

**EFFECTIVNESS OF COMMUNICATION SYSTEMS AND INDIGENOUS KNOWLEDGE IN
ADAPTATION TO CLIMATE CHANGE BY SMALLHOLDER FARMERS OF KILIFI
DISTRICT, KENYA**

GRACE A. ACHIANDO

**A Thesis submitted to the Graduate School in Partial Fulfillment for the Requirements of
the Master of Science Degree in Agricultural Information and Communication
Management (AICM) of Egerton University**

EGERTON UNIVERSITY

OCTOBER, 2012

DECLARATION AND APPROVAL

DECLARATION

I declare that this thesis is my original work and to the best of my knowledge, it has not been presented in this or any other university for the award of a degree.

Grace A. Achiando

Signature: _____

Date: _____

APPROVAL

This work has been prepared under our supervision and submitted to the Graduate school for examination with our approval as university supervisors.

1. Dr. Rhoda Birech

Department of Crops, Horticulture and Soil Sciences,
Egerton University,

Signature: _____

Date: _____

2. Dr. Washington Ocholla

Department of Agricultural Education and Extension,
Egerton University,

Signature: _____

Date: _____

COPYRIGHT

Whole or part of this thesis may not be reproduced, stored in any retrieval system, or transmitted in any form or means such as electronic, mechanical, photocopying, recording or otherwise without prior written permission of the author or Egerton University on behalf of the author.

©2012

Grace A. Achiando (KM18/2259/08)

All rights reserved

ACKNOWLEDGEMENT

I thank Almighty God for bringing me this far. I also wish to acknowledge the entire staff of the Department of Crops, Horticulture and Soil Sciences, Egerton University under the leadership of Dr. Joshua Ogendo for their sincere and honest support since I enrolled for my studies. Special thanks also go to my university supervisors, Dr. Rhoda Birech and Dr. Washington Ochola for their tireless and invaluable effort in guiding and supporting me during the entire study and research period.

I would like to extend my sincere gratitude to SCARDA (Strengthening Capacity for Agricultural Research Development in Africa) through the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for financially supporting my studies and research. The same goes to African Technology Policy Studies Network (ATPS) for financially supporting my research.

My appreciation is further extended to my fellow colleagues for sharing with me useful ideas during the entire period of study and research. I also wish to thank my field guides, Festus Mwasaga and Joseph Kiti who provided invaluable assistance during my field work, the staff from Kenya Agricultural Research Institute (KARI), Mtwapa and District Agricultural Office, Kilifi and the farmers of Ganze and Kikambala divisions for allowing me to learn and collect data from among them.

Finally, I want to express my deepest gratitude to my family, Collins and the children; Hellen, Peter and Redeptor and the entire Achiando family for their constant prayers, patience, goodwill and understanding during my constant absence from their midst. May God bless them abundantly.

DEDICATION

I dedicate this work to my beloved father, the late Peter Achiando and my loving mother Margaret Achiando for their care and for showing me the importance of education, and all the sons and daughters of the Achiando family.

ABSTRACT

Food production in Kilifi district, like in other parts of Kenya, has been declining over the years, lowering food sufficiency to about 30 percent down from 50 percent. Food production continues to decline despite all the efforts put in by the Government and non-governmental agencies, and this has been exacerbated by changes in climate. The adaptation strategies that are in place have not lead to any meaningful improvement and farmers continue to get reduced crop yields each year. Farmers have lived with climate variations for many years and have developed their own coping strategies, referred to as indigenous technical knowledge (ITK). Indigenous technical knowledge is an accumulated experience over time, which could provide insightful guidance into management of climate variability if it was integrated into modern scientific knowledge. However, this local knowledge related to adaptation to climate variability has largely not been recognized or documented and it is only lately that it is deemed to be critical in formulating policies to mitigate the harsh effects of the rapidly changing climate. This study is aimed at identifying indigenous knowledge and perception of effectiveness of communication systems for adaptation to climate change by smallholder farmers in Kilifi District, Kenya. It also aimed at determining the extent to which agricultural information and communication systems (AICS) have integrated indigenous knowledge for climate change adaptation by information end users. Purposive and systematic random samplings were used to select 167 study subjects (smallholder farmers). Both primary and secondary data sources were collected using observations and interviews with the help of a semi-structured questionnaire. Data was analyzed by use of both descriptive and inferential statistics using SPSS version 15 for windows. Findings indicated that 84% of the respondents have had contact with extension providers. Farmers have perceived AICS to be effective in disseminating knowledge regarding climate change management strategies. The study was able to identify existing ITK that farmers use. Based on the results, it is recommended that policy interventions be employed in creating strategies that would encourage integration of ITK into scientific agricultural practices that would enable farmers to plan for and cope with current climate risks and adapt to future climate change. This would ensure sustainability and vitality in improving agricultural production for food security.

TABLE OF CONTENTS

DECLARATION AND APPROVAL.....	ii
COPYRIGHT.....	iii
ACKNOWLEDGEMENT.....	iv
DEDICATION	v
ABSTRACT.....	vi
TABLE OF CONTENTS	vii
LIST OF TABLES.....	x
LIST OF FIGURES.....	xi
ACRONYMS AND ABBREVIATIONS.....	xii
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background Information	1
1.2 Statement of the Problem	2
1.3 Objectives.....	3
1.3.1 General Objective	3
1.3.2 Specific Objectives	3
1.4 Research Questions	4
1.5 Justification	4
1.6 Expected Outputs	5
1.7 Definition of Terms as used in this Study.....	5
CHAPTER TWO	7
LITERATURE REVIEW	7
2.1 Agricultural Information and Communication Systems in Kenya.....	7

2.2 Farmers' Perception of Effectiveness of Agricultural Extension Services	8
2.3 Climate Change Impacts on Agriculture	9
2.4 Farmers' Perception of Climate Variability	11
2.6 Indigenous Technical Knowledge amongst Coastal Farmers	13
2.7 Role of Indigenous Technical Knowledge in Climate Change Adaptation	15
2.8 Recording and Documenting ITK	16
2.9 Integrating Indigenous Knowledge with Science.....	17
2.10 Conceptual Framework	19
CHAPTER THREE	22
METHODOLOGY	22
3.1. Study Area.....	22
3.2 Research Design	23
3.3 Sampling Procedures and Sample Size	24
3.4 Instrument Development	25
3.4.1 Reliability of the Instrument.....	26
3.5 Data Collection Procedures	26
3.6 Data Analysis	26
RESULTS AND DISCUSSION	28
4.1 Farmer Characteristics.....	28
4.1.1 Age of the Respondents	28
4.1.2 Gender of the Respondents.....	28
4.1.3 Level of Education of the Respondents	29
Source: Survey data, 2011	30
4.1.4 Land Tenure of Respondents	30

4.1.5 Contact with Extension Providers	31
4.2. Perception of Farmers on Effectiveness of Existing AICS in Knowledge Dissemination	31
4.2.1. Exposure of Farmers to Extension Contact Compared to Crop Yields.....	32
4.2.2 Practices Extension Providers Promote and have been Adopted by Farmers	32
4.3 Main Mode of Communication by Extension Providers.....	34
4.4 Extent to which Feedback is Encouraged from Farmers.....	35
4.5 ITKs Practiced by Farmers to Manage Climate Change Challenges	36
4.5.1 ITK Practices Used in Managing Floods.....	37
4.5.2 ITK Practices Used in Managing Erratic Rainfall.....	38
4.5.3 ITK Practices Used in Managing Drought	38
4.5.4 ITK Practices Used in Managing Pests	39
4.5.5 ITK Practices Used to Manage Heat on Crops.....	41
4.6 The Extent to which ITK has been Integrated into Scientific Climate Change Adaptation Practices	42
CHAPTER FIVE	46
CONCLUSIONS AND RECOMMENDATIONS.....	46
5.1 Conclusions	46
5.2 Recommendations	46
5.3 Further Research	47
REFERENCES.....	48
APPENDIX 1: QUESTIONNAIRE FOR FARMERS	52
APPENDIX 2: INTERVIEW GUIDE FOR RESEARCHERS AND EXTENSION OFFICERS	59
APPENDIX 3: FOCUS GROUP DISCUSSION (OPINION LEADERS).....	61

LIST OF TABLES

Table 1: Number of farmers selected from each location.....	25
Table 2: Number of Respondents	25
Table 3: Distribution of respondents by age	28
Table 4: Distribution of respondents by gender.....	29
Table 5: Distribution of respondents by level of education.....	30
Table 6: Land tenure	30
Table 7: Change in yield compared to the duration of contact with extension providers	32
Table 8: Distribution of practices promoted by extension providers and those that have been adopted by farmers.....	33
Table 9: Farmers' Perceptions Index	34
Table 10: Farmers' Perception category	34
Table 11: Relationship between the main mode of communication and the extent of feedback..	35
Table 12: Extent to which feedback is encouraged by locations (%).....	36
Table 13: Frequency distribution of ITK practices used in managing floods (%).....	37
Table 14: ITK practices used to manage erratic rainfall.....	38
Table 15: Distribution of ITK practices used to manage drought	39
Table 16: Distribution of ITKs used in managing pest incidences.....	40
Table 17: Distribution of ITK practices used to manage heat on crops.....	41
Table 18: The extent to which ITK has been integrated into scientific climate change adaptation practices by locations (%).....	43

LIST OF FIGURES

Figure 1: Average annual rainfall in Kikambala and Ganze divisions, Kilifi district (mm)	11
Figure 2: Conceptual frame work	21
Figure 3: Map of Kilifi district.....	23
Figure 4: Contact with extension providers (%).....	31
Figure 5: Summary of extent of feedback encouragement (%).....	36
Figure 6: Extent of ITK integration (%)	44

ACRONYMS AND ABBREVIATIONS

- i) AGED** - Agricultural Extension and Education
- ii) AICM** - Agricultural Information and Communication Management
- iii) AICS** - Agricultural Information and Communication Systems
- iv) AIM** - Agricultural Information Management
- v) AKIM** - Agricultural Knowledge and Information Management
- vi) AKIS** - Agricultural Knowledge and Information Systems
- vii) ASALs** - Arid and Semi-Arid Lands
- viii) FAO** - Food and Agriculture Organization
- ix) GDP** - Gross Domestic Product
- x) ITK** - Indigenous Technical Knowledge
- xi) KARI** - Kenya Agricultural Research Institute
- xii) NGO** - Non-Governmental Organization
- xiii) NALEP** - National Agricultural and Livestock Extension Program
- xiv) NARE** - Natural Resources
- xv) SPSS** - Statistical Package for Social Science

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Climate change is the fluctuation around the mean climate state or pattern that has built over a long period of time, usually decades or longer, typically 30 years (IPCC, 2007). The world's climate is continuing to change at rates that are projected to be unprecedented in recent human history. Some models are now predicting that the temperature increases by the year 2100 may be larger than previously estimated in 2001 (Thornton *et al.*, 2006). Floods and droughts are becoming more frequent and severe, which is likely to seriously affect farm productivity and the livelihoods of rural communities. The impacts of climate change are likely to be considerably high in tropical regions. Sub-Saharan Africa is currently the most food-insecure region in the world (World Bank, 2008). Climate change threatens to aggravate the food situation unless adequate measures are put in place. The environmental and social consequences of climate change put farmers' livelihoods at risk and this is worse where farming is done at small scales. It is known that these farmers have lived with climate variations for many years and have developed their own coping strategies, known as indigenous technical knowledge (ITK).

Indigenous technical knowledge (ITK) refers to a body of knowledge belonging to communities or ethnic groups, shaped by their culture, traditions and way of life (Mazonde and Thomas, 2007). The usefulness of ITK in agricultural management has been overlooked by agricultural information and communication managers when advising policy makers. Of interest to climate change adaptation should be indigenous practices in food production systems, water-stress management, socio-cultural systems, and cross-cutting and supportive issues represented in indigenous knowledge (Mazonde and Thomas, 2007).

In Kenya, climate change effects have been felt most in the arid and semi-arid lands (ASAL). The agricultural sector, which forms the base of rural livelihoods in the country, is confronted with the major challenge of increasing food production to feed a growing and increasingly prolific population amidst a situation of decreasing availability of natural resources. This situation is exacerbated by the challenges related to climate change. To help farmers

overcome climate change challenges, researchers and extension agents have put in place modern agricultural technologies, which they disseminate to farmers on a regular basis. There is, however, a wide gap between agricultural technologies produced in research institutions and the translation of the same into increased yields and subsequent food security.

