POSITIVE DEVIANCE IN THE ADOPTION OF AGROFORESTRY TECHNOLOGIES WITHIN LOWER NYANDO BASIN, KENYA

By

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DECLARATION

This thesis is my original work and has not been presented for a degree or any other award in any other Institution

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This thesis has been submitted with our approval as university supervisors.

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DEDICATION

To all the farmers within Lower Nyando River basin in Western Kenya that are practicing agroforestry.

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ACRONYMYS AND ABBREVIATIONS

ANAFE	African Network for Agriculture, Agroforestry and Natural Resources Education
CBO	Community Based Organizations
DPU	District Planning Unit
FAO	Food and Agriculture Organization of the United Nations
ICRAF	International Centre for Research in Agroforestry (World Agroforestry Centre)
KDDP	Kisumu District Development Plan
KEDDP	Kisumu East District Development Plan
KFS	Kenya Forest Services
LVEMP	Lake Victoria Environmental Management Programme
M.o.A	Ministry of Agriculture
NEMA	National Environmental Management Authority
NGO	Non Governmental Organizations
SCC-VI	Swedish Cooperative Centre Agroforestry
VIRED	Victoria Institute for Research on Environment and Development

ABSTRACT

This study was set to examine positive deviance in the adoption of agroforestry technologies by some farmers in Kadibo Division, lower Nyando river basin in Western Kenya. The study was necessitated on understanding that despite widespread effort by extension agents to diffuse agroforestry practices in Kadibo Division, only a few farmers have been able to acquire and sustain the practices. Given this background, the study sought to assess approaches to successful adoption of agroforestry technologies by low-resource farmers who are constrained by environmental factors, which traditionally has impeded uptake of the practices within the division. A stratified sample of 92 agroforestry practicing farmers was interviewed at household level besides an interview of 9 key informants. In the study, a mixture of quantitative and qualitative research approaches was used. The quantitative information was mainly obtained using a semi-structured questionnaire and an observation checklist, whilst formal interviews, focused group discussions and extended case studies were used to obtain the qualitative information. The quantitative data was subjected to descriptive analysis such as percentages, frequencies and mean on one hand, and linear logistic regression analysis. Whilst narrative-log was mainly used in analysis of the complementary qualitative data. Findings from this study reveal that at least 9 typical agroforestry technologies have been disseminated to local farmers by governmental and non-governmental actors within Kadibo Division. The common technologies observed include: woodlots and shade tree, which was adopted by 22% and 20% of the farmers, respectively. It was further revealed that non governmental organizations and lead farmers are crucial players in influencing 43% and 32% of farmers' decision to acquire the various agroforestry technologies, respectively. The findings further revealed that some of the assessed farmers do engage in both short-term agroforestry crop production and long-term crop production practices in a complementary way as a strategy to minimize the high initial cost needed to acquire and sustain the practices. In this arrangement, the resource poor farmers demonstrated how income earned from short-term maturing crops is continuously invested into long-term agroforestry ventures. On the other hand, at 5% significant level, a linear logistic regression revealed that ability to sell agroforestry produce, $p=0.018$; increased number of marketable farm produce, $p=0.028$; and increased quality and variety of produce, $p=0.007$ and $p=0.003$, respectively are key driving factors to adoption of agroforestry technologies. The study results have showcased the success stories of farmers who have prevailed upon socio-economic and biophysical constraints to engage in the right thing. The key recommendations for out scaling of agroforestry practices in the study area and beyond include: intensification of flood water management strategies to enhance survival of agroforestry trees in adverse times; improve co-ordination and consultations by key institutions at local level to boost farmers' adoption of agroforestry trees; and intensification of farmers information sharing.

Key words: Positive Deviance, Agroforestry technology, Motivation, Nyando river basin

CHAPTER ONE
INTRODUCTION

1.1 Background to the study

Since ancient days, human societies all over the world have under a unified management system maintained woody perennials, farm crops or, and livestock on the same unit of land. In Africa, most food crops (yams, maize, pumpkins, and beans e.t.c) were grown under cover of scattered trees. Trees were therefore an integral part of many traditional land-use practices and these are some example of what is now known as agroforestry (Nair, 1993). Agroforestry practice has gained prominence for its potential to enhance sustainable agriculture and forestry production. Thus the practice has been viewed as a remedy to the increasing ill-being of human and ecosystem given the socio- economic and environmental benefits it provides to land users. Agroforestry has been promoted as a viable solution to land use problems in the developing world (Masangano, 1996) following the less success seen by agriculture technologies that are successful in the developed world (mainly monocultures).

