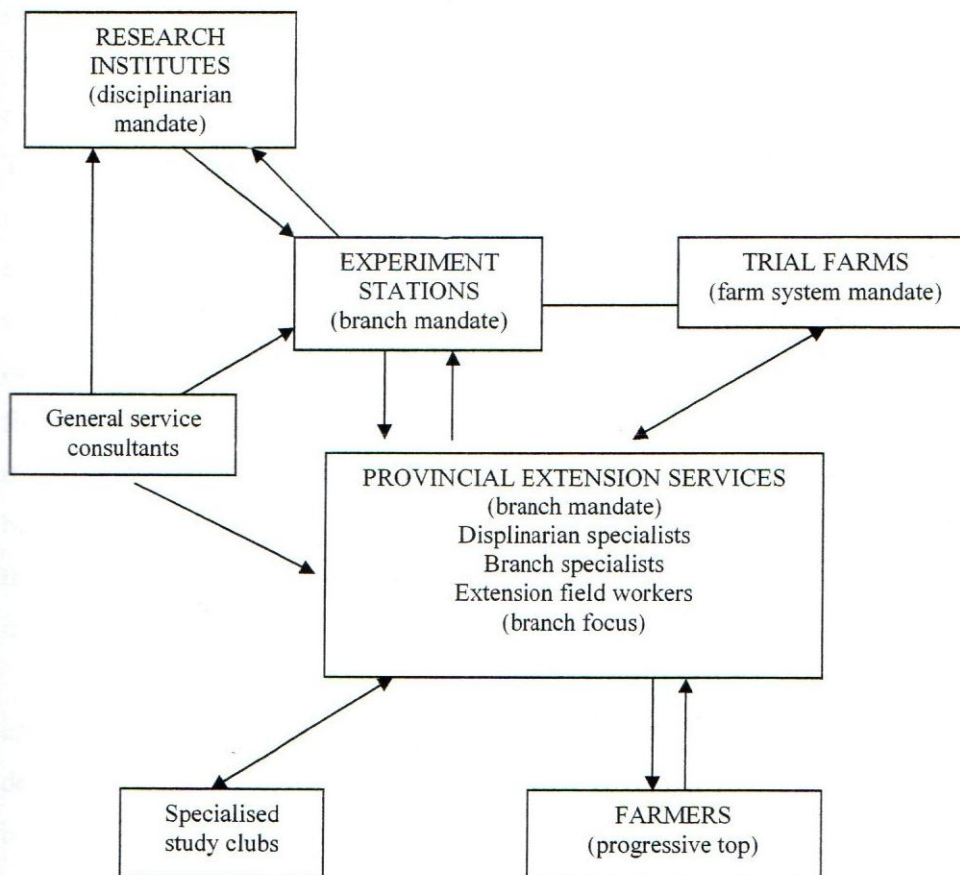


Figure 1: The Dutch Agricultural Information System

The regional extension services in the Dutch system are fairly autonomous and organized according to branch specialization. Thus one will find regional services for arable farming, dairy farming, mixed farming, intensive animal production, and

horticulture. Each provides management to 20 to 30 general field extension workers, specialized in the branch being served by the office. They focus on technological and economic aspects of farm management and are discouraged from providing recipe extension that is, being at the beck-and-call for every technical problem the farmer faces. They are supervised by Branch Specialists. These specialists have an information link to the experiment stations serving their branch mandate. Each regional service also has some Disciplinary Specialists. These are linked, in turn, to the research institutes with a disciplinary mandate (IAC, 2005).

An important linkage mechanism between the regional extension services and the research institutes and the experiment stations are roving liaison officers (IAC, 2005). These General Service Consultants are highly specialised extension officers, housed at the research institutes and experiment stations but serving the regional extension services. They carry research results down, and field problem up (Buttel, 1991). One other very interesting development is the evolution of 'study clubs'. These are usually set up by the extension worker, but have grown into 'mutual interest networks' (Dilman, 1986). They consist of relatively small groups of farmers who regularly come together and study each others' farm management practices. There is an amazing openness with respect to the financial results and the exchange of technological information. The computer has allowed these networks to become interconnected and to exchange information from the bookkeeping office to which they belong (Roling, 1988; IAC, 2005). These study clubs, therefore, play an important part in information exchange and in social pressure to innovate.

Chinas' agricultural information system has appreciably developed. As the country entered into World Trade Organization (WTO), China's agricultural sector was affected deeply, which forced agriculture operators to learn the agriculture technology and information of the world by all means (Guo and Zhu, 2002). Thus management of agricultural information became a hot topic in the agriculture field. With the mind of leaders and agriculture information workers' hard at work, they got good result in agriculture information's development. In recent years, they have developed various databases and many comprehensive and professional databases have been set up. Examples include "agriculture science documentary database", "national agriculture macro-development database", national agriculture economy foundation database", "agriculture

practical technology, new breed, new achievement databases”, and “agriculture ministry award results database” developed by China Agriculture Science Academy Documentary Information Center; (Sheng, 2000). Besides these, the Agriculture Academy, Agriculture Institute and University in different provinces have set up many professional database, such as “aquatic product information database” designed by Dalian Aquatic Product Institute; “World Yak Documentary Database” and “ Economize on Water Agriculture Database” designed by Gansu Agriculture University Library (Sheng, 2000).

China’s agriculture network construction began late, but has developed very fast (Qamar, 2002). The agriculture websites can be divided into four kinds according to the current website of over 3100. First is government engineering agriculture websites. Province and city agriculture information website (www.bjagri.gov.cn) is the typical case. Second is the comprehensive agriculture website with the typical case of China agriculture information website (www.agri.gov.cn) designed by agriculture ministry. Third is the professional agriculture website with the typical case of China plant protecting consultative website (www.zhibao.net) designed by preventing and Treating Division of Agriculture Technology popularization service centre. Fourth is the business agriculture website with the typical case of China agriculture website (www.nong.net) and China agriculture capital website (www.ebc.com.cn). The rationale behind the elaborate agricultural information system that China is putting in place is the necessary adjustments needed for developing her agriculture. There is need to link the research, extension, production and the market system (Sheng, 2000; Guo and Zhu, 2002). All these reforms require responsive and effective agricultural information services.

The concept of agricultural information system for extension science was earlier introduced and elaborated for use in India (Nagel, 1980). The aim was to establish viable institutions that would produce and safeguard a stream of new technological knowledge and a flow of industrial inputs in which the new knowledge is embodied, complemented by investments in general education and in production education for farmers and by efforts to transform institutions to be consistent with the new growth potentials. Such a system would deliberately be designed to include a research subsystem, a dissemination subsystem, and a user subsystem (Banerjee and Sachdeva, 1995). The key feature of the system is the interactive flow of information between the various subsystems made possible by use of computer networks. The system is interactive and not a one-way flow.

It delivers information that supports the management functions of the agricultural sector accurately, exhaustively, cost-effectively and on a timely basis leading to its improved performance.

The above examples have vital lessons for the local situation. They underscore the significance of an elaborated, tested and shared model of an ICT-based agricultural information management system. The system would ensure efficiency in collecting, processing, transmitting, and storage of information on the resources, programmes and accomplishments of the agricultural subsystems. This would be vital for effective performance of the agricultural sector.

2.5 Agricultural Information Management System in Kenya

The satisfactory formulation and successful implementation of any agricultural development initiative inevitably requires an accurate information base of the resources actually or potentially available, and the degree to which, they are being used. A good agricultural information management system provides information towards this end. Because most developing countries have poor agricultural information infrastructures, many important agricultural management projects aimed at boosting agricultural production are often poorly implemented or abandoned (Mulaku & Galcano, 2002). In Kenya a study conducted by Ngesa, (1991) found that:

- (i) There was hardly any information flow between research subsystem and education subsystem.
- (ii) Collaboration and information flow between research and the frontline extension workers (FEWs) was very limited.
- (iii) There was limited information flow between extension subsystem and education subsystem.

In the same study Ngesa (1991) suggested that the approaches to improving agricultural information management between the subsystems include:

- (i) Creation of an agricultural information management system.
- (ii) Establishment of liaison departments in the research, education and extension subsystems.

Many years later, the management of agricultural information situation is yet to show significant improvement in line with current developments in the information sector (Ochieng, 2004; Kamau, 2006; NETF, 2007). There is lack of ICT-based agricultural information management systems in the sector (Kenya, 2001). Inadequate skills to use the ICT-based systems, use of old processors and lack of up to date software are still critical problems that need to be addressed (Kenya, 2004; NETF, 2007). The sector is still characterised by much paper processing of information and a redundant “go it alone” approach by different interested professionals (Kenya, 2001; Mulaku & Galcano, 2002). This results in a lot of duplicated effort and data redundancy, in addition to frustrating the stakeholders who need the information. Use of ICT-based systems would make it possible to store immense quantities of information, avoid many errors that would find their way into manual records and make calculations and comparisons that would be practically impossible in a manual system (Banerjee and Sachdeva, 1995; Kenya, 2004). It is therefore imperative that an audit of ICT capacity is undertaken in the agricultural subsystems and recommendations given on ways to improve the situation.

The implementation of a comprehensive strategy on communication technology will cost Kenya shillings 3 billion and is scheduled to be completed in 2010 (Kenya, 2004). To ensure that this succeeds, a lot of emphasis will have to be placed among other things on research and development, improving capacity and bringing in the best practice skills and methods within the various sectors of government. The results expected from this are efficiency of information flow and dissemination to users.

Just as government seeks to achieve public policy outcomes; agricultural industry organizations have a responsibility for seeing that industry policy outcomes are achieved. A recent focus of agricultural industry policy in Kenya has been on increasing farm productivity to enhance competitiveness (MOARD, 2004). To achieve such competitiveness, farmers have to be empowered to be innovative so as to enhance achievement of productivity and sustainability in agriculture (Altieri, 1995; Pretty, 1995;1998; Thrupp, 1996; Conway, 1997; Hinchcliffe et al., 1999; NRC, 2000; Li Wenhua, 2001; McNeely and Scherr, 2001; Uphoff, 2002). Other players in the agricultural sector have also to play their roles effectively so that together they can solve common agricultural problems and move the sector forward.

It is therefore imperative that the agricultural sector develops and maintains effective and efficient systems of agricultural information management, for it is on the basis of this information that decisions are made and actions taken that impact on the performance of the sector (Kinara, 1984; Mugo, 1992; Banu and Bode, 2002). A variety of different factors influence change and innovation at the farm level. Some factors pertain to the skills, knowledge and personal characteristics of individual farmers, some to the farming enterprise, some to the availability of information, and in relation to adoption of new technology, and the nature of the technology itself (Stoop, 1988; Pretty, 1995). Individuals and institutions seeking to facilitate on-farm innovation and change need to understand the contribution of ICT to effective and efficient dissemination of agricultural information and take this into account when designing the methods they use. The focus of this study was on how the institutional arrangements within the agricultural sector influence the application of ICT in the management of agricultural information to move sector participants to the industry productivity goals.

2.6 The Subsystems of the Agricultural Sector in Kenya

The major subsystems in the Kenyan agricultural sector include the agricultural research, the extension service, the training institutions, the user/farmer and the agri-business subsystems. Literature on the agricultural research subsystem, the extension service subsystem, the training institution subsystem and the farmer subsystem is cited in this section. The agri-business, though a critical subsystem is not included because it was beyond the scope of this study.

2.6.1 The Agricultural Research Subsystem in Kenya.

Agricultural research is the source of technology, innovations and knowledge that propel current and future agricultural development. The Kenya Agricultural Research Institute (KARI) carries out most of the agricultural research work on agriculture in Kenya (Ndiritu, 1990; Murithi, 2003). As Kenya's premier agricultural research institution, KARI is looked upon for cutting-edge sustainable technologies that will contribute to the national economic development through promotion of food security, rural household incomes for

poverty reduction, and sustainable use of natural resources (Murithi, 2003; Kenya, 2004b). Educational institutions, parastatals, private agribusinesses and international research bodies also undertake other research work in this sector.

The Kenya Agricultural Research Institute came into being after it was realised that spreading agricultural research among several separately managed agencies was impending effective use of research resources. In 1986, a joint donor report recommended that a parastatal body be constituted to consolidate the research activities of the KARI at Muguga, the Scientific Research Division (SRD) of the Ministry of Agriculture and the Veterinary Research Division (VRD) of Ministry of Livestock Development (Ndiritu, 1988). The same recommendation was contained in the National Agricultural Research Report (NARP) of 1986. The consolidated research body was to be a parastatal organisation and be called Kenya Agricultural Research Institute (KARI). It was established under the Science and Technology Act of 1979, the act under which other research parastatal bodies in other fields are created. Two major commodities Coffee and Tea, were however, not brought under KARI and have their research activities falling under the Coffee Board of Kenya and Tea Board of Kenya, respectively.

The research centres are classified as National Research Centres (NRCs), Regional Research Centres (RRCs) and Research Sub-centres (Ndiritu, 1990). The National Research Centres are expected to conduct research on commodities or factors of production. The Regional Research Centres focus their activities on the identification of and finding solutions to production constraints in the agro-climatic zones in which they are located. The Research Sub-centres are sites for conducting trials, and collection of samples and information from the area.

Three of the National Research Centres, - Njoro, Kitale and Katumani – have, in addition to their national mandates, regional responsibilities, while two Regional Research Centres – Mtwapa and Kakamega, conduct research on specific commodities, thus assuming responsibilities assigned to National Research Centres.

The reorganised KARI, in an effort to be able to better serve the agricultural industry set out to improve linkages with the extension, universities and colleges, and other research institutions. In its effort to acquire and apply scientific knowledge to resolve pertinent agricultural constraints, KARI conducts strategic and adaptive research focusing on

specific production systems and varying socio-economic circumstances of the Kenyan farming community, paying particular attention to small-holder farmers.

KARI has institutionalised the research planning and implantation process to be more responsive to the national development agenda. Its current Strategic Plan (2005-2015) reflects the change in national policy direction, as elaborated in the Economic Recovery Strategy for Wealth and Employment Creation, (ERS) and the Strategy for Revitalising Agriculture (Kenya, 2004b). Despite envisioning a vibrant commercially-oriented agricultural sector propelled by innovative knowledge and approaches that respond to demands and opportunities, weak linkages with its partners still dog KARI's effort. In his address during the launch of the Kenya Agricultural Productivity Project in 2006, the then Acting Director of KARI, Dr.E.Mukisira after proffering that linkages between research and extension were weak, argued that it was imperative that the organisation and management of the reorganised and rationalised research system provide mechanisms for effecting linkages with extension. This would allow for the annual work programmes in areas of common interest and facilitate effective co-ordination at all levels of administration.

Currently on-farm research trial approach is being used to revitalize the contribution of agricultural research to agricultural development. Apart from suiting the agricultural technologies to the farmers' socio-economic conditions and agro-ecological zones (AEZs), this approach emphasizes the importance of research-extension-farmer linkage (MOARD, 2002). The approach is multidisciplinary, and requires strong working linkages between the farmers, extension agents, and researchers. Although agricultural research, agricultural extension and farmers obviously have a common ultimate objective, their collaboration needs to be adequately addressed. In the new and more market oriented environment, farmers need to have constant access to agricultural research technologies and extension services as without such services they will not be able to diversify rapidly and effectively.

Research and extension personnel in Kenya have used a number of approaches to transfer technologies to the farmers. Some of these technology transfer approaches are Conventional Extension Approach (CEA), Training and Visit system (T&V), Agriculture Technology Information Research Initiative (ATIRI) of KARI, and Farmer Field Schools (FFS). These approaches have had varying degrees of success and shortcomings. A

common weakness that has been noted over the years is their Top-Down nature and weak inter-group linkages (MOARD, 2002). Therefore, as the role of agricultural research continues to evolve, it will need strengthening in a number of areas among them:

- its capacity to identify research subject areas in close collaboration with producers in order to provide an effective response to the expectations of the latter;
- its capacity to report and disseminate the results of their research to the stakeholders involved (decision-makers or those actively involved);
- its capacity to undertake genuine multi-disciplinary research, combining technical, economic, and social issues, and to ensure better links between modern and local traditional skills and knowledge; and
- its capacity to find the best way of linking national, regional and international research.

2.6.2 The Agricultural Extension Service Subsystem in Kenya.

Agricultural development depends to a great extent on how successfully knowledge is generated and applied, and indeed knowledge intensiveness has featured prominently in most strategies to promote agricultural development (Riikka et. al. 2008). Agricultural extension is widely regarded as playing an important role in improving the information and knowledge systems worldwide. The provision of extension services has been seen for many years as a principal responsibility of the state in most developing countries. Large public organizations hierarchically structured and staffed with permanent employees fulfilling various roles and functions were thought to maintain a broad impact and equity in treatment of clients, while also providing a firm regulatory system. However, the general observation is now apart from offering inadequate services to farmers that do not effectively cater for their knowledge needs, these administrations are too inflexible and unresponsive. Together with the high costs of running large extension organizations, the need to understand and adopt innovation systems thinking is real (Cary, 1993; Beynon, 1996; Ndungu, et.al., 2003).

The general dissatisfaction on the performance of extension services in many developing countries has been compounded by misconceptions about what agricultural extension actually is and what it should do (Andy, 2006). Extension became adversely

associated with the notion of transfer of technology of 'top-down' projects of a centralized state instead of being regarded as the more open, helping people through a systematic use of communication to solve their problems as partners both contributing their own knowledge and capabilities (Albrecht, 1995), it was co-opted into restrictive notions of bureaucratic organization and meaning (Roling, 1988).

One response to this crisis of identity in agricultural extension, as with many other sectors, is to talk of reducing the role of the state as an important mechanism for improving service provision in many countries throughout the world, whether these are richer or poorer ones. Indeed, since the early 1980s, important changes have been taking place in both higher- (the North) and in lower-income countries (the South) with regard to the involvement of public and private sectors in the financing and provision of agricultural extension services. The central idea is that farmers should be given opportunities for obtaining the advice and information they seek from those most able and willing to do so (MOARD, 2002). Approaches that cultivate habits of proactive information acquisition among farmers to independently seek and use information of their own choice at their own pace should thus be a key feature in modernization of extension services (Okoth et al., 2003; Ochieng', 2004; Kenya, 2004b; Kamau, 2006).

As public involvement in the provision of extension services stagnates or reduces, private professionals would be expected to fill the gap of information delivery, while competition would encourage them to do this at as low a cost as possible (Maalouf et al., 1991; Rivera and Gustafson, 1991). Furthermore, a role for a third sector, farmers and their organizations, is also being increasingly emphasized so that users can take on more responsibility for extension (Saito and Spurling, 1992; Wilson-Grau, 1994; Gubbels, 1994; Uphoff, 1995; Carney, 1996; Ndungu, et. al., 2003). However, though promotion of the private sector (whether for-profit or not for-profit) is popular and the pace of reform is increasing, there has been perhaps insufficient critical reflection on principles which should guide the process. Whichever paradigm one holds for external assistance in agricultural systems change, whether technology transfer or farmer-first, the changes currently taking place are of great importance. There is need to review some experiences with the changing roles of the public and private sectors in agricultural extension delivery and draw some cautious conclusions for those involved in managing the change process in light of the apparent advances in the information communication technology sector.

Because of the centrality of agricultural extension in agricultural development, the Kenya Government has created institutions for providing public agricultural extension to farmers (Kenya, 2002). The Ministries of Agriculture and that of Livestock and Fisheries Development, assume the responsibility of public extension services in the country. The Research – Extension Liaison Division has been charged with the objective of facilitating the dissemination of agricultural information between the research and extension subsystems (Kinara, 1984).

The Government of Kenya has over the years attempted to modify and revitalize the agricultural extension services by incorporating various systems to extension that would improve agricultural information management (Kenya, 1970; Leonard, 1977; Kenya, 2002; Kenya, 2004b; Kamau, 2006). The shift ranges from the Farmers Training Centres (FTCs) system and the Training and Visit (T &V) system to the National Agricultural and Livestock Extension Programme (NALEP) now currently being used (Kenya, 2002). The Farmers Training Centre System, which had its own branch within the Division of Agricultural Extension and Services of the Ministry of Agriculture, consisted of twenty nine (29) educational centres, twenty six (26) of which were Government-funded, and three (3) church-run, where residential training of farmers were conducted (Ngesa, 1985). Very few of these FTCs are now active. The Training and Visit system (T&V) was introduced in Kenya in 1982, under the title of National Extension Programme (Benor et.al., 1989). The T & V aimed at improving the flow of agricultural information through continuous and systematic training of Frontline Extension Workers (FEWs) and programmed visits to farmers.

The Commodity development system is commonly used by parastatal bodies and private firms to promote the production of a small range of commodities. The technical recommendations, which are usually passed through a well-defined line of command, are usually accompanied by credit facilities, input supply and marketing arrangements (Swanson et. al., 1990). The Kenya Tea Development Agency (KTDA) is charged with developing small-scale tea production while the British American Tobacco (BAT) Limited, a private tobacco company, oversees tobacco production (Leonard, 1977). The commodity development system focuses only on the crop of interest while ignoring other extension needs that the farmer might have. Company interests thus override farmer interests. In the Agricultural Development and Rural Development Model, extension service is just a part

of a package of several services provided to the farmers and rural people. The focus is usually overall improvement in agricultural production and rural life. These models are popular with Non-Governmental Organizations (NGOs) (Swanson, 1984; Roling, 1988; Von Blackenburg, 1984).

Farmer Field Schools (FFS) are one of the most noteworthy recent contributions to agricultural development practice. They have a well-deserved reputation for successfully introducing Asian rice farmers to principles of Integrated Pest Management (IPM). In the 1990s, more than 75,000 FFS were conducted in Asia (Pontius et. al., 2002). As a result of this experience, the term FFS is now widely used and the concept features in a growing range of settings. FAO, which took the lead in supporting FFS for IPM in Asia, is now promoting the concept of Integrated Production and Pest Management (IPPM) through FFS in a number of African countries (Okoth et al., 2003). In the past few years, at least five major donors have funded 1,500 FFS in Kenya alone (Sones et. al., 2003). There are worldwide examples of the FFS approach being applied to programs in livestock health and production, soil fertility, community forestry, gender, HIV/AIDS prevention, and other topics. The synthesis of a recent workshop on the subject featured a diagram showing a possible trajectory for FFS, with an arrow originating in rice IPM and pointing outwards through ever broader responsibilities in crop and resource management, eventually arriving at "advocacy," "democracy," and "life" (CIP-UPWARD, 2003). The FFS approach supports current interest in participation, empowerment, and decentralization for rural development, and it provides an attractive package for NGOs or donor projects to manage.

In the late 1980s and early 1990s, there were socio-economic changes and agricultural reforms taking place that led to formulation of many government policies. As a result of these changes in the agricultural sector, agriculture extension services did not adequately respond satisfactorily (Ndiritu, 1988). During the same period, the country started a process of democratization and decentralization calling for stronger involvement of stakeholders and beneficiaries at local level (Murithi, 2003).

To respond to these changes, the then Ministry of Agriculture and Rural Development formulated the National Agriculture Extension Policy (NAEP) to guide and harmonize management and delivery of agricultural extension services, which had more or less become a monopoly of the public sector. The policy recognizes the need to diversify,

decentralize and strengthen the provision of extension services with a view to increased sustainability and relevance to farmers (MOARD, 2002).

To operationalize the NAEP, the Ministry of Agriculture in consultation with stakeholders developed an Implementation Framework called the National Agriculture and Livestock Extension Programme Implementation Framework (NALEP-IF). Both NAEP and NALEP-IF were launched in December, 2001. Despite efforts by the two Ministries in publicizing and promoting NAEP and NALEP-IF, it has been noted that many stakeholders do not engage with the policy framework as expected (MOARD, 2002; Ochieng', 2004). The Kenyan agricultural sector has thus continued to perform below expectations and new efforts are needed in addition to previous ones, to reverse this situation (World Bank, 2004). A policy paper on revitalizing agriculture in the country (Strategy for Revitalizing Agriculture, SRA), was launched in March 2004 with a main goal to achieve a progressive reduction in unemployment and poverty, the two major challenges that Kenya continues to face (Kenya, 2004b; World Bank, 2004). To modernize the agriculture sector and respond to Millennium Development Goals (MDGs), SRA has identified six crucial areas that require public action:

- i. Streamlining agricultural policy framework
- ii. Creating an enabling environment for private sector investment
- iii. Improving delivery of support services
- iv. Promoting marketing, agro-processing and trade
- v. Mainstreaming agricultural development issues in other sectors
- vi. Strengthening institutional implementation framework

Efficient and effective agricultural extension is one of the most important services for increasing agricultural productivity. Through facilitation of reforms in extension service delivery to embrace pluralism (private/public sector extension services), farmers will have the option to decide on who to provide them with services through a well coordinated but decentralised system (ISNAR, 1989). As agricultural extension is expected to play a key role in the implementation of SRA, it is important to ensure that the extension policy and strategy is providing the right environment in promoting these services. It therefore, became necessary to review NAEP with the aim of transforming into an inclusive policy document that is in line with SRA. In this connection, NAEP review process started in

June 2005. The review process involved consultations with key stakeholders. Two national stakeholders forum were held to receive their inputs and suggestions. Written comments were also received from several stakeholders after circulation of the Reviewed Draft document. The outcome of the NAEP review is the National Agricultural Sector Extension Policy (NASEP) which has taken a sector-wide approach in management and provision of agricultural extension services.