Kilifi, one of the ASAL districts in coastal Kenya, faces serious food insecurity. Food production has been declining over the years and this has persisted with continued changes in climate. The district has one of the highest incidences of poverty countrywide. Nearly 70% of its residents fall below the poverty line despite mean monthly household earnings of Ksh. 7,432. The district houses Ganze, one of the poorest constituencies in the country, with nearly 84% of its populace living below the poverty line (Kahindi *et al.*, 2003). In Coastal Kenya, a lot of indigenous knowledge is noticed in the farmers' way of carrying out agronomical practices and these hold crucial leads towards sustainable management of climate change related stresses. However, communication systems devoted to food production strategies have not been keen on incorporating feedback from information users, and have therefore missed out on the benefits of ITK. Some of the dissemination models, especially Training and Visits (T&V) did not recognize the farmers' voice as a way of feedback. Agricultural information and communication systems (AICS), as part of Agricultural Knowledge and Information Systems (AKIS) should be active in influencing the integration of ITK in climate change adaptation. If the ITK is well tapped, transformed and introduced in current technology development, it can have the potential to help solve some of the problems that are faced by smallholder farmers. This can contribute in alleviating the poverty level in Kilifi, improve its food production and make the district food secure.

1.2 Statement of the Problem

The impacts of climate change on agriculture threaten food security, especially in ASAL districts like Kilifi. The district is considered very susceptible to climate change due to its vulnerability as a result of the harsh weather conditions. Food production in the district has been declining over the years and this has persisted with continued changes in climate, despite the much effort put in by the Government and non-governmental agencies. This has resulted in low food self sufficiency of 30 percent down from 50 percent over a period of 30 years (Ministry of

Agriculture, 2008). The adaptation strategies that are in place have not shown meaningful improvement and farmers continue to get reduced crop yields. Indigenous technical knowledge (ITK) is now considered important in formulating strategies to adapt to the challenges of the rapidly changing climate. It is not clear what influence feedback from farmers and the incorporation of the available indigenous knowledge into the agricultural information and communication systems (AICS) would have on the uptake of climate change adaptation strategies.

This study therefore investigated the effectiveness of AICS, the role of ITK and the potential of integrating ITK into scientific approaches in enhancing the management of climate change challenges for increased food production by smallholder farmers.

1.3 Objectives

1.3.1 General Objective

To contribute to improvement of agricultural information and communication systems through integration of ITK in the management of climate change adaptation strategies.

1.3.2 Specific Objectives

- i) To determine the smallholder farmers' perceptions of effectiveness of existing agricultural information and communication systems in disseminating climate change adaptation strategies.
- ii) To determine the extent to which agricultural information and communication systems encourage feedback from smallholder farmers in respect to climate change management.
- iii) To determine the role of ITK in the management of challenges related to climate change such as erratic rainfall, floods, drought, food scarcity, pest incidences and temperature.

- iv) To determine the extent to which ITK has been integrated into scientific climate change adaptation strategies by different agricultural information and communication managers.

1.4 Research Questions

- i) Are the existing agricultural information and communication systems perceived by smallholder farmers to be effective in disseminating climate change related knowledge?
- ii) To what extent do the agricultural information and communication systems encourage feedback from information users in respect to climate change?
- iii) Does ITK play any role in the management of problems related to climate change?
- iv) To what extent has ITK been integrated into scientific climate change adaptation strategies by different information managers?

1.5 Justification

Food production in Kilifi district has been declining over the years. This has reduced food self-sufficiency from 50 percent to 30 percent over a period of 30 years, whereas there is enough agricultural land (Ministry of Agriculture, 2008). The district has suffered from repeated drought, erratic rainfall as well as floods, which have been exacerbated by climate change. There are strategies and information that have been developed by government agencies for adaptation to climate change. These strategies have however not been effective in managing this unprecedented change in climate. Farmers have lived with climate change for years and have developed their own coping strategies, making them a depository of valuable knowledge. The usefulness of ITK in agricultural management has been overlooked by agricultural information and communication managers. If agricultural information and communication systems could recognize the existing ITK and its role in climate change management strategies, it is assumed that there would be better resilience to cope with climate change uncertainties and livelihoods of the smallholder farmers in ASALs would improve. This study therefore investigated the effectiveness of AICS and the existence of feedback mechanisms, and subsequent integration of

indigenous knowledge into the developed scientific climate change strategies. Incorporating ITK can add value to the development of sustainable climate change adaptation strategies that are rich in local content, and planned in conjunction with local people. Although research is gradually recognizing the importance of indigenous systems in development studies, the value of ITK in climate change studies has received little attention.

1.6 Expected Outputs

- i) development of an Msc. thesis in Agricultural Information and Communication Management (AICM)
- ii) proposal of an appropriate agricultural information and communication framework that incorporates ITK
- iii) production of publications for a referred journal and seminars
- iv) presentation at local and international conferences

1.7 Definition of Terms as used in this Study

Adaptation: Ability by farmersto adjust to the conditions presented by climate change.Itmay involve development of new ways that will enable them to cope with the conditions.

Adoption: The acceptance and actual continued use of the recommended agricultural practices by smallholder farmers.

Agricultural Extension: Educational system or procedure that is used to assist farmers to improve farming methods and techniques. It involves conveyance of the modified innovations from research and educational institutions to farmers.

Household: A group of about15 people cultivating the same farm and relying on it for food as found in Kilifi district. Theymay live on the same compound or not.

Indigenous technical knowledge: A body of knowledge built by a group of people through generations of living in close contact with nature.

Integrate: To incorporate ITK into scientifically generated agricultural knowledge in such a way that it becomes fully part of modern farming practices among smallholder farmers.

Agricultural research: Investigation or finding of new agricultural innovations or technologies that are passed down to farmers for adoption.

Smallholder farmer: A farmer cultivating less than 10 acres of land and this is usually for subsistence.

CHAPTER TWO

LITERATURE REVIEW

2.1 Agricultural Information and Communication Systems in Kenya

Agricultural extension could be considered as a bridge between scientists and governmental bodies on one hand, and agricultural practices and farming on the other hand. Many different agricultural extension models have been utilized in developing countries in Africa, in order to bring about rural development (Davis and Place, 2003). In Kenya, numerous approaches have been tried, with varying success. According to Davis and Place (2003), current extension concepts in Kenya include participation, facilitation, partnership and sustainability. With increasing emphasis on farmers themselves and community-based extension, the approaches in Kenya included Training and Visits (T & V) and Farmer Field Schools (FFS). Training and visits involved route maps of eight farmers being visited by an extension provider per day, whether they demanded or not. This made some farmers feel left out. On the other hand, the farmers on the route maps also felt 'over-visited'. Another short fall was that the farmer was never given the chance to set his priorities. The extension provider could come with the entire package and the farmer was only a recipient. These shortfalls have led to the development of agricultural knowledge and information systems (AKIS), which recognize indigenous technical knowledge. This concept has, however, not been introduced in the current agricultural information and communication systems, and especially in relation to climate change adaptation strategies.

Chambers *et al.* (1989) noted that knowledge flows in one direction only- downwards – from those who are strong, educated and enlightened, towards those who are weak and ignorant. This is in line with this study's assumption that the communication systems do not encourage dialogue with farmers, and that research agenda is generated without the farmers' contribution. In many ways, the hierarchical and highly bureaucratic way in which the services are organized hampers a full realization of their potential. Lately, there has been an increasing drive in Kenya to put more emphasis on farmers-centered and community-based extension, which encourages participation, facilitation, partnership and sustainability (Davis and Place, 2003). Though these

noble concepts are generally accepted, they are rarely practiced. This study assumes that the existing agricultural information and communication systems used have very little regard, if any, for farmers' views. Based on this assumption the study had an objective on determine the extent to which farmers' indigenous knowledge (ITK) is incorporated in scientific climate change adaptation strategies.

Demand driven innovation systems can only be successful with substantial technical contributions from the demand side (knowledge users). Ison and Russell (2008) argue that the approach should respect the indigenous knowledge of the farmers – knowledge which may not be known by scientists. It should consider the farmers as the basic units for setting research priorities. The major objective is to give farmers the power to dominate their situation, and to create a better future for themselves, rather than being passive recipients of new technology (Maru, 2003). This study concurs with these findings as it seeks to determine the level of integration of farmers' knowledge in climate change adaptation strategies.

2.2 Farmers' Perception of Effectiveness of Agricultural Extension Services

A number of studies have emphasized the importance of agricultural extension officers as a source of information on new farming technologies that farmers are expected to adopt. Suda (2000) found that farmers rarely make decisions on the type of conservation techniques on their own, primarily because of the existing knowledge gap between the agricultural extension officers and farmers. Joint decision making between the farmers and the extension personnel was found to be very limited. This is in line with an objective of this study which seeks to find out if farmers' knowledge is recognized by agricultural extension providers through feedback mechanisms.

A study by Maru (2003) supports the fact that extension officers play a big role in farmers' adoption of new technology. His study points to a need for participatory extension approaches, resource allocation, as well as participatory monitoring and evaluation systems, where the farmer has a say in the technologies to be adopted. Like the study of Maru, the current study seeks to determine the level at which feedback from farmers is encouraged by extension

providers. If the technologies developed and disseminated by the AICS are not adopted by farmers, the methods could be perceived not to be effective. Maru's study is also in line with this study as one of its objectives is to evaluate the farmers' perception of effectiveness of existing AICS. Extension officers could have all the resources needed but if the systems under which they operate are not effective, then their efforts go to waste.

2.3 Climate Change Impacts on Agriculture

The environmental and social consequences of climate change, especially for the poor, put their livelihoods at risk. Pippa (2008) found out that increase in temperature, decline in fresh water availability, rise in sea level, increase in frequency and intensity of extreme weather events, and shifting of cropping zones - all impact agriculture and the related food sector. Taratola (2008) found out that climate change encourages the spread of pests and may increase the geographical range of some diseases. Orindi (2009), however, found it necessary to divide climate change impacts into two groups:

i) Biophysical impacts-

- changes in rainfall amounts and distribution, leading to an increased frequency and intensity of extreme climatic events, such as floods and drought,
- high temperatures and subsequent snow melt in the polar regions, resulting in sea level rise that may displace populations and destroy infrastructure in low lying coastal areas

ii) Socio-economic impacts:

- decline in yields and production,
- reduction in marginal GDP from agriculture,
- increase in number of people at risk of hunger and food insecurity

To cope with the impacts of climate change requires measures that will minimize losses or take advantage of the opportunities presented, a process referred to as adaptation (Pippa, 2008). The author further argues that the development of appropriate adaptation options therefore depends on the availability of accurate information on climate change impacts and reliable communication strategies, which need to be availed to empower poor communities. This study concurs with all these observations since its significance lies in the exploration of coping strategies for adaptation to climate change by smallholder farmers.

Kenya has been identified by the World Bank as being among the countries at highest risk from climate change, particularly through the impacts of droughts (World Bank, 2008). Extreme climatic events, such as floods and droughts, have affected agricultural performance and food security frequently in the last few decades and resulted in diversion of resources from development planning to emergency response in Kenya. Repeated rain failures and the severe droughts of 2001/2002 and 2006 could be evidence of an early signal of climate change (World Bank, 2008). These impacts are particularly severe in the vulnerable arid and semi-arid lands (ASALs) (World Bank, 2008). Such weather patterns are likely to deplete water resources leading to resource scarcity (GoK, 2007).

Davis and Place (2003) argue that low production by Kenya's smallholder farmers is partly due to their limited access to farm inputs, lack of appropriate technical skills, lack of access to appropriate agricultural information system, insufficient use of yield-enhanced technology and unreliable rainfall patterns that is enhanced by climate change variations. The poor are hardest hit by all this because of their vulnerability to the effects of climate change. Since most of them depend on natural resources and rain fed agriculture for their livelihoods, and they are least able to cope with the shocks of climate change-induced droughts, floods and other natural disasters (Besada and Sewankambo, 2009). Strategies that should be employed include technical, financial and capacity building.

Kilifi district is faced with serious environmental problems. The Arabuko Sokoke forest is under threat from human encroachment and uncontrolled exploitation (Kahindi *et al.*, 2003). Its smallholder farmers rely on rainfall for their farming activities. The district being an ASAL has faced serious unreliable rainfall for the last 20 years (Figure 1). Important to note is the variability between the two divisions under study. While Kikambala could receive up to an average of 220 mm of rainfall per year over the last 20 years, Ganze could only record a maximum average of 38 mm per year.