Like in the other parts of developing world, agroforestry technologies have been promoted in Kenya; perhaps the most prominent time when this was extensively done was way back in 1980s. During this period, agroforestry was promoted as a practice that enhances sustainability, showing great potential to increased crop yields, control soil erosion and enhance nutrients recycling with the added benefit of fuel wood, fodder, fruit and timber production (Mugendi et al., 2007). But despite the long period of promotion in Kenya, only a few farmers have successfully embraced the practice. The efforts of such

farmers have not been popularized as deserved. It is in light of this that a clear understanding of the attributes of the few successful agroforestry practicing farmers forms a basis of up-scaling agroforestry technologies across large areas. This is because indications are that there is limited experience with facilitating self-mobilized on-farm tree-growing activities by communities in agricultural areas in Sub Sahara Africa (Kaudia, 2003).

The case of agroforestry up take by farmers in Kisumu East district is an interesting one. This is because farmers settled on this side of Kisumu have to overcome a number of environmental challenges in order to achieve any substantial out put from their agriculture endeavors. In the past Kisumu East district has been categorized amongst the worst infected districts with waterborne diseases in Kenya. These diseases are widely known as precursors to low productivity in communities. Moreover, the perennial floods coupled with interspersed droughts characterizing Kisumu East District has been a major constraint to advancement of agrosilviculture innovations. How a section of farmers within Kisumu East have managed to overcome the aforementioned challenges (herein referred to as positive deviance) is something interesting to learn. Perhaps taping the wealth of knowledge from these few farmers may help unfold some of the underlying opportunities for up-scaling and out-scaling agroforestry within Kisumu East District and even beyond. Therefore, there is need for more research to spread the benefits of agroforestry practices or scaling up across large areas (Franzel and Scherr, 2002).

1.2 Problem Statement

In Kisumu East District, only a few farmers have successfully adopted agroforestry technologies despite continuous efforts to up-scale the practices by extension agents. How these few farmers faced with similar odds, challenges and obstacles as their neighbors have managed to acquire and sustain the technologies, unlike their neighbors, is subject to investigation. It is worthwhile to investigate the factors, which are driving these few farmers to adopt agroforestry practices given the inability to sustain the practices by many of their neighbors. Besides that, deficient knowledge exists on achievement anecdote of farmers who have gone out of their way and embraced agroforestry practices in the entire Lower Nyando river basin. It has been reported elsewhere in the developing world that only limited effort has been made in current studies to show-case success stories and state of traditional agroforestry systems in rural communities (Edmund, 2005). Perhaps the inadequacy in highlighting farmer's success is one of the impediments to up-scaling and out-scaling of agroforestry practices in Nyando river basin.

Not enough highlight has been made on the successes of farmers practicing agroforestry in the entire Lower Nyando river basin. This is despite determination by a few of them overcoming localized socio-economic and biophysical challenges amongst other obstacles to practice agroforestry where many of their neighbors are unable. Actually, this is what we call in this study positive deviance by local farmers.

It is in light of the positive deviance that this assessment was set to tap the wealth of experiences from the few successful local farmers. Such positive experiences by the few farmers in Kadibo are bound to generate the much needed knowledge required for out scaling agroforestry practices across a wider region. Cooper and Denning (2000) in their report identified ten essential elements for scaling out agroforestry innovations; amongst these elements were learning from successes and failures of farmers. As such, the purpose of this study is to learn from successes of some farmers who have endeavored to overcome environmental constraints to adopt agroforestry practices.

1.3 Research Questions

1. What are the agroforestry technologies being disseminated by various actors to farmers in Kadibo?
2. How have the few successful farmers been able to acquire agroforestry technology in Kadibo?
3. How have the few successful farmers been able to sustain agroforestry technology in Kadibo?
4. What are the factors driving farmers to successfully adopt agroforestry practices in Kadibo despite the reigning environmental challenges in the division?