The Kenya Agricultural Productivity Programme (KAPP) is one of the initiatives to implement two thematic areas of the SRA namely; reviewing and harmonizing the legal, regulatory and institutional framework and improving delivery of research and extension advisory support services (Kenya, 2004b; World Bank, 2004). It is multi-institutional and jointly supported by the Kenya Government and the World Bank. The theme of KAPP of improving Agricultural sector productivity and competitiveness through enhanced adoption of appropriate technologies and practices is emphasized in the SRA (Kenya, 2004b). The initiative is to contribute to sustainable agricultural productivity and improvement of the livelihoods of rural communities through the improved performance of agricultural technology supply and demand system. It lays emphasis on the recognition and support for coordinated pluralism in research and development towards a national agricultural research system, and a reformed national agricultural extension and farmer empowerment. KAPP recognizes the need for a holistic approach integrating a wide range of stakeholders and disciplines in order to enhance its contribution to the national goals of food security, poverty reduction, and sustainable resource management.

In the Policy and Institutional Reforms, efforts were directed at establishing the institutional framework required to increase agricultural productivity in the country; project coordination structures as well as building capacity and provision of technical assistance for policy analysis for sector ministries (Kenya, 2004b; World Bank, 2004). With regard to the Extension System Reform, KAPP in collaboration with other stakeholders sought to build on achievements made under the National Agricultural Extension Policy (NAEP) framework to establish a new system of national agricultural extension (Kamau, 2006). This was to be achieved through reforms in agricultural extension services delivery coordinated by the SRA-National Forum through a consultative process that includes the entire extension service providers as well as clients, that is, researchers, farmers, public and private sector service providers and market agents

(National Extension Task Force, 2007). Activities under this component are being implemented in 12 pilot districts: Busia, Butere/Mumias, Meru Central, Nakuru, Nyandarua, Nyeri, Siaya, Taita Taveta, Tana River, Trans Nzoia, Uasin Gishu, and Wajir Districts. Best practices from these districts would be duplicated in other parts of the country in subsequent phases.

In the Research System Reform, the aim was to bring together all the actors within the field (farmers, universities, local and international public/private research organizations, NGOs). In recent years there have been substantial attempts at restructuring the national Agricultural Research Systems (NARS) with the objective of developing solutions to constraints inhibiting increase in agricultural productivity (Kenya, 2004b; World Bank, 2004). Varying capacities exist in different institutions and considerable capacity building has also been undertaken in agricultural research (Ochieng, 2004). However, coordinated pluralism that integrates a wide range of stakeholders and disciplines has been lacking in research (Murithi, 2003). The Kenya Agricultural Productivity Programme attempts to facilitate further reforms in the sub sectors towards coordinated pluralism for greater efficiency and accountability (World Bank, 2004). The reforms aim at increasing the role of end-users in planning of activities, resource allocation, and monitoring of implementation; promote performance/results-based resource allocation; induce greater collaboration and synergy between and among public and private research institutions; ensure effective integration of research, education and extension services at local levels; and increase the volume of appropriate technologies and knowledge generated and applied.

The synergism between extension and research is well known and well recognized, but in practice, there is often a lack of cooperation between research and extension in many developing countries like Kenya (Ndiritu, 1988; Stoop, 1988). Kaimowitz (1991) identifies five mechanisms to enhance linkages between research and extension:

- (i) Integrate the organization
- (ii) Establish liaison units
- (iii) Organise committees for coordination
- (iv) Have members of respective institutions carry out joint activities; and
- (v) Communicate better.

The implications of these tactical options have been discussed extensively and sufficiently (Sims and Leonard, 1990; Roling and Engel, 1991; Kaimowitz, 1991; Eponou, 1993). In countries like Kenya, where there is institutional separation between research and extension, none of the mechanisms Kaimowitz mentioned seems to work well (Ochieng', 2004; National Extension Task Force, 2007). Nevertheless, one step towards breaking these boundaries would be to make it professionally advantageous for individual scientist and extension personnel to access agricultural information online through well worked out linkage mechanisms (Eponou, 1990; Faylon and Acoba, 2002). This may call for tackling of institutional rigidities and lack of a universal prescriptive solution to the perennial problem of poor linkage. The seriousness of the disjunction between research and extension clearly needs to be recognized and prompt action taken to remedy the situation.

Considerable and improved approaches to develop the agricultural sector, reforms in agricultural information technology have yet to be given the emphasis they deserve (Mulaku & McLaughlin, 1996; Kenya, 2004). There are major weaknesses of agricultural information management that need to be addressed for the country to gain immensely from the various applications of information and communication technology.

2.6.3 The Agricultural Training Institutions Subsystem in Kenya

The primary mission of the agricultural training institutions subsystem is to prepare agricultural professionals who take up positions in the public and private sectors. Though the primary focus of this preparation is the pre-service education and training, some in-service training is also conducted by the subsystem. This preparation mission of the subsystem requires that the prescription of the programmes be based on the needs of the agricultural sector. In planning the whole structure of agricultural education and training to meet Kenya's needs in agricultural development, an important basic need is the preparation of estimates for trained manpower, at all levels and in the many complementary branches of the agricultural services (Ong'ondo, 1984). During the many meetings and workshops to review progress in agriculture, two of the greatest handicaps in agricultural development in the country have been identified to include lack of trained staff in adequate numbers and lack of sufficient funds for the improvement and expansion of agricultural development

programmes (MOARD, 2002; Kenya, 2002; National Extension Task Force, 2004; Kamau, 2006).

There can be no doubt about the need for a planning unit at the national level, but also within the Ministry of Agriculture, to keep under constant review the needs of trained manpower implicit in national development plans and in the agricultural sector of such development. Such a unit would advise on the training needs in the sector. Williams (1970) suggested three methods of prescribing the needs of agricultural professionals, namely (1) Post Description, (2) Organisation Operations and Man Analysis, and (3) Critical Incident Technique. In the post description method, the tasks to be performed by the officers at the end of the training determine the programmes offered. The organisations operations and man analysis arrives at the programmes by examining tasks performed by organisations' personnel and the competencies needed by each member of the organisation. The final method, the critical incident technique, examines the abilities needed by the professionals to adequately perform their functions and then evolving the training around these needs. The significance of these methods of determining programmes offered by training subsystem is that the subsystem is a subject of a wider agricultural system and that the information needs of the professionals within the subsystem are always changing depending on the needs of the other subsystems within the total system.

In Kenya, the training subsystem of the agricultural sector system is spread over three government ministries, the Ministry of Education Science and Technology, the Ministry of Agriculture, and the Ministry of Livestock and Fisheries Development. Professionals are trained at degree, diploma and certificate levels. All the public universities offer degree and diploma programmes and fall under the Ministry of Education. Bukura Agricultural College, offer diploma level of education, while others, the Animal Health and Industry Training Institutes (AHITI) of Kabete, Nyahururu and Ndomba, the Dairy Training School at Naivasha and the Meat Inspection School at Athi River, Kilifi Agricultural Institute(now Pwani University College) and the church-sponsored Baraka Institute in Molo offer certificate and diploma levels of education.

Three broad categories or levels of staff are needed to spur the agricultural sector forward: senior professional staff, intermediate level technical and supervisory staff, and field level staff. Each level has its appropriate recognized training and so far as the civil service is concerned, required entry qualifications. In many instances there are avenues of

promotion from the intermediate level to the senior, either through proved ability in the service or by means of further educational opportunity. In a country like Kenya that is emerging from subsistence agriculture and is unable to afford expensive agricultural services there may be need for large numbers of relatively low level workers trained to undertake very specific duties in measures directed at improving crop and livestock production. As the sector develops, more highly trained people will be required with a knowledge in farm management, marketing, cooperative organization, farm mechanization, accountancy, information technology and other matters relevant to a rapidly developing agricultural economy (MOARD, 2002).

Job demands dictate the training needs of any category of workers (Williams, 1967; 1970; Smithels, 1972). The FAO (1984) report on training of workers for agricultural development observes that personnel is needed who can provide direction in the way the sector should move. The implication here is that trainers need to specify both technical and professional competencies in their training programmes, as the objective of any training is to enable the trainees to acquire the ability to perform some specific activities or series of activities effectively (Maunder, 1962; Ndegwa, 1971; FAO, 1984). The training programmes as of necessity will have to be flexible and responsive to a large and diverse country in which agriculture is inevitably at different stages of development in different areas.

Together with identifying training needs of personnel in the agricultural sector, trainers need to decide when each of the needs should be taught and learnt. Swanson (1984, categorised the training stages as, pre-service, induction training, and in-service training. In-service training programmes mainly should be conducted according to the needs of the personnel in updating them where they feel deficient as far as the job at hand is concerned (Williams, 1967; FAO, 1984). Hecht (1978), observed that the amount and quality of systematic in-service training appeared to be below what was needed in Kenya. He further observed that formal pre-service training was essentially a preparation for the absorption rather than acquisition of all the requisite skills. The implication would be that academic education alone may never introduce sufficient knowledge and skills to enable one fulfil a complete role. Whether personnel in the agricultural sector will be effective in their work in light of advances and the changing world economy would not only depend on

pre-service training but also how this training is reinforced by subsequent in-service upgrading and training.

Whereas there has been general agreement on the need for expanded and improved training facilities and programmes, there is less certainty regarding the numbers of trained persons required. This is partly a reflection of uncertainty as to the funds likely to be available for the expansion of the agricultural services in the future and also the scarcity of reliable statistics upon which estimates might be based. Thus, in any attempt at forecasting requirements for trained manpower, allowance has to be made for unpredictable factors such as the rate of growth of the gross national product and the proportion of the national budget devoted to the agricultural services. There are also factors such as the competition for trained manpower of different elements of the economy, brain drain, wastage or drop-out of trainees during training, and losses within the agricultural services due to retirement, illness, natural attrition and other causes.

There is need for a close working relationship between these training institutions, agricultural research and extension organizations and even with different categories of farmers and agricultural organizations. This would lead to an interactive approach to the training of the personnel so that they would be sufficiently broad based as to be able to perform optimally in the agricultural sector. A curriculum for such training would be easy to develop and implement when there is an effective agricultural information exchange between the various stakeholders. It will be appreciated from what has already been stated that the planning of manpower requirements and training needs would be complex. Quite clearly it must be a continuous process involving regular adjustment so as to cater for the agricultural sector sufficiently.

2.6.4 The Farmer Subsystem in Kenya

Kenya's population currently stands at over 30 million. Seventy per cent of the people depend on agriculture for their livelihood (Kenya, 2005). The agricultural sector is a source of employment, industrial raw materials, food security, and gross domestic product, foreign exchange earning and rural incomes. There is, therefore, need for the country to spur this sector forward owing to its strategic position in the nations' overall development process. Sustainable agriculture is essential for Kenya's economic

development because it utilizes available physical and human resources better, leading to increased capacity of people and land to adapt to change while minimizing dependency on external and non-renewable inputs. The quality, capability and performance of farmers in agriculture are fundamental indicators of the agricultural sector's efficiency, productivity, development and sustainability (Sigman and Swanson, 1982; Roling, 1988; Ochieng', 2004).

Agriculture as a lead sector in the economy and a source of livelihood for majority of Kenyans, has been recognized in both the country's current National Development Plan and the Strategy for Revitalizing Agriculture (Kenya, 2002; Ministry of Agriculture and Ministry of Livestock and Fisheries Development, 2004). Recognizing this fact the Kenya Government stresses improvement of agricultural productivity through special focus on smallholder farmers (who use 80 % of the arable land) as a source of economic development (Ministry of Agriculture and Ministry of Livestock and Fisheries Development, 2004). Despite the fact that smallholders constitute 80% of agricultural producers in the country, about 25% make little use of commercial inputs, 67% lack managerial skills, and much labour for cultivation is provided by people working using simple hand tools (Mwangi, 1999; World Bank, 2004). The poor performance of farmers has been attributed to the use of traditional production methods, lack of adequate extension information, poor managerial skills and rampant illiteracy (Feder and Umali, 1993; Carl and John, 1998; Mwangi, 1999; World Bank, 2004).

Farmers must have efficient allocation decisions, if they are to continue contributing to Kenya's economic growth (Kenya, 2005). The country's agricultural future therefore depends critically on raising the productivity of farmers. Apart from being financially poor, rural communities, who depend mainly on agriculture, the farmers lack information and confidence to make rational decisions on their farms (Ochieng', 2004). This affects agricultural production and results in the farmers' socioeconomic deprivation. Useful information for agricultural needs is, however, constantly being produced and is available in research institutions, public offices and public libraries. Most of this information is normally packaged as documents or in machine-readable formats for target groups (Roling and Engel, 1991; Hall et al., 2003). However, evidence shows that only a small amount of information on various innovations for improving agricultural productivity reaches the majority of smallholder farmers (ISNAR, 1989; Laizer, 1999;

Ochieng,' 2004). Indications are that farmers are not empowered enough to solve their agricultural problems using information and knowledge emanating from the innovations (Kitetu and Chai, 2004).

Although a number of extension initiatives aimed at knowledge transfer to farmers have been introduced in different sectors in Kenya, the approaches have been riddled with problems. A major shortcoming is that in most cases extension approaches have tended to be package oriented in solving predetermined farmers' problems (Wessler and Brinkman, 2002). These approaches do not necessarily consider differences among farmers in terms of needs, priorities, abilities and attitudes towards farming activities or towards the approach. By nature the conventional extension approaches do not cultivate habits of proactive information acquisition among farmers so as to independently seek and use information of their own choice at their own pace.

In the agricultural innovation literature Smits and Kuhlmann's (2004) linear view on innovation, which postulates that agricultural research and development generates technologies that agricultural extension transfers to farmers for adoption, is criticized, and replaced by innovation systems approaches (Sumberg and Reece, 2004). Under the innovation systems approaches, innovation is considered as a complex, interactive process in which there is a large amount of co-evolution of scientific, technological and societal systems, in which cause and effect are often difficult to distinguish (Smits, 2002). It requires deliberate efforts to create effective linkages between technological arrangements, people and social organizational arrangements (Geels, 2004), that is, between hardware, software and liveware (Smits, 2002). Whereas linear views on innovation are considered to be largely supply-driven, systems approaches emphasize the needs of the demand side and active involvement of end-users of innovations (Edquist and Hommen, 1999; Oudshoorn and Pinch, 2003).

In the innovation systems perspective, several actors are seen as relevant to agricultural innovation, including agricultural entrepreneurs, researchers, consultants, policymakers, supplier and processing industries and the farmers. These actors form networks, called innovation configurations by Engel (1995). Biggs and Smith (1998) call the same networks coalitions. The authors, however, concur that these networks are supposed to engage in a process of joint learning and negotiation to shape an innovation. Pittaway et al. (2004) suggest that active involvement of stakeholders is critical to

innovation. In such innovation configurations, agricultural research and development and knowledge intensive business services are not the dominant providers of knowledge and information, but are amongst many stakeholders (Van Dijk and Van Boekel, 2001; Sumberg, 2005). In the innovation systems perspective, production and exchange of (technical) knowledge and information are not the only prerequisites for innovation; several additional factors play a key role, such as policy, legislation, infrastructure, funding, and market developments (Klein et al., 2005). Hence, farmers will require agricultural information management systems that give them opportunity to closely interact with the other actors in development of innovation.

Starting from an innovation systems perspective with a strong emphasis on effective linkages between actors, the changes in the interface between producers and users of knowledge and information discussed above pose a number of constraints and challenges to actors in the agricultural knowledge infrastructure. On the demand side, the changing structure of the agricultural sector makes new demands on farmers' entrepreneurial skills. With regard to coping with these new demands Phillipson et al. (2004) maintain that farmers should be encouraged to be more market oriented, to seek out new opportunities, and to act in a more strategic manner. This shift from a production to a business and market orientation has focused attention on the adequacy and application of generic business skills within the farming sector as opposed to technical skills and knowledge in livestock and crop production. Hence, farmers have to become agricultural entrepreneurs who need to play an active role in the acquisition of knowledge and information to support their business strategies and innovation projects (Gielen et al., 2003; Knudson et al., 2004; De Lauwere, 2005). Instead of being beneficiaries, receiving free-of-charge innovation supports from a public service, agricultural entrepreneurs need to explore the market and contract suitable private providers of research and development and knowledge intensive business services (besides finding other cooperation partners).

Because of failures, such as information asymmetries, poor identifiability of research and development, and imperfections in their competences, farmers often face constraints with regard to acquisition of innovation related knowledge. The constraints experienced by agricultural entrepreneurs are similar to those experienced by nonagricultural small and medium enterprises (SMEs), as both types of enterprises display similar characteristics (Roling, 1990; Senker and Faulkner, 2001). These include: lack of

awareness of strategic, organizational, and technological deficiencies; difficulties in needs articulation; embedded ness in strong networks, which may preclude new insights; lack of awareness of or failing access to appropriate sources of knowledge and information; and practical constraints such as lack of time and funds for innovation (Vos et al., 1998; Bessant and Francis, 1999; Kaufmann and Todtling, 2002; Garforth et al., 2003; Edwards et al., 2005).

Factors that influence farmers' productivity have variously been studied using farm level data (Adenisa and Zinna, 1993; Ahmed and Hossain, 1990; Ngaje, 1990). Current debate postulates that the factors of production may include more than capital, land and labour as is commonly assumed. It may include advanced innovations of material capital, managerial skills, and technical knowledge of farmers (Cassman et al., 1997). From the studies, a farmer emerges as a key decision maker on the farm who allocates human and material resources and directs the operations of the farm. Debertin (1993) identifies key functions that are performed at this level and they include selection of amount of output to be produced; determination of the proper quantities of inputs to be used and allocation of inputs among the various outputs. The farmer has then to oversee the general development of the enterprise and bear the risk associated with the production and marketing of products. Extension contact coupled with work experience, indigenous knowledge, and other forms of education can improve the managerial ability of farmers (Schultz, 1964; Swanson and Peterson, 1989; Roling and Engel, 1991; Quizon et al., 2001). The contribution of extension contact to agricultural productivity is much higher in modern than traditional agricultural environment and also with farmers who have higher levels of formal education (Nelson and Phelps, 1979).

Many agricultural development specialists concur that extension contact introduces agricultural information and knowledge that influences important attitudes and other personal characteristics that raise human productivity (Lionberger and Gwin, 1982; McDermott, 1987; Swanson and Peterson 1989; Feder and Umali, 1993; Qamar, 2002; Ochieng' 2004; Kamau, 2006). It gives farmers information that promotes their adaptability to changes in agricultural development (Adhikarya et al., 1987; Feder and Umali, 1993; Quizon et. al., 2001). Contact between agricultural extension agents and farmers is a measure of availability of information about new and improved technology, inputs and prices and the utilization of such information is almost certainly dependent on

its availability to the farmers. Sustainability of agricultural production depends largely on actions of the farmers and their ability to make decisions, given the level of knowledge and information available to them (Qamar, 2002; Ochieng,' 2004). Thus farmers with more extension contact would be more inclined and be in a better position to adopting new methods of production and applying modern inputs efficiently due to their informed background.

Continuing high rates of population growth have intensified pressure on natural resources. Less and poorer quality of land and water must provide food and income for more people. Inequality of access to land, water, government services and other resources tends to increase, and thus create a widening socio-economic benefits gap. The challenge to extension policy and decision –makers is that of large numbers of farmers needing extension services and limited public funds to provide needed extension help. As a consequence, large numbers of farmers cannot be reached by publicly supported extension services. Data from an FAO report indicate that hundreds of thousands of farmers are not yet being reached by agricultural extension services (FAO, 1990). Data analysis shows that in Africa, two out of every three farmers have no contact with public extension services (Wessler and Brinman, 2002). In Kenya during the last 10 years, the staffing and facilitation of public sector, extension has declined mainly as a result of freezing public employment and reduced funding for operations and maintenance. Currently, the ratio of frontline extension worker (FEW) to farmers is about 1:1000 compared to the desired level of 1:400 (Ministry of Agriculture and Ministry of Livestock and Fisheries Development, 2004, Ochieng,' 2004; Kamau, 2006).

In the absence of effective private sector operations to fill the vacuum, the situation has led to reduced spatial coverage, targeting and effectiveness of service delivery reflected by clientele complaints (Ochieng,' 2004; Kamau, 2006). Low farmer/extension agent ratios are necessary but fiscally unsustainable. Fortunately, modern telecommunication technologies have reduced drastically the unit cost of information dissemination and sharing and offer a number of options compared to the conventional systems. It offers some very real means to overcome information transfer obstacles. The inadequacy of trained staff, the high cost of such training and the sheer enormity of the target audiences make the use of modern communication technologies necessary to widen the reach of conventional information transfer and dissemination systems. Continuous

advances in technology now give agricultural development specialists a wide range of options for improving communication with farmers. Linked to a central information bank by cable or telephone, a farmer can continuously receive available information, or interactively request specific information. By this process, farmers in remote areas can directly be connected with expertise and services of information in central locations (ISNAR, 1989; Xu, 2001; Wessler and Brinkman, 2002; Kenya, 2004)

Given this backdrop, this study examined one of the least touched upon issues related to diffusion of modern agricultural information, specifically examination of farmers' awareness, attitudes and willingness to adopt information and communication technologies (ICTs) in sourcing of agricultural information. The study emphasizes the need to understand the diversity of information-acquisition problems from the farmers' perspective and to use a combination of approaches in mainstreaming information-seeking practices into the regular lifestyles of farmers to solve information- and knowledge-related problems. To realize this, there will be need to align policies and institutions to reflect the importance of science and innovation and harmonize standards for packaging of user-friendly extension messages to farmers.

2.7 Conceptual Framework

Studies on the theories and practices of agricultural development provides a basis for viewing communication in the agricultural sector as a system consisting of five primary subsystems of agricultural research, extension, training institutions, farmers (users) and markets. The agricultural research, extension and training subsystems should engage in the generation, encoding, sending, receiving and decoding of knowledge and information during the communication process (Roling, 1988; Roling, 1990; Mowlana and Wilson, 1988; Nagel, 1980; Van den Ban and Hawkins, 1996). The farmers are the chief beneficiaries of the agricultural information. The market subsystem is increasingly gaining prominence as agricultural development demands that the sector assumes business characteristics. Agricultural development specialists stress the need for effective interaction among the subsystems. New developments in information and communication

technology now mean that these subsystems can greatly improve the flow of information within and between them.

Contrary to the widely held belief that many farmers do not fancy ICT for sourcing agricultural information, experience among rural poor farmers in India has proved that they have readily adopted and used it to improve a marketing system for their produce. In his book, "The Profits at the Bottom of the Pyramid," Prahalad (2001), gives the example of Information Technology Centre, an Indian conglomerate which decided to connect farmers with personal computers in the villages. The ITC "*e-Choupal*" (literally meaning village meeting place) allowed the farmers to source information on improved practices of soy bean production and finally check prices of soy bean futures at Chicago Board of Trade. The network thus allowed the farmers to source information on production as well as marketing thus improving their margins. Though the interventions used by other countries vary, the critical element of interacting research, extension and user subsystems permeate all the systems reviewed (Meyanathan, 1994). The theoretical model and the case from India provided the foundation by identifying the kind of networks that should be put in place using modern communication technologies. The subsystems should interact on a continual basis. The model provided the foundations for research procedures which focused on factors influencing adoption of information and communication technologies in accessing agricultural information. The focus of this study was the application of ICT in the management of agricultural information within and between the various agricultural subsystems. Specifically, the study analyzed and documented:

- current uses of ICT in extension delivery systems
- extension staff's perceived proficiency in use of ICT for management of agricultural information
- the state of ICT application for management of agricultural information in the agricultural research
- the state of ICT application for management of agricultural information in agricultural training institutions
- level of awareness and willingness to use ICT by farmers to source agricultural information
- factors that have worked against the deployment of ICT in the management of agricultural information.

Modern organizations and institutions now run on information (Menou and Niang, 1991; Muyepa, 2002; Kenya, 2002; Mchombu, 2003). Agricultural information is thus vital for agricultural development at various levels. Agricultural research requires information from the field that is timely, accurate, exhaustive, reliable and usable for the research themes to be user focused. Agricultural extension requires information on the developed technologies that is relevant and readily available to address the field situation. With regard to training institutions, there is need to acquire information on current technologies and trends in the agricultural sector. Farmers equally need to have information on material technology and knowledge-based technology (FAO, 1994; Swanson, 1997; Muyepa, 2002; Wessler and Brinkmann, 2002; Temu and Msuya, 2004). They equally need to have knowledge about market trends so that they can make informed decisions in the day to day running of their farming businesses. There is need therefore, to put in place an interactive agricultural information management system that networks these key players in the agricultural sector and ensures efficient and effective information flow. In such kind of an arrangement, all the operational phases would include participatory approach activities by soliciting relevant feed forward from target beneficiaries

The agricultural information flow envisioned in this regard is based on the triangular schema (IFAP, 1995). The theory of the triangular schema works on the perspective that links between the farmers, research and extension is a prerequisite for a healthy agriculture. That is, farmers, extension and research are closely inter-linked through a multiplicity of formal and informal contacts and working institutions (figure 2).