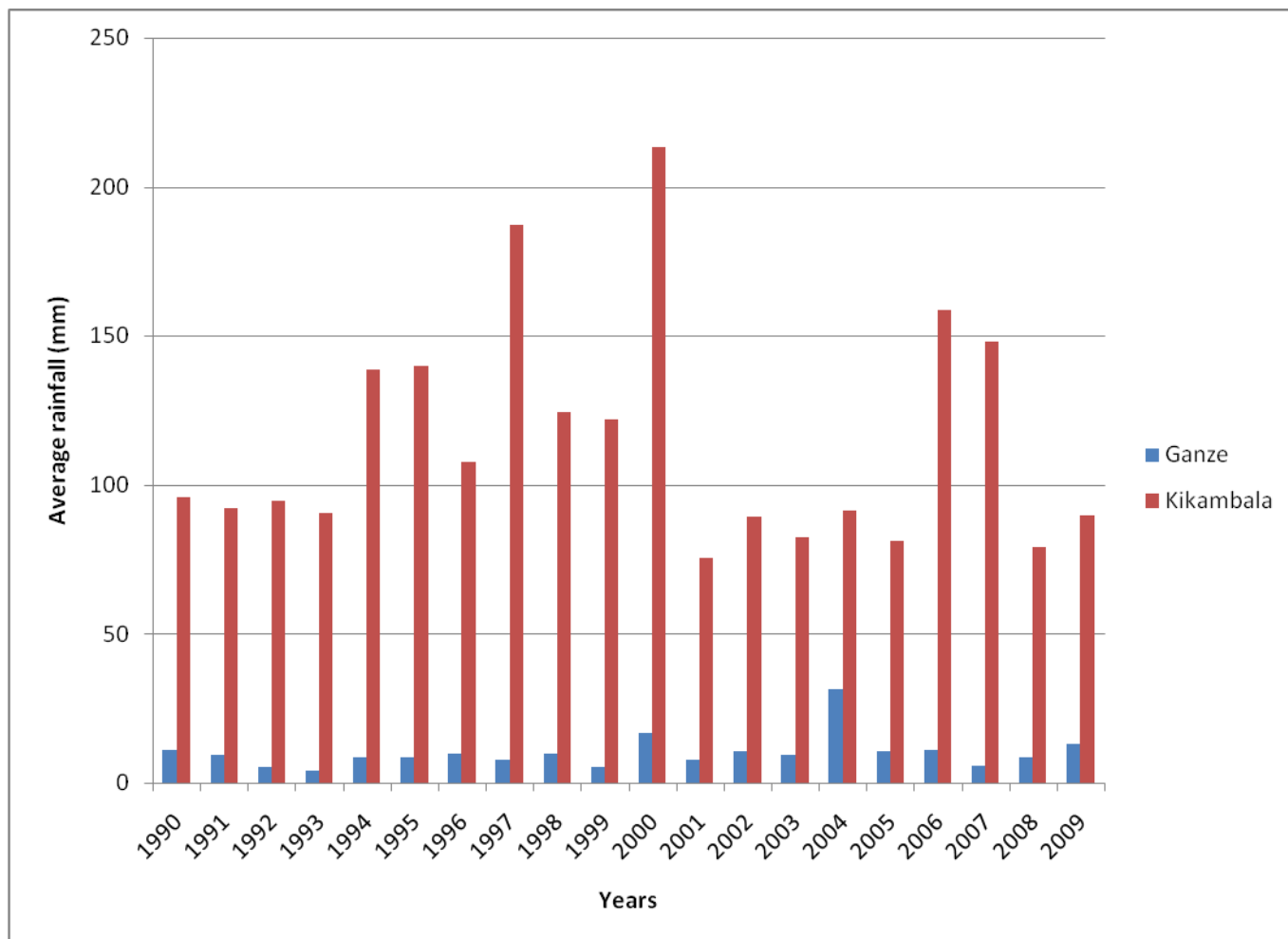


Figure 1: Average annual rainfall in Kikambala and Ganze divisions, Kilifi district (mm)

Source: Metrological stations – Mtwapa and Ganze (2010).

2.4 Farmers’ Perception of Climate Variability

The effects of global warming are already visible in much of the world. Farmers are well aware of the general climate in their localities, its variability, and the probable nature of the variability and its impacts on crop production. Rao *et al.* (2010) argue that there is a great need to be aware of and account for during the development and promotion of technologies to farmers. These technologies must be developed with farmers’ perceptions about long term climate variability and change in mind as they might involve significant investments by farmers. The

uptake of climate change strategy depends on farmers' attitude instead of its importance. Further, farmers' perceptions are also likely to be shaped by the agro-economic performance of crops and other farm enterprises.

Farming in the semi-arid tropics, where season-to-season variability in rainfall dictates productivity and profitability is a risky endeavor especially for small and marginal farmers with limited land and financial resources (Rao *et al.*, 2010). Therefore, they have to make several decisions such as which crop or variety to grow, on how much land, what inputs to use and what soil, water and crop management strategies to adopt. Rasheed (2003) concludes that the outcome of such decisions is directly linked to the amount and distribution of rainfall during the season. Because of the variability and uncertainty associated with seasonal rainfall, farmers make these decisions based on their knowledge and experience gained that would enable them to plan for and cope with current climate risks and adapt to future climate change.

The major impact of drought on smallholder activities is increased food insecurity and loss of livelihoods (Ojwang *et al.*, 2010). The means to food security in every community vary from place to place as do the adaptation strategies to environmental hazards such as droughts and floods. Ojwang *et al.* (2010) further assert that the climate projection for the ASAL of Kenya may include longer and more frequent dry periods interspersed with intense but shorter and unpredictable periods of rainfall.

Considering the important role indigenous knowledge can play in developing practical and realistic approaches that facilitate smallholder farmers in adapting to impacts of current and future climates, several studies have been carried out to understand and assess farmer perceptions about climate variability and the mechanisms employed to cope with it across Africa and elsewhere. However, the main focus of these studies was sociological. Rasheed (2003) tried to assess the accuracy of farmers' perceptions of current climate-induced risk and possible long-term changes in climate.

According to a study carried out in semi-arid Kenya by Rao *et al.* (2010), most farmers interviewed agreed that the impacts of climate change were real but they were at a loss as to what tangible solution they could apply. According to them, major changes had taken place in the

amount and distribution of rainfall, dry temperatures as well as in the onset and length of wet and dry seasons.

2.5 Climate Change Coping Strategies and Adaptation

Farmers have minimized or spread risks by managing a mix of crops, crop varieties and sites, staggering the sowing/planting of crops, and adjusting land and crop management to suit the prevailing weather conditions (Ochola *et al.*, 2010). Adaptation to climate change is concerned 'with adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Given the current extreme impacts of climate change, adaptation to environmental variability has been undertaken (to varying degrees of success) by people for a long time. Farmers' adaptation to their environment, livelihood diversification and copying strategies to deal with the overall variability of their social and natural environment are well documented (Ochola *et al.*, 2010).

2.6 Indigenous Technical Knowledge amongst Coastal Farmers

For many generations, people around the World have used indigenous knowledge, in autonomous ways. Bernet *et al.* (2005) reason that ITK exists in every community since it is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about their relationships with one another and with their environment. Kahindi *et al.* (2003) in their study of the Giriama community of coastal Kenya came out with the following findings on the various ways in which coastal people employ ITK:

- i) Land preparation and planting - traditionally, farmers in coastal Kenya practice non-tillage (soil is not tilled) farming techniques. Farmers normally clear the land either by hand or by burning, they then raise crops with minimum disturbance to the soil. Holes for planting are made using a small traditional hoe called *kiserema*. Although weed infestation is greater with this kind of tillage, its benefits include soil and water conservation and lower labor inputs.

- ii) Use of local varieties - varieties like *mzihana*, *mwangongo* and *kanyelenyele* (maize) used by the farmers are adapted to soils that are low in nutrients and moisture, thus the use of chemical fertilizers and the heavy reliance on water are reduced. The traditional varieties are also known to be less susceptible to insect pest attack and farmers claim that the flour obtained from them is heavier and more filling when taken in a meal. Similarly, traditional cassava varieties include *kibanda meno*, *kaleso* and *nguzo* that can give good performance under harsh climatic conditions such as high temperatures and low rainfall. The farmers also claim that they taste better than the conventional ones.
- iii) Timing of planting - coastal farmers have their ways of determining when it is about to rain. This can be shown by the way livestock behave the strength and direction of winds, and movement of tides in the ocean. Very strong winds do not necessarily mean the rains are about to come, but winds blowing from the East signify heavy rains.
- iv) Maintaining soil fertility - different ways are used by farmers in coastal to maintain soil fertility and these include mixed cropping, especially of maize and pulses, where both seeds are planted in the same hole, and inter cropping of maize (*Zea mays*) and cassava (*Manihot esculanta*) . Cattle manure, chicken waste, compost manure and green manure are also used to increase soil fertility.
- v) Pest management - The farmers use locally available trees like *Mkilifi* (*Azadracta indica*) for both on- farm and post- harvest pest management, and use of wood ash to preserve harvested grains and cereals. Harvested cereals are also preserved by keeping them above fireplaces in specially made *lutsaga*.
- vi) Diverse feeding patterns - climate change has contributed to decline in yields of major crops including maize, which has been a major staple food in the coast. The people have therefore diversified their consumption patterns and can feed on delicacy insects, rodents, cassava leaves, local vegetables, sea food, etc.

The above study by Kahindi *et al.* (2003) found that ITK is present in the Giriama community that occupies almost the whole of Kilifi district.

2.7 Role of Indigenous Technical Knowledge in Climate Change Adaptation

Rao *et al.* (2010) found out that as much as climate change should involve long term changes in seasonal or annual temperatures or precipitation, it was commonly associated with events such as floods, droughts and many others therefore involving anticipatory action. Adaptations to climate change are occurring at the individual level with little involvement of Government stakeholders. These are characterized by responsive activities such as avoiding, retreading, coping, accommodating, adjusting or spreading risks and securing resources. Since rain-fed farmers are already vulnerable to current weather variability and associated shocks, it is essential to help them build their livelihood resilience through coping better with current weather-induced risks as a pre-requisite to adapting to future climate changes (Bernet *et al.*, 2005). ITK integration in modern technology planning and development has been observed in other areas. Extensionists now recommend the longer soaking time for concoctions made from local trees to control insect pests by farmers in Kakamega. Elsewhere farmers in Kasikeu sub-location of Makueni district of Eastern Kenya had detailed and accumulated knowledge on soils classification which saved soil scientists a great deal of time during soil sampling in the district (Mureithi *et al.*, 2003). Research by KARI in Trans Nzoia, West Pokot, Homa Bay and Kiambu districts of Kenya, found that farmers had useful undocumented knowledge on crop and livestock production. Using the information from farmers on concoctions used in pest management (*Tithonia diversifolia*, *Mexican marigold* and *hot pepper*), KARI went a step further to verify and give proper preparation methods and dosage rates for effective pest control in crops and livestock. This technology has been found to be cost effective and therefore affordable and easily adaptable by farmers (Mureithi *et al.*, 2003). These examples help to strengthen the fact that continuous experimentation, adaptation and knowledge sharing among researchers, extensionists and farmers are critical in ensuring that practices developed by researchers and promoted by extensionists are appropriate over large areas to farmers who are the ultimate implementers (Bohringer, 2001).

There is a powerful case that favours the use of available farmers' indigenous knowledge in climate change adaptation strategies. ITK together with knowledge from researchers, extensionists and documented science can form a basis of modeling the influence of a vast range of technologies in climate change adaptation. This requires a platform that combines and

integrates this information from different sources and representing it in an appropriate way (Sinclair and Walker, 1998). Integrated climate change information coupled with an appropriate information flow can be expected to be a key resource for planning and implementing research and development programs. Relevant programs are more likely to be achieved where planned with due regard for the farmers' perspective on needs and priorities. This model presents promising opportunities for ensuring sustainable climate change adaptation by resource-poor smallholder farmers. Indigenous knowledge therefore remains important for many tangible and practical reasons as Kumar (2009) found out:

- i) Indigenous technical knowledge is useful where it is difficult for formal knowledge to relate to indigenous means of production.
- i) Indigenous technical knowledge can be used to enhance new technology and motivate farmers.
- ii) Indigenous technical knowledge enhances local problem solving capacity of farmers.
- iii) Farmers identify with ITK and it therefore becomes easy for them to adopt it.

The above studies emphasized the role of ITK in the management of climate change challenges. This is in line with the present study which endeavored to determine the role of ITK in the management of challenges related to climate change such as floods, drought, food scarcity, pest incidences and weather extremes.