1.4 Research Assumption

The following assumption guided this study:

There are farmers who have adopted agroforestry practices in Kadibo Division despite the reigning socio-economic and biophysical constraints

1.5 Overall objective

To assess approaches to successful adoption of agroforestry technologies by low-resource farmers who are constrained by environmental factors, which traditionally has impeded uptake of the practices within Kadibo Division

1.5.1 Specific objectives

1. To determine the type (s) of agroforestry technology(ies) promoted by various actors in Kadibo Division
2. To assess how some farmers acquire agroforestry technology (ies) despite the reigning socio-economic and biophysical challenges in the division
3. To assess how some farmers sustain the agroforestry technologies despite the reigning socio-economic and biophysical challenges in the division
4. To determine the motivating factors behind successful adoption of agroforestry technologies by some farmers in the division

1.6 Research output

This study explored experiences of those farmers in Kadibo Division who have overcome the socio-economic and environmental difficulties to adopt agroforestry technologies. The study gathered information that identified knowledge gap on agroforestry technologies dissemination in Kisumu East District. The up to date scientific information generated in this assessment is useful in up-scaling and out-scaling agroforestry activities within and even beyond the Lake Victoria region.

1.7 Conceptual Framework

This study was guided by the preconceived framework presented as Figure 1.1. The figure depict that there exist various agroforestry technologies developed by research institution (s). The first channel of these technologies reaching the targeted farmer (s) for adoption is indirectly through agents including: extension agents from governmental and non governmental organizations; researchers or lead farmers amongst others. In this case, the prevailing socio-economic and biophysical challenges and opportunities influences technology uptake by the farmers. The second channel is on the technology (ies) reaching the targeted farmers directly from the research institutions after successful trials. The farmer's motivation to acquire and sustain the technology (ies) will also be greatly influenced by the challenges and opportunities within their environmental setting.