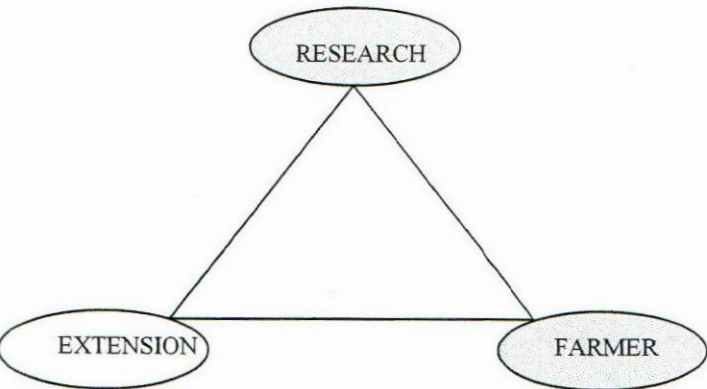


Figure 2: Extension –Research- Farmer Triangle

To realise the information flow as outlined in Figure 1, a conceptual model of agricultural information management system based on a generic model originally put forward by Adhikarya (1978) is proposed that includes other stakeholders of the agriculture sector. Roling (1988) was later to emphasise the need to carry out agricultural information management in a systematic sequential and process-oriented manner, rather than on an ad-hoc basis. It ought to be a planned process with inter-related activities to be carried out following a management implementation plan by well-trained personnel within a given time schedule. The operational phases in the various subsystems should not be implemented or conducted in isolation because these are part of an interactive and systems process that requires them to reinforce each other and to produce a synergetic effect (figure 3).

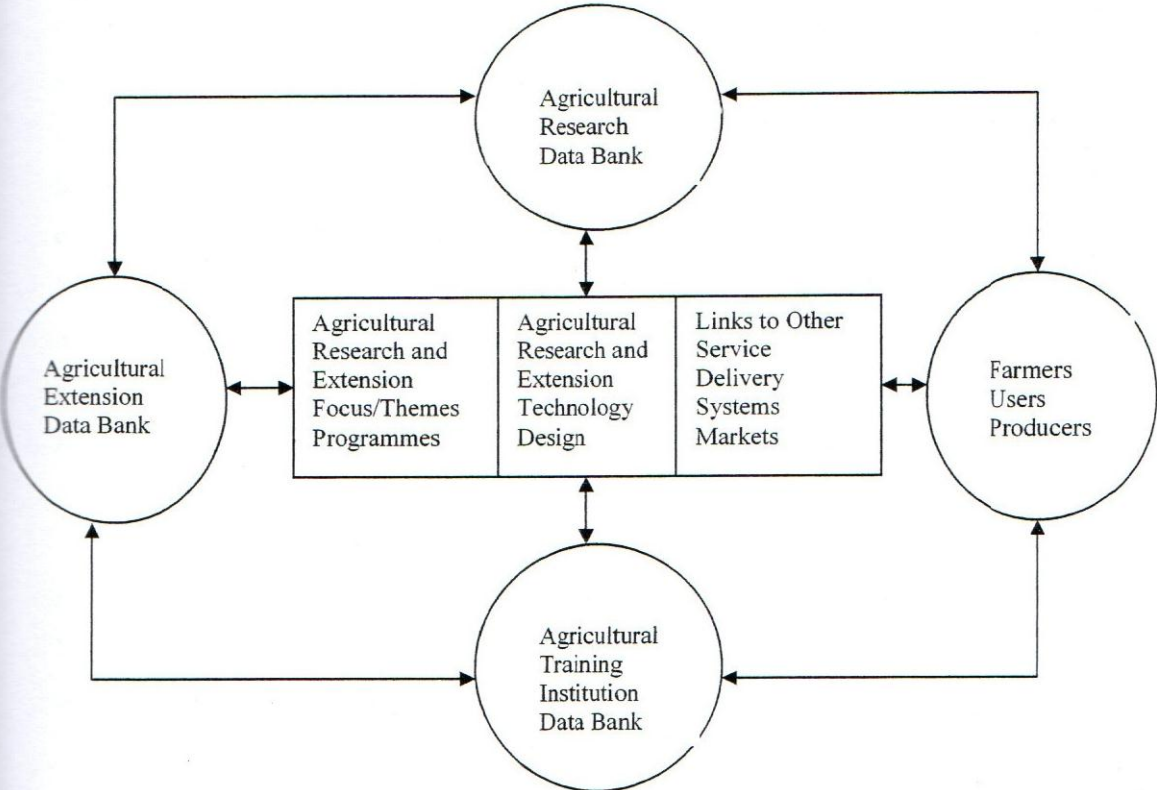


Figure 3: Agricultural Information Flow among the Agricultural Subsystems

Review of literature ((Lindner et al, 1982; Menou and Niang 1991; Mugo, 1993; Banu and Bode 2002; Banu and Bode 2002; Garforth, et al.2003) indicated that agricultural information has a direct impact on the pace of agricultural development. That the impact of this information is greatly influenced by the way this information is managed has also been emphasised (Carl and John, 1998; Wessler and Brinkman, 2002; Lopez and Bruening, 2002; Mchombu, 2003; Ochieng', 2004). The role of ICT in improving the effectiveness of the management of agricultural information has variously been stated (Edquist and Hommen, 1999; Kaufmann and Todling, 2001; Clark, 2002; Temuand Msuya, 2004; WTO, 2004).

Effective management of agricultural information and agricultural development are interrelated. Information empowers users and leads to making informed choices and decisions which would make it possible to reach goals (Jatta, 2000). Information enhances acquisition of technology that is critical to improved farm production. In this study, common factors affecting the application of ICT in the management of agricultural information were selected for investigation. They formed the independent variables and consisted of those factors related to ICT infrastructure and the working environment. Variables such as support services, incentives, sensitization, awareness, and attitudes were assumed to be intervening variables and studied to determine the extent to which they related to the dependent variables. The dependent variables were ICT proficiency skills and participation in innovation, production and market systems through enhanced agricultural information management.

There is therefore, a strong case for information management through ICT-based system that would enhance effective management of agricultural information within and between the subsystems. The application of an ICT-based system approach also points out to the need to train staff to master the whole process rather than only some elements of the process, or part of the activities. Therefore it is suggested that training activities related to the operational phases or implementation steps that follow closely the conceptual framework be included in the setup of the agricultural information management system. Figure 4 is a summary chart of the conceptual framework showing the relationship between the variables in the study.

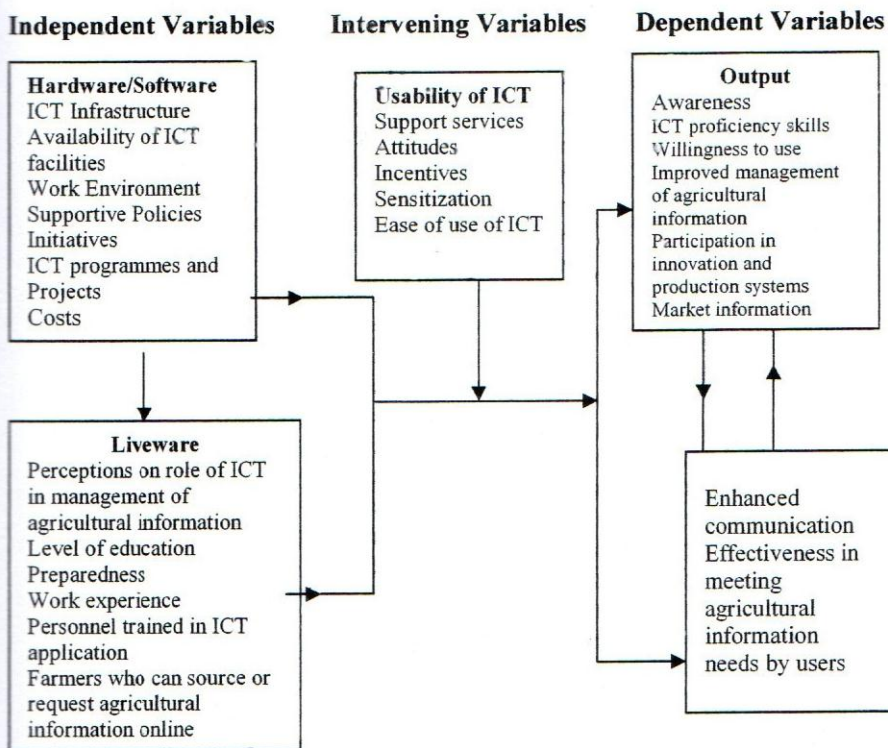


Figure 4: Factors Influencing the Application of ICT in the Management of Agricultural Information

With the right policies and supportive services, it is possible to have people train and effectively use ICT-based systems for management of agricultural information with the resultant benefits. This demands that the relevant infrastructure be put in place. An efficient agricultural information management system would ensure that all stakeholders are actively involved in the generation, storage, access and exchange of relevant information and knowledge in forms that they can understand and apply. It is therefore imperative to study the subsystems of the research, extension, training institutions and farmers to point out where there are weaknesses as far as deploying ICT-based agricultural information systems is concerned and recommend possible remedies.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The basic hypothesis underlying this study is that management of agricultural information in resource-constrained countries like Kenya is different from that in developed countries in the way it is organized and conducted, in the amount of resources available to it, and in its priorities and orientation. These differences suggest that the state and role of ICT services for the management of agricultural information will also be different. In general, developing countries do not have sufficient capacity to deploy ICT-based agricultural management systems that their agricultural sectors require. They, must, therefore rely on paper-based systems with their inherent limitations. This suggests that the agricultural sector should develop the necessary ICT capacity for its agricultural information management. Without this capacity, the management of agricultural information will remain underdeveloped. The issue for those who manage agricultural information is to determine what resources and efforts are required to build the capacity that their system needs.

The main objective of this study was to identify mechanisms and strategies that could be used to realize ICT based agricultural information management systems. Nakuru District was used to provide a description and a basis for discussion of ICT information systems to enhance agricultural development. The results form a foundation for further discussion with agricultural development managers and information specialists and would be incorporated into guidelines on how best to realize effective ICT-based agricultural information systems in the country. This chapter documents the processes, which were followed to achieve this goal. The first section contains a description of the research design that was used in the study. The second section focuses on the research area while the third section describes the population of the study. The fourth section describes the sampling procedures followed and the sample sizes while the fifth section focuses on development of the research instruments. The data collection procedures and administration of the instruments and are detailed in section six. Section seven summarizes the statistical procedures that were used for data analysis.

3.2 Research Design

The study adopted an ex post facto design in which a modified Delphi technique was employed for investigation. Borg and Gall (1989) maintain that the Delphi technique can be used whenever a consensus is needed from persons who are knowledgeable about a particular subject. It can be used to identify problems, define needs, establish priorities, and identify and evaluate solutions. One of the assumptions in this study was that staff in the agricultural research, training institutions and the extension service are knowledgeable about management of agricultural information.

In this design, the researcher did not deliberately manipulate any variables but studied them in retrospect in search of possible relationships and effects. The relationship and effects among the variables were studied as they occur in the natural setting (Wiersma, 1995). Through this design the study identified the factors that influence the application of ICT-based systems in the management of agricultural information within and between the agricultural research, extension and training institutions and subsequently gained insight on the preparedness of farmers to access agricultural information from an e-enabled system.

3.3 Location of Study

The study was carried out in Nakuru District, Kenya. The district has a wide range of farming activities and is representative in major research and extension activities. The district agricultural office, responsible for the management of agricultural extension in the district was a core part of the study. The district has the Kenya Agricultural Research Institute (KARI) stations at Njoro, Lanet, and Naivasha, and a Pyrethrum Field Station at Molo. The KARI, Njoro and Naivasha research stations were purposively used in the study since they provided the research scientists who provided valuable data that shaped the study. Egerton University, the Baraka Agricultural College and the Naivasha Dairy Institute, which are situated in the district train personnel to work in the agricultural sector. The staff from these institutions were purposively included in the study since they are the few and major training institutions in the district.

3.4 Population

This study focused on management of agricultural information within and between the agricultural research, extension and training institutions and subsequently farmer preparedness to use ICT facilities to access agricultural information. Best and Khan (1998) define population as any group of individuals or subjects of study who have one or more characteristics in common that are of interest to researchers. However, a target population according to Borg and Gall (1989) is defined as “a large population from which a small proportion of population is selected for observation and analysis”. The population for study therefore consisted of staff at the agricultural research, extension and training institutions and all farmers in the district. Currently 121 researchers serve at the Njoro, Naivasha and Lanet research station. They include plant breeders, entomologists, soil scientists, agronomists, plant pathologists, biometricians, socio-economists, horticulturists, food scientists, animal breeders, animal pathologists and animal nutritionists. There were 186 members of faculty in Egerton University training personnel for the agricultural sector. Baraka Agricultural College has 20 members of staff while the Naivasha Dairy Institute has 14 members of staff. Nakuru District has 147 technical staff in the agricultural extension service. They include soil and water engineers, agronomists, horticulturists, animal production scientists, home economists, and farm management specialists who worked in the 16 administrative divisions.

3.5 Sampling

Egerton University, Baraka Training Institute, the Naivasha Dairy and the KARI stations of Njoro, Naivasha, and Lanet were purposively included in the study to provide the sample. Peil (1950) defines purposive sampling as a sample chosen because it fulfils certain criteria. Kathuri and Pals (1993) suggest that a purposive sample is chosen because it is considered as either typical or outstanding example of variables with which the research is concerned. The training institutions and the research stations met these criteria, in the sense that they dealt with a lot of agricultural information. Thus they were selected to provide samples for the study. The rest of the sample was drawn from the technical extension staff and farmers in Nakuru District.

Sample size can be derived from previous studies, mentor recommendations or budgetary constraints. In most studies, sample sizes of 60 to 300 or an average of 200 respondents are common (Balian, 1988). The nature of a research study dictates the specific sample size but in quantitative research, says Balian; statistical tests require a minimum of 20 to 30 subjects per strata group. At Egerton University, Baraka Agricultural College, and Naivasha Dairy Institute, the heads of sections that train persons who would serve in agricultural research and extension were contacted for lists of staff who serve under them in order to construct sampling frames from which the appropriate sample size for this study were determined using the Table 1 (Israel, 1992). However for the technical extension staff and the research staff the population also was taken as the sample (Table 2). This decision was based on observations that were made during preliminary visits to the study centres that a number of staffs though posted and recorded as working there were away either on study leave or leave of absence. This substantially reduced the population which, therefore, would not meet Balian's recommendation for sample size. There was therefore need to treat the population as the sample in order to increase the sample sizes. This made it possible for meaningful interpretation of the findings to be made.

Farmers in Nakuru district were to provide specific information regarding the use of ICT in the management of agricultural information. Cluster sampling was used to select a manageable 350 farmers who were included in the study sample. Bailey (1987) argues that cluster sampling is used when it is impractical to construct a sampling frame. The selected farmers included both large and small scale commercial farmers engaged in a variety of enterprises. They were purposively included in the study (Kathuri and Pals, 1993).

Table1**Determining Appropriate Sample Size (S) from a Finite Population (N)**

N	S	N	S	N	S	N	S
10	10	55	48	100	80	240	148
15	12	60	52	110	84	250	152
20	16	65	56	120	92	260	155
25	24	70	59	130	97	270	159
30	28	75	63	140	101	280	162
35	32	80	66	150	104	290	165
40	36	85	70	160	108	300	169
45	40	90	73	220	140	320	175
50	44	95	76	230	144	340	181

N= population size; S = appropriate sample size

Source: Israel (1992) page 87.

Table 2**Appropriate Sample Size for the Study**

Category of respondents	Population	Sample size
Agricultural extension service staff	147	147*
Agricultural research staff	121	121*
Agricultural training institution staff	220	140
Farmers	-	350

*sample size same as population

3.6 Instrumentation

Four sets of questionnaires were used to collect data. Questionnaire 1 was used to collect data from agricultural extension staff. Questionnaire 2 was administered to staff in

agricultural research and Questionnaire 3 was used to collect data from trainers in the agricultural training institutions. Questionnaire 4 was used to collect data from farmers. The questionnaires sought information on the current approaches in management of agricultural information. The questionnaires also solicited data on the extent of preparedness of the human resource for using the ICT-based agricultural information systems and other factors that would influence the application of ICT-based systems.

The trustworthiness of a study is generally based on validity and reliability (Guba and Lincoln, 1981). The survey instruments were developed based on previous studies and instruments. Cross-checking with the corresponding items catered for the research objectives. Similar items were placed in different parts of the instruments by reversing their direction to serve as a deterrent against response set and fake responses (Wiersma, 1986; 1995). A team of experts in agricultural education and extension reviewed the questionnaires and gave suggestions that were used to amend the instruments on question wording and length. The instruments were pilot -tested before final versions were developed for use to collect data. The samples for pilot testing were drawn from KARI Muguga, Kisii District extension service, and the Jomo Kenyatta University of Agriculture and Technology. These institutions offer similar services that the study was concerned with and they were not to be used for the study. Farmres from Kisii District were also used for pilot testing the farmer questionnaire.

The instruments were tested for reliability using the Cronbach's coefficient alpha (α) (Guilford and Fruchter, 1978). The alpha value for extension staff was 0.74 while that for agricultural research staff was 0.79. The value for training institution staff was 0.81 while that for farmers was 0.71. A reliability coefficient of 0.7 or more was found to be acceptable (Borg and Gall, 1989; Hair, et al., 1992). This method for testing reliability was chosen because it is recommended for use with instruments that employ a Likert-type scale and is also a default procedure in SPSS (Paula and Lloyd, 2000). The resultant questionnaires are included as Appendices A, B, C, and D.

3.7 Data Collection

The researcher sought for a research permit from the Ministry of Education headquarters as required by the law. A copy of the permit is included in Appendix E. Thereafter, the study

centres were visited to introduce the study to the heads of the institutions to seek their permission to conduct data collection. To ensure a high response rate the researcher used trained enumerators to administer the questionnaires. The enumerators also conducted interviews with farmers. The data collected were coded and analyzed, to describe the current agricultural information management systems, the level of preparedness to use ICT-based systems for agricultural information management, the factors that must be addressed to enhance the usage of ICT-based systems, and finally test the hypotheses of the study.

3.8 Data Analysis

Data were collected from four categories of respondents. The first set was from agricultural research staff. Of the 121 questionnaires administered to this category, 114 were filled and returned. The second set was the agricultural extension staff. Of the 147 questionnaires administered 121 were completed and returned. The third set was made up of information provided by staff from the agricultural training institutions. Of the 140 questionnaires administered 123 were filled and returned. The last set was the 350 questionnaires used to conduct interviews with farmers. Three hundred questionnaires were completed and returned.

The Statistical Package for Social Sciences (SPSS) was used for data analysis. Means, frequencies, and standard deviations were used to describe the respondents' awareness and appreciation of ICT usage in handling agricultural information. T-test was used to determine if there were significant differences in the extent to which staff perceived they needed and possessed ICT skills for agricultural information management. Pearson –correlation and Chi-square were also run to determine if any relationships existed between the variables of study. Descriptive statistics and content analysis were used to summarise data obtained from farmers to describe their awareness, attitude and ability to use ICT to access agricultural information. Tables were generated to help in summarising the results. Statistical procedures that were used in data analysis are shown in Table 3.

Table 3

Statistical Procedures Used in Data Analysis

Hypothesis	Independent variable	Dependent variable	Statistical procedure
Ho ₁	Work station Education attainment Work experience	ICT proficiency skills	T-test
Ho ₂	Work station Education attainment Work experience	ICT proficiency skills	T-test
Ho ₃	Work station Education attainment Work experience	ICT proficiency skills	T-test
Ho ₄	Education attainment Scale of operation	Awareness of ICT and willingness to use ICT to source information	Pearson Correlation

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The findings presented here encapsulate quantitative and qualitative information collected from the respondents. This chapter is organised by objectives and hypotheses of the study. The objectives of the study were to:

- (i) identify and document the approaches currently being used in the management of agricultural information within and between the agricultural research station, the extension services, the training institutions and farmers.
- (ii). determine and document the institutional factors that influence the application of information and communication technology in the management of agricultural information.
- (iii) determine and document the personal factors that influence the application of information and communication technology in the management of agricultural information.
- (iv) determine the disincentives to the use of ICT-based systems in the management of agricultural information within and between the agricultural research, extension and the training institutions.
- (v) determine the extent of preparedness in training of the agricultural research, extension service and training institution staff in the use of ICT-based agricultural information management systems.
- (vi) assess farmers' awareness, attitudes, and abilities to use ICT to access agricultural information.

The hypothesis and variables were:

H₀₁: There is no significant difference between the extent to which agricultural research staff need ICT-based agricultural information management skills and the extent to which they possess these skills.

Independent variables

- i. work station

institutions are presented in the first section. The second section presents the institutional factors that influence adoption of ICT for the management of agricultural information. In section three, findings on the ICT training capacities and needs in the various agricultural subsystems that were under study are presented. The fourth section documents the requirements to effectively deploy ICT-based systems for agricultural information management within and between the various agricultural subsystems under study. Findings on farmers' awareness, attitudes and ability to use ICT to access agricultural information are presented in the fifth section. Finally in the last section of this chapter, a summary of the study findings are presented with the aim of addressing the objectives in an integrated manner.

4.2 Current State of Agricultural Information Management in the Agricultural Subsystems

The first three objectives of the study sought to determine and document the current state of agricultural information management within and between the research, training institutions and extension service. Questionnaires were administered to staff in these institutions and interviews were conducted to gather data on the current practices, and future plans for management of agricultural information.

4.3 Management of Agricultural Information in the Agricultural Research

All the 121 research staffs in the KARI stations of Njoro, Naivasha and Lanet were included in the study. Trained enumerators were used to administer the questionnaire. Follow ups were also made resulting in a response rate of 94.21%. One hundred and fourteen usable returns were used for data analysis giving a usable response rate of 81.8%. The respondents were asked to respond to questions relating to their education and professional experiences. Table 4 displays their responses. Majority of the research staff (67.53%) were found to have attained at least a Bachelors level of education. This in essence indicated highly trained staff in the agricultural research subsystems. Further 76.8% of those with Bachelors level degree, indicated that they wished to further their

education to a Masters level, and 63.5 % of those with masters indicated that they wished to advance to doctoral levels.

Table 4

Educational Attainment of Agricultural Research Staff

Highest level of education attainment	n	%
Certificate	12	10.52
Certificate plus in-service	5	6.14
Diploma	14	12.28
Diploma plus in-service	6	5.26
Bachelors degree	32	28.07
Bachelors degree plus in-service	7	6.14
Masters	21	18.42
Masters plus in-service	6	5.26
Doctorate	11	9.64
Total	114	100.00

The number of years of work experience reported by the research staff ranged from 3 to 31 with a mean of 14.2 years. Most of the years had been spent in agricultural research. 42.6% of the respondents indicated that they had spent more than half of their entire working time in their current stations. In all cases the respondents indicated that they dealt with a lot of agricultural information in the course of their work.

The research staffs were asked to indicate the methods of processing agricultural information available to them and their frequency of use. Table 5 summarises their responses. The conventional paper-based method of processing agricultural information was indicated to be available to almost all the respondents and was the most frequently used. Computer-based methods were indicated to be available to only 46.49% of the agricultural research staff, but only 24.56% of the respondents indicated that they frequently used computer-based systems for processing agricultural information. This would suggest that some of the staff though having access to computer-based systems still preferred to use the manual system for handling of agricultural information. Only 27.19%

of the respondents indicated that they frequently used both the paper-based and digital methods for handling agricultural information. The conventional paper-based method of processing agricultural information was indicated to be available to all the respondents and was the most frequently used. Computer-based methods were indicated to be available to 46.49% of the agricultural research staff, but only 24.56% of the respondents indicated that they frequently used computer-based systems for processing agricultural information. This would suggest that some of the staff though having access to computer-based systems still, continued to use the manual system for handling of agricultural information. Only 27.19% of the respondents indicated that they frequently used both the paper-based and digital methods for handling agricultural information.

Table 5
Methods of Processing Agricultural Information by Research Staff

Method	<u>Available for use</u>		<u>Type most used</u>		
	Freq ^a .	Percent	Freq.	Percent	Rank
Paper based	114	100.00	89	78.07	1
Computer based (Digital)	53	46.49	28	24.56	3
Combination	53	46.49	31	27.19	2

^a The total number is greater than the number of respondents because some had more than one method available.

Table 6 displays the responses of the research staff when asked to compare their use of conventional paper-based method of processing agricultural information currently compared to when they first began working in the research. Use of the conventional paper-based method for processing of agricultural information was indicated to be dominant with 30.70% of the staff reporting a drop in the frequency of use now while 45.62% reported no change. 23.68% reported to be using this method more now than when they first began work.

Table 6**Current Use of Conventional Paper-Based Method Compared to When Research Staff First Began Work**

Use	Freq.	%
I use paper-based method less currently	35	30.70
I use paper-based method about the same	52	45.62
I use paper-based method more currently	27	23.68
Total	114	100.00

Table 7 present results of the cross tabulation using chi-square of the relationship between the preformed attitude and level of education. The results indicated that staff with lower levels of education was more negative in their attitude towards use of ICT-based systems for management of agricultural information. The respondents who had a Masters degree and above had a more positive attitude compared to those with bachelors and below. Presence of preformed negative attitudes affects the eventual adoption of the technologies (Epenou, 1994). Higher education level improves the preparedness to use new technology. This is collaborated by the observation that staff with lower levels of education reported low levels of confidence in using computer-based systems in processing agricultural information compared to those who had higher levels (Table 8).

Asked to comment on their computer literacy, 89.34% of the research staff considered themselves to be computer-literate. The research staff were also asked Likert-type questions dealing with the emphasis given to computer applications in processing of agricultural information during their pre-service training. These questions contained a five item response scale, ranging from (1) none at all to (5) very strong emphasis. Table 9 summarises their responses. About 78.06% indicated that their pre-service training was deficient in computer applications in processing agricultural information having received none to low emphasis. Only 10.52% of the agricultural research staff indicated a mean rating of above of the emphasis given to computer applications in processing of agricultural information during their pre-service training. The staff reported no knowledge of precise in-service training programmes in their institutions to make them proficient in

using computers for processing agricultural information. This result would point to a gap in training as far as computer applications in the management of agricultural information are concerned.