By applying participatory community or action research, ITK can be tapped and utilized to form a basis for research. This requires efficient collection and collation of knowledge from local communities.

2.8 Recording and Documenting ITK

Many of the indigenous technologies in agriculture and allied fields have been replaced by modern technologies and they have become obsolete, especially among the younger generations (Bollier, 2009). Now these indigenous practices are endangered and they are found only with the aged and elderly farmers as an unwritten body of knowledge. Hence, there is a possibility of this knowledge becoming extinct particularly during this era of liberalization, privatization and globalization. Ison and Russell (2000) recommend that there is, therefore a

need to systematically document, validate, standardize and to propagate the indigenous knowledge technologies so as to reduce dependence on external inputs, to reduce the cost of production and to propagate eco-friendly agriculture. The most urgent problem associated with ITK is its rapid disappearance owing to the passing on of elders. Loss of ITK is due to inadequate research effort in this field. This has been due to influences of increased elitisms, urbanization, sophistication and religious influence, such that as each generation passes, there is a diminishing interest in the ITK practices. This is exacerbated by migration of young people to urban centers to look for employment, hence breaking family links, which are pre-requisite to passing on the much guarded knowledge (Inglis, 1993). Documentation of ITK is important and critical if this body of knowledge is to be maintained and conserved for future generations. Currently there is no system of harnessing this knowledge. Communication of ITK is mainly through dialogue. This makes it necessary to record and document it so that it can be made available for others to use, as was found out by Ison and Russell (2000).

2.9 Integrating Indigenous Knowledge with Science

According to Bollier (2009), indigenous knowledge not only preserves the past, but can be vital to ensuring a sustainable future. Indigenous knowledge has always been dismissed as inferior and insignificant, but it has been realized to be important in reducing disaster risk and adaptation to climate change. However, the importance of science in reducing disaster risk also needs to be recognized. The answer lies in an integration of the most effective and culturally compatible innovations into scientific knowledge. Too often in the past, disaster risk reduction strategies have failed due to their inability to fit the local context (Bollier, 2009). Combining local knowledge and science may be a way to overcome such problems and deal with the effects of climate change. Indigenous technical knowledge can address climate change impacts and reduce disaster risk but it must be combined with other knowledge and used in the broader context of sustainable development (Ison and Russel, 2000). Farmers take a central position in agricultural activities but their role has been given very little attention in the past, where they are expected to adopt innovations that have been developed by others. Farmers can easily identify their needs and capacities, through the use of their ITK. What they need is technical guidance so that they can manage challenges in their farming activities. This can best be achieved by

integrating their ITK with science. Bollier (2009) further argues that indigenous knowledge and perception about climate change can be integrated into development programs. This can then be used in objective assessment and evaluation and in promoting effective integration with modern science. This is in line with this study's objective which seeks to find out if ITK has been integrated into scientific climate change adaptation strategies. Ison and Russell (2000) argue that there is much to learn from the ITK system if we are to move toward interactive technology development from the conventional transfer of technology approach. It is feasible, efficient and cost effective to learn from the village- level experts.

Indigenous knowledge draws on local resources. People are less dependent on outside supplies which can be costly, scarce and available only irregularly. There are a lot of advantages with the use of ITK which include the fact that they are:

- i) Less time consuming: This is because the small size of the farms and the system of production are compatible.
- ii) A compatible system of production: Farmers are familiar with indigenous practices and technologies. They can understand, handle and maintain them better than introduced western practices and technologies.

Ison and Russell (2000) further argue that incorporating ITK can add value to the development of sustainable climate change adaptation strategies that are rich in local content, and planned in conjunction with local people. Although research is gradually recognizing the importance of indigenous systems in development studies, the value of ITK in climate change studies has received little attention. In order to integrate ITK into formal climate change studies, there are steps that must be taken:

- i) Acknowledgement that ITK has provided communities with the capability of dealing with past and present vulnerabilities to climate extremes and other stresses.
- ii) Adopting the bottom-up participatory approach that encourages the highest level of local participation. Benefits of this are that it provides valuable insights into how communities and households interact and share ideas. It also allows the intended beneficiaries to develop the skills and practices necessary to forge their own path and sustain the project.
- iii) The local communities should be seen as equal partners in the development process. Local actors should progressively take the lead while external partners should back their

efforts to assume greater responsibility for their development. Capacity building should emphasize the need to build on what exists, to utilize and strengthen existing capacities.

- iv) In as much as we acknowledge the importance of indigenous practices in climate change adaptation, they should not be developed as a substitute of modern techniques. It is important that the two are complements and learn from each other in order to produce 'best practices' for adaptation. A 'best practice' is the result of articulating ITK with modern techniques- a mix that proves more valuable than either one on its own. The interaction between the two different systems of knowledge can also create a mechanism of dialogue between local populations and climate change professionals which can be meaningful for the design of projects that reflect people's real aspirations and actively involve communities.

2.10 Conceptual Framework

The conceptual framework of the study evaluated the farmers' perception of the effectiveness of Agricultural Information and Communication Systems (AICS) as part of Agricultural Knowledge and Information Systems (AKIS) in influencing the integration of ITK in climate change adaptation. The uptake of climate change strategy as indicated by extension agents and other service providers depends on farmers' attitude instead of its importance. That is the reason the study emphasizes recognition and integration of ITK, a body of knowledge owned and understood by the farmers. Effectiveness of the AICS will be determined by the dissemination of climate change adaptation strategies to SHF, knowledge of ITK practices by farmers, use of ITK, extent of feedback from farmers and extent of integration of ITK on climate change strategies.

The study assumed that other extraneous factors notwithstanding, the adoption of such strategies would enhance food and income security among smallholder farmers. As a basis of the climate change knowledge systems, the exchange of climate change adaptation knowledge and technologies between service providers, especially extension agencies, smallholder farmers, researchers and other climate change knowledge users could only be effective with the interpretation of ITK. The farmers' perception of the effectiveness of AICS was measured by the

changes realized due to dissemination of climate change adaptation strategies, knowledge and recognition of ITK and extent of feedback on communication.

As the main dependent variables, climate change strategies were measured through the determinants of traditional knowledge-attitude-practice framework. The main independent variable was perception of the effectiveness of AICS, which was measured by comparing the duration of contact the farmers had had with extension providers, against the influence the existing methods had had on crop yields. A comparison of the practices the information providers promote and those that farmers acknowledged to have adopted and had increased yield was also done. On ITK, the main variable was the role that ITK had played in the management of challenges related to CC. The extent of integration of ITK in scientific technologies was also evaluated. The study also recognized the possible influence of other factors (extraneous factors). These included farmers' socio-economic characteristics such as age, education level, gender and household size. Figure 2 presents a graphical presentation of the logical framework.

The study assumed that agricultural production context factors including policy, climate, extension and many others were uniform to all the framers in the district. Farmer socio-economic characteristics were studied to control/isolate the influence.

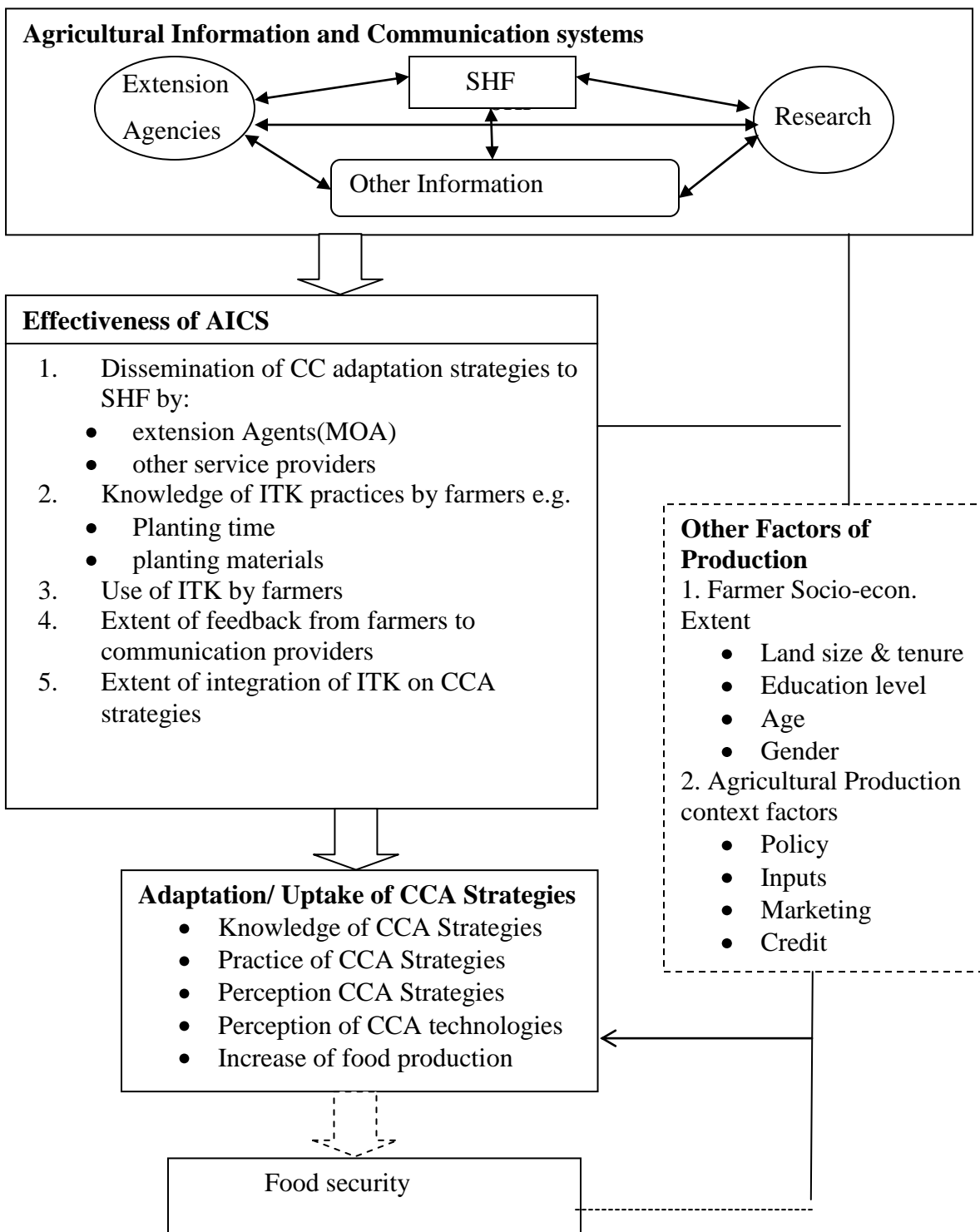


Figure 2: Conceptual frame work

Source: Literature review 2011

CHAPTER THREE

METHODOLOGY

3.1. Study Area

Kilifi district is in Coast province and is bordered by Mombasa district to the South, Taita Taveta to the West and Malindi to the North as well as the Indian Ocean to the East. The district is divided into 8 divisions namely: Kikambala, Bahari, Chonyi, Ganze, Vitengeni, Kaloleni, Bamba and Arabuko Sokoke (Figure 3). The average annual rainfall in the district is from 38 mm (Ganze) in the upper to 220 mm (Kikambala) in the lower zones per year, occurring biannually with long rains (April-June) being heavier than short rains (October) (Ministry of Agriculture, 2008). Temperatures range between 24⁰ and 35⁰ C. Soils change from sandy to sandy-loam as one moves away from the coast line. The district has remained food deficit for a long time with about 30% food sufficiency when cereals alone are considered, resulting in some divisions receiving relief food from the government and Non-Governmental Organizations (NGO) (Ministry of Agriculture, 2008).