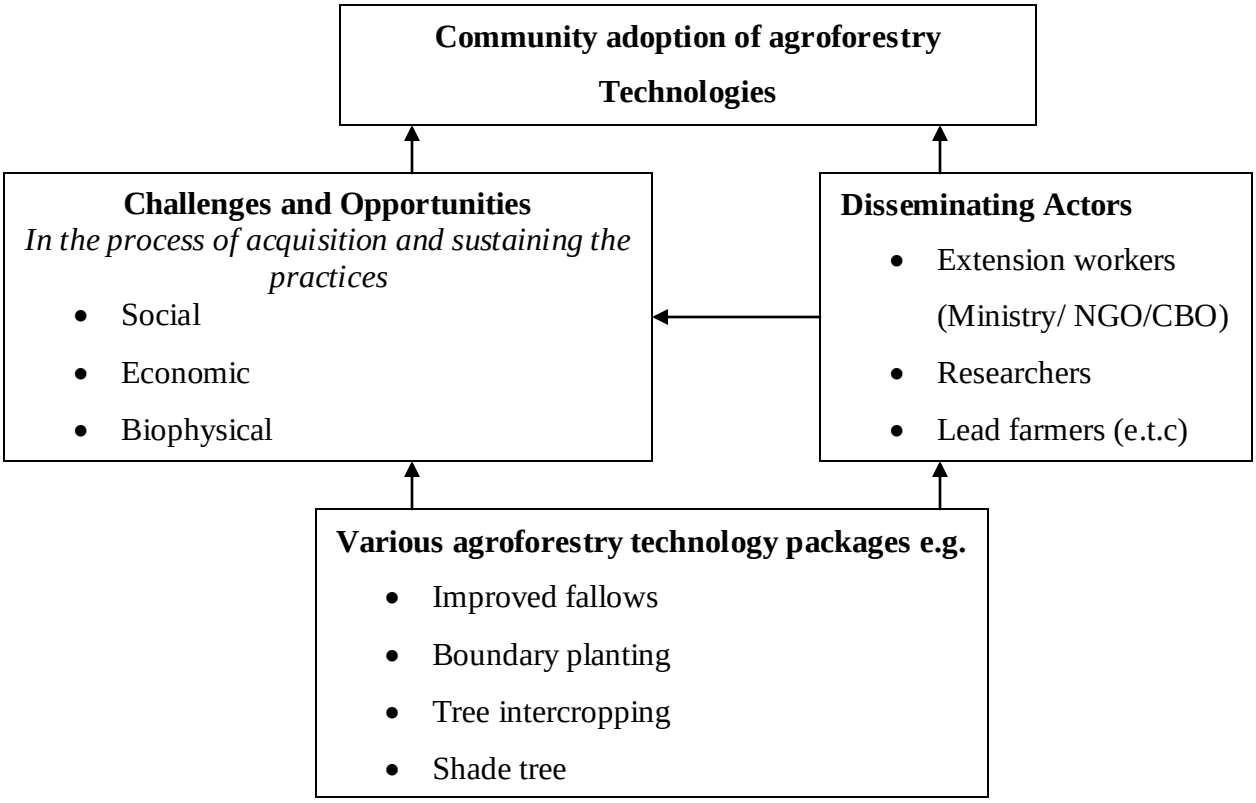

Figure 1.1: Conceptual framework

Source: *Author, 2009*

1.8 Definition of Analytical Concepts

Conservation it refers to the optimizing of farming system to achieve a balance of economic, social and environmental benefits. It involves a system of farm activities that increases the farmers' yields and at the same time enhances the protection and ultimate human and ecosystem well-being.

Positive deviance is based on the observation that in every community there are certain individuals or groups whose uncommon behaviors and strategies enable them to find better solutions to problems than their peers, while having access to the same resources and facing similar or worse challenges. In this study, it denotes the bold decision that some farmers have made to overcome economic, social and climatic challenges within the study area to adopt agroforestry. This term emanates from the premise that in the study area most of the farmers have faulted economic, social and climatic factors for not adopting agroforestry practices.

Adoption to acquire and sustain agroforestry practices from extension agents / lead farmers or others. Adoption in this study has been used to mean the act of farmers accepting and taking over agroforestry practices after initial knowledge. Only farmers who had been practicing agroforestry for more than two years were assessed. Choosing how to model adoption depends on the type of technology, the local context and research question examined (Cheryl, 2005)

Motivations these are the deep-rooted factors stimulating farmers to adopt agroforestry practices. The farmers' motivations in this study assessed from the perceived and actual benefits of agroforestry practices such as increased; quantity in production, income, quality of produce and household nutrition among others.

Short-term production in this study it implies the production of agroforestry out-put on seasonal basis as opposed to longer production period. For this case one season implies the production of farm products that take about a period of 8 months or less to be ready for harvest. For instance, honey production, farm vegetables, fuel wood production from certain shrubs amongst others.

Long-term production this has been used to refer to investments by farmers in agroforestry production practices that have relatively longer harvest periods. These include investment in wood/poles production from trees and shrubs, livestock amongst others.

Agroforestry in-put the labour, technical skills and materials injected in agroforestry production at different levels to optimize yields from the practice. Therefore, in-put in agroforestry mean the advice from extension agents, planting material, maintenance of crop.

Agroforestry out-put these are the products or ultimate functions of an agroforestry practice. The output can be of economical, social or ecological benefit to the farmer. The out put include but not limited to fruits, soil fertility improvement, fodder, honey and shade.

Environment these are all the biological, chemical, physical and socio-economic factors surrounding agroforestry farming activities within the study area. In this study the biophysical factors include: planting material, nature of soil, water, climatic/weather regimes; while the socio-economic factors include; local cultures that has a bearing on tree/shrub planting, financial resources, and management regimes.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This section of the study reviews various aspects critical to successful acquisition and sustaining of agroforestry practices by farmers. It reviews some of the challenges and opportunities for agroforestry advancement with a focus on analysis of information to reveal the knowledge gap in the existing studies. The information in the section has been organized based on the four objectives of the study. Agroforestry has been defined as; a dynamic, ecologically based, natural resource management system that sustains and diversifies production for improved economic, social and environmental benefits to farmers, through integration of trees in agricultural landscape (Leakey, 2001).

2.2 Agroforestry systems

A typical agroforestry system consists of various components: trees/shrubs, agricultural crops, pastures, livestock and soils, trees/shrubs being present at all agroforestry systems (Young, 1997). The interactions between the components have been equated to a myriad of benefits to farmers. Trees in the system provide fuel-wood, fodder, fruit (productive function) as well as fencing and shade service function (Mugendi et al., 2007). Besides, the productive and service functions, agroforestry systems are a good supplement to forest functions, which have over the years dwindled in most countries. In Kenya for instance, the gazetted forest cover has reduced from about 10% to less than 2% of the total land size in the last three decades (Kenya Land Alliance, 2002; Ngece, 2003).