Table 7

Chi-Square Results Showing the Relationship between Preformed Attitude towards ICT and Level of Education of Research Staff

Test scores	Certificate	Diploma	Degree	Masters and above	Totals
Very poor	9	7	4	2	22
Poor	4	3	4	4	15
Fair	1	4	8	10	23
Good	2	3	9	11	25
Very good	1	3	14	11	29
Total	17	20	39	38	114

* $P < 0.05$ Chi-square value = 31.385*, df = 12, $P = 0.002$, N = 114

Table 8

Chi-Square Results Showing the Relationship between Level of Confidence in using ICT and Level of Education of Agricultural Research Staff

Test scores	Certificate	Diploma	Degree	Masters and above	Totals
No confidence	12	9	3	1	25
Low confidence	3	4	6	4	17
Average confidence	2	4	7	9	22
High confidence	0	2	9	11	22
Very high confidence	0	1	14	13	28
Total	17	20	39	38	114

* $P < 0.05$ Chi-square value = 32.185*, df = 12, $P = 0.002$, N = 114

Table 9**Emphasis Given to Computer Application in Processing Agricultural Information during Pre-service Training of Agricultural Research Staff**

Training Emphasis	Frequency	%
None	53	46.49
Low	36	31.57
Medium	13	11.40
Strong	10	8.77
Very Strong	2	1.75
Total	114	100.00

On usage of the available computers, the research staff reported their major use to be in report writing and maintaining basic data. In all the cases, stand alone systems were maintained. None of the research centres had a centralised system for integrating all the agricultural information for onward dissemination to users. No interactive online linkages were reported with other subsystems of the agricultural sector for receiving or disseminating agricultural information. Equally, none of the stations had an institution-based website, all of them being catered for by the general KARI website for general communication.

Correlation between selected characteristics of agricultural research staff and willingness to use ICT in handling agricultural information is summarized in Table 10.

Table 10

Pearson Product-Moment Correlation of Selected Characteristics of Agricultural Research Staff and Willingness to Use ICT-based System in Processing Agricultural Information

Staff attribute	Characteristic of research staff	r
Willingness to use ICT in work	Number of years in research work	0.332*
	Education level	0.521
	Position in service	0.533

Note *p<0.05

There was a low positive correlation (0.332) between the number of years in active service and the willingness to use ICT in processing agricultural information. There was moderate positive correlation (0.521) between respondents' educational level and willingness to use ICT in processing agricultural information. Similarly there was moderate positive correlation between position in service and willingness to ICT usage. Interpretation of the strength of the correlations was based on verbal descriptions of correlations suggested by Guilford (1956).

Agricultural research, extension and staff in training institutions belong to different institutions with certain aspects that can affect the deployment of ICT- based systems for the management of agricultural information. The study examined some institutional factors that may influence the ICT based system deployment. The staff were asked to indicate their level of satisfaction with the resources and initiatives being taken by their institutions to realize ICT-based systems for the management of agricultural information. Table 11 is a summary of comparison of their responses.

Table 11**Level of Satisfaction Expressed by Researchers, Extension Agents and Agricultural Training Institution Staff with ICT Resources and Initiatives**

Level of satisfaction		Occupation			
		Research	Extension	Training	Totals
Satisfied	Freq	37	23	50	110
	%	32.45	21.10	49.01	33.84
Undecided	Freq	42	31	14	87
	%	36.84	28.44	13.72	26.76
Dissatisfied	Freq	35	55	37	127
	%	30.70	50.45	36.27	39.07
Total	Freq	114	109	102	325
	%	100	100	100	100

The results indicate that a moderate number of the agricultural research staff (32.45%) interviewed indicated satisfaction on what their institution was doing to enhance ICT-based agricultural information management systems. An almost equal number (30.70%) indicated that they were not satisfied, with an even bigger percentage (36.84%) indicating that they were undecided. A few extension agents (21.10%) indicated satisfaction with almost half of them (50.45%) indicating dissatisfaction. Training institutions had 49.01% of the respondents indicating satisfaction with 36.27% showing dissatisfaction. The results would imply that there are gaps that need to be addressed to realize ICT-based agricultural management systems in the various institutions. This would call for clear-cut programmes and commitment for rolling out ICT-based agricultural information management systems in the institutions.

The research staff were asked to answer a set of questions that was used to determine the presence of preformed attitude towards ICT-based agricultural information systems. Extension agents were also asked to respond to the same set of statements that was scored to determine their attitudes toward the same for comparison. Analysis done by cross tabulation using chi-square test (Table 12), revealed a significant relationship between the attitude and occupation (Chi-square value = 10.333, df = 4, $P < 0.05$).

Table 12

Chi-Square Results Showing the Relationship between Preformed Attitude towards Use of ICT-based Agricultural Information Systems and Occupation

Test scores	Research	Extension	Totals
Very poor	09	21	30
Poor	10	34	44
Fair	21	23	44
Good	35	17	52
Very good	39	14	53
Total	114	109	223

* $P < 0.05$ Chi-square value = 10.333*, $df = 4$, $P = 0.035$, $N = 223$

The results indicate that research staff scored well in the attitude compared to the agricultural extension agents. This would mean that the research staff would be more predisposed to adopt ICT-based systems for the management of agricultural information than the extension agents. Adoption of technology is enhanced by the presence of preformed positive attitude.

The agricultural research staff were asked to respond to a series of items designed to assess their perceptions of possible factors that inhibit their use of ICT-based systems in the management of agricultural information in their institutions. A five-point Likert scale was used to assist respondents in describing their perceptions. Means above 3.5 were used to indicate agreement with an item; those below 3.5 indicted disagreement with an item. These data are presented in Table 13.

Table 13**Reasons Reported by Research Staff for Low Usage ICT- based Systems in Management of Agricultural Information**

Reason	Mean ^a	SD	Rank
Poor infrastructure	3.64	0.98	8
Computer illiteracy	3.51	1.02	10
Lack of appropriate software	3.87	1.12	6
Lack of computer related in-service training	3.95	1.25	5
Weak linkages with other institutions	4.06	0.92	4
Lack of clear policy on computer usage	4.14	1.37	3
Lack of support from administration	3.50	1.43	11
Low level computer application skills	3.78	1.35	7
Lack time to learn on computer use	3.59	1.08	9
Insufficient computer facilities	4.17	1.06	2
Lack of connectivity	4.33	0.87	1

Note ^a 1= No Influence 5= Very Heavy Influence

Respondents strongly indicated that lack of connectivity, unclear policy guidelines on computer use, weak linkages with other institutions, insufficient computer facilities, lack of training opportunities on computer applications and lack of appropriate software as the key factors that hindered computer applications in processing agricultural information in research work. Other factors indicated included poor infrastructure, lack of time to learn computer applications in information processing, low level computer skills, and lack of support from the administration.

The prime role of agricultural research is to generate useful agricultural information and effectively disseminate this information to users. To be in a position to play this role effectively, computer application skills in the processing of agricultural information are essential for the research staff. To determine the degree to which specific computer application skills are needed and possessed by the research staff, 31 skills items were presented to the staff for rating on four-point scales, ranging from 1 (Not Needed) to 4 (Highly needed) and 1 (Not Possessed) to 4 (Highly Possessed).

The data analysis included means and standard deviations. To test if significant differences exist, T-test was used for analysis. Table 14 gives a summary of the test of differences between the mean scores of the extent to which the computer application skills were perceived as needed and the extent to which they are possessed.

Table 14

Test for Differences between Mean Scores on Computer Application Skills for Management of Agricultural Information Needed and Possessed by Agricultural Research Staff

Skill	<u>Needed</u>		<u>Possessed</u>		T-value	2-tail probability
	Mean	SD	Mean	SD		
1. Identifying information sources available.	3.31	1.03	3.21	1.58	3.45*	0.0001
2. Accessing information online	3.64	1.12	3.38	2.21	2.51*	0.0000
3. Identifying the types of information needed	3.43	0.89	3.42	1.43	2.13	0.0001
4. Keeping up to date with user information demands	3.27	1.12	3.03	1.22	1.67*	0.0001
5. Searching information online	3.66	0.98	3.33	1.11	2.21*	0.0000
6. Interpreting user information demands online	3.44	0.13	3.64	1.04	2.32*	0.0001
7. Disseminating information online	3.52	1.02	3.55	1.17	1.78	0.0000
8. Reporting appropriately to stakeholders online	3.49	0.92	3.08	1.08	2.32*	0.0001
9. Designing appropriate styles and procedures for information capture	3.46	1.11	2.98	0.75	2.43*	0.0001
10. Word processing	3.39	1.02	3.41	1.11	2.21	0.0000

Table 14 continued.....

Skill	<u>Needed</u>		<u>Possessed</u>		T-value	2-tail probability
	Mean	SD	Mean	SD		
11. Spreadsheet construction	3.50	0.87	2.97	1.06	1.94*	0.0001
12. Database set-up	3.76	0.99	2.57	1.21	2.54*	0.0000
13. Information storage	3.49	1.12	3.23	1.04	5.97	0.0000
14. Information retrieval	3.52	0.71	3.40	0.92	3.96	0.0000
15. Information display	3.50	0.93	3.48	0.74	4.78	0.0000
16. Downloading information	3.40	0.76	3.29	0.44	4.14	0.0001
17. Data communication	3.56	1.10	3.43	1.08	5.87	0.0000
18. Data recovery	3.43	0.95	3.40	0.74	5.27	0.0000
19. Updating information	3.59	1.13	3.49	1.20	1.38	0.0000
20. Data analysis	3.67	1.32	3.06	0.91	1.31*	0.0001
21. Validating information	3.54	1.44	3.19	0.99	1.79*	0.0000
22. Requesting information online	3.68	1.32	3.23	1.67	2.34*	0.0001
23. Soft-ware development and engineering	1.35	1.07	1.32	1.09	1.89	0.0000
24. Hardware maintenance and repair	2.18	1.00	2.16	1.16	2.11	0.0001
25. Local area networking	3.59	0.45	2.95	0.66	2.01*	0.0000
26. Wide area networking	3.19	1.05	2.57	1.07	2.20*	0.0000
27. Coordinating communication	3.11	1.56	2.99	0.67	1.98*	0.0001
28. Relational database construction	3.52	1.21	2.88	1.47	2.35*	0.0000
29. Internet and web-based communication	3.89	1.11	3.34	1.30	1.45*	0.0000
30. E-learning	3.55	0.69	2.45	1.15	3.54*	0.0001
31. Basic computer operation	3.61	0.86	3.67	1.00	4.18	0.0001
Overall Mean	3.39	0.47	3.10	0.48	3.56*	0.0000

* Significant differences at $p < 0.05$

Of the 31 computer skills presented to the agricultural research staff, 28 were rated as needed for agricultural information management with a mean score of 3.10 and above. The skills that were rated as highly needed included: internet and web-based communication, mean = 3.89; database set-up, mean = 3.76 and accessing information online, mean = 3.64. The skills that were rated as lowly needed by the research staff for management of agricultural information included: soft-ware development and engineering mean = 1.35, and hardware maintenance and repair, mean = 2.18. In all but three cases, mean scores of skills needed were reported to be greater than possessed. The areas where the staff perceived they possessed more skills than needed were: interpreting user information demands online, (needed, mean = 3.44; possessed, mean = 3.64); disseminating information online, (needed, mean = 3.52; possessed, mean = 3.55); word processing, (needed, mean = 3.12; possessed, mean = 3.41) and basic computer operation, (needed, mean = 3.61; possessed, mean = 3.67).

Significant differences were found between the extent to which the agricultural research staff perceived they needed computer application skills for management of agricultural information and the extent they perceived they possessed them. The null hypothesis H_{01} : *“There is no significant difference between the extent to which agricultural research staff need ICT-based agricultural information management skills and the extent to which they possess these skills”* was thus rejected. The respondents had much greater need for 24 of the 31 skills areas than they possessed. The only areas where the differences were not significant were: identifying types of information needed (needed, mean = 3.43; possessed, mean = 3.42); disseminating information online (needed, mean = 3.52; possessed mean = 3.55); word processing (needed, mean = 3.39; possessed, mean = 3.41); downloading information (needed, mean = 3.11; possessed, mean = 3.09); software development and engineering (needed, mean = 1.35; possessed mean = 1.32); and hardware repair and maintenance (needed, mean = 2.18; possessed, mean = 2.16).

4.4 Management of Agricultural Information in the Agricultural Extension

All the 147 agricultural extension staff in Nakuru District were included in the study and trained enumerators were used to administer the questionnaire. Follow ups were arranged to improve on the response rate. The resultant response rate was 88.09 %. One

hundred and nine usable returns were used for data analysis giving a usable response rate of 84.49%. The respondents were asked to respond to questions relating to their education and professional experiences. In addition, they were asked to indicate the methods they frequently use in handling agricultural information in the course of their work. Table 15 displays their responses. Majority of the extension staff (74.30%) were found to have attained at least a diploma level of education and above. Only 22.01% of the respondents were found to have certificate level of education. In all, over 80.01% of the extension staff indicated that they wished to further their education to higher levels. The number of years of work experience reported by the extension staff ranged from 5 to 28, with a mean of 16.2 years. Most of the years had been spent in agricultural extension. In all cases the respondents indicated that they handled a lot of agricultural information in the course of their work.

Table 15
Educational Attainment of Agricultural Extension Staff

Highest level of education attainment	n	%
Certificate	15	13.76
Certificate plus in-service	9	8.26
Diploma	29	26.61
Diploma plus in-service	15	13.76
Bachelors degree	21	19.27
Bachelors degree plus in-service	16	14.68
Masters	4	3.66
Total	109	100.00

The extension staff were asked to indicate the methods of processing agricultural information available to them and of their use of the methods. Table 16 displays their responses. Paper-based methods of agricultural information processing were predominant. Majority of the extension staff (87.8%) were, however, aware of the value of modern information and communication technologies in the management of agricultural information. Table 17 displays the extension staff responses on use of conventional paper-

based method for processing agricultural information currently compared to when they first began working in the extension service.

Table 16

Methods of Processing Agricultural Information by Extension Staff

Method	<u>Available for use</u>		<u>Type most used</u>		
	Freq ^a .	Percent	Freq.	Percent	Rank
Paper based	109	100.00	99	90.82.	1
Computer based (Digital)	17	15.59	11	10.09	2
Combination	17	15.59	9	8.25	3

^a The total number is greater than the number of respondents because some had more than one method available.

Table 17

Current Use of Conventional Paper-Based Method Compared to When Extension Staff First Began Work

Use	Freq.	%
I use paper-based method less now	11	10.09
I use paper-based method about the same	48	44.03
I use paper-based method more now	50	45.88
Total	109	100.00

Use of the conventional paper-based method for processing of agricultural information was indicated to be dominant with only 10.09 % of the staff reporting a drop in the frequency of current use while 44.03% reported no change. 45.88 % reported to be using this method currently more than when they first began work. This would suggest a slow pace towards adoption of ICT-based agricultural information management systems. Table 18 summarises the response of the agricultural extension staff as regards their level of confidence in using ICT-based system for processing agricultural information. Staff with

higher levels of educational attainment had correspondingly higher levels of confidence in using ICT-based systems for processing agricultural information.

Table 18

Chi-Square Results Showing the Relationship between Level of Confidence in using ICT and Level of Education of Extension Staff

Test scores	Certificate	Diploma	Degree	Masters and above	Totals
No confidence	14	16	7	1	38
Low confidence	5	17	10	0	32
Average confidence	5	7	8	1	21
High confidence	0	2	8	2	12
Very high confidence	0	2	4	0	6
Total	24	44	37	4	109

* $P < 0.05$ Chi-square value = 31.165*, $df = 12$, $P = 0.002$, $N = 109$

A high number of respondents indicated a lukewarm attitude to use of modern information and communication technology in their work deeming it irrelevant. Table 19 is a Chi-square result showing the relationship between preformed attitude towards ICT among the agricultural extension staff and their level of education. Analysis done by cross tabulation using chi-square test revealed a significant relationship between the preformed attitude and level of education among the agricultural extension staff. The results indicated that staff with lower levels of education had a more negative attitude towards use of ICT in their work. Many of the respondents with a bachelor's degree were more positive towards ICT in extension work. Presence of preformed positive attitude among staff is expected to eventually influence adoption of technology (Epenou, 1994).

service and the ability to use computers in processing agricultural information. There was moderate positive correlation (0.551) between respondents' educational level and ability to use computers in processing agricultural information. There was a high positive correlation (0.627) between position in service and computer usage amongst the extension staff. Interpretation of the strength of the correlations was based on verbal descriptions of correlations suggested by Guilford (1956).

Table 21

Pearson Product-Moment Correlation of Selected Characteristics of Extension Staff and Willingness to Use ICT in Extension Work

Staff attribute	Characteristic of extension staff	r
Willingness to use ICT in extension work	Number of years in extension work	0.212
	Education level	0.551
	Position in service	0.627

Note * $p < 0.05$

The extension staff were asked to respond to a series of items designed to gauge their perceptions of possible factors that inhibit their use of ICT-based systems in processing agricultural information. A five-point Likert scale was used to assist respondents in describing their perceptions. Means above 3.5 were used to indicate agreement with an item; those below 3.5 indicated disagreement with an item. The results are presented in Table 22. The agricultural extension staff strongly indicated that poor infrastructure, lack of computer facilities, computer illiteracy, lack of training opportunities on computer applications, unclear policy guidelines on computer use and weak linkages with other institutions were key factors that hindered computer applications in processing agricultural information in research work. Other factors indicated included lack of appropriate software and lack of support from the administration.

The key role of agricultural extension is to source, package and disseminate useful agricultural information to users. To be in a position to play this role effectively and efficiently, it would be necessary for this cadre of staff to possess computer application skills in the processing of the agricultural information.

Table 22**Reasons Reported by Extension Staff for Not Using Computers for Processing Agricultural Information**

Factor	Mean ^a	SD	Rank
Poor infrastructure	4.62	0.78	1
Computer illiteracy	4.51	1.12	2
Lack of appropriate software	3.57	1.07	10
Lack of computer related in-service training	4.50	0.92	3
Lack of clear policy on computer usage	4.14	1.06	7
Weak linkages with other institutions	4.36	1.02	6
Lack of support from administration	3.50	1.17	11
Low level computer application skills	4.45	1.01	5
Lack time to learn computer use	3.59	1.15	9
Insufficient computer facilities	4.47	0.76	4
Lack of connectivity	3.67	1.07	8

Note ^a 1= No Influence 5= Very Heavy Influence

To determine the degree to which specific computer application skills are needed and possessed by the extension staff, 31 skills items were presented to them for rating on four-point scales, ranging from 1 (Not Needed) to 4 (Highly needed) and 1 (Not Possessed) to 4 (Highly Possessed). The data analysis included means and standard deviations. The analysis also included the T-test to identify significant differences at the 0.05 level. Table 23 gives a summary of the test of differences between the mean scores of the extent to which the computer application skills were perceived as needed and the extent to which they are possessed.

Table 23**Test for Differences between Mean Scores on Computer Application Skills for Management of Agricultural Information Needed and Possessed by Agricultural Extension Staff**

Skill	<u>Needed</u>		<u>possessed</u>		T-value	2-tail probability
	Mean	SD	Mean	SD		
1. Identifying information sources available.	3.61	0.76	2.21	0.68	2.75*	0.0011
2. Accessing information online	3.74	0.52	2.38	1.07	4.51*	0.0000
3. Identifying types the information needed	3.51	0.01	3.50	0.01	1.67	0.0001
4. Keeping up to date with user information demands	3.56	0.88	3.13	1.10	3.58*	0.0001
5. Searching information online	3.66	0.78	2.33	0.91	4.21*	0.0000
6. Interpreting user information demands online	3.54	0.67	2.44	1.04	5.32*	0.0000
7. Disseminating information online	3.52	1.00	2.65	1.03	4.82*	0.0000
8. Reporting appropriately to stakeholders online	3.59	0.96	2.88	0.87	4.52*	0.0001
9. Designing appropriate styles and procedures for information capture	3.37	1.01	2.98	0.88	6.43*	0.0000
10. Word processing	3.59	1.02	2.41	0.99	3.21*	0.0000
11. Spreadsheet construction	3.78	0.97	2.37	1.03	4.94*	0.0000
12. Database set-up	3.71	0.94	2.57	1.21	2.54*	0.0000
13. Information storage	3.69	1.02	2.29	1.14	4.97*	0.0001
14. Information retrieval	3.58	0.82	2.04	1.09	5.96.*	0.0000
15. Information display	3.50	0.93	2.18	0.94	4.78*	0.0000

Table 23 continued.....

Skill	<u>Needed</u>		<u>possessed</u>		T-value	2-tail probability
	Mean	SD	Mean	SD		
16. Downloading information	3.40	0.76	2.29	0.44	4.04*	0.0001
18. Data recovery	3.43	0.95	2.34	0.74	5.27*	0.0000
19. Updating information	3.59	1.11	2.25	0.79	6.38*	0.0001
20. Data analysis	3.67	0.69	2.06	0.92	7.14*	0.0001
21. Validating information	3.44	0.74	2.59	0.89	6.79*	0.0000
22. Requesting information online	3.38	0.72	2.53	0.67	3.34*	0.0000
23. Soft-ware development and engineering	2.42	1.05	1.27	1.06	4.89*	0.0001
24. Hardware maintenance and repair	2.47	0.98	2.06	0.76	5.11*	0.0001
25. Local area networking	3.41	0.75	2.45	0.86	5.05*	0.0000
26. Wide area networking	3.39	1.05	2.57	1.06	2.20*	0.0000
27. Coordinating communication	3.31	1.06	2.58	0.77	5.98*	0.0001
28. Relational database construction	3.64	0.81	2.38	0.97	4.35*	0.0001
29. Internet and web-based communication	3.85	1.11	2.34	1.01	3.45*	0.0000
30. E-learning	3.65	0.79	2.55	0.59	6.42*	0.0001
31. Basic computer operation	3.71	1.02	2.85	0.86	5.23*	0.0001
Overall Mean	3.49	0.32	2.46	0.39	4.87*	0.0001

* Significant differences at $p < 0.05$

All the 31 computer skills presented to the extension staffs were rated as needed for agricultural information management with a mean score of at least 2.40 and above. The skills that were rated as highly needed include: internet and web-based communication, mean = 3.85, SD = 1.11; spreadsheet construction, mean = 3.78, SD = 0.79; database set-up, mean = 3.78, SD = 0.97 and accessing information online, mean = 3.74, SD = 0.52 and basic computer operation

mean = 3.71, SD = 1.02. Others included Data analysis, mean = 3.67, SD = 0.69; E-learning, mean = 3.65, SD = 0.79 and relational database construction, mean = 3.64, SD = 0.81. The skills that were indicated as lowly needed by the extension staff for management of agricultural information included: soft-ware development and engineering mean = 2.42, SD =1.05 and hardware maintenance and repair, mean = 2.47, SD =0.98. In all cases, mean rating scores of the extent to which the skills were perceived to be needed were found to be greater than possessed. Only in areas of identifying the types of information needed, did the staff perceive they possessed as much skill as they needed. In all the other cases, the staffs perceived they possessed less skill than they needed. Significant differences were thus found between the extent to which the agricultural extension staff perceived they needed computer application skills for management of agricultural information and the extent they perceived they possessed them. The null hypothesis **H₀₂**: *“There is no significant difference between the extent to which agricultural extension staff need ICT-based agricultural information management skills and the extent to which they possess these skills”* was rejected. The respondents had greater need for all the skills than they possessed.

4.5 Management of Agricultural Information in the Agricultural Training Institutions.

The main agricultural training institution in Nakuru District is Egerton University. Other institutions include Baraka Agricultural College and the Navaisha Dairy Institute. They all provided respondents for the study. Table 24 gives a breakdown of the sample sizes from each of these institutions. Questionnaires were administered to the 136 sampled staff. Follow ups and reminders were done resulting in a response rate of 78.67%. Of the one hundred and seven questionnaires returned, one hundred and two were used for data analysis giving a usable response rate of 95.32% which was acceptable for the study.

Table 24**Agricultural Training Institution Staff Sample Breakdown**

Institution	No. of Staff	Sample
Baraka Agricultural College	15	12
Egerton University	160	108
Naivasha Dairy Institute	20	16
Total	195	136

The teaching staff in the agricultural training institutions were asked to respond to questions relating to their education and professional experiences. In addition, they were asked to indicate the number of years they had served in extension work. Table 25 summarises their educational attainment. Majority of the teaching staff (68.61%) were found to have attained at least a Masters level of education and were mainly stationed at Egerton University. Over 80% of the Diploma and Bachelors degree holders worked at the Baraka Agricultural College and Naivasha Dairy Institute. The number of years of work experience reported by the teaching staff ranged from 4 to 25 with a mean of 13.6 years. In almost all cases the respondents indicated that they dealt with a lot of agricultural information in the course of their work.