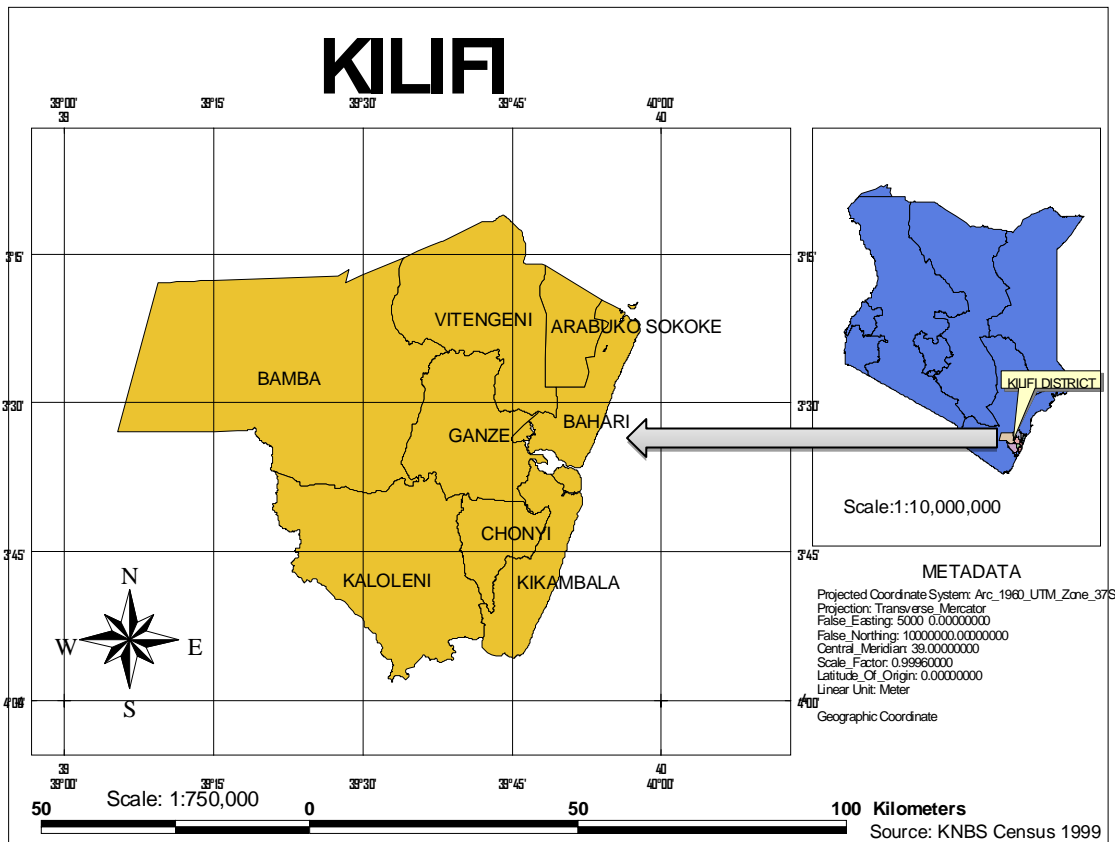


Figure 3: Map of Kilifi district

Source: Barazaet al. (2008)

3.2 Research Design

The study was carried out under a purposive, multi-stage random sampling technique. Thus the study relied on a set of structured and standardized questions which were administered to the respondents through personal interviews using questionnaires. Using the design the study sought to determine and describe the relationships between the dependent and independent variables. Focused group discussions were also held with selected respondents, for secondary information on importance of ITK to authenticate the information given by farmers. The discussions were also to enhance and supplement the information got from the questionnaires. Information also came from researchers from KARI, Mtwapa and extension officers from Kilifi district. The design focused on the effectiveness of agricultural information and communication

systems, by smallholder farmers in Kilifi district, with the objective of trying to understand how the incorporation of their feedback and ITK into the agricultural information systems could enhance food production, with the prevailing changes in climate. The existing ITK among the farmers clearly came out for further study recommendations. The recommendations of Yamane (1973) and Gall *et al.* (1996) on planning and execution the research were followed throughout the data collection and analysis.

3.3 Sampling Procedures and Sample Size

Within Kilifi district, Kikambala and Ganze divisions were purposively selected based on their diverse agricultural practices that would help in determining climate change effects. The two divisions were also rich in indigenous knowledge and were able to give the required data. From the two divisions, random sampling technique was used in selecting four locations (Palakumi, Ganze, Mtwapa and Junju). The four locations therefore gave the sampling frame. The target population comprised of all smallholder farmers from the two divisions. Ganze has a population of 52,330 persons while Kikambala has 60,040 persons.(Ministry of Agriculture, 2008; Central Bureau of Statistics, 2001).A sample frame consisting of smallholder farmers from the study area was developed. To select the desired sample size from the total population, a random sampling was done and the number of respondents was arrived at using the following formula from Yamane (1973):

$$n = \frac{z^2 pqN}{(z^2 pq + Ne^2)}$$

Where z = the standard deviate

p = the proportion of the population with the desired characteristics,

q = $1 - p$

N = total population in the two divisions,

e = desired degree of accuracy

n = required sample.

($z=1.96$ for 96% confidence level, $p=1/8$, $q=7/8$, $N= 112,370$, $e=0.05$, **$n= 167$**)

Table 1: Number of farmers selected from each location

Location	No of Farmers
Palakumi (Ganze division)	30
Ganze (Ganze division)	38
Mtwapa (Kikambala division)	56
Junju (Kikambala division)	43
Total	167

Source: Survey data, 2011

Selection of opinion leaders was done with the help agricultural staff. In addition, agricultural extension officers from Kilifi and researchers from Kenya Agricultural Research Institute, Mtwapa were also interviewed (Table 2).

Table 2: Number of Respondents

Description	Number
Farmers	167
Opinion Leaders	20
Researchers (KARI)	8
Extension Officers	8

Source: Survey data, 2011

3.4 Instrument Development

The purpose of the study was to evaluate the farmers' perception of the effectiveness of agricultural information and communication systems (AICS) in managing climate change challenges and also to determine the extent to which AICS have integrated existing ITK for increased food production by smallholder farmers. According to Gall *et al.* (1996), most techniques for measuring social and psychological environment, rely on verbal material in the form of questionnaires and interviews. Therefore, the main instruments for this study were questionnaires (closed and open- ended). Closed-ended questions were useful in quantifying the

data, while open-ended were used at capturing farmers' opinions as it provided for probing in-depth understanding.

3.4.1 Reliability of the Instrument

The questionnaire was piloted by the researcher in one location in Bahari division, to test its reliability. Bahari was chosen because of its proximity to and similarities to the study area. Ten smallholder farmers were randomly selected from a list obtained from the divisional agriculture office for questionnaire pre-testing. Thereafter, the questionnaire was reviewed again for suitability and reliability, and the necessary amendments made.

3.5 Data Collection Procedures

Information was gathered from four different levels of respondents: 167 household heads, four focused group discussions, 8 key informants namely the agricultural extension officers and researchers. These qualitative methods allowed for gathering of data that was rich, detailed and in the language of the subjects and were essential in getting the meaning behind some data. Direct observation and informal conversations with farmers were also done to help confirm information from the questionnaires. This gave the researcher a chance to ask relevant questions with regard to observation made in the farms concerning climate change impacts. Photographs were taken during group discussions and during visits to farms to authenticate existence of indigenous knowledge and climate change impacts.

3.6 Data Analysis

The data collected was sorted before being coded and scores assigned for the purposes of data entry. It was then categorized as desired. The assigned scores were specified values for meaningful interpretation based on the scales of measurement of the data. Analysis and presentation of data was carried out with the aid of Statistical Package for Social Science research (SPSS) version 15.0 for windows, involving the use of descriptive and inferential statistics. Descriptive statistics enabled a meaningful description of scores within the use of frequencies and percentages. Inferential statistics included the use of Chi-square as shown in the equations below.

$$X^2 = \sum ((fo-fe)^2)$$

Where; fo = Observed frequency

fe = Expected frequency

These tests were preferred because most of the data was categorical and could easily be translated into frequencies. Results were presented in narrative form, frequency tables and/or pie-charts as recommended by Gall *et al.* (1996).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Farmer Characteristics

Description of the farmer characteristics was done to elaborate the farmer conditions.

4.1.1 Age of the Respondents

Age of the household head plays an important role in the uptake of new technologies. In this study, the youngest farmer was found to be 19 years while the oldest was 68 years (Table 3). In the overall the mean age was 51 years. The results indicate that majority of the respondents were of 50 years and above, and the minority of the respondents were young farmers of age range between 18 and 25 years.

Table 3: Distribution of respondents by age

Age range in years	Frequency	%
18-25	11	7.3
26-33	33	22.0
34-42	37	24.7
43-50	27	18.0
Above 50	42	28.0

Source: Survey data, 2011

4.1.2 Gender of the Respondents

Gender affects the division of labour in agricultural related activities. From the results shown in Table 4, it can be concluded that male respondents were more than the female respondents. Chambers *et al.* (1989) found out that gender, in many African societies, is vital as it affects the use and ownership of resources, how farming operations are undertaken, how new

ideas and technologies are perceived and to a large extent how information is disseminated. Understanding this socio-cultural set-up in any given community helps researchers and extensionists to develop and disseminate technologies, which are in harmony with the belief of the people in question.

Table 4: Distribution of respondents by gender

Gender of respondents	Frequency	%
Female	56	37.3
Male	94	62.7

Source: Survey data, 2011

4.1.3 Level of Education of the Respondents

Education is a means of facilitating the instilling of favourable attitudes towards the use of new farming practices. Table 5 presents the results of the level of education of household heads in the study area. The results shows that majority of the respondents had received upper primary education while the least proportion of the population had obtained tertiary education. The low percentage of farmers who had tertiary education can be attributed to the fact that people with high level of education engage in off-farm livelihoods and rarely engage in farming.

Table 5: Distribution of respondents by level of education

Highest level of education	Frequency	%
No formal education	36	24.0
Lower primary	18	12.0
Upper primary	43	28.7
Secondary	36	24.0
College/ University	17	11.3

Source: **Survey data, 2011**

4.1.4 Land Tenure of Respondents

The situation as regards the land tenure system in Kilifi district is varied, as shown in Table 6. Most of the respondents own communal land which is clan owned. The fact that they do not have title deeds hampers their active involvement in agricultural activities as they cannot even access financial institutional loans. Squatters live in fear of eviction and therefore are always reluctant when it comes to adoption of new ideas, while communally owned land rarely reaches its maximum utilization level. The fact that the farmers do not “own” the farms contributes to them not doing serious farming. This will affect their level of involvement in development planning. Nair (1989) contends that clan owned lands may either be cultivated communally, with each clan member receiving a proportionate share of the output, or apportioned among the individual households of the clan and used in a semi-private manner.

Table 6: Land tenure

Land tenure	Frequency	%
Individual	48	30.8
Leasehold	26	16.7
Communal	75	48.1
Squatter	1	0.6

Source: Survey data, 2011

4.1.5 Contact with Extension Providers

Extension contacts are very important when introducing new technologies to farmers because this is the time they need a lot of advice and guidance. Figure 4 summarizes the results on contact with extension providers. Only 16% of the farmers interviewed indicated that they had not had contact with extension providers, raising concern on why the farmers are still food insufficient, yet they are largely exposed to extension services.

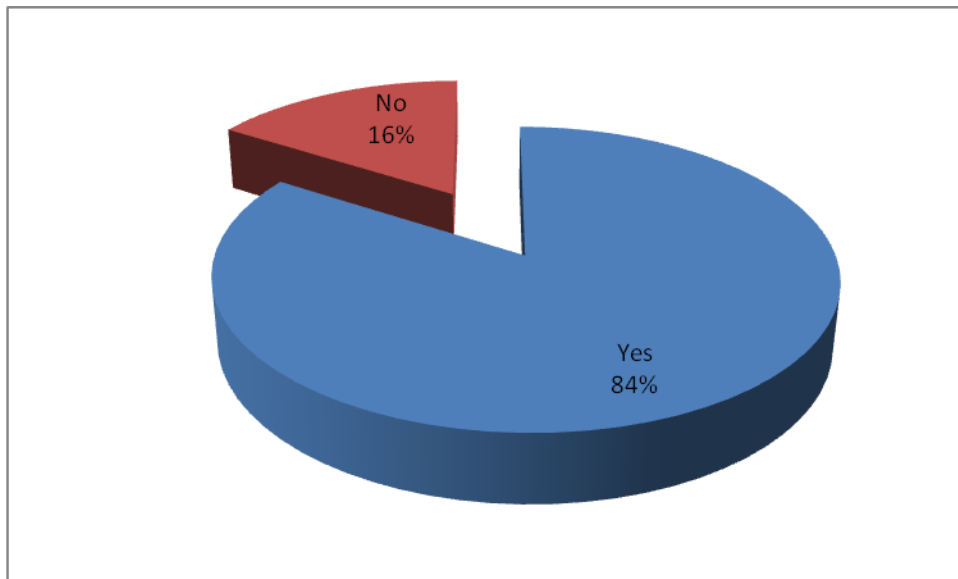


Figure 4: Contact with extension providers (%)

Source: Survey data, 2011

4.2. Perception of Farmers on Effectiveness of Existing AICS in Knowledge Dissemination

The agricultural information and communication systems (AICS) that have been used to disseminate knowledge to farmers include Training and Visits (T&V) and Farmer Field Schools (FFS). Two approaches were utilized to capture the farmers' perception on the effectiveness of the existing AICS in disseminating knowledge namely: i). exposure to extension vis-à-vis change in yields; ii). relationship between technologies promoted and those that had been adopted.