In light of rapid deteriorating problems of forest, exploitation and conservation (Edmund, 2005) the scientific attention has increasingly focused on agroforestry because of its potential to solve many problems related to productivity and sustainability of agriculture (Kamara et al., 1993). However, there is little recognition of effort made by low-resource farmers in harsh environmental settings who attempt to sustain agroforestry practices.

Agroforestry technologies are designed to reduce risks associated with agriculture and to increase its' sustainability by helping to conserve and even improve the soil (Martin and Sherman, 1992). However, notably most farmers in low productive agro-ecological zones have not fully integrated these technologies in their farming systems. This is despite the potential benefits that may accrue from agroforestry system if up-taken by the farmers. As such there is need to learn from the positive experiences of farmers who have been able to fight constraints to emerge successful under disadvantage environment.

2.3 Acquisition versus extension services

Extension approaches to aid access to forestry technologies, information and knowledge have been developed into models that call on consumers, communities and industrial interests to be proactive (Kaudia, 2003). By being proactive the targeted farming communities are likely to better derive the benefits extension services including getting clear advantages in acquiring new innovations. Thus extension is a two way education process where both the local people and the extension workers learn from each other (Tegnass, 1994) and not necessarily involving heavy subsidies or material support.

Despite the enormous investments in training as a means of developing capability and enhancing knowledge dissemination, designs of most programmes have not incorporated participatory training methods that enhance learning by adults (Kaudia, 2003). In review of Nkonya et al. (2004) work, Rayes (2008) observes that a low education level can be a barrier for agricultural development since education normally has a significant influence on a household's income strategies, land management and labour use. Therefore, extension should be regarded as a process of integrating indigenous and derived knowledge, attitudes and skills to determine what is needed how it can be done, what local co-operation and resources can be mobilized and what additional assistance is available and may be necessary to overcome particular obstacles (Sim and Hilmi, 1987).

The emerging extension strategies in Africa, which are founded on demand-driven policies and community-driven practices, presume that the extension practitioners have the knowledge and social skills to facilitate knowledge dissemination by community members, and that community members' have the financial capacity to afford extension services (Kaudia, 2003). Kaudia (2003) questioned these assumption on the basis of limited experience in the African region context hence lack of sustainability of community driven extension. She further, questioned the rationale of a poor hungry person serving as a volunteer community-extension provider. The remedy to this may be farmers' need to access credit and comprehensive extension (Reyes, 2008).

Marcado et al. (1999) observed that even though it is not its' explicit mandate, ICRAF has committed to develop effective extension program to strengthen existing government

programs and to help technology dissemination develop into self perpetuating farmer movement in the area towards highly productive, resources-conserving agroforestry based farming systems. This is a recent initiative technology dissemination program to ensure that derived innovations' will reach the users group. Inadequate extension services may contribute to unsustainable land management practices if the farmers adopt improved crop varieties without the soil fertility management measures needed for the cultivation of such high yield crop varieties (Reyes, 2008).

2.4 Motivations in sustaining system

The success of any new agricultural technologies is judged ultimately by its adoption and acceptance by farmers and consumers and the positive changes it brings about at household, local, national and regional level (Sonia, 1997; Kabwe, 2001). These changes may be productive involving increased material benefits to local farmers; consequently the increased quantity of produce motivates farmers' adoption of the practices. On the other hand, sustaining of the practices is affected by several factors which the adopting farmer has to overcome in order to succeed. These includes; the biophysical characteristics of the technology itself, the individual and household characteristics of the farmers, policies and the institutional context within which the technology is disseminated (Ajayi *et al.,* 2007; Kuntashula, *et al.,* 2004; Mekuria and Waddington, 2004).

The recent moves to identify necessary conditions for enhanced acquisition and sustenance of agroforestry technologies, as well as the introduction of market-oriented production are indications that adoption of agroforestry technologies has not attained the

expected levels and scale (Kaudia, 2003; ICRAF, 2002; Cooper and Denning, 1999). Some aspects of these assertions have been echoed in Franzel et al. (2002) who recommends that studies should be done on how farmers can sell their agroforestry products to local, regional and international markets.