Table 25**Educational Attainment of Agricultural Institutions Training Staff**

Highest level of education attainment	n	%
Certificate	5	4.90
Diploma	11	10.78
Bachelors degree	15	14.70
Masters	49	48.03
Doctorate	22	21.56
Total	102	100.00

The agricultural training institutions teaching staff were asked to indicate the methods of processing agricultural information available to them and their frequency of use. Table 26 summarises their responses. The conventional paper based system was indicated to be available to all the respondents though not all of them used it for processing agricultural information. 66.66% of the respondents indicated it to be their main method of processing agricultural information. 57.84% of the staff indicated that they had access to computer facilities though not all of them frequently used this method for processing agricultural information.

Table 26
Methods of Processing Agricultural Information by Agricultural Training Teaching Staff

Method	<u>Available for use</u>		Freq.	<u>Type most used</u>	
	Freq ^a .	Percent		Percent	Rank
Paper based	102	100.00	68.	66.66	1
ICT-based (Digital)	59	57.84	49	48.03	2
Combination	59	57.84	41	40.19	3

^a The total number is greater than the number of respondents because some had more than one method available.

The teaching staff were also asked to compare their use of conventional paper-based method of processing agricultural information currently compared to when they first began working in the agricultural training institutions. Table 27 summarises their responses. A significant number of respondents (39.22%) indicated a drop in the use of the conventional paper-based method for processing of agricultural information. About 47% of the respondents indicated no change in frequency of use of this method since they began work. Only 13.72% reported to be using the paper method currently more than when they first began work.

Table 27

**Current Use of Conventional Paper-Based Method Compared to When
Agricultural Training Institution Teaching Staff First Began Work**

Use	Freq.	%
I use paper-based method less currently	40	39.22
I use paper-based method about the same	48	47.06
I currently use paper-based method more	14	13.72
Total	102	100.00

Table 28 is a summary of the presence of preformed attitude towards use of ICT among the agricultural training institution teaching staff.

Table 28

**Chi-Square Results Showing the Relationship between Preformed Attitude towards
use of ICT and Education Level of Training Institution Staff**

Test scores	Certificate	Diploma	Degree	Masters and above	Totals
Very poor	0	0	0	0	0
Poor	0	0	0	3	3
Fair	3	3	5	28	39
Good	2	7	6	23	38
Very good	0	1	4	17	22
Total	5	11	15	71	102

* $P < 0.05$ Chi-square value = 10.175*, $df = 8$, $P = 0.001$, $N = 102$

Analysis done by cross tabulation using chi-square test did not reveal a significant relationship between the preformed attitude and level of education among the staff. It would appear that staff in the agricultural training institutions had a more positive attitude towards use of ICT in their work, regardless of their educational attainment. Table 29

presents a summary on the confidence levels in using ICT by the training staff. Staff with higher levels of education tended to score high on the confidence scale.

Table 29

Chi-Square Results Showing the Relationship between Level of Confidence in using ICT and Level of Education of Agricultural Training Institution Teaching Staff

Test scores	Certificate	Diploma	Degree	Masters and above	Totals
No confidence	0	0	2	7	9
Low confidence	3	3	5	5	16
Average confidence	2	6	2	26	36
High confidence	0	2	4	19	25
Very high confidence	0	0	2	14	16
Total	5	11	15	71	102

* $P < 0.05$ Chi-square value = 30.382*, df = 12, $P = 0.001$, N = 102

Table 30

Emphasis Given to Computer Application in Processing Agricultural Information during Pre-service Training of Agricultural Teaching Staff

Training Emphasis	Frequency	%
None	31	30.39
Low	39	38.23
Medium	22	22.00
Strong	8	7.84
Very Strong	2	1.96
Total	102	100.00

Asked to comment on their computer literacy, 88.72% of the agricultural training institution staff considered themselves to be computer-literate. Table 30 above, however indicates the staff felt that emphasis on computer applications in processing agricultural information did not receive adequate emphasis during their pre-service training. The question contain that elicited this response was on a five item response scale, ranging from (1) none at all to (5) very strong emphasis

About 68.62% indicated that training in computer applications in processing agricultural information received none to low emphasis. This would call for in-service training opportunities to enhance the ICT proficiency skills that the staff may need for processing of agricultural information.

The agricultural training institution staff indicated that computers were mainly used for sourcing information from the internet, communication, report writing, and storage of basic data. In all the cases, stand alone systems were predominant. None of the agricultural training institutions had a centralised system for integrating all the agricultural information for onward dissemination to users. No interactive online linkages were reported with other subsystems of the agricultural sector for receiving or disseminating agricultural information. However, both Egerton University and Baraka Agricultural College had websites for general communication.

Correlation between selected characteristics of agricultural training institutions teaching staff and willingness to use ICT in processing agricultural information is summarized in Table 31. There was a low positive correlation (0.431) between the number years in active service and the ability to use computers in processing agricultural information. There was moderate positive correlation (0.570) between respondents' educational level and willingness to use ICT in processing agricultural information. Similarly there was moderate positive correlation between position in service and ICT usage for information processing. Interpretation of the strength of the correlations was based on verbal descriptions of correlations suggested by Guilford (1956).

Table 31
Pearson Product-Moment Correlation of Selected Characteristics of Agricultural Training Staff and Willingness to Use ICT in Processing Agricultural Information

Staff attribute	Characteristic of agricultural training staff	r
Ability to use computers in work	Number of years in work	0.431*
	Education level	0.570
	Position in service	0.503

Note * $p < 0.05$

The respondents were required to respond to a series of items designed to assess their perceptions of possible factors that inhibit their use of computers in processing agricultural information. A five-point Likert scale was used to assist respondents in describing their perceptions. Table 32 is a summary of the responses. Means above 3.5 were used to indicate agreement with an item; those below 3.5 indicated disagreement with an item. Respondents strongly indicated that insufficient computer facilities, lack of connectivity, weak linkages with other subsystems, unclear policy guidelines on computer use, and lack of appropriate software were key factors that hindered computer applications in processing agricultural information in research work. Other factors indicated included poor infrastructure, lack of training opportunities on computer applications, lack of time to learn computer applications in information processing, lack of support from the administration, and low level computer skills.

Table 32**Reasons Reported by Agricultural Training Institution Teaching Staff for Not Using Computers for Processing Agricultural Information**

Factor	Mean ^a	SD	Rank
Poor infrastructure	3.97	1.05	6
Computer illiteracy	3.41	0.82	11
Lack of appropriate software	4.16	1.10	5
Lack of computer related in-service training	3.95	1.17	7
Weak linkages with other institutions	4.22	1.20	3
Lack of clear policy on computer usage	4.21	1.06	4
Lack of support from administration	3.63	1.09	9
Low level computer application skills	3.61	1.12	10
Lack time to learn on computer use	3.86	1.01	8
Insufficient computer facilities	4.48	1.14	1
Lack of connectivity	4.37	1.21	2

Note ^a 1= No Influence 5= Very Heavy Influence

To determine the degree to which specific computer application skills for management of agricultural information are needed and possessed by the teaching staff in agricultural training institutions, 31 skills items were presented to the staff for rating on four-point scales, ranging from 1 (Not Needed) to 4 (Highly needed) and 1 (Not Possessed) to 4 (Highly Possessed). The data analysis included means and standard deviations. A T-test was done to test for significance of differences at the 0.05 level. Table 33 gives a summary of the test of differences between the mean rating scores of the extent to which the computer application skills were perceived as needed and the extent to which they are possessed.

Table 33

Test for Differences between Mean Scores on Computer Application Skills for Management of Agricultural Information Needed and Possessed by Agricultural Training Institution Teaching Staff

Skill	<u>Needed</u>		<u>Possessed</u>		T-value	2-tail probability
	Mean	SD	Mean	SD		
1. Identifying information sources available.	3.51	1.13	3.49	1.17	3.45	0.0000
2. Accessing information online	3.54	1.01	3.53	1.22	3.57	0.0001
3. Identifying the types of information needed	3.43	1.09	3.42	1.43	4.13	0.0001
4. Keeping up to date with user information demands	3.37	1.12	3.13	1.12	3.87*	0.0000
5. Searching information online	3.60	1.08	3.42	1.01	5.21*	0.0000
6. Interpreting user information demands online	3.59	0.93	3.61	1.04	3.32	0.0000
7. Disseminating information online	3.62	1.12	3.64	1.08	2.48	0.0000
8. Reporting appropriately to stakeholders online	3.49	0.92	3.48	1.01	2.32	0.0001
9. Designing appropriate styles and procedures for information capture	3.32	1.19	3.29	0.85	4.43*	0.0001
10. Word processing	3.51	1.13	3.53	0.81	5.11	0.0001
11. Spreadsheet construction	3.52	1.07	3.35	0.96	3.97*	0.0000
12. Database set-up	3.66	1.09	3.27	1.03	6.14*	0.0001
13. Information storage	3.71	0.92	3.69	1.04	2.67	0.0000
14. Information retrieval	3.56	1.03	3.41	0.99	3.74*	0.0001
15. Information display	3.58	0.77	3.49	1.04	3.68*	0.0001

Table 33 continued.....

Skill	<u>Needed</u>		<u>Possessed</u>		T-value	2-tail probability
	Mean	SD	Mean	SD		
16. Downloading information	3.32	0.87	3.39	1.14	3.10	0.0001
17. Data communication	3.59	1.03	3.31	1.19	4.87*	0.0000
18. Data recovery	3.43	0.99	3.04	0.77	2.43*	0.0000
19. Updating information	3.50	0.89	3.41	1.20	3.48*	0.0001
20. Data analysis	3.71	1.01	3.16	0.94	4.31*	0.0001
21. Validating information	3.52	1.05	3.28	0.91	4.79*	0.0000
22. Requesting information online	3.58	1.12	3.56	1.07	4.34	0.0001
23. Soft-ware development and engineering	2.34	0.86	1.33	1.00	3.89*	0.0000
24. Hardware maintenance and repair	2.49	0.89	1.46	1.16	4.01*	0.0001
25. Local area networking	3.59	1.13	2.91	1.03	4.45*	0.0001
26. Wide area networking	3.61	0.73	2.85	0.87	5.10*	0.0000
27. Coordinating communication	3.46	1.14	3.32	1.11	3.93*	0.0000
28. Relational database construction	3.44	0.92	3.41	0.77	3.21	0.0001
29. Internet and web-based communication	3.54	1.03	3.57	1.02	2.63	0.0000
30. E-learning	3.65	0.83	3.35	1.05	4.64*	0.0001
31. Basic computer operation	3.67	0.76	3.69	1.01	3.78	0.0000
Overall mean	3.46	0.30	3.25	0.53	4.41*	0.0000

* Significant differences at $p < 0.05$

Of the 31 computer skills presented to the agricultural training institutions teaching staff, 29 were rated as needed for agricultural information management with a mean rating score of 3.30 and above. The skills that were rated as lowly needed by the teaching staff included: soft-ware development and engineering, mean = 2.34; and hardware maintenance and repair, mean = 2.49. Cases where the staff perceived they had more skills than needed

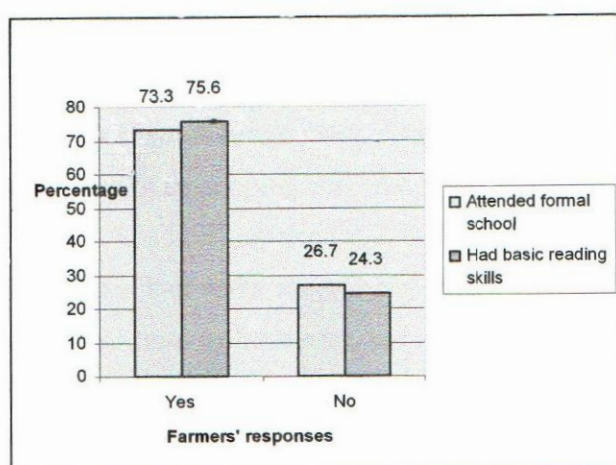


Figure 5: Farmers' level of schooling and basic reading

Among those with formal schooling, 65.66% had primary school level of education and 34.33% had post-primary education (Table 34).

Table 34

Gender and Education Level of Respondent Farmers

Gender of respondent	Distribution by number and percentage of highest level of education of the respondents			
	Primary education		Post-primary education	
	No.	%	No.	%
Male	128	64.97	79	76.69
Female	69	35.02	24	23.30
Total	197	100	103	100
% of 300	65.66		34.33	

Male respondents accounted for about 64.97% of those with primary school education and 76.99% of respondents with post-primary education (20 farmers had secondary school education, and only 7 had post-secondary or college education). Dominance of males in the relatively higher education category is not surprising considering the cultural and historical

gender imbalances in education in the country (UNESCO, 2000). Most respondents who had completed primary education were aged 27–51 years. The fact that people in the economically active age category could read basic instructions is crucial and points to the possibility of developing new technology for sourcing agricultural information for use.

It has been reported that lack of information on agricultural innovations is among the reasons that some innovations such as new crop varieties, crop and animal husbandry techniques, and technologies, are not adopted by farmers. Aina (1991) and Kaniki (1991) consider regular studies essential for updating farmers' information needs to accommodate changes in their environment. In this regard farmers' needs were identified from two perspectives. The first approach sought to establish the needs as reflected in identified problems that affected farmers during the preceding three farming seasons (Table 35), some of which could probably be overcome with appropriate information and knowledge. Almost all farmers (94.5%) reported facing problems during that period.

The second approach required the respondents to mention any agricultural innovation, idea or technique they wished to know more about. Some of the needs were found to be specific to particular areas, probably because of slight variations in agricultural activities. Farmers' information needs were in areas such as crop husbandry in general, proper use of fertilizers, irrigation agriculture, food preservation methods, bee keeping and 'modern agriculture', which though broad was frequently mentioned by farmers in all areas. Identification of current information needs was necessary in arguing for methods and approaches that would make this information readily available to farmers. Lack of markets was mentioned as the most important problems that the farmers faced during the three preceding farming seasons. This would actually be an agricultural information problem due to lack of market information.

Table 35**Most Important Problems Reported by Farmers during the Three Preceding Farming Seasons**

Most important problems	Respondents who indicated a particular problem as most disturbing	
	No.	%
Crop Diseases	182	60.66
Low Extension Contact	197	65.66
Rodent Infestation	134	44.66
Livestock Diseases	201	67.00
Lack of Markets	241	80.33
Soil Erosion	123	41.00
Lack of Money to Buy Inputs	233	77.66
Lack of Information	187	62.33

Table 36 summarises the findings on the most preferred means of getting information by the farmers. The most preferred means of obtaining information on agricultural innovations indicated included consulting the local extension officers, mentioned by about 68.66% of all respondents followed by listening to radio programmes (41.33%). Printed information sources were indicated by 36.66% of the respondents as a most preferred source of agricultural information. Others indicated included seeking information from neighbours and friends (35.00%), agricultural input shops where farmers bought their inputs mentioned by 31.00%, FTCs were indicated by 27.66%, while information from religious bodies was mentioned by 19.33%. ICT-based sources were indicated as most preferred by 24.33% of all the respondents. These included farmers who indicated that they used internet services from their mobile phone providers to source agricultural information. Only 14.00% of the sampled farmers preferred obtaining agricultural information from private consultants.

Table 36**Most Preferred Means of Obtaining Information on Agricultural Innovations by Farmers**

Means for Information Acquisition	<u>Respondents Who Most Prefer Means</u>	
	No.*	%
Extension Staff	206	68.66
Agricultural input shop	93	31.00
Private consultancies	49	14.00
Farmers Training Centres	83	27.66
Radio programmes	124	41.33
Agricultural Exhibitions	73	24.33
Printed Materials	110	36.66
Neighbours and Friends	105	35.00
ICT-based sources	73	24.33
Religious Institutions	58	19.33

* Total number more is than 300 because some respondents indicated more than one means of getting information about agricultural innovation

The level of education was related to the most preferred source of agricultural information. While the majority of respondents with semi-formal or lower level of education mostly preferred friends or relatives for information, this same means was only slightly preferred by the majority of the relatively more educated group. Consultation with extension staff was highly preferred by all groups irrespective of level of education. As shown in Table 37 all relatively highly educated respondents had a higher preference for extension personnel, probably because this category were more familiar with the technical information that could be offered by extension staff. The level of education was a significant factor ($p \leq 0.05$) influencing the information means preferred.

Table 37

Farmers' Preferences for Sources of Agricultural Information against their Level of Education

Preferred means of obtaining information	Level of education	Level of preference						χ^2
		Most preferred		Slightly preferred		Not preferred		
		No.	%	No.	%	No.	%	
Talking to friends and relatives	Semi-formal	69	65.71	41	47.12	19	17.59	$p \leq 0.05$
	Primary	24	22.85	32	36.78	20	18.51	
	Post-primary	12	11.42	14	16.09	69	63.88	
Consulting extension worker	Semi-formal	64	31.06	33	45.83	9	40.90	$p > 0.05$
	Primary	69	33.49	20	27.77	8	36.36	
	Post-primary	73	35.43	19	26.38	5	22.72	
Reading short publications	Semi-formal	4	3.63	19	18.44	61	70.11	$p < 0.05$
	Primary	34	30.90	30	29.12	17	19.54	
	Post-primary	72	65.45	54	52.42	9	10.34	
ICT- based sources	Semi-formal	8	10.95	26	28.8	69	65.09	$p > 0.05$
	Primary	20	27.39	41	23.5	26	24.52	
	Post-primary	45	61.64	54	33.3	11	10.37	

Percentages are calculated from among the respondents' level of education.

Short-texts were the preferred format of information presentation to books with detailed information. Majority of the respondents (60.4% of 300) preferred the information to be presented in Kiswahili, with 33.7% preferring English as the language of communication and 27.6% indicating that they would not mind either language. Only 9.6% of the respondents preferred materials in local languages, a finding that is not unexpected since Kiswahili, the national language and English the official language, are

emphasized as a medium of instruction in all public primary schools and are widely spoken throughout the country.

It is important to note that a significant number of respondents, irrespective of their reading ability regarded printed materials as useful sources of information on agricultural knowledge and skills. These included even farmers without basic reading skills, who thought printed materials, would be useful to them as they would get the information indirectly through those who could read. Recorded sources of information whether print or electronic, have a great advantage because they are permanent records and allow consultation at farmers' pace and according to their preferences and ability for information assimilation. Farmers' preferences in this study were similar to those of farmers in Uganda and Ghana, where farmers greatly preferred printed information sources because they could be used for reference once extension staff had gone or a radio programme had ended (Carter, 1999).

The relatively high number of respondents with basic literacy confirms the fact that levels of literacy in Kenya had generally improved over time (UNESCO, 2000). This has positive implications for empowerment of farmers through knowledge provision for economic development. Although poor reading habits have been one of the reasons for focusing on oral channels for information transfer in Africa, the practice is inevitably changing mainly because of dynamism of societies as a result of globalization and developments in information and communications technology.

On preferred points and locations for sourcing agricultural information, respondents were required to select from four locations where they could go for this service. The majority (77.2% of 300 respondents) chose the division extension office as their most preferred location, mainly because of the centrality of such offices in respect to other facilities such as shops and markets. In addition, these offices are more open for the whole public compared with other facilities such as places of worship, schools and social clubs and private businesses. The prominence of extension services as the most preferred source of information is attributed to the fact that the extension services have existed in the country since the 1960s and are therefore well known by farmers despite their poor past performance (Kamau, 2006). Despite their long existence, the extension services have not exposed farmers to a number of agricultural innovations. It would appear that farmers may have not been exposed or encouraged to use other complementary methods for acquiring

agricultural information and may have developed dependence on extension staff. The high number of farmers with a positive attitude to individual reading is a useful finding when considering alternative methods for delivering information on agricultural innovations.

The scales of operation of the farmers affect their participation in actively seeking agricultural information to solve their information needs. The findings indicate that large scale farmers had higher participation levels compared to the small scale farmers. Large scale farmers are therefore, likely to be more proactive in solving their agricultural information needs than small scale farmers. This may be so because of cost considerations. Chi-square test as shown in Table 38, revealed a significant relationship between scale of operation and level of participation of farmers in seeking agricultural information. (Chi-square value = 28.025, df = 8, $P < 0.05$).

Table 38

Chi-Square Results Showing the Respective Relationship between Participation in Seeking Agricultural Information and Scale of Operation of Farmers

Participation in seeking agricultural information	Large scale	Medium scale	Small scale	Totals
Very low	01	11	72	84
Low	03	15	58	76
High	09	52	20	81
Very high	11	30	18	59
Total	24	108	168	300

* $P < 0.05$ Chi-square value = 28.025*, df = 8, $P = 0.001$, N=300

Further analysis using Pearson's correlation coefficient (r) two-tailed test indicated that there was a significant positive relationship between proactive agricultural information acquisition tendencies and the scale of operation of the farmers ($r = 0.772$). From the results in Table 39 it can therefore, be concluded that there was a strong positive relationship between the scale of operation of the farmers and their agricultural information acquisition tendencies.

Table 39:
Means, Standard Deviations and r-Test Analysis for the Relationship between the Scale of Operation and Agricultural Information Acquisition Tendencies

	N	Mean	SD	r value	p value
Scale of Operation	300	57.046	5.0736		
Participation level	300	12.5952	3.9081	0.772	0.000

r > 0.7, p< 0.05, N= 300

The unique qualities of ICT in availing agricultural information to farmers were included to find out whether farmers were aware of them. Usage of these facilities was included to test the level of involvement of farmers in using this technology. A number of variables were hypothesized to influence the ICT awareness and adoption by farmers for accessing agricultural information. They included the availability of ICT facilities, its characteristics, technical capacity of farmers, socio-economic characteristics of farmers and extension contact. Most of the respondents (76.8%) were aware of the developments in the communications sector and indicated that it would be possible to access agricultural information online. This was as a result of developments in the private sector as indicated in responses in follow-up questions. On the low usage of online services to access agricultural information, majority of respondents (87.9%) cited lack of ICT-based agricultural information services as a major reason for not using this service and low level skills to use the service (83.8%). Other reasons given included lack of knowledge about the service (80.3%), difficulty of meaningfully accessing agricultural information online (78.8%), lack of time for accessing agricultural information online (31.7%), sight problems (17.1%) and lack of interest (15.3%). Only 8.4% of the respondents indicated they did not wish to access agricultural information online because it would not benefit them.

Table 40 presents the description, measure, hypothesized direction of the relationship between the explanatory variables with the dependent variable ICT awareness index (ICTAI).

Table 40

Description, Summary Statistics and Hypothesized Direction of Influence of the Variables Specified

Description	Measurement	Hypothesized direction of influence	Mean	Standard deviation
ICT Characteristics				
Adaptability	Number	+	4.52	3.32
Feasibility	Number	+	3.78	2.73
Costs	Percent	+	0.42	0.33
Level/Extent of involvement	Years	+	6.32	4.44
Incentives	Number	+	3.77	2.01
Policy	Number	+	2.98	1.86
Infrastructure	Number	+	4.31	2.21
Government initiative			3.88	2.83
Socio-economic Characteristics				
Education level	Completed years of schooling	+	8.67	6.27
ICT Skills	Number	+	2.43	2.01
Age of farmer	Years	±	45.27	14.31
Land tenure status	Value 1 if owner 0 otherwise	±	0.77	0.48
Land size	Value 1 if large 0 otherwise	±	0.33	0.24
Enterprise	Value 1 if commercial 0 otherwise	±	0.54	0.22
Subsistence pressure	Persons per household	+	6.02	2.50
Extension contact	Value 1 if had extension contact in the past one year	+	0.31	0.22

Note ± means that the direction of influence is indeterminate, and + means positive influence

Use of age and education level of farmer as explanatory variables in adoption-perception studies is fairly common (Neupane et al., 2002; Mbaga-Semgalawe and Folmer, 2000; Baidu-Forson, 1999; Adesina and Baidu-Forson, 1995; Adesina and Zinnah, 1993). These variables, acting as a group or separately, are expected to have an influence in raising technology awareness for the following reasons: The education variable is used as a surrogate for a number of factors. At the technical level, availability of information as well as capacity to understand the technical aspects related to the modern technology may influence its usage. Age of the farmer is incorporated to account for the maturity of the farmer in his/her decision-making ability. Extension contact can be singled out as one of the important sources of information dissemination directly relevant to making farm decisions practices. This is reinforced by the fact that many studies have found a significant influence of extension education on agricultural productivity (Baidu-Forson, 1999; Adesina and Zinnah, 1993). Therefore, this variable was incorporated to account for its influence as well as to make a case for strengthening extension services and networks if proved useful.

The Chayanovian theory of the peasant economy indicates that higher subsistence pressure, increases the tendency to seek means to improve productivity (Ngaje, 1990). The findings of this study were consistent with this theory where farmers with higher subsistence pressure were found to be keen to access agricultural information to enhance their performance in their farms. The subsistence pressure variable, measured by family size per farm household was incorporated to account for its influence in raising awareness, if any, of how ICT would be used to avail agricultural information to the users with its attendant benefits.

Land ownership in Kenya serves as a surrogate for a large number of factors as it is a major source of wealth and influences farm operations. The impact of tenancy on the extent of awareness and willingness to seek agricultural information through ICT was found to be varied. The tenancy variable was incorporated to test whether there is any difference in the level of perception between landowners and tenant farmers. A positive coefficient for this variable implied that landowners are relatively more aware than the tenants.

The percentage of income earned off-farm was included to reflect the relative importance of non-agricultural work in these farm households. It was used as a proxy for

measuring investment potential in ICT usage for accessing agricultural information. The state of infrastructure and government policy affects availability and usage of ICT facilities. Government initiative was found to be necessary in creating awareness and enthusiasm among farmers on bringing services closer to where they live and work.