4.2.1. Exposure of Farmers to Extension Contact Compared to Crop Yields

The relationship between farmers' contact with extension providers and the change in yield was evaluated. The results are represented in Table 7. Only 2.4% of the respondents have had contact with extension agents for less than 1 year. Majority of the respondents have had contact with extension providers, yet many farmers have not realized any changes or have had a decrease in their yields, prompting the concern on how farmers perceive the methods promoted by extension. With a chi-square of 7.746 and a p-value of 0.459, there is no statistical significance and the null hypothesis is therefore accepted that the existing AICS are not effective in disseminating knowledge to farmers. Change in farmers' yields is not related to the duration over which they have had contact with extension providers.

Table 7: Change in yield compared to the duration of contact with extension providers

Duration of Contact (Yrs.)	Change in Yields (%)		
	Decrease	No change	Increase
Less than 1	0	4.3	0
1-5	10.7	4.3	3.6
5-10	7.1	15.9	21.4
10-15	21.4	23.2	32.1
Over 15	60.7	52.2	42.9

Chi-square =7.75, p-value=0.459 ($p > 0.05$), Not significant

Source: Survey data, 2011

4.2.2 Practices Extension Providers Promote and have been Adopted by Farmers

In order to obtain information on the practices extension officers promote and have been adopted, respondents were asked to list the practices that have been promoted and the ones they perceive to have increased their yields and have therefore adopted. The results are presented in Table 8. In terms of the practices the extension providers promote, findings indicate that water harvesting techniques and new varieties were widely promoted by extension providers. The least practice was planting along contours. Of the practices that have been adopted by farmers, early

planting leads followed by water harvesting techniques. The order of promotion and adoption follow similar patterns, indicating that extension messages are favored by farmers, meaning that AICS are perceived to be effective.

Table 8: Distribution of practices promoted by extension providers and those that have been adopted by farmers

Practices	Frequency of practices promoted	%	Frequency of practices adopted	%
Use of manure	102	68	63	42
New varieties	111	74	103	68.7
Water harvesting techniques	111	74	89	59.3
Correct plant population	62	41.3	49	32.7
Line planting	30	20	29	19.3
Early planting	17	11.3	17	11.3
Tractor ploughing	3	2	3	2
Ploughing along contours	1	0.7	1	0.7
Tree planting	10	6.7	3	2

Source: Survey data, 2011

4.2.3 Summary of Farmers' Perception to Effectiveness of AICS

As a summary to determine the farmers' perception to effectiveness of AICS, perception index as well as perception categories were determined. Three items namely; duration of contact with extension providers, changes realized regarding yields and attribution of changes in yield to contact with extension providers, were considered. This data was treated as ordinal after which it was scored then means computed for each item to get the perception index. This index was used to measure perception since it encompassed all the three items. This came to 2.6035 on a continuum of 0-3. Using the mid- point formula, categories of perception were arrived at. An index of 0-1.66 was considered as negative while that of 1.67-3.33 was considered positive. The results are shown in Tables 9 and 10. Out of the 126 respondents only one had a negative

perception to effectiveness of AICS, meaning that AICS are perceived by smallholder farmers to be effective in disseminating climate change strategies.

Table 9: Farmers' Perception Index

Items	N	Mean	Std. Deviation
For how long have you had contact with extension providers	126	4.18	1.038
Since your first contact with extension providers, what changes have you realized regarding yields?	125	2.00	0.672
Do you attribute this change to contact with extension providers?	126	1.66	0.476
Perception index (mean of means)	126	2.609	0.420
Valid N (list wise)	125		

N= 126 (Those who have had contact with extension providers)

Source: Survey data, 2011

Table 10: Farmers' Perception category

Perception Category	Frequency	Percentage (%)
Negative perception	1	0.8
Positive perception	125	99.2
Total	126	100.0

Source: Survey data, 2011

4.3 Main Mode of Communication by Extension Providers

Extension uses different modes of communication when disseminating knowledge to farmers. The type of mode will also determine the level of feedback farmers are encouraged to give. Findings of the relationship between the main mode of communication and the extent of feedback are shown in Table 11 for the 126 farmers who reported to have had contact with extension providers. In terms of mode of meeting, the one with the highest frequency was farm

visits while seminars came last. It can be concluded that farmers prefer face-to-face communication with extension agents. Farmers' needs are addressed fully when extension personnel come home, and when a new idea is not well understood, a farmer has an opportunity to ask questions for clarification. Besides, the extension agent can demonstrate the hard technical aspect of a technology on the farm in the presence of the farmer.

Table 11: Relationship between the main mode of communication and the extent of feedback

Main mode of meeting	Frequency	%	Mean extent to which AICs encourage feedback
Farm visits	34	27.0	Often
Group visits	19	15.1	Often
Field days	17	13.5	Often
Office visits	11	8.7	Often
Barazas	15	11.9	Never
Seminars	3	2.4	Often

Source: Survey data, 2011

4.4 Extent to which Feedback is Encouraged from Farmers

Feedback is important in any communication. There is a direct relationship between any mode of communication and the extent to which feedback is encouraged in extension. Most of the research officers as well as the extension officers interviewed asserted that there is encouragement of feedback from information users during dissemination of extension messages. This is confirmed by the results in Table 12 which show that feedback is encouraged in all the four locations with varied levels though. Palakumi had the highest level of feedback while Junju had the least.

Palakumi and Junju locations fall in one division prompting the concern over the modes of communication that the extension providers in the division use. With a chi-square of 26.587 and a p-value of 0.09, there is no statistical significance and the null hypothesis is therefore accepted that there is no relationship between the level of feedback encouragement and the locations.

Table 12: Extent to which feedback is encouraged by locations (%)

Extent of feedback	Locations			
	Palakumi	Ganze	Mtwapa	Junju
Never	0	0	1.8	8.3
Very little	41.7	0	7.1	16.7
When I offer it	0	16.7	35.7	33.3
Often	50.0	50.0	35.7	16.7
Always	8.3	33.3	19.6	25.0

Chi-square = 26.587, p-value = 0.09 (p>0.05), Not significant

Source: Survey data, 2011

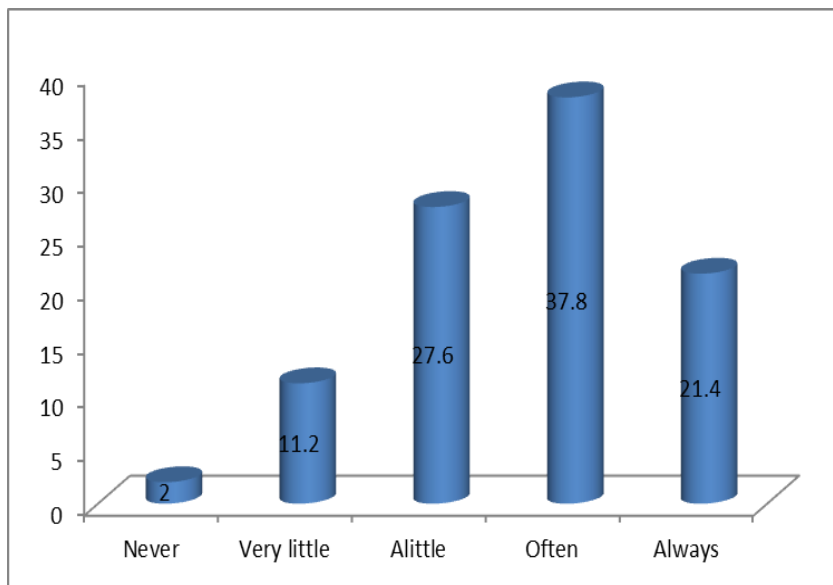


Figure 5: Summary of extent of feedback encouragement (%)

Source: Survey data, 2011

4.5 ITKs Practiced by Farmers to Manage Climate Change Challenges

This section describes the various ITK practices used by the farmers to manage the various challenges related to climate change in the study area and the challenges identified were:

- i) floods;
- ii) erratic rainfall;
- iii) drought;
- iv) pest incidences;
- v) heat on crops.

In order to obtain information regarding the role of ITK in the management of challenges related to climate change, respondents were asked to state indigenous practices they know had existed or currently exist that can be used to manage these challenges. The results are presented in Tables 13, 14, 15, 16 and 17.

4.5.1 ITK Practices Used in Managing Floods

Data as shown in Table 13 indicate that the most ITK practice used to manage floods is planting water tolerant crops and the least is digging trenches. The reason could be that farmers tend to go for easy and low labour-intensive practices. Moving to higher grounds can only be practiced by those with available raised grounds. Traditional water conservation techniques known as zai pits as well as digging trenches could be labour intensive or expensive to undertake.

Table 13: Frequency distribution of ITK practices used in managing floods (%)

ITK practice	Frequency	%
Digging trenches	3	2
Moving to higher grounds	34	31.2
Planting water-logging/ flood tolerant crops	48	44.0
Traditional water conservation	26	23.9

Do nothing	11	10.1
------------	----	------

Source: Survey data, 2011

4.5.2 ITK Practices Used in Managing Erratic Rainfall

In managing erratic rainfall, planting traditional seed is the ITK widely used by farmers while deep planting was the least (Table 14). These traditional seeds are with the farmers and have been used for a long time. They therefore know their performance and reliability. As an opinion leader from Palakumi location asserted, “Giriama traditional maize seeds are more reliable and store well without being damaged by pests unlike the hybrids.” Extension providers, on the other hand are not directly interested in these traditional varieties though farmers have found out that they have a role in managing erratic rainfall. Again, as in the earlier discussion, farmers tend to go for practices they perceive as easy to carry out. Farmers do early planting after using traditional ways of determining when rains would come. These include traditional trees shedding their leaves and also bloom in a particular manner. It is also possible to tell whether rains would be heavy or light depending on the direction of winds.

Table 14: ITK practices used to manage erratic rainfall

ITK practice	Frequency	%
Deep planting	4	2.8
Planting fast growing crops	5	3.5
Using traditional varieties	83	58.5
Early/ Timely planting	43	28.2
Traditional water conservation	22	14.8
Do nothing	16	11.2

Source: Survey data, 2011

4.5.3 ITK Practices Used in Managing Drought

Planting drought tolerant crops was cited as the ITK most farmers use to manage drought (Table 15). Farmers find it easy to adopt drought tolerant crops as a practice because of its simplicity and the fact that these seeds are locally available with the farmers. Focused group

discussions clarified that the particular drought tolerant varieties used in the study area include *Mengawa* and *Tela*, These traditional maize varieties are able to withstand drought. Interestingly, the extension systems have not come up to recognize them. Instead, Pwani hybrids - PH 1 and PH 4 are promoted as fast or early maturing crops that have been developed for the coast region. The main challenges that hinders the full adoption of hybrids are that i) their seeds are expensive and are not easily available to farmers and that ii) the hybrids cannot withstand the very low rainfall and the changing rainfall patterns in the coast. A research officer from KARI, Mtwapa reported that PH 1 was developed for the coast region as an early maturing variety with a mechanism for drought escape. However, under low rainfall conditions like in the last 4 years PH 1 has been performing dismally discouraging farmers from its use. It can be concluded that some options promoted by the extension staff do not exactly fit into the real environmental and farmers' situations.

Table 15: Distribution of ITK practices used to manage drought

Practice	Frequency	%
Deep planting	3	2.1
Early/ Timely planting	24	16.6
Leaving farm fallow	4	2.8
Mulching	22	15.2
Planting drought tolerant crops	97	66.9
Planting fast/ early growing crops	2	1.4
Traditional water conservation	24	16.6
Do nothing	10	6.9

Source: Survey data, 2011

4.5.4 ITK Practices Used in Managing Pests

Farmers were asked to list the ITK practices they use in managing pests. The results in Table 16 show that integrated pest management (IPM) emerged as the most used method. Integrated pest management involves the use of different methods in managing pests in crops at a given time, which include biological, cultural, chemical and mechanical methods. Harvested

cereals are also preserved by keeping them above fireplaces in specially made stores known *aslutsaga*. Farmers however, acknowledged that cereals stored in *lutsaga* still get infested by pests. They are not aware of the correct heap width and even for how long the *lutsaga* can be effective, leave alone the amount of heat needed. This is where researchers and extensionists could come in.