The respondents highly valued agricultural information for making decisions in their farms. Only 31% of the respondents indicated that they had had extension contact within the last one year, but still classified this contact as inadequate. They highly rated the usefulness of the help they got from this initial contact. Generally the respondents had average levels of formal education (see Tables 23 and 26). The influence of education on awareness of ICTs become clear when 61.64% of those who attained above primary level of education indicated that they were aware, and highly rated ICTs in accessing agricultural information. Only 10.37% of those who attained primary level education and above indicated that they would prefer ICT-based systems for accessing agricultural information. Sixty five percent of those who did not prefer ICT –based sources of agricultural information had semi-formal education. Hypothesis H_{04} : *“There is no significant relationship between farmers’ education attainment and level of farm operation and their willingness to use ICT to access agricultural information,”* was thus rejected. Advances in telecommunications and adoption of ICTs by the private sector that regularly interacts with the farmers prompted this awareness. However 89% of the respondents indicated that they lacked the skills that would enable them to effectively use this technology to access agricultural information. Table 28 gives a summary of the factors that militate against adoption of ICT for accessing agricultural information.

Majority of the farmers owned their farms (77%). Partnerships and limited company status (23%) was mainly observed with large scale commercial farms. A minor objective of the study was to determine if there were differences in ICTs awareness and usage between the small and large scale farmers. Close examination of the results indicated that a significant number of the large scale farmers (58%) indicated that they use the internet to get information related to their agricultural activities. Only a small percentage of the small scale farmers (6.2%) indicated that they used internet facilities for communication with a large number indicating that mobile telephony was a major leap forward in terms of their communication with the outside.

Sixty seven percent of the respondents indicated their willingness to participate in programmes that would easily avail information to them. As many as 62% of the respondents lamented slowness on the part of the government to initiate programmes that would use modern communication technologies to promptly cater for their agricultural information needs. Citing lack of resources and limited individual capacities, they were keen to see the government set up information centres near their locality where they would easily get information on inputs, prices, markets and other developments. On this, they were quick to draw comparisons with the private sector especially the mobile telephones which had brought communication services right to the farmers.

4.7 Summary of the Findings

The study had six objectives and four hypotheses. In this summary the findings of the study are presented by addressing each of the objectives and hypotheses. The first objective of the study was to identify and document the approaches currently being used in the management of agricultural information within and between the agricultural research stations, the extension services, the training institutions and farmers. The conventional manual paper-based method was found to be the predominant system in the management of agricultural information in the agricultural research stations, the extension service and the agricultural training institutions. Online linkages for sharing and dissemination of information between these subsystems were minimal. Farmers were found to mainly rely on visits by the extension staff for their information needs. A few sought information from agricultural input stockists and agricultural exhibitions. Very few farmers accessed agricultural information online.

The second objective of the study was to determine and document the institutional factors that influence the application of information and communication technology in the management of agricultural information. The study established that supportive policy, strategic planning, collaborative work, and adequate resource allocation would be critical in realizing ICT-based agricultural information systems in the various subsystems. In all the agricultural subsystems, there were no clear guidelines and precise targets that were known by staff towards realizing ICT-based agricultural information systems.

The third objective was to determine and document the personal factors that influence the application of information and communication technology in the management of agricultural information. It was established that positive attitudes and training in computer applications were major factors in staff appreciating the value of ICT-based agricultural information systems. Staff who had basic computer application skills highly rated ICT-based agricultural information management systems.

The fourth objective was to determine the disincentives to the use of ICT-based systems in the management of agricultural information within and between the agricultural research, extension and the training institutions. It was established that poor infrastructure, inadequate ICT facilities, weak policies, lack of appropriate software, poor connectivity and insufficient skills were key factors in limiting the application of ICT-based systems for agricultural information management in the various agricultural subsystems.

The fifth objective was to determine the extent of preparedness in training of the agricultural research, extension service and training institution staff to use ICT-based agricultural information management system. In all these subsystems it was established that the staff needed to upgrade their skills in computer-based systems for agricultural information management. Thus hypotheses **H₀₁**, **H₀₂** and **H₀₃** were rejected. The staff indicated that they had much greater need for most of the skills than they possessed.

The final objective of the study was to assess farmers' awareness, attitudes, and abilities to use ICT to access agricultural information. It was established that farmers educational attainment, their levels of operation, the land tenure systems and extension contact were factors in influencing their awareness attitudes and ability to use ICT to access agricultural information. The influence of education on awareness of ICTs become clear when majority of those who had attained above basic level of education indicated to be aware and highly rated ICTs for accessing agricultural information. The same positive influence was noted for land ownership and scale of operation, with land owners and large scale farmers seeming to be more receptive of ICT for accessing agricultural information. Thus **H₀₄** was rejected.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This final chapter presents a summary of the findings, conclusions drawn from the findings and recommendations made for realizing ICT-based agricultural information management system within and between the agricultural research, extension, and training institutions for onward dissemination to farmers.

5.2 Summary

This section briefly covers the contents of chapter one, two three and four. Chapter one presented the background information on the study, the problem, and objectives. The literature review was presented in chapter two with the purpose of emphasizing emerging trends in the management of agricultural information and pinpointing gaps that require attention. Chapter three dealt with the methods and procedures of the study while chapter four captured the findings of the study.

The underlying theme of the study was that it is possible to revitalize the management of agricultural information within and between the various agricultural subsystems. Information and communication technology (ICT) was thought to have the potential to substantially improve the management of agricultural information. The key features of ICT that make it crucial in this regard include its reliability, efficiency, responsiveness, speed, adaptability and connectivity. Few studies have, however, been undertaken on the application of ICT in agricultural information management. This study sought to provide empirical information on the current state of agricultural information management and the application of ICT in the same. Also examined were demands for putting in place such a system.

The first part of the literature reviewed was on agricultural information and agricultural development and presented a discussion of the role of agricultural information in agricultural development. This section drew from various authors and researchers (Rogers, 1983; Mowlana & Wilson, 1988; Nagel, 1990; Ngesa, 1991; Mugo, 1993). Literature on the role of Information and Communication Technology and agricultural development was presented in the second section. The works of Hurtubise, 1984; Ahituv,

Neuman & Riley, 1994; Babu, Singh, & Sachdeva, 1997 and government reports (Kenya, 2001; 2004) and the National Extension Task Force (2007) were cited to underscore the critical role of ICT in the development process.

The third section of the literature reviewed was on the development trend of overseas agricultural information management systems. Included here were features from the US, India, China and Dutch agricultural information systems. The idea was to point out possible models for the local situation as elaborated by various authors (Sheng, 2000; Guo & Zhu, 2002; Dilman, 1986; Wielinga, 1986; Barnejee & Sachdeva, 1995; Roling, 1988). Literature on the management of agricultural information in Kenya was included in the fourth part. A description of the local scenario was presented as captured in the works of various people (Ochieng, 2004; Mugo, 1992; Ngesa, 1991; Kinara, 1984; Kamau, 2006). The idea was to draw a parallel between the local situation and what is happening elsewhere. Gaps were pointed out that required attention if the management of agricultural information is to be revitalized.

The fifth section of the literature review gave highlights of four agricultural subsystems in Kenya that the study was concerned with namely the agricultural research, the extension service, the agricultural training institution and the farmer subsystems. The idea was to capture the dynamics within and between these subsystems as a basis for formulating a conceptual framework for the study that came at the end of the literature review.

The study used an ex post facto design in which a modified Delphi technique was employed. No variables were manipulated but they were studied in retrospect in search of possible relationships. Questionnaires were used to collect data which was analysed using descriptive statistics and t-test. The major finding of the study was that there was limited application of information and communication technology in the management of agricultural information in the various subsystems. Factors that were identified to be contributing to this state include, weaknesses in policy, inadequate facilities, lack of skills, poor infrastructure and connectivity, lack of training opportunities.

5.3 Conclusions

From the findings of the study, a number of conclusions were made.

- 5.3.1 Agricultural information is a critical resource that farmers need to realize progress in their farms. Majority of the farmers indicated that they highly valued and needed agricultural information for use in their farming activities and 76% of them expressed their willingness to participate in programmes that would make this information easily available to them.
- 5.3.2 The conventional manual paper based system of management of agricultural information is still predominant in the agricultural subsystems in the country. Limited diversification and adoption of modern technologies in the processing of agricultural information was evident, with majority of the respondents still using the manual paper system.
- 5.3.3 There is limited application of information and communication technology in the management of agricultural information in the various agricultural subsystems. In all of the subsystems studied, there were limited cases of consolidation of information production, storage, dissemination industries and networks. Online content for dissemination to users was practically not available to any significant extent.
- 5.3.4 Poor infrastructural development and limited investment in ICT are major impediments in the adoption of this technology in the management of agricultural information in the agricultural research, extension and training institutions. Respondents from these subsystems pointed at low resource allocation to ICT for infrastructure development, establishment of ICT support units and for staff development as some of the major impediments for use of this technology.

- 5.3.5** Lack of adequate facilities was indicated as a major reason for not using this technology. Majority of respondents indicated that they did not have sufficient access to computer facilities.
- 5.3.6** Supportive institutional ICT policies would enhance the adoption of this technology. Weak institutional policies that support the deployment of ICT enabled systems for management of agricultural information were indicated as major reason for not using this technology.
- 5.3.7** Limited skills for effectively using ICT-enabled systems for the management of agricultural information exist in all the agricultural subsystems studied. The staff in the research, extension and training institutions perceived that they had less skill than they needed in effectively using ICT enabled systems.
- 5.3.8** There is negligible partnership building for ICT collaborating among research, extension and training institutions. Linkages among these subsystems are weak and poorly coordinated.
- 5.3.9** Inappropriate software and poor connectivity hamper the deployment of ICT-enabled system for management of agricultural information. The high costs of software and limited connectivity were rated highly as stumbling blocks to using ICT-enabled systems.
- 5.3.10** Majority of farmers depend on the public extension service for their agricultural information needs. More than half of the farmers in the study indicated that the extension service was their major source of agricultural information.
- 5.3.11** Though majority of farmers indicated that they depend on the public extension service to access agricultural information, they nevertheless also indicated that they were aware of alternative means of sourcing agricultural information. More than half of the farmers in the study highly rated and actively sought agricultural information from other sources other than the extension service.

5.3.12 Developments in the telecommunications sector have increased farmers awareness of improved communication. More than half of the farmers in the study indicated that they possessed mobile phones and were actively using them for communication. However few of them ever used the mobile phone technology to source agricultural information from the internet.

5.3.13 ICT-based agricultural information points are yet to established and be used by the farmers for accessing agricultural information. Majority of the farmers indicated nonexistent ICT information points as a major factor in not using them.

5.3.14 Educational level is a key factor in farmers' willingness to use modern ICTs to access agricultural information. Majority of farmers with post primary level of education indicated their willingness to use ICT-based sources to access agricultural information while a minority in this category would not prefer ICT-based sources for their agricultural needs. Inversely, a minority of those with semi-formal education and below would be willing to access agricultural information through ICT-based sources, while majority of this category would not be willing to use the ICT-based sources.

5.4 Implications

The findings of the study point to the possibility of revitalizing the management of agricultural information by adopting information and communication technologies as has happened in other countries. The agricultural research, extension and training institutions should initiate more vibrant programmes and projects that use modern ICTs for the management of agricultural information. There is, however need to realize that adoption of ICT for the management of agricultural information puts demands on government, the various institutions and staffs, and even farmers. It would require that all the government commits more resources and establishes the necessary infrastructure to make use of the ICT a possibility. On this, the right policies have to be in place and be implemented. The institutions involved must also put in place supportive policies and commit more resources towards development of ICT infrastructure. To optimize on the appropriateness and

efficiency of ICT-enabled systems, mechanisms for linkages should be put in place to enhance agricultural information exchange and sharing.

The staff in the various agricultural sub sectors indicated that they possessed less skill than they needed in use of ICT for the management of agricultural information. This will demand therefore, that they set apart time to upgrade their proficiency in ICT applications in the management of agricultural information. For trainers of prospective staff for the agricultural subsystems, there is need to strengthen the ICT application component of their training. Equally farmers should be empowered to be able to access agricultural information through ICT-enabled systems. This would mean that farmers be sensitized and be willing to undertake basic computer literacy programmes.

5.5 Recommendations

From the findings of the study, a number of recommendations are made.

- 5.5.1** Agricultural information being a critical resource in agricultural development means that initiatives should be undertaken by the key agricultural subsystems of the research, extension and training to ensure that users have unlimited access to it. Being key in decision-making would mean that users conveniently access it in a usable form, on timely and convenient basis.
- 5.5.2** Modern ICT and appropriate information communication management are vital for agricultural development but they are both changing rapidly and major investments in this area are essential if the country is to address the egregious deficiency in the management of agricultural information. There is need to establish the actual situation on the ground as far as agricultural information issues are concerned and take appropriate steps towards establishing ICT-enabled systems for the management of agricultural information.
- 5.5.3** A more enlightened science and technology policy which reflects a conviction that ICT will ensure future agricultural information management is required. Supportive policies are essential to ensure deployment of ICT-based systems for the management of agricultural information.

- 5.5.4** Awareness building and sensitization on ICT is necessary at the local, institutional and national level as an integral part of any efforts to modernize agricultural information management. This will ensure that all the major stakeholders appreciate the importance of ICT in the management of agricultural information.
- 5.5.5** There is need to facilitate partnerships and linkages among individuals and institutions and through the networks provide a basis form for exchange of information on ICT. This would be one way of initiating ICT projects that would link the concerned institutions.
- 5.5.6** ICT-related capacity building should be undertaken in the agricultural research, extension and training institutions. It would be necessary to identify candidates for training and their preferred areas of specialization and develop short-term training curricula for individual staff categories, possibly combining several related training areas for the in-service staff. This would bestow the requisite ICT skills on staff.
- 5.5.7** Pre-service training for personnel for the agricultural sector should lay due emphasis on ICT and agricultural information management. This will ensure that prospective staffs are well grounded in computer applications in the management of agricultural information. This calls for periodic curriculum reviews by trainers to ensure that their graduates are ICT literate and are able to integrate ICT into their work.
- 5.5.8** Government should establish information centres at appropriate locations where farmers and other users can easily access them. This calls for having agricultural information and knowledge management specialists at the national headquarters and at the district levels whose role should be to manage the systems, products and services that respond to identified needs and carrying out research in agricultural information and communication management. The specialists will also be responsible for the content because infrastructure is useless without content.

- 5.5.9** The government should work closely with the private sector due primarily to bountiful expertise and experience that they already have in improved communication systems. The private sector already has significant presence in the field and government can tap from this if the relevant mechanisms are put in place. Interventions such as rural electrification and other incentives would motivate more private sector participation. The central idea is that farmers should be given opportunities for obtaining advice and information from those most able and willing to do so.
- 5.5.11** Stakeholders in the agriculture sector should develop or adopt open source software as a step towards getting appropriate software. Open source software provides opportunities to lower the cost of ICT and increases access to the same. It also offers ideal training environment for the development of computer skills which were identified to be lacking in the staffs and farmers.
- 5.5.12** The extension subsystem should design and test complementary and viable mechanisms for empowering farmers to become proactive in acquiring agricultural information. Such mechanism could by design be geared towards making farmers capable of making use of ICT-based sources to access agricultural information for improving agricultural productivity.
- 5.5.13** Adult education programmes should include computer literacy aspects to make it functional to farmers who may need it. The idea is to give farmers technological capabilities to do online business regardless of their level of schooling.
- 5.5.14** The agricultural research, the extension service and the agricultural training institution should embark on developing online content of agricultural information for dissemination to users.
- 5.5.15** Researchers should conduct a detailed e-readiness assessment in the agricultural research, agricultural extension and the agricultural training institutions to determine the extent to which they are ready to embrace ICT-based agricultural

information management systems. The assessment would also be extended to determine the actual attitudes and ability of farmers to effectively source agricultural information from ICT-based systems. The results of such an assessment would contribute significantly towards developing roadmaps for accession to higher state of e-readiness of the various agricultural subsystems.

REFERENCES

- Adenisa, A. A. and Baidu Forson, J. (1995). Farmers Perception and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina Faso and Guinea; West Africa. *Agricultural Economics*. 13, 1-9.
- Adesina, A.A., Zinnah, M.M. (1993). Technology Characteristics, Farmers' Perceptions and Adoption Decisions: a Tobit Model Application in Sierra Leone. *Agricultural Economics* 9, 297-311.
- Adhikarya, R. (1978) Guideline Proposal for Communication Support in Transmigration Project: A Consultancy Report Prepared for FAO/United Nations (Projects 6/INS/01/T). Rome, Italy, FAO.
- Agbamu, J.U. (2000). Agricultural Research-Extension Linkage Systems; An International Perspective. *Agricultural Research and Extension Network Paper No. 106a, ODI: London*.
- Ahituv, N., Neumann, S., and Riley, H.N. (1994). Principles of Information Management Systems for Management. (4th Ed.). Dubuque, IA: Wm. C. Brown Communications.
- Ahmed, R. and Hossain, M., 1990. Developmental Impact of Rural Infrastructure in Bangladesh., Research Report No. 83: International Food Policy Research Institute, Washington, DC.
- Aina L.O. (1991). Information for Successful Agriculture. *Third World Libraries* 2(1):49-53.
- Albrecht, H. (1995). Shared Meaning: Conditions for Productive Development Communication. In Oepen, M. (Ed.), Media Support and Development Communication in a World of Change. Horlemann, Bad Honnef, pp. 65-69.
- Altieri, M. 1995. Agroecology: The Science of Sustainable Agriculture. Westview Press, Boulder.
- Andy, H. (2006). Enhancing Agricultural Innovation. Framework and Principles. Unpublished Workshop Presentations. The World Bank. Washington DC.
- Asiedu, E. (2004). Policy Reform and Foreign Direct Investment in Africa: Absolute Progress but Relative Decline. *Development Policy Review*. 22 (1), 41-48.
- Awad, E.M and Gotterer, M.H. (1992). Database Management. Danvers. MA :Boyd & Fraser.

- Babu, A.R., Singh, Y.P. and Sachdeva, R.K. (1997). Establishing a Management Information System. In B.E. Swanson and R. Bentz. Current Status of Agricultural Extension Worldwide. FAO Rome.
- Baidu-Forson, J. (1999). Factors Influencing Adoption of Land-enhancing Technology in the Sahel: lessons from a case study in Niger. *Agricultural Economics* 20, 231–239
- Bailey, K.D. (1987). Methods of Social Research. (2nd Ed.) New York. N.Y. The Free Press
- Balian, E.S. (1988). How to Design, Analyse, and Write Doctoral or Masters's Research, (2nd Edition). New York, NY: University Press of America.
- Banerjee, U.K and Sachdeva, R. K (1995). *Management Information System: A New Framework*. New Delhi: Vikas Publishing House.
- Banu, L.J. and Bode, B. (2002). CARE Bangladesh's FFS Approach: New Frontiers in Farmer Empowerment. Paper Presented at the International Learning Workshop on Farmers' Field Schools: Emerging issues and challenges. Indonesia, Yogyakarta, 21-25th October 2002.
- Bennel, P. (1989). Intergroup Relationship in Agricultural Technology Systems. Linkages Theme paper No. 2. ISNAR. The Hague.
- Benor, D., Harrison, J.Q. and Baxter, M. (1984). Agricultural Extension: The Training and Visit System. Washington DC: World Bank.
- Bessant, J., Francis, D. (1999). Using Learning Networks to Help Improve Manufacturing Competitiveness. *Technovation* 19 (6-7), 373–381.
- Best, J.N. and Khan, B. (1989). Research in Education. Practice of India Ltd. New Delhi.
- Beynon, J. (1996). Financing of Agricultural Research and Extension for Smallholder Farmers in Sub-Saharan Africa. ODI Natural Resource Perspectives No. 15, November 1996.
- Biggs, S. and Smith, G. (1998). Beyond Methodologies: Coalition-Building for Participatory Technology Development. *World Development* 26 (2), 239–248.
- Boehlje, M. (1998). Information and Technology Transfer in Agriculture: The Role of the Public and Private Sectors. In Wolf, S.A. (Ed.), Privatization of Information and Agricultural Industrialization. CRC Press, Boca Raton, pp. 23–38.

- Borg, W.R. and Gall, M.D. (1989). Education Research. An Introduction. (5th Ed.). New York. NY. Longman Publishing Company.
- Carter I. (1999). Locally Generated Printed Materials In Agriculture: Experience from Uganda and Ghana. Education Research Paper No. 31, Department for International Development(DfID).[Online]AvailableWWW:<http://www.dfid.gov.uk/education/Research/Library/content/dif10e/ch12.htm> (Accessed 6th August 2005).
- Carney, D. (1996). Formal Farmers Organisations in the Agricultural Technology System: Current Roles and Future Challenges. ODI Natural Resources Perspectives No.14, November 1996.
- Cary, J.W. (1993). Changing Foundations for Government Support of Agricultural Extension in Economically Developed Countries. *Sociologica Ruralis* 33 (3/4), 336-347.
- Carl, E. and John, S. (1998). International Agricultural Development. The John Hopkins University Press. Baltimore and London.
- Cassma, K., Olk, D., and Dobermann, A. (1997). Scientific Evidence of Yield Productivity Declines in Irrigated Rice Systems of Tropical Asia. International Rice Committee Newsletter 46:7-18.
- Castillo, F. Parker, D., and Zilberman, D. (1998). Offices of Technology Transfer: Privatizing University Innovations for Agriculture. *Choices*, 13(1), 19-25.
- CIP-UPWARD (2003). Farmer Field Schools: From IPM to Platforms for Learning and Empowerment. Users' Perspectives with Agricultural Research and Development, Los Banos, Philippines.
- Clarke, A.C. (1991). New Communication Technologies and the Developing World. Sri Lanka.: Department of Government Printing.
- Clark, N. (2002). Innovation Systems, Institutional Change and the New Knowledge Market: Implications for Third World Agricultural Development. *Economics of Innovation and New Technology* 11 (4-5), 353-368.
- Conway, G.R. (1997). The Doubly Green Revolution. Penguin, London.
- Davis, G.B. and Olson, M.H. (1985). Management Information System: Conceptual Foundations, Structure, And Development. New York:McGraw-Hill.

- Derbertin, D.L. (1993). *Agricultural Production Economics* (2nd Edition) New York: University of Kentucky.
- De Lauwere, C.C. (2005). The Role of Agricultural Entrepreneurship in Dutch Agriculture of Today. *Agricultural Economics* 33, 229–238.
- Dilman, D. (1986). Cooperative Extension at the Beginning of The 21st Century. *The Rural Sociologist*, 6, 102-19.
- Edquist, C., Hommen, L. (1999). Systems of Innovation: Theory and Policy for the Demand Side. *Technology in Society* 21 (1), 63–79.
- Edwards, T., Delbridge, R., and Munday, M. (2005). Understanding Innovation in Small and Medium-Sized Enterprises: A Process Manifest. *Technovation* 25 (10), 1119–1127.
- Engel, P.G.H. (1995). *Facilitating Innovation: An Action-Oriented Approach and Participatory Methodology to Improve Innovative Social Practice in Agriculture*. Wageningen University, Wageningen, The Netherlands.
- Eponou, T. (1990). Information Linkage Mechanisms and Technology Transfer: The PACO Project in Cote d'ivoire. Linkage Discussion Paper No. 5, PACO. The Hague.
- Eponou, T. (1993). *Partners in Agricultural Technology: Linking Research and Technology Transfer to Serve Farmers*. ISNAR Research Report No. 1. ISNAR. The Hague.
- Eponou, T. (1994). Linking Research to Technology Dissemination. In: Meindertsma P.J eds, *Setting Research Priorities: Towards Effective Farmer-Oriented Research*. Royal Tropical Institute, Amsterdam.
- Faylon, P.S, and Acoba, E.P. (2002). *Agricultural Research and Development (R&D) – Extension – Farmer Interface and Technology Transfer*. Paper presented during the Expert Consultation on Agricultural Extension, Research-Extension-Farmer Interface and Technology Transfer, 16th – 19th July 2002. FAO, Regional Office, Bangkok Thailand.

- Food and Agriculture Organization (1984). A Guide to Extension Training. FAO, Rome Italy.
- Food and Agriculture Organization (1990). Report of the Global Consultation on Agricultural Extension. FAO, Rome. Italy.
- Food and Agriculture Organization (1994). Strategic Extension Campaign. FAO, Rome. Italy.
- Food and Agriculture Organization (2003). The State of Food Insecurity in the World. FAO, Rome. Italy.
- Food and Agriculture Organization (2004). The State of Food Insecurity in the World 2004: Monitoring Progress Towards the World Food Summit and Millennium Development Goals. FAO, Rome, Italy.
- Feder, G., Murgai, R. and Quizon, J.B. (2004). Sending Farmers Back to School. The Impact Of Farmer Field School In Indonesia. *Review of Agricultural Economics* 26 (1) 45-62.
- Feder, G. and Umali, D.L. (1993). Adoption of Agricultural Innovations: A Review. *Technology Forecasting and Social Change*, 43 (3&4):215-39.
- Garforth, C., Angell, B., Archer, J., and Green, K. (2003). Improving Farmers' Access to Advice on Land Management: Lessons from Case Studies in Developed Countries. AgREN Network Paper 125. Overseas Development Institute, London.
- Geels, F.W. (2004). From Sectoral Systems of Innovation to Socio-Technical Systems: Insights about Dynamics and Change from Sociology and Institutional Theory. *Research Policy* 33 (6-7), 897-920.
- Gielen, P.M., Hoeve, A., Nieuwenhuis, L.F.M. (2003). Learning Entrepreneurs: Learning and Innovation in Small Companies. *European Educational Research Journal* 2 (1), 90-106.
- Green, R.H. (1996). Poverty, Basic Services, Survival and Development in Sub-Saharan Africa: Some Issues of Public Service Professionalism, Productivity and Pay. *Development* 2, 48}53.
- Guba, E.G and Lincoln, Y. (1981). *Effective Evaluation*. San Franscisco: Jossey-Bass

- Gubbels, P., 1994. The Role of Peasant Farmer Organisations in Transforming Agricultural Research and Extension Practices in West Africa. In *Agricultural Extension in Africa, Proceedings of an International Workshop*, Yaounde, Cameroon. CTA, Wageningen, pp. 95-120.
- Guilford, J.P. (1956). *Fundamental Statistics in Psychology and Education*. New York: McGraw-Hill.
- Guilford, J.P. and Fruchter, B. (1978). *Fundamental Statistics in Psychology and Education*. New York: McGraw-Hill Inc.
- Guo, Y. and Zhu, E. (2002). Developing Tendency of China Agriculture Network. *World Agriculture* 2002 (2):12-13.
- Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1992). *Multivariate Data Analysis with Readings*. (3rd Ed.) New York. NY: Macmillan Publishing Co.
- Hagmann, J., & Chuma, E. (2000). Tying Up Loose Ends: Integrating Soft and Hard Methodologies in NRM Research and Extension. In I. Guijt, J. Berdegue', & M. Loevinsohn (Eds.), *Deepening the Basis of Rural Resource Management* (pp. 109–121). The Hague: ISNAR.
- Hall, A., Rasheed Sulaiman, V., Clark, N., Yoganand, B. (2003). From Measuring Impact to Learning Institutional Lessons: An Innovation Systems Perspective on Improving the Management of International Agricultural Research. *Agricultural Systems* 78 (2), 213–241.
- Haverkort, A.W. and Engel P. (1986). *Knowledge Systems and Agricultural Development. Manual for Workshop iii of the International Course in Rural Extension*, Wageningen: International Agriculture Centre.
- Hildreth, R.J. and Armbruster, W.J. (1981). Extension Program Delivery: past, present and future, an overview. *American Journal of Agricultural Economics*, 4, 853-8.
- Hinchcliffe, F., Thompson, J., Pretty, J., Guijt, I., and Shah, P. (Eds.) (1999). *Fertile Ground: The Impacts of Participatory Watershed Development*. IT Publications, London.
- Hurtubise, R. (1984). *Managing Information Systems: Concepts and Tools*. West Hartford (Conn.): Kumarian Press.

- Hussey, G.A. (1985). *Electronic Technology: Impact on Extension Delivery Systems*. Washington, DC: U.S. Department of Agriculture, Extension Service.
- International Agriculture Centre (2005). *Inventing a Better Future: A Strategy for Building Worldwide Capacities in Science and Technology*. InterAcademy Council, Amsterdam.
- International Fund for Agricultural Development (1995). *Negotiating Linkages: Farmers' Organizations, Agricultural Research and Extension*. The 6th IFAD Publication.
- International Monetary Fund (1999). *Growth in Sub-Sahara Africa; Performance, Impediments and Policy Requirements*. World Economic Outlook.
- Imboden, N. (1980). *Managing Information for Rural Development Projects*. Paris: Organization for Economic Co-operation and Development.
- Israel, G. (1992). *Determining Sample Size. Program Evaluation and Organisational Development*. IFAS. University of Florida. PEOD-5.
- International Service for National Agricultural Research (1989). *The Technology Triangle: Linking Farmers, Technology Transfer Agents and Agricultural Researchers*. Summary Report of an International Workshop, 20–25 November 1989, ISNAR, The Hague.
- Jatta, S. (2000). *Peoples Empowerment and Ownership in Agricultural Development in Mali*. International Fund for Agricultural Development., February 2000. Rome, Italy. IFAD.
- Kaimowitz, D. (1991). "The Evolution of Links Between Research and Extension in Developing Countries." In *Agricultural Extension Worldwide: Institutional Evolution and Forces for Change*. Edited by William Rivera and Dan Gustafan. New York. Elsevier.
- Kamau, F.K. (2006). *An Overview of Extension Services in Kenya*. A paper presented during the animal production society of Kenya, annual conference held in Isiolo. 8th -10th March 2006.
- Kaniki AM. (1991). *Information Seeking and Information Providers among Zambian Farmers*. Libri 41(3):147–164.

- Kathuri, N.J and Pals, D.A. (1993). Introduction to Educational Research. Njoro, Kenya: Educational Media Centre, Egerton University.
- Kaufmann, A., Todtling, F. (2002). How Effective is Innovation Support for SMSs? An Analysis of the Region of Upper Austria. *Technovation* 22 (3), 147–159.
- Kaufmann, A. and Todtling, F. (2001). Science-Industry Interaction in the Process of Innovation: The importance of Boundary-Crossing between Systems. *Research Policy* 30 (5), 791–804.
- Kenya, Republic of. (1970). *The National Development Plan 1970/1974*. Government Printer, Nairobi, Kenya.
- Kenya, Republic of (1994) *The National Development Plan. 1994/1998*. Government Printer, Nairobi, Kenya.
- Kenya, Republic of. (2001). The Government Information Technology Investment and Management Framework. A Working Paper. Nairobi, Kenya: Ministry of Economic Planning.
- Kenya, Republic of. (2002). The National Development Plan 2002/2008 Nairobi, Kenya: Government Printer.
- Kenya, Republic of. (2004a). E- Government Strategy: The Strategic Framework, Administrative Structure, Training Requirements and Standardisation Framework. Nairobi. Kenya: Directorate of E-government.
- Kenya, Republic of (2004b). Strategy for Revitalizing Agriculture, 2004 – 2014. Nairobi, Kenya: Government Printer.
- Kenya, Republic of. (2005). Economic Survey. Ministry of Planning. Nairobi. Kenya: Central Bureau of Statistics.

- Kitetu C.W. and Chai F. (2004). Conversation and Adherence with Agricultural Technologies: An Application of Micro-Interactional Analysis in Agriculture. Paper presented at the AICAD workshop on final research presentations, 9–10 September 2004, Jomo Kenyatta University of Agriculture and Technology, Juja, Kenya.
- Kinara, A.M. (1984). Information and Communication in Kenya Agriculture: Basic Problems and Possible Solutions. Nairobi, Kenya.: Africa Book Services (E.A) Ltd.
- Klein Woolthuis, R., Lankhuizen, M., and Gilsing, V. (2005). A System Failure Framework for Innovation Policy Design. *Technovation* 25 (6), 609–619.
- Knudson, W., Wysocki, A., Champagne, J., and Peterson, H.P. (2004). Entrepreneurship and Innovation in the Agri-Food System. *American Journal of Agricultural Economics* 86 (5), 1330–1336.
- Leonard, D.K. (1977). Reaching Peasant Farmers. Organisation, Theory and Practice in Kenya, Chicago Illinois, U.S.A. The University of Chicago Press.
- Li W. (2001). Agro-ecological Farming Systems in China, Man and the Biosphere Series, Vol. 26. Paris, France: UNESCO.
- Lindner, R.K, Pardey, P.G., and Jarrett, F.G. (1982). Distance to Information and the Time Lag to Early Adoption of Trace Element Fertilizers. *Australian Journal of Agricultural Economics* 26, 98–113.
- Lionberger, H.F. and Chang, H.C. (1982). The Development and Delivery of Scientific Farm Information: the Taiwan system as an Organisation alternative to Land Grant Universities. PP 155-183 in Crouch, BR and S. Chamala (Eds) Extension Education and Rural Development, Vol. I John Wiley and Sons Brisbane, Australia.
- Lionberger, H.F. and Gwin, P.H. (1982). Communication Strategies: A Guide for Agricultural Change Agents. Danville, IL: Interstate.
- Lionberger, H.F. and Wong T.S. (1982). Information Developer-User System Linking Roles of Education Assistants in The Missouri Small Farm Development Program. Columbia.(Missouri): University of Missouri, Columbia College of Agriculture, Agricultural Experiment Station.

- Lopez J. and Bruening T.H. (2002). *Farmers Communication Process. A Route to Sustainability*. Rome, Italy. FAO Publication.
- Maalouf, W.D., Contado, T.E., Adhikarya, R. (1991). *Extension Coverage and Resource Problems: The Need for Public-Private Co-operation*. Elsevier, Amsterdam.
- Maunder, A.H. (1962). *Agricultural Extension in Kenya*. Ministry of Agriculture. Nairobi. Kenya: Government Printer.
- Mbaga-Semgalawe, Z., Folmer, H. (2000). Household Adoption Behaviour of Improved Soil Conservation: The Case of the North and West Usambara Mountains of Tanzania. *Land Use Policy* 17, 321–336.
- McDermott, J.K. (1987). Making Extension Effective: The Role of Extension /Research Linkages. In W.M. Rivera & S.G. Schram (Eds), *Agricultural extension worldwide* (pp 89-103). London Croom Helm.
- Mchombu K. (2003). Information Dissemination for Development: An Impact Study. *Information Development* 19(2):111–125.
- McNeely, J.A., Scherr, S.J. (2001). *Common Ground, Common Future. How Eco-agriculture Can Help Feed the World and Save Wild Biodiversity?* IUCN and Future Harvest, Geneva.
- Menou, M.J. and Niang, T. (1991). "Progefia": A Co-operative Effort Toward the Strengthening of Education for Agricultural Information in Less Developed Countries in B.G. Goedegebuure, H.R. Arango Sales and S. Sotolongo Aguilar(Eds.) *Information: A Resource for Development : Proceedings of the Forty-Fifth FID Conference and Congress*. Amsterdam: FID, pp.65-79.
- Meyanathan, S.D. (1994). *Industrial Structures and The Development of Small and Medium Enterprise Linkages: Examples from East Asia*. . Washington, D.C., USA: The World Bank.
- Metcalfe, J.R. (1994). Where is the Information Industry Going? *New Information Technologies in Agriculture- Quarterly Bulletin of the International Association of Agricultural Information Specialists*, vol. 39, 1-2, p.31-35.
- Michael E. (1991). *Education and the Information Society: A challenge for European Policy*. Cassell Educational Limited. Villers House 41/47 Strand. London WC2N 5JE.

- Ministry of Agriculture and Rural development. (2002). National Agricultural Extension Policy. Nairobi Kenya. Government Printer.
- Mugo, J.O. (1992). Agricultural Information Needs of East African Countries: Nairobi Kenya: CTA and Kenya Agricultural Research Institute.
- Mulaku, G.C. and McLaughlin, J. (1996). Concepts for Improving Property Mapping in Kenya, South African Journal of Surveying and Mapping. Vol.23, Part 4, April 1996, pp211-216.
- Mulaku, G.C. and Galcano, C. (2002). Land Information Management in Kenya. An Integrated Approach. A working Paper.. Nairobi, Kenya: University of Nairobi. Department of Survey.
- Murithi, F.M. (2003). Adoptive Research Needs and the Role of Farmers Participatory Research. Proceedings of the 2nd Scientific Conference of the Soil Management and Legume Research Network Project June 2000 Mombasa, Kenya. KARI 2003 Publication.
- Muyepa F. (2002). The Role of Agricultural Information in Poverty Monitoring in Malawi. Paper presented at the Poverty Monitoring Stakeholders Workshop. [Online]. Available WWW: http://www.sarpn.or.za/documents/d0000293/p288_muyepa.pdf. (Accessed 18 March 2004).
- Mwangi, J.G. (1999). Policy Milestones in Kenya That Have Supported or Constrained Sustainable Agriculture and Poverty Alleviation. A Research Report. Nairobi Kenya: Tegemeo Institute.
- Nagel, U.J. (1980). Institutionalization of Knowledge Flow. An analysis of the Extension Role of Two Agricultural Universities in India. Special issues of the Quarterly Journal of International Agriculture, number 30, Frankfurt: DDLG Verlag, Federal Republic of Germany.
- National Extension Task Force (2007). National Agricultural Sector Extension Policy. Implementation Framework. Ministry of Agriculture; Ministry of Livestock and Fisheries Development; Ministry of Cooperative Development and Marketing. Nairobi.

- Ndegwa, D.N. (1971). Report of the Commission of Inquiry. Government Printer, Nairobi, Kenya.
- Nelson, R. and Phelps, E.S. (1979). Investment in Human, Technological Diffusion and Economic Growth. *American Economic Review* 56:69-75.
- Neupane, R.P., Sharma, K.R., Thapa, G.B. (2002). Adoption of Agro forestry in the Hills of Nepal: A Logistic Regression Analysis. *Agricultural Systems* 72, 177-196.
- Ndiritu, C.G. (1988). Integration of Research Extension and Training. PP.21-29 in Nguyo W. (Ed). *Proceedings of University Planning Workshop*. Egerton University, Njoro, Kenya.
- Ndiritu, C.G. (1990). New Research Structure and Kenya's Efforts in this Regard. pp24-40. In *proceedings of Regional Workshop on Research and Extension and their Interactions*. Nairobi, Kenya.
- Ndungu, F.W., Nkonge, C., and Rees, D.J. (2000). Agricultural Knowledge and Information Systems (AKIS) Paradigm. It's Potential in Disseminating Soil Management technologies. Paper presented during a conference on Participatory Technology Development For Soil Management By Small Holders In Kenya. *Proceedings of the 2nd Scientific conference of the Soil Management and Legume research network project June 2000 Mombasa, Kenya*. KARI 2003 Publication.
- Nganje, W.E. (1990). Productivity Analysis of Small-Holder Yam Production in Fako Division: A Case Study in the Bonakandsa and Malende Zones. *Memoir*, Dschang University, Cameroon.
- Ngesa, F.U. (1985). Residential Training for Farmers: The Theory and Practice of the Farmers Training Centre System in Kenya. Iowa State University, Ames IOWA, U.S.A.
- Ngesa, F.U (1991) Agricultural Information Processing between Agricultural Research Stations and Frontline Extension Workers in Kenya. OSSREA. Addis Ababa, Ethiopia.

- National Research Council. (2000). *Our Common Journey: Transition towards Sustainability*. Board on Sustainable Development, Policy Division, National Research Council. National Academy Press, Washington, DC.
- Ochieng' P. (2004). *Kenyan Initiatives to Take Science to Its Farmers*. Scidev.Net (London). [Online]. Available WWW: <http://allafrica.com/200502150673.html>. (Accessed 12 February 2005).
- Okoth, J. R., Khisa, G. S., and Julianus, T. (2003). Towards Self-Financed Farmer Field Schools. *LEISA Magazine*, 19(1), 28–29.
- Ong'ondo, W.N. (1984). *The Competencies Needed By Intermediate Agricultural Extension Personnel in the Kenya Agricultural Extension Service*. Unpublished PhD Thesis. Pennsylvania State University, University Park PA: U.S.A.
- Oudshoorn, N. and Pinch, T.J., (2003). *How Users Matter: the Co-construction of Users and Technologies*. MIT Press, Cambridge, Massachusetts.
- Paula, E.L and Lloyd, K.B. (2000). *Handbook of Tests and Measurement in Education and the Social Sciences*. The Scarecrow Press Inc. Lanham. Maryland London.
- Peil, M. (1950). *Social Science Research Methods. A handbook for Africa*. East African Publishers. Nairobi.
- Phillipson, J., Gorton, M., Raley, M. and Moxey, A., (2004). *Treating Farms as Firms? The Evolution of Farm Business Support from Productionist to Entrepreneurial Models*. *Environment and Planning C: Government and Policy* 22, 31–54.
- Pittaway, L., Robertson, M., Munir, K., Denyer, D. and Neely, A. (2004). Networking and Innovation: A Systematic Review of the Evidence. *International Journal of Management Reviews* 5–6, 137–168.
- Pontius, J., Dilts, R., and Bartlett, A. (Eds.) (2002). *Ten years of IPM Training in Asia—from Farmer Field School to Community IPM*. Bangkok: FAO.
- Pretty, J.N., (1995). *Regenerating Agriculture: Policies and Practice for Sustainability and Self-reliance*. Earthscan Publications, London, National Academy Press, Washington, DC, ActionAid, Bangalore.
- Pretty, J.N. (1998). *The Living Land: Agriculture, Food Systems and Community Regeneration in Rural Europe*. Earthscan Publications, London.

- Pretty, J.N. and Ward, H. (2001). Social Capital and the Environment. *World Development*. 29 (2), 209–227.
- Qamar, M.K. (2002). *Global Trends in Agricultural Extension: Challenges Facing Asia and the Pacific Region*. FAO. Rome Italy.
- Quizon, J. Feder, G., and Murgai, R. (2001). Fiscal Sustainability of Agricultural Extension: The Case of Farmer Field Schools. *International Journal of Agricultural Extension Education* 8 (Spring):13-24.
- Regional Agricultural Information Network. (2007). *Regional Postgraduate Programme in Agricultural Information and Communication Management*. Association for Strengthening Agricultural Research in Eastern and Central Africa. RAIN. Plot 5 Mpigi Road. Entebbe.
- Reece, J.D., Sumberg, J., and Pommier, L., (2004). Matching Technologies with Potential End Users: A knowledge Engineering Approach for Agricultural Research Management. *Journal of Agricultural Economics* 55 (1), 25–40.
- Riika, R. Willen, J. and Eija, P. (2008). *Agricultural Innovation Systems: From Diagnostics toward Operational Practices*. Agriculture and Rural Development Discussion Paper 38. The World Bank. Washington, DC.
- Rivera, W.M., Gustafson, D.J. (1991). *Agricultural Extension: Worldwide Institutional Evolution and Forces for Change*. Elsevier, Amsterdam.
- Roling, N.G. (1988). *Extension Science: Information System in Agricultural Development*. Cambridge, U.K. Cambridge University Press.
- Roling, N.G. (1990). The Agricultural Research-Technology Transfer Interface: A Knowledge Systems Perspective. In: Kaimowitz, D. (Ed.), *Making the Link: agricultural Research and Technology Transfer in Developing Countries*. Boulder CO: Westview Press, pp. 1–42.
- Roling, N.G. and Engel, P.G.H. (1991). IT from A Knowledge System Perspective: Concepts and Issues. In: Bos, D., Roling, N.G. (Eds.), *Edited Proceedings of the European Seminar on Knowledge Management and Information Technology*, 23 and 24 November, 1989. Wageningen University, Wageningen, The Netherlands.
- Saito, K.A., and Spurling, D. (1992). *Developing Agricultural Extension for Women Farmers*. In: *World Bank Discussion Paper No. 156*. The World Bank, Washington, D.C.

- Schultz, T.W. (1964). *Transforming Traditional Agriculture*. New Haven, CT: Yale University Press.
- Senker, J., and Faulkner, W., (2001). Origins of Public-Private Knowledge Flows and Current State-of-the Art: Can Agriculture Learn from Industry? In: Wolf, S.A., Zilbermann, D. (Eds.), *Knowledge Generation and Technical Change. Institutional Innovation in Agriculture*. Kluwer Academic Publishers, Boston, pp. 203–232.
- Sigman, V.A. and Swanson, B.E. (1982). *Problems Facing National Agricultural Extension Managers in Developing Countries*. Champaign. Urbana. IL. University of Illinois.
- Simpson, B., and Owens, M. (2002). Farmer Field Schools and the Future of Agricultural Extension in Africa. In *Sustainable Development Dimensions*. Rome Italy: FAO.
- Sims, H. and David, L. (1990). "The Political Economy of the Development and Transfer of Agricultural Technologies." In: *Making the Link: Agricultural Research and Technology Transfer in Developing Countries*. Edited by David Kaimowitz, Boulder Colo. Westview Press.
- Sheng, Y. (2000). Trends of Agricultural Information Abroad. *World Agriculture*. 2000 (1):43-45.
- Smithells, J.E. (1972). *Agricultural Extension Among Rural Women*. Reading, UK: University of Reading.
- Smits, R., (2002). Innovation Studies in the 21st Century: Questions From a User's Perspective. *Technological Forecasting and Social Change* 69 (9), 861–883.
- Smits, R., and Kuhlmann, S. (2004). The Rise of Systemic Instruments in Innovation Policy. *International Journal of Foresight and Innovation Policy* 1 (1/2), 4–30.
- Sones, K. R., Duveskog, D., and Minjauw, B. (Eds.).(2003). *Farmer Field schools: The Kenyan Experience*. Nairobi Kenya: FAO/KARI/ILRI.
- Stoop, W.A. (1988). *NARS Linkages in Technology Generation and Technology Transfer*. ISNAR, working paper II 33pp ISNAR, The Hague.
- Sumberg, J., (2005). Systems of Innovation Theory and the Changing Architecture of Agricultural Research in Africa. *Food Policy* 30 (1), 21.
- Sumberg, J., Reece, D. (2004). Agricultural Research through a New Product Development Lens. *Experimental Agriculture* 40 (3), 295–314.

- Swanson, B.E. and Claar, J.B. (1983). Technology Development, Transfer and Feedback System in Agriculture: Proposal for International Programme for Agricultural Knowledge system (INTERPAKS): Urbana ILL, U.S.A. At University of Illinois.
- Swanson, B.E. and Peterson, W. (1989). A Field Manual for Analyzing Agricultural Technology Development and Transfer Systems. INTERPAKS Report. Urbana. University of Illinois. INTERPAKS.
- Swanson B.E. (1997). Strengthening Research- Extension – Farmer Linkages. In B.E Swanson R. Bentz and A.J Sofranco. (ed). Improving Agricultural Extension .(PP71-178) Rome, Italy, FAO.
- Temu, A.E. and Msuya, E.E. (2004). Capacity Building in Information and Communication Management (ICM) towards Food Security. Paper presented at a CTA Seminar on “ The Role of Information Tools in Food and Nutrition Security.” Maputo, Mozambique 8th -12th November 2004.
- Thrupp, L.A. (1996). Partnerships for Sustainable Agriculture. World Resources Institute, Washington, DC.
- United Nations Education Social Cultural Organization. (2000). The EFA 2000 *Assessment: Country Reports Kenya* [Online]. Available WWW: http://www2.unesco.org/wef/country-reports/Kenya/rapport_2_2_2. (Accessed 27 April 2004).
- Uphoff, N. (Ed.), (2002). Agroecological Innovations: Increasing Food Production With Participatory Development. Earthscan, London.
- Uphoff, N. (1995). Why NGOs are Not a Third Sector: A Sectoral Analysis With Some Thoughts on Accountability, Sustainability and Evaluation. In: Edwards, M., Hulme, D. (Eds.), Non-Governmental Organisations Performance and Accountability: Beyond the Magic Bullet. Earthscan, London, pp. 17-30.
- Van Dijk, G., and Van Boekel, P. (2001). Governance of Innovation in Animal Production: New Roles for Science, Business and the Public Sector. Livestock Production Science 72 (1-2), 9–23.

- Von Blackenburg, T. (1984). Agricultural Extension System in Some African and Asian Countries. Rome, Italy: FAO.
- Vos, J. P., Keizer, J.A., and Halman, J.I.M., (1998). Diagnosing Constraints in Knowledge of SMEs. *Technological Forecasting and Social Change* 58 (3), 227–239.
- Wesseler, G. and Brinkman, W. (2002). Bridging Information Gaps Between Farmers, Policy-makers, Researchers and Development Agents. Paper Presented at the General Conference on Agroforestry Impacts on Livelihoods in Southern Africa: Putting Research into Practice. Aventura Warmbaths, South Africa, 20-24 May 2002. [Online]. Available WWW: <http://www.cta.int/pubs/wd8030/informationgaps-final.pdf>. (Accessed 14th March 2006).
- Wielinga, H.E. (1986). Plenary Lecture for International Course in Rural Extension. Wageningen. Netherlands: IAC.
- Wiersma, W. (1986). Research Methods in Education. An Introduction. 4th Edition. Boston. U.S.A. Allyn and Bacon Inc.
- Wiersma, W (1995). Research Methods in Education. An Introduction 6th Edition. Boston USA. Allyn and Bacon Inc.
- Williams, S.K. (1967). Identification of Professional Training Needs of Agricultural Extension Agents in Western Nigeria as a Basis for Developing a College Training Curriculum. Cornell University, Ithaca, New York, U.S.A.
- Williams, S.K. (1970). Training Agricultural Extension Officers in Extension Rome, Italy: FAO.
- Wilson-Grau, R., (1994). Alternative Sources of Income for Novib Partners. Novib, The Hague.
- World Bank. (2004). Kenya Agricultural Productivity Programme. Programme Appraisal Document. April 2004.
- World Bank, (2006). Economic Indicators. World Bank, Washington, DC.
- World Trade Organization (2004). Trade Policy Review: Report by the Secretariat. WT/TPR/S/134.

Xu, J. (2001). The Development and Role of Rural Libraries in China. *Rural Libraries*, 21(2): 24-36.

Zilberman, D., and Sunding, D. (2000). The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector. In B. Gardner, & G. Rausser (Eds.), *Handbook of Agricultural Economics*. Amsterdam: North Holland.