Table 16: Distribution of ITKs used in managing pest incidences

Practice	Frequency	%
Crop rotation	33	23.7
Integrated pest management	61	43.9
Selection/ Avoidance of crops	24	17.3
Shifting cultivation	4	2.9
Use of <i>mkilifi</i> tree	2	1.4
Use of sand	1	0.7
Do nothing	21	15.1

Source: Survey data, 2011

Farmers could find it easy to use IPM because of its diversity and ease of accessibility. It also allows farmers to use their own knowledge to suit their environment and be compatible with their agricultural practices. Franzel *et al.* (2001) noted that farmers modify new technologies in their own way through integrating ecological, social and economic factors which are at their disposal. Shifting cultivation could be limited to those with big parcels of land, thus discouraging its use. Use of preparations of *mkilifi* (*Azandrica indicia*) tree or sand alone could be of low acceptability because farmers do not have proper preparation methods and dosage rates.

4.5.5 ITK Practices Used to Manage Heat on Crops

About half of the respondents chose planting heat tolerant crops as the ITK mostly used to manage the effect of excessive heat on crops (Table 17). Heat tolerant crops like cassava (*Manihot esculanta*) have been grown in Coast province over the years and farmers have come to a level of even selecting locally suitable varieties like *kibanda meno*, *kipenda roho* and *mzihana* which can withstand extreme heat. Crops that are concentrated along cool river banks have been observed by farmers to get least affected by heat.

Table 17: Distribution of ITK practices used to manage heat on crops

Practice	Frequency	%
Mulching	52	38.5
Planting heat tolerant crops	66	48.9
Planting in cool areas	54	40
Do nothing	3	2.2

Source: Survey data, 2011

These ITK practices now with the people, if well tapped, transformed and introduced in current technology development, have the potential to help solve some of the problems that are faced by farmers. Grange (2010), in his study on climate change adaptation among the Karamajong, found out that farmers have a wealth of indigenous knowledge about their surroundings, crops, livestock and many others built up over the centuries of observations and experiments. He further observed that researchers had done and continued to do their best, but farmers operate under different socio-economic situations.

Farmers have different levels of education, different cultures and beliefs and different amounts of land and capital. Prices of inputs fluctuate violently and some farmers cannot even afford to buy the fertilizer and chemicals needed to improve crop yields. It is therefore not easy for researchers to design packages of technology to produce the best yields in all conditions. This is exacerbated by the fact that farmers face all sorts of biophysical constraints that researchers

have found difficult to take into consideration; erratic rainfall, variable soils, floods, drought, and pests and diseases. These conditions further vary from place to place, farmer to farmer and from year to year. The technical people interviewed in the study area concurred that the changes in climatic conditions have also become unpredictable. A year can experience both long and short rains only to be followed by a year of very little rains. Further, these rains can come either earlier or later than expected. It therefore becomes very important to implement isolated technologies to plan for all scenarios.

4.6 The Extent to which ITK has been Integrated into Scientific Climate Change Adaptation Practices

Farming practices promoted by extension officers, to a large extent do not include the ITK that farmers use. The potential of ITK practices can only be tapped if what is in custody of farmers is shared with extension personnel and other farmers. This is possible if the extension systems are open to integration of feedback in research agendas. Results in Tables 13, 14, 15, 16 and 17, show that ITK exists and is actively being used among farmers to manage challenges that they face in their daily farming activities. Since ITK seems to play a significant role in managing challenges related to climate change as discussed in section 4.5, there is therefore need to integrate it in extension messages. If farmers feel they are involved, they will embrace the new technologies that are developed by researchers and passed to them by extension officers. Similarly, if they interact with extension personnel in receiving extension messages, the mutual gain favours the integration of ITK in modern technology development and testing.

Table 18: The extent to which ITK has been integrated into scientific climate change adaptation practices by locations (%)

Extent of integration	Locations			
	Palakumi	Ganze	Mtwapa	Junju
Never	0	3.4	2.7	0
Very little	43.3	20.7	6.8	50.0
A little	13.3	24.1	24.7	27.8
Often	33.3	31.0	49.3	11.1
Always	10.0	20.7	16.4	11.1

Source: Survey data, 2011

Chi-square= 31.033, p-value= 0.02 ($p < 0.05$), Significant

Results in Table 18 show that the extent of integration of ITK with science differs in the 4 locations in the study area. With a chi-square of 31.033 and a p-value of 0.02, there is a significant statistical difference and the null hypothesis that there is no association between the ITK level of integration and the locations is rejected. Integration is highest in Mtwapa and lowest in Junju. These two locations are in the same division. Their level of integration could be different since Mtwapa is a cosmopolitan location with farmers who value extension services. Junju on the other hand is so much interior and could be missing out on extension services with most of the farmers practicing only ITK methods of farming.

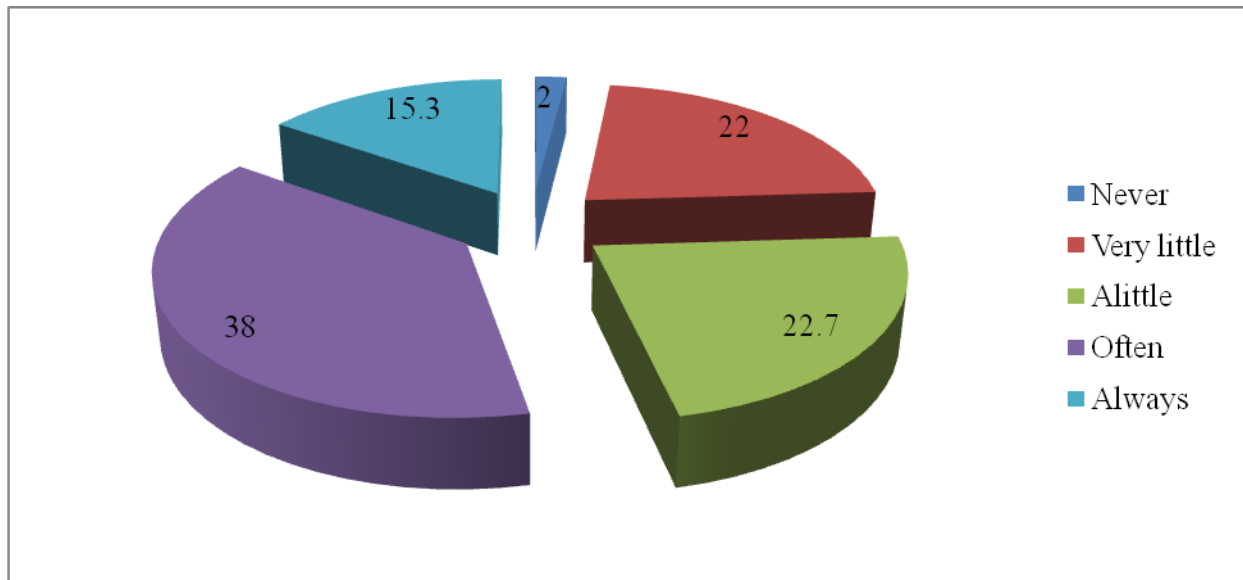


Figure 6: Extent of ITK integration (%)

Source: Survey data, 2011

An opinion leader from Ganze division while responding to the question on the extent of integration of ITK and scientific practices said that it is present to a large extent (Figure 6). The only drawback is that the researchers and extension officers have not shown interest in responses, making farmers fail to realize the full potential of integration. He gave an example of integrated pest management. Farmers in Kilifi have known the use of *lutsaga* in preserving their cereals but scientists have never come out fully to work on the correct depth, amount of heat or how long the cereal should stay in the *lutsaga* before it is treated with chemicals to avoid infestation by pests. A similar sentiment was given by a village elder from Kikambala division while commenting on the traditional seeds that they use. The elder said that scientists have ignored these seeds and have never tried to bulk or even preserve them in anticipation of their extinction.

Combining local knowledge and science may be a way to overcome problems related to climate change and also deal with its effects. Indigenous knowledge can address climate change impacts but it must be combined with other knowledge and used in broader context of sustainable development. The interaction between the two different systems of knowledge can also create a mechanism of dialogue between local populations and climate change professionals,

which can be meaningful for the design of projects that reflect people's real aspirations and actively involve communities. In Kilifi district, integration of ITK in scientific management strategies is seen in the use of *zai pits*, which was initially an idea from farmers to manage challenges related to erratic rainfall and drought. Extension officers have gone ahead to show them the correct size of these pits and even the maximum number of maize plants that each pit can accommodate. This practice has gained popularity especially in the upper dry parts of this district like Ganze division.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study aimed to evaluate the farmers' perception of effectiveness of agricultural communication systems and existence of farmer-extension interaction in the form of feedback, and to investigate the existence of ITK in the management of climate change related vulnerabilities. It was also to determine the extent to which AICS have integrated ITK for climate change adaptation by smallholder farmers of Kilifi district, Kenya. The following conclusions were made from the study:

- i) The existing agricultural information and communication systems are perceived to be effective in disseminating agricultural knowledge to farmers.
- ii) Agricultural information and communication systems being used by extension providers have been found to encourage feedback from information users. However, this feedback does not translate to farmers' needs and priorities being incorporated in research agendas.
- iii) Indigenous technical knowledge plays a big role in addressing many problems and farmers in Kilifi use it in the management of climate change challenges such as floods, drought, erratic rainfall, pest incidences, and heat on crops.
- iv) Farming practices promoted by extension officers, to a large extent do not include the ITK that farmers have.

5.2 Recommendations

The region is vulnerable to the current weather variability and associated shocks, Ganze having been declared one of the poorest divisions in the country. It is therefore, important to find ways by which the farmers can build their livelihood resilience through coping better with current weather-induced risks as a pre-requisite to adapting to future climate change. The study has therefore made the following recommendations;

- i) There is a need to review AICS approaches being used to disseminate knowledge to farmers. Agricultural knowledge and information systems (AKIS) which recognize ITK should be introduced in the present AICS.
- ii) There should be a national framework for mainstreaming climate change adaptation.
- iii) Though the findings indicated that the agricultural and information communication systems encourage feedback from information users, this feedback is rarely considered in development programs. There is need for inclusion of ITK in development programs.
- iv) Traditional seeds used by farmers face the risk of extinction because farmers will most likely use them as food in case of famine. There is need for the Government to develop a participatory program for seed improvement, production, preservation and distribution.
- v) There is need to target research to farmers' needs more effectively to produce technology more appropriate to farmers, as there is a growing importance of farmer participation in defining research agendas and technology generation. Indigenous technical knowledge needs to be tapped by use of appropriate mechanisms to save it from disappearing.

5.3 Further Research

The study proposes further research:

- i) Comprehensive documentation of ITK related to climate change in Kilifi and other parts of Kenya.
- ii) Verification of the effectiveness of ITK as a strategy to manage climate change challenges.

REFERENCES

- Baraza, D. S., Chepkwony, E. and Githae, T. (2008). Kenya Food Security Steering group 2008 Long rains Rapid Food Security in Uasin Gishu District, 22nd to 25th July, 2008.
- Bernet, T., Ortiz, O., Estrada, R. D. and Quiroz, R. (2003). Tailoring Agricultural Extension to farmer needs: A user-friendly farm-household Model to improve Decision Making in Participatory Research. Proceedings: *The 3rd International Symposium on systems approaches for Agricultural Development (1-12)*. 2nd to 5th December, 2003.
- Besada, H. and Sewankambo, N. (Eds) (2009). Climate change in Africa: Adaptation, mitigation and governance challenges. A report: The Centre for International Governance Innovation.
- Bohringer, A. (2001). Facilitating the wider use of Agroforestry for development in southern Africa. *Development in practice* 11 (4): 434-448.
- Bollier, D. (2009). Protecting Indigenous Knowledge. *Electronic journal of Indigenous Knowledge* (Online). Vol.12, No. 1. Accessed on 15th May 2009 from <http://www.organicagcentre.ca/Docs/protecting/content/vol12.org.phpid=2453>
- Central Bureau of Statistics, Ministry of Finance and Planning. (2001). Population and Housing Census Volume 1. Government Printers. Nairobi.
- Central Bureau of Statistics, Ministry of Finance and Planning. (2005). Population and Housing Census Volume 1. Government Printers. Nairobi.
- Chambers, R., Pacey, A. and Thrupp, L. A. (Eds.) (1989). *Farmer First. Farmer Innovation and Agricultural Research*. London: Intermediate Technology publications.
- Davis, K. and Place, N. (2003). *Current Concepts and Approaches in Agricultural extension in Kenya*- Proceedings of the 19th Annual conference. Raleigh, North Carolina, USA.
- Franzel, S. (1999). Social Economic factors affecting the Adoption Potential of Improved Fallows in Africa. *Agroforestry Systems*, 47 (3): 305-321.