APPENDICES

A. AGRICULTURAL EXTENSION STAFF QUESTIONNAIRE

You have been selected randomly to provide invaluable data in a study on:- *“Factors Influencing the Application of Information and Communication Technology in the Management of Agricultural Information in District, Kenya.”* Please freely provide answers to all the following questions. All the information you will give will be treated confidentially. **DO NOT WRITE IN THE SECTION LABELLED CODE.**

PART I

1. Indicate your job title _____
2. Indicate the year in which you joined the Agricultural Extension Service.

3. Tick (✓) against your current level of educational attainment and indicate the year of attainment against it.

1. Certificate ()	2. Diploma ()
3. BSc. ()	4. Postgraduate Diploma ()
5. Masters ()	
6. Any other? Please specify. _____	
4. From your professional experience, freely express your opinion about information and communication technology (ICT)-based agricultural information management system in the research-education-extension – farmer linkages. Mark (✓) against the statement that best expresses your opinion about its importance.

1. Very important ()	2. Important ()
3. Moderately important ()	4. Insignificant ()
5. No opinion ()	
5. Among the following methods, which one do you mainly use in handling agricultural information? Mark (✓) against the one you most frequently use in the field.
 1. Paper- based system ()
 2. Electronic (computer-based) systems ()
 3. Any other? Please specify

CODE

6. Please rate your use of the conventional paper-based method for processing agricultural information now compared to when you first joined extension work. Tick(√) the most appropriate response.

1. I use paper- based method less now ()

2. I use paper- based method about the same ()

3. I use paper -based method more now ()

7. Do you have access to computer facilities at your place of work?

1. Yes () 2. No ()

8. If yes, in 7 above, do you use the facilities to process, store and disseminate agricultural information to other users?

1. Yes () 2. No ()

9. Please rate the extent to which you use computer-based systems for processing agricultural information in the course of your work. Tick(√) the most appropriate response.

1. No usage ()

2. Low usage ()

3. Average usage ()

4. High usage ()

5. Very high usage ()

10. Please rate your level of confidence in using computers in processing agricultural information. . Tick(√) the most appropriate response.

1. Very low confidence ()

2. Low confidence ()

3. Average confidence ()

4. High confidence ()

5. Very high confidence ()

11. Do you receive agricultural information from other agricultural institutions on-line?

1. Yes () 2. No ()
12. If yes in 11 above, please specify _____
-
13. Do you disseminate agricultural information to users on-line?
1. Yes () 2. No ()
14. Does your work station have online linkage arrangements for sharing information with other users ?
1. Yes () 2. No ()
15. If yes in 14 above, please specify. _____
-
16. Does your work station maintain an electronic database of the clients you serve?
1. Yes () 2. No ()
17. Does your work station maintain a centralised electronic information bank?
1. Yes () 2. No ()
18. Does your work station have telephone services?
1. Yes () 2. No ()
19. If yes in 17 above, please indicate whether mobile or landline.
1. Mobile () 2. Landline ()
20. Is your work station supplied with electricity?
1. Yes () 2. No ()
21. Freely rate your ability to process, store, retrieve, update, and disseminate agricultural information online. Mark (✓) against the statement that best expresses your ability.
1. No ability () 2. Low ability ()
3. Average ability () 4. High ability ()
22. Have you ever taken computer application courses?
1. Yes () 2. No ()
23. If yes in 22 above, please indicate whether pre-service or in-service.
1. Pre-service () 2. In-service ()

a
b
c

24. If yes in 23 above, did the course(s) include aspects of handling agricultural information online?

1. Yes () 2. No ()

25. How would you rate the emphasis given to computer application in processing agricultural information during your pre-service training?

Circle the appropriate response.

1. None 2. Low 3. Medium 4. Strong. 5. Very strong

26. Please indicate any other ICT facilities that you have access to and freely comment on their use in your work. _____

27. Below is a list of possible factors that would have hindered effective use computer-based systems for processing agricultural information in your work station. Using the scale given below, please indicate the amount of influence each factor had to your not using computer-based systems for processing agricultural information.

**Scale: 1= no influence 2= slight influence 3= considerable influence
4= heavy influence 5= very heavy influence**

Factor

Extent of Influence

1. Poor infrastructure
2. Insufficient computer facilities
3. Computer illiteracy
4. Lack of appropriate software
5. Lack of computer related in-service
6. Lack of clear policy on computer usage
7. Lack of support from administration
8. Low level computer application skills
9. Lack time to learn computer applications
10. Lack of connectivity

28. Kindly indicate any other factors that have not been indicated above and rate them. _____

29. State the critical resources that would be required at your work station to put in place an effective computer-based system for agricultural information management _____

- a.
- b.
- c.
- d.

- a.
- b.
- c.
- d.

30. Are there specific plans and precise targets for use of computers to receive, process, store, and disseminate agricultural information to users at your work station that you are aware of?

1. Yes () 2. No ()

31. If yes in 28 above, please indicate the ones are aware of.

- a.
- b.
- c.
- d.
- e
- f

32. Kindly indicate your level of satisfaction at your work place. Mark (✓) against the statement that best describes your feelings.

- (a) satisfied ()
- (b) undecided ()
- (c) dissatisfied ()

PART II

Each item below states a possible skill that you may **need** for an ICT-based agricultural information management system. Using any number 0-3 along the given scales, please indicate by ticking (✓) in the appropriate box the extent which these skills are **needed** and **possessed** by you.

Scale indicating the extent to which skills are needed:

Not needed (NN)	0
Lowly needed (LN)	1
Averagely needed (AN)	2
Highly needed (HN)	3

Scale indicating the extent to which skills are possessed:

Not possessed (NP)	0
Lowly possessed (LP)	1
Averagely possessed (AP)	2
Highly possessed (HP)	3

	Skills in	a.Extent skill needed				b.Extent skill possessed				CODE	
		NN	LN	AN	HN	NP	LP	AP	HP	a.	b
		1	2	3	4	1	2	3	4		
33	identifying information sources available.									a.	b
34	accessing information online									a.	b
35	identifying the types of information needed									a.	b
36	keeping up to date with user information demand									a.	b
37	searching information online									a.	b
38	interpreting user information demands online									a.	b
39	disseminating information online									a.	b
40	reporting appropriately to stakeholders online									a.	b

41	designing appropriate styles and procedures for information capture									a.	b
42	word processing									a.	b
43	spreadsheet construction									a.	b
44	database set-up									a.	b
45	information storage									a.	b
46	information retrieval									a.	b
47	information display									a.	b
48	downloading information									a.	b
49	Data communication									a.	b
50	Data recovery									a.	b
51	updating information									a.	b
52	Data analysis									a.	b
53	validating information									a.	b
54	requesting information online									a.	b
55	soft-ware development and engineering									a.	b
56	hardware maintenance and repair									a.	b
57	local area networking									a.	b
58	Wide area networking									a.	b
59	coordinating communication									a.	b
60	relational database construction									a.	b
61	internet and web-based communication									a.	b
62	e-learning									a.	b
63	basic computer operation									a.	b

PART III

CODE

64. Mark (✓) against your preference as to when training on these skills would done.

1. Pre-service () 2. In-service on the job ()
 3. In-service short courses ()
 4. Any other?, Please specify
-

B. AGRICULTURAL RESEARCH STAFF QUESTIONNAIRE

You have been selected randomly to provide invaluable data in a study on:- *"Factors Influencing the Application of Information and Communication Technology in the Management of Agricultural Information in District, Kenya."* Please freely provide answers to all the following questions. All the information you will give will be treated confidentially. **DO NOT WRITE IN THE SECTION LABELLED CODE.**

PART I

	CODE
1. Indicate your job title _____	
2. Indicate the year in which you joined the Agricultural Research Service. _____	
3. Tick (✓) against your current level of educational attainment and indicate the year of attainment against it. 1. Certificate () 2. Diploma () 3. BSc. () 4. Postgraduate Diploma () 5. Masters () 6. Any other? Please specify. _____	
4. From your professional experience, freely express your opinion about information and communication technology (ICT)-based agricultural information management system in the research-education-extension – farmer linkages. Mark (✓) against the statement that best expresses your opinion about its importance. 1. Very important () 2. Important () 3. Moderately important () 4. Insignificant () 5. No opinion ()	
5. Among the following methods, which one do you mainly use in handling agricultural information? Mark (✓) against the one you most frequently use in the field. 1. Paper-based system () 2. Electronic (computer-based) systems () 3. Any other? Please specify _____	

6. Please rate your use of the conventional paper-based method for processing agricultural information now compared to when you first joined extension work. Tick(✓) the most appropriate response.

1. I use paper- based method less now ()

2. I use paper- based method about the same ()

3. I use paper -based method more now ()

7. Do you have access to computer facilities at your place of work?

1. Yes () 2. No ()

8. If yes, in 7 above, do you use the facilities to process, store and disseminate agricultural information to other users?

1. Yes () 2. No ()

9. Please rate the extent to which you use computer-based systems for processing agricultural information in the course of your work. Tick(✓) the most appropriate response.

1. No usage ()

2. Low usage ()

3. Average usage ()

4. High usage ()

5. Very high usage ()

10. Please rate your level of confidence in using computers in processing agricultural information. . Tick(✓) the most appropriate response.

1. No confidence ()

2. Low confidence ()

3. Average confidence ()

4. High confidence ()

5. Very high confidence ()

11. Do you receive agricultural information from other agricultural institutions on-line?

1. Yes () 2. No ()

12. If yes in 11 above, please specify _____

13. Do you disseminate agricultural information to users on-line?
 1. Yes () 2. No ()
14. Does your work station have online linkage arrangements for sharing information with other users ?
 1. Yes () 2. No ()
15. If yes in 14 above , please specify. _____

16. Does your work station maintain an electronic database of the clients you serve?
 1. Yes () 2. No ()
17. Does your work station maintain a centralised electronic information bank?
 1. Yes () 2. No ()
18. Does your work station have telephone services?
 1. Yes () 2. No ()
19. If yes in 18above, please indicate whether mobile or landline.
 1. Mobile () 2. Landline ()
20. Is your work station supplied with electricity?
 1. Yes () 2. No ()
21. Freely rate your ability to process, store, retrieve, update, and disseminate agricultural information online. Mark (√) against the statement that best expresses your ability.
 1. No ability () 2. Low ability ()
 3. Average ability () 4. High ability ()
22. Have you ever taken computer application courses?
 1. Yes () 2. No ()
23. If yes in 22 above, please indicate whether pre-service or in-service.
 1. Pre-service () 2. In-service ()

a
b
c

24. If yes in 23 above, did the course(s) include aspects of handling agricultural information online?

1. Yes () 2. No ()

25. How would you rate the emphasis given to computer application in processing agricultural information during your pre-service training?

Circle the appropriate response.

1. None 2. Low 3. Medium 4. Strong. 5. Very strong

26. Please indicate any other ICT facilities that you have access to and freely comment on their use in your work. _____

27. Below is a list of possible factors that would have hindered effective use computer-based systems for processing agricultural information in your work station. Using the scale given below, please indicate the amount of influence each factor had to your not using computer-based systems for processing agricultural information.

**Scale: 1= no influence 2= slight influence 3= considerable influence
4= heavy influence 5= very heavy influence**

Factor

Extent of Influence

1. Poor infrastructure
2. Insufficient computer facilities
3. Computer illiteracy
4. Lack of appropriate software
5. Lack of computer related in-service
6. Lack of clear policy on computer usage
7. Lack of support from administration
8. Low level computer application skills
9. Lack time to learn computer applications
10. Lack of connectivity

28. Kindly indicate any other factors that have not been indicated above and rate them. _____

29. State the critical resources that would be required at your work station to put in place an effective computer-based system for agricultural information management _____

a.
b.
c.
d.

a.
b.
c.
d.

30. Are there specific plans and precise targets for use of computers to receive, process, store, and disseminate agricultural information to users at your work station that you are aware of?

1. Yes () 2. No ()

31. If yes in 29 above, please indicate the ones are aware of.

a.
b.
c.
d.
e
f

32. Kindly indicate your level of satisfaction at your work place. Mark (✓) against the statement that best describes your feelings.

(a) satisfied ()

(b) undecided ()

(c) dissatisfied ()

PART II

Each item below states a possible skill that you may **need** for an ICT-based agricultural information management system. Using any number 0-3 along the given scales, please indicate by ticking (✓) in the appropriate box the extent which these skills are **needed** and **possessed** by you.

Scale indicating the extent to which skills are needed:

Not needed (NN)	0
Lowly needed (LN)	1
Averagely needed (AN)	2
Highly needed (HN)	3

Scale indicating the extent to which skills are possessed:

Not possessed (NP)	0
Lowly possessed (LP)	1
Averagely possessed (AP)	2
Highly possessed (HP)	3

	Skills in	a.Extent skill needed				b.Extent skill possessed				CODE	
		NN	LN	AN	HN	NP	LP	AP	HP	a.	b
		1	2	3	4	1	2	3	4		
33	identifying information sources available.									a.	b
34	Accessing information online									a.	b
35	identifying the types of information needed									a.	b
36	keeping up to date with user information demand									a.	b
37	searching information online									a.	b
38	interpreting user information demands online									a.	b
39	disseminating information online									a.	b
40	reporting appropriately to stakeholders online									a.	b

41	designing appropriate styles and procedures for information capture									a.	b
42	word processing									a.	b
43	spreadsheet construction									a.	b
44	database set-up									a.	b
45	information storage									a.	b
46	information retrieval									a.	b
47	information display									a.	b
48	downloading information									a.	b
49	Data communication									a.	b
50	Data recovery									a.	b
51	updating information									a.	b
52	data analysis									a.	b
53	validating information									a.	b
54	requesting information online									a.	b
55	soft-ware development and engineering									a.	b
56	hardware maintenance and repair									a.	b
57	local area networking									a.	b
58	Wide area networking									a.	b
59	coordinating communication									a.	b
60	relational database construction									a.	b
61	internet and web-based communication									a.	b
62	e-learning									a.	b
63	basic computer operation									a.	b

CODE

PART III

64. Mark (✓) against your preference as to when training on these skills would done.

- 1. Pre-service () 2. In-service on the job ()
- 3. In-service short courses ()
- 4. Any other?, Please specify

D. AGRICULTURAL TRAINING INSTITUTIONS STAFF QUESTIONNAIRE

You have been selected randomly to provide invaluable data in a study on:- *"Factors Influencing the Application of Information and Communication Technology in the Management of Agricultural Information in District, Kenya."* Please freely provide answers to all the following questions. All the information you will give will be treated confidentially. **DO NOT WRITE IN THE SECTION LABELLED CODE.**

PART I

	CODE
1. Indicate your job title _____	
2. Indicate the year in which you joined the Agricultural Training Service. _____	
3. Tick (✓) against your current level of educational attainment and indicate the year of attainment against it. 1. Certificate () 2. Diploma () 3. BSc. () 4. Postgraduate Diploma () 5. Masters () 6. Any other? Please specify. _____	
4. From your professional experience, freely express your opinion about information and communication technology (ICT)-based agricultural information management system in the research-education-extension – farmer linkages. Mark (✓) against the statement that best expresses your opinion about its importance. 1. Very important () 2. Important () 3. Moderately important () 4. Insignificant () 5. No opinion ()	
5. Among the following methods, which one do you mainly use in handling agricultural information? Mark (✓) against the one you most frequently use in the field. 1. Paper- based system () 2. Electronic (computer-based) systems () 3. Any other? Please specify _____	

6. Please rate your use of the conventional paper-based method for processing agricultural information now compared to when you first joined extension work. Tick(✓) the most appropriate response.
1. I use paper- based method less now ()
 2. I use paper- based method about the same ()
 3. I use paper -based method more now ()
7. Do you have access to computer facilities at your place of work?
1. Yes ()
 2. No ()
8. If yes, in 7 above, do you use the facilities to process, store and disseminate agricultural information to other users?
1. Yes ()
 2. No ()
9. Please rate the extent to which you use computer-based systems for processing agricultural information in the course of your work. Tick(✓) the most appropriate response.
1. No usage ()
 2. Low usage ()
 3. Average usage ()
 4. High usage ()
 5. Very high usage ()
10. Please rate your level of confidence in using computers in processing agricultural information. . Tick(✓) the most appropriate response.
1. No confidence ()
 2. Low confidence ()
 3. Average confidence ()
 4. High confidence ()
 5. Very high confidence ()
11. Do you receive agricultural information from other agricultural institutions on-line?
1. Yes ()
 2. No ()

12. If yes in 11 above, please specify _____

13. Do you disseminate agricultural information to users on-line?
 1. Yes () 2. No ()
14. Does your work station have online linkage arrangements for sharing information with other users ?
 1. Yes () 2. No ()
15. If yes in 14, please specify. _____

16. Does your work station maintain an electronic database of the clients you serve?
 1. Yes () 2. No ()
17. Does your work station maintain a centralised electronic information bank?
 1. Yes () 2. No ()
18. Does your work station have telephone services?
 1. Yes () 2. No ()
19. If yes in 18above, please indicate whether mobile or landline.
 1. Mobile () 2. Landline ()
20. Is your work station supplied with electricity?
 1. Yes () 2. No ()
21. Freely rate your ability to process, store, retrieve, update, and disseminate agricultural information online. Mark (√) against the statement that best expresses your ability.
 1. No ability () 2. Low ability ()
 3. Average ability () 4. High ability ()
22. Have you ever taken computer application courses?
 1. Yes () 2. No ()
23. If yes in 22 above, please indicate whether pre-service or in-service.
 1. Pre-service () 2. In-service ()
24. If yes in 23 above, did the course(s) include aspects of handling agricultural

a
b
c

information online?

1. Yes () 2. No ()

25. How would you rate the emphasis given to computer application in processing agricultural information during your pre-service training?

Circle the appropriate response.

1. None 2. Low 3. Medium 4. Strong. 5. Very strong

26. Please indicate any other ICT facilities that you have access to and freely comment on their use in your work. _____

27. Below is a list of possible factors that would have hindered effective use computer-based systems for processing agricultural information in your work station. Using the scale given below, please indicate the amount of influence each factor had to your not using computer-based systems for processing agricultural information.

Scale: 1= no influence 2= slight influence 3= considerable influence
4= heavy influence 5=very heavy influence

Factor

Extent of Influence

1. Poor infrastructure
2. Insufficient computer facilities
3. Computer illiteracy
4. Lack of appropriate software
5. Lack of computer related in-service
6. Lack of clear policy on computer usage
7. Lack of support from administration
8. Low level computer application skills
9. Lack time to learn computer applications
10. Lack of connectivity

28. Kindly indicate any other factors that have not been indicated above and rate them. _____

29. State the critical resources that would be required at your work station to put in place an effective computer-based system for agricultural information management _____

a.
b.
c.
d.

a.
b.
c.
d.

30. Are there specific plans and precise targets for use of computers to receive, process, store, and disseminate agricultural information to users at your work station that you are aware of?

1. Yes () 2. No ()

31. If yes in 29 above, please indicate the ones are aware of.

a.
b.
c.
d.
e.
f.

32. Kindly indicate your level of satisfaction at your work place. Mark (✓) against the statement that best describes your feelings.

(a) satisfied ()

(b) undecided ()

(c) dissatisfied ()

PART II

Each item below states a possible skill that you may **need** for an ICT-based agricultural information management system. Using any number 0-3 along the given scales, please indicate by ticking (✓) in the appropriate box the extent to which these skills are **needed** and **possessed** by you.

Scale indicating the extent to which skills are needed:

Not needed (NN)	0
Lowly needed (LN)	1
Averagely needed (AN)	2
Highly needed (HN)	3

Scale indicating the extent to which skills are possessed:

Not possessed (NP)	0
Lowly possessed (LP)	1
Averagely possessed (AP)	2
Highly possessed (HP)	3

	Skills in	a.Extent skill needed				b.Extent skill possessed				CODE	
		NN	LN	AN	HN	NP	LP	AP	HP	a.	b
		1	2	3	4	1	2	3	4		
33	identifying information sources available.									a.	b
34	accessing information online									a.	b
35	identifying the types of information needed									a.	b
36	keeping up to date with user information demand									a.	b
37	searching information online									a.	b
38	interpreting user information demands online									a.	b
39	disseminating information online									a.	b
40	reporting appropriately to stakeholders online									a.	b

41	designing appropriate styles and procedures for information capture									a.	b
42	word processing									a.	b
43	spreadsheet construction									a.	b
44	database set-up									a.	b
45	information storage									a.	b
46	information retrieval									a.	b
47	information display									a.	b
48	downloading information									a.	b
49	Data communication									a.	b
50	Data recovery									a.	b
51	updating information									a.	b
52	data analysis									a.	b
53	validating information									a.	b
54	disseminating information online									a.	b
55	soft-ware development and engineering									a.	b
56	hardware maintenance and repair									a.	b
57	local area networking									a.	b
58	Wide area networking									a.	b
59	coordinating communication									a.	b
60	relational database construction									a.	b
61	internet and web-based communication									a.	b
62	e-learning									a.	b
63	basic computer operation									a.	b

64. Mark (✓) against your preference as to when training on these skills would done.

1. Pre-service () 2. In-service on the job ()

3. In-service short courses ()

4. Any other?, Please specify



D. FARMER QUESTIONNAIRE

You have been selected randomly to provide invaluable data in a study on:-“*Factors Influencing the Application of Information and Communication Technology in the Management of Agricultural Information in Nakuru District, Kenya*”. Please freely provide answers to all the following questions. All the information you will give will be treated confidentially. **DO NOT WRITE ANYTHING IN THE COLUMN MARKED CODE.**

1 Indicate the division in which the farm is located

2.What is the type of ownership of the farm? Mark (✓) against the appropriate answer.

- 1.Individual ()
 2. Family ()
 3. Partnership ()
 4. Other, please specify
- _____

3. Mark (✓) against the approximate size range of the farm.

1. 0- 20 hectares ()
2. 20-50 hectares ()
3. 50-100 hectares ()
4. Over 100 hectares ()

4.Mark (✓) against the approximate distance range of the farm from the nearest public agricultural extension office.

1. 0 -10 Kms ()

CODE

2. 10- 20 Kms ()
3. 20- 30 Kms ()
4. Over 30 Kms. ()

5. Please (√) against the main decision maker in the farm.

1. Farmer (owner) ()
2. Hired farm manager ()
3. Others, please

specify_____

6. Indicate the sex of the farmer/manager.

1. Female ()
2. Male ()

7. Age of the farmer_____

8. What is the highest level of formal education of the main decision maker in the farm? Mark (√) against the appropriate level.

1. No formal education ()
2. Primary ()
3. Secondary ()
4. Diploma ()
5. University degree ()

Others, please specify_____

9. Please indicate number of people in household_____

Part II

11. Do you consider agricultural information valuable?

1. Yes ()
2. No ()

12. Is the farm supplied with electrical power?

1. Yes ()
2. No ()

13. How often do you need agricultural information for your farm operations?

- 1. Never ()
- 2. Rarely ()
- 3. Often ()
- 4. Very Often ()

14. Does the farm have telephone services?

- 1. Yes ()
- 2. No ()

15. If yes in 9 above, please indicate whether landline or mobile.

- 1. Landline ()
- 2. Mobile ()

16. Do you use telephone facilities to source agricultural information?

- 1. Yes ()
- 2. No ()

17. Do you use the internet service of your mobile phone to obtain agricultural information?

- 1. Yes ()
- 2. No ()

18. Which of the following are the chief sources of agricultural information for making management decisions in the farm?

- a. Friend ()
- b. Media ()
- c. Public agricultural extension agents ()
- d. Agro-input suppliers ()
- e. NGOs ()
- f. Research institutions ()
- g. Internet ()
- h. Others, please specify

19. Indicate other methods, if any, of getting agricultural information that has benefited the farm.

20. How would you rate availability of services from the public extension

a

b

c

d

e

f

g

h

a

b

c

d

e

office? Mark (✓) against the most appropriate response.

1. Easily available () 2. Available () 3. Rare () 4. Very Rare ()

code

PART III

21. Are you aware that it is possible to source and send agricultural information online?

1. Yes () 2. No ()

22. Do you consider sourcing agricultural information online valuable?

1. Yes () 2. No ()

23. Do you use internet facilities to obtain agricultural information?

1. Yes () 2. No ()

24. If yes in above 18, which among this factors mostly encourages you to use this method?

Easy to use ()

Easily available ()

Cheap source of information ()

Convenient ()

Has a lot of information ()

Instant source of information ()

Others, Please specify _____

25. If no in 18 above, which among the following factors mainly discourage you from using this method?

Limited skills ()

Unavailability of the service ()

Expensive to Use ()

Complicated method ()

Inconvenient to use ()

See no value in Method ()

Others, please specify _____

E. LETTER OF APPROVAL

MINISTRY OF EDUCATION, SCIENCE & TECHNOLOGY

Telegrams: EDUCATION", Nairobi

Fax No.
Telephone: 318581
When replying please quote



REPUBLIC OF KENYA

JOGOO HOUSE
HARAMBEE AVENUE
P. O. Box 30040
NAIROBI
KENYA

MOEST 13/001/35C 246/2

2nd June, 2005

**Justus M. Ombati
Egerton University
P.O. BOX 536
NJORO**

Dear Sir

RE: RESEARCH AUTHORIZATION

Following your application for authority to conduct research on "Factors influencing the application of information and communication technology in the management of Agricultural information: The case of Nakuru District". I am pleased to inform you that you have been authorized to conduct research in Nakuru District for a period ending 30th August, 2006.

You are advised to report to the District Commissioner, the District Education Officer and the District Agricultural Officer Nakuru District before embarking in your research project.

Upon completion of your research project, you are expected to submit two copies of your research findings to this Office.

Yours faithfully

For **PERMANENT SECRETARY**
MINISTRY OF EDUCATION
SCIENCE AND TECHNOLOGY

M. O. ONDIEKI

FOR: PERMANENT SECRETARY