- Franzel, S., Cooper, P., denning, G. L. and Eade, D. (Eds). (2002). *Development and agroforestry: Scaling up the impact of research*. Oxford: OXFAM.
- Gall, M. D., Borg, W. R. and Gall, P. J. (1996). *Educational Research: An introduction*. Longman Publishers. United States of America.
- GoK, 2007: National Draft Policy on the sustainable development of ASALS. OP. Nairobi.
- Inglis, T. J. (Ed) (1993). *Traditional Ecological Knowledge: Concepts and Cases*. Ottawa: Internal program on Traditional Ecological Knowledge.
- Ison, L. R. and Russell, D. B. (2008). *Agricultural Extension and Rural Development: Breaking out of Traditions*. Cambridge University Press. United Kingdom.
- Intergovernmental Panel on Climate Change (IPCC) (2007). Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva. Available at: <http://www.ipcc.ch>.
- Kahindi, B, Morimoto, Y. and Maundu, P. (2003). *Documenting the Diversity of Tradition foods in the Giriama Community of Coastal Kenya. A community-led ethno biological research and development initiative*. EthnoForum 4.
- Kroma, M. (2003). Participation and Social Learning: *Supporting Farmer Innovation in Central Ghana*. Journal of International Agriculture and extension Education.10:(2) 43-45.
- Kumar, V. (2009). *Indigenous Technical Knowledge in Agriculture*: Journal of Agriculture and Indigenous Knowledge, 4: (2)1-8
- Maru, A. (2003). *Information and Communication Systems in Agricultural Extension in India*. Journal on Agricultural information and Communication, 12: (9) 4-10.
- Mazonde, T. and Thomas, K. (2007). A systems Approach to Comparing Indigenous and Scientific Knowledge: Consistency and Discriminatory Power of Indigenous Knowledge. *Journal of Agricultural Systems*. 4: (5) 291-312.
- Mureithi, J. G., Macharia, P. N., Gichuru, M., Mugendi, D. N. and Gachene, C. K. (Eds) (2003). Soil Science of East Africa. *Proceedings of the 18th conference and end of the*

Millennium celebrations 4th-8th December 2000. Theme: sustainable use of land resources to alleviate poverty in the new millennium. Nairobi: Soil Science Society of East Africa, National Agricultural Research Laboratories.

Ochola, W., Sanginga, P. and Bekalo, I. (Eds) (2010). *Managing Natural Resources for Development in Africa- a resource book.*

Orindi, V. (Ed) (2009). *Adapting to Climate Change in Africa: Climate Change and the Threat to African Food Security.* International Development Research Centre, Nairobi, Kenya. 5 (1-2): 167-250

Nair, P.K.R. (1989). *Agroforestry Systems in the Tropics.* Kluwer Academic Publishers, Netherlands.

Pippa, S. (Ed) (2008). *CTA Responds to the Winds of Change: Climate Change and Agriculture. The Technical Centre for Agriculture and Rural Corporation (CTA) Annual Report, 2008, Ouagadougou, Burkina Faso.* 42 (6-7): 342-345

Place, F. and Dewees, P. (1999). *Policies and incentives for the adoption of improved fallows. Agroforestry systems.* 47 (1-3): 323-343.

Rao, K. P. C., Ndegwa, W. G., Kizito, K. and Oyoo, A. (2010). *Climate variability and Change: Farmer perceptions and understanding of intra-seasonal variability in rainfall and associated risk in semi-arid Kenya:* Cambridge University press.

Rasheed, S. (2003). *Funding and Delivering Agricultural Extension in India. Journal of International Agriculture and Extension Education.* 27-31/2003/10. Accessed on 10th May, 2010 from <http://www.worldbank.org/WBSITE/EXTERNAL/EXTOED/EXT1EGIMPEVA/O,,co>.

Sinclair, F. L. and Walker, D. H. (1998). *Acquiring Qualitative Knowledge about Complex Agro ecosystems. Journal of Agricultural Systems.* 56: (1):341-363.

- Suda, C. A. (2000). Gender, Culture and environmental Conservation in Western Kenya: Contextualizing participation and the choice of Techniques. *Nordic Journal of African Studies*. 9 (1): 31-48.
- Taratola, D. (2008). Agriculture and Development: A summary of the International Assessment on Agricultural Science and Technology for Development. Accessed on 23rd August, 2010 from <http://www.greenfacts.org/en/agriculture-iaastd/o.co>
- Thornton, P. K., Jones, P. G., Owiyo T. M., Kruska, R. L., Herrero, M., Kristjanson, P., Notenbaert, A., Bekele, N. and contributors from Orindi, V., Otiende, B., Ochieng A., Bhadwal, S., Anantram K., Nair, S., Kumar V. and Kulkar, U. (2006). Mapping Climate Vulnerability and Poverty in Africa. Report to the Department for International Development, ILRI, Nairobi, Kenya.
- World Bank Report (2008). Agricultural Extension: The Kenya Experience - An Impact Evaluation. Climate Change Adaptation for Smallholder Agriculture in Kenya.
- Yamane, T. (1973). Statistics: An Introductory Analysis. Harper International, Tokyo.

APPENDIX 1: QUESTIONNAIRE FOR FARMERS

You are one among several farmers in this area who have been selected for this study. The study seeks to determine the existing farmer knowledge in production of crops in regard to climate change and the level of feedback appreciation by agricultural information providers, in order to enhance food production among smallholder crop farmers. The information you will give will therefore be strictly confidential.

Questionnaire identification

Questionnaire number-----

Division-----Location-----

Farmer's name-----

Date-----

1.0 Farmer's background information

1.1 Age (In years) _____

1.2 Gender

1. Male Female

1.3 Highest level of education

1. No formal education 2. Lower primary 3. Upper primary

4. Secondary 5. College/University

1.4 Household size (*number of people living and eating together*) _____

1.5 Respondent's relation to household head (*Tick where appropriate*)

1. Self

2. Wife

3. Sibling

4. Others (*Specify*) -----

A. 2.0 Physical and economic factors

2.1 Land tenure

1. Individual 2. Leasehold 3. Communal 4. Other (*specify*) -----

2.2 Farm size (acres) _____

A. 3.0 Indigenous Knowledge

3.1 What indigenous knowledge do you know and practice regarding:-

a) Planting time determination	Explanation
1. Livestock behavior	
2. Strength and direction of wind	
3. Movement of tides in the ocean	
4. Others (<i>specify</i>)	
b) Crop planting material	Explanation
1. Own traditional seeds	
2. Recommended traditional seeds	
3. Others (<i>specify</i>)	

c).Pest management	Explanation
1.Use of sand / ash on growing crop	
2.Hand picking and crushing	
3.Rouging	
4.Pricking	
5.Others (<i>specify</i>)	

d).Soil fertility management	Explanation
1.Mixed cropping	
2.Inter cropping	
3.Use of cow dung / chicken waste	
4.Use of farm yard manure	
5.Others (<i>specify</i>)	

e).Storage of harvested crops	Explanation
1.Storing underground	
2.Using ash	
3.Using air-tight guards and pots	
4.Drying and keeping in gunny bags	
5.Use of <i>Mkilifi</i> leaves	

6.Others (<i>specify</i>)	
-----------------------------	--

3.2 Which ITK practices have you used in an attempt to adapt to the following effects of Climate Change:-

(a) Floods

1. Moving to higher grounds
2. Planting water-tolerant crops
3. Traditional water conservation practices
- 4.Others (*specify*)_____

(b) Erratic rainfalls

1. Planting fast growing crops
 2. Timely planting
 3. Traditional water conservation practices
 4. Planting traditional seeds
 5. Others (*specify*) _____
-

(c) Drought

1. Planting drought tolerant crops
2. Early planting
3. Mulching
4. Use of zai pits

5. Others (*specify*) _____

(d) Increased pest incidences

1. Crop rotation

2. Integrated pest management practices

3. Selection/ avoidance of selected crops

4. Others (*specify*) _____

(e) Effects of increased heat on crops

1. Planting heat- tolerant crops

2. Planting in cool areas, near river banks

3. Mulching

4. Others (*specify*) _____

3.3. To what extent have the following ITK practices been integrated in climate change strategies?

(1- Never 2- Very little 3- A little 4- Often 5- Always)

1 2 3 4 5

A. 4.0 Agricultural information and communication systems

4.1 How often do you meet with extension agents?

1. Fortnightly 2. Once a month 3. Once in three months

4. Once in six months 5. Once a year 6. Never

4.2 What is the mode of meetings? (*Tick appropriately*)

1. Farm visits 2. Group visits 3. Field days 4. Office visits 5. Barazas

6. Others (*specify*) _____

4.3.(a) For how long have you had contact with extension providers?

0. Never 1. Less than 1 year 2. 1-5 years 3. 5-10 years 4. 10-15 years
5. Over 15 years

4.3. (b) Since your first contact with extension providers, what change(s) have you realized regarding yield in your farm?

0. No contact 1. Decreased 2. No change 3. Increased

4.3. (c). Do you attribute this change to contact with extension providers?

0. No contact 1. Yes 2. No

4.4. Do you air your views to the information providers?

(1- Yes 2-No)

4.5. To what level do the information providers consider your views?

(1- Always, 2- Often, 3- when I offer it, 4- very little, 5- Never)

1 2 3 4 5

4.6. a) Which technologies in relation to climate change do information providers promote among smallholder farmers?

1. Early planting

2. Correct plant population

3. New varieties

4. Water harvesting techniques

5. Others (*specify*)

(b) Which technologies have been adopted?

1. Early planting
2. Correct plant population
3. New varieties
4. Water harvesting techniques
5. Others (*specify*)

4.7 Which of these technologies have helped increase farm outputs?

1. Early planting
2. Correct plant population
3. New varieties
4. Water harvesting techniques
5. Others (*specify*)

A. 5.0 Climate change

5.1. Indicate the changes you have realized in the following, in the last 10 years:

	Increased	No change	Reduced
Rainfall amounts			
Crops yields			
Rainfall consistency			
Frequency of droughts			
Temperature			
Disease and pest			

incidence			
Frequency of floods			

1. Decreased
2. No change
3. Increased

5.2 To what extent has climate change affected food production in your opinion?

(1- Never 2- Very little 3- A little 4- Often 5- Always)

5.3 In your opinion, to what extent has climate change affected your income level?

(1- Never 2- Very little 3- A little 4- Often 5- Always)

APPENDIX 2: INTERVIEW GUIDE FOR RESEARCHERS AND EXTENSION OFFICERS

Interviewee

Researcher (KARI)

Extension Officer (District)

Extension Officer (Location)

B.1. Agricultural information systems

B 2.1. Which technologies have farmers adopted and have had positive impacts on the crop outputs and livelihoods?

B.2.2 To what extent does the research institution encourage feedback from its information users?

B.3. Indigenous technical knowledge

B.3.1. What are the existing ITKs related to maize and cassava production that have been documented?

B.3.2. To what level do the Research Institutions respect and integrate the above farmers' ITK into research policies?

B.3.3. Which ITKs used by farmers in climate change management have had positive impacts like increased yields of major crops like maize and cassava?

B.3.4. Which ITK practices related to crop production does extension integrate with scientific practices?

B.4. Climate change

B.4.1. Which climate change adaptation strategies and technologies related to crop production do research institutions give farmers?

B.4.2. What are research institutions doing about degradation of natural resources especially regarding crop production?

B.4.3. What changes (increase or decrease) have you recognized in the following in the last 10 years?

- i) Temperatures
- ii) Frequency of drought
- iii) Frequency of floods
- iv) Rainfall amounts & consistency
- v) Crop yields

B.4.4. Which Agricultural Extension policies exist on climate change management?

APPENDIX 3: FOCUS GROUP DISCUSSION (OPINION LEADERS)

C.1. Have you realized any changes in the following, in the last 10 years? How have the changes been?

Crop yields-

Rainfall amount and consistency-

Frequency of drought-

Temperature-

Disease and pest incidences-

Frequency of floods-

C.2. What indigenous knowledge do you know regarding:

Land preparation-

Planting time determination-

Crop planting material-

Pest management-

Soil fertility management-

Weed control-

Storage of harvested crops-

C.3. Which ITK practices have you used in managing;

Floods, erratic rainfall, drought, increased pest incidence, effects of increased heat on crops?

C.4. To what extent do you integrate scientific agricultural practices with the ITK practices you have mentioned?

C.5. How often do you meet with extension agents?

C.6. What is the mode of meetings?

C.7. To what level do the extension agents encourage feedback from you?

C.8. Which ITKs related to crop production have been documented?