2.5 Summary and conclusion

From the literature review, it has emerged that the productive and functional importance of agroforestry in natural resource conservation cannot be underestimated. This is especially in the developing countries where farmers' access to modern production methods is minimal. Much of the focus has thus been on solving productive and sustainability issues in agriculture system production. In this light, an understanding of acceptable sustainable agriculture and forestry production technologies especially amongst the resource poor farmers has potential to improve community livelihoods. Such lessons can only reasonably be deduced from farmers who have demonstrated some level of success at the backdrop of non-success by their peers.

In the literature, the criterion of judging a successful agroforestry system has been given. These have mainly been on the positive changes that it brings at all levels in a society starting with well-being of households'. Understanding the factors that do motivate positive acquisition of agroforestry practices especially in places where farmers are constrained with environmental, socio-economic and biophysical provides an opportunity for advancing the practices. However, objective data on this may only be acquired in areas where agroforestry extension messages are scale neutral across farmers of different social status.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Study area

The study site was Kadibo Division in Kisumu East District. The rationale for its selection was that: first it is the poorer as compared to Winam Division which is the other division in Kisumu East District (KDDP, 2002); secondly, the division is rurally based as compared to Winam Division and thirdly Kadibo Division is home to most of the farmers found within Kisumu East District (KEDDP, 2008).

3.1.1 Position, size and administrative units

Kisumu East District in Nyanza province Kenya lies between 33^0 20′E and 0^0 20′S. The district comprises two provincial administrative divisions namely Kadibo (see Appendix 2) and Winam. Kadibo Division is the smallest in size of the two divisions and it covers a total area of approximately 162.7 square kilometers (KEDDP, 2008). The division covers a large part of the low land region. Kadibo Division borders River Nyatini to the East and Rivers Nyamasaria to the West: Lake Victoria to the South and Winam/Miwani Divisions to the North. It has 8 administrative locations namely; Bwanda, Kanyagwal, Katho, Kawino North, Kawino South, Kochieng' East, Kochieng' West and Kombura. The Division has a total of 19 sub-locations.

3.1.2 Drainage and soil

Kadibo is part of the Nyando river drainage system. The main drainage river channels are river Nyando, river Kibos, river Ombeyi, river Orije, river Nyatini, and river Obuso amongst others. Most of these rivers are seasonal in nature and given the weather pattern in Kadibo they only come to life during high rainy seasons, the waters from these rivers

have often been harnessed by small-scale farmers for irrigation. The soils in Kadibo are dominated by *vertisols* (black soils) such soils contain little organic matter and are poorly drained (Laura, 1998). The black soils found in Kadibo contains abundant clay size particles in them causing the black coloration, in dry season wide deep cracks develop that allow a lot of rain water to penetrate at the beginning of rainy season. Once the ground is wet, the soils expand, the cracks then close and water cannot further infiltrate the soils leading to flooding of the plain terrain.

3.1.3 Topography and vegetation

Kadibo division is largely in the famous plains of Kano in Western Kenya. The division is topographically located on the low ridges where rivers occasionally break into and cause devastating loss of property and human lives. This is because the Kano plains formation renders itself vulnerable to flooding by heavy rains especially the lower plains (KEDDP, 2008). The plain terrain and the seasonal flood has traditionally been exploited by a section of local residents for rice farming, but this notwithstanding, many a times the local farmers have experienced losses resulting from seasonal flooding of the lower Nyando river basin.

In addition, the entire Kisumu East Districts lack a designated gazetted forest area (KEDDP, 2008). Kadibo in particular has sparsely distributed vegetation cover. The division is also home to patches of wetland and marshy land that is rich in a collection of biota. Local residents have in the past mainly harvested the available tree species for use in construction activities and as source of fuel.

3.1.4 Climate and agriculture

The type of rainfall received in Kadibo is bimodal with peaks in April to May and short rains in September to November (Owuor, 1999). Generally, the division lies in the low land area that forms the trough of low rainfall and receives a mean annual long rainfall of between 1,000 mm and 1800 mm. During the short rains the average annual rainfall ranges between 450 mm and 600 mm. The reliability of the long rains is low and are unevenly distributed making cultivation of second crops difficult (KEDDP, 2008). On the other hand, there is a general temperature fluctuation throughout the year, with a low of between 9^0 C and 18^0C and a high of between 25^0 C and 30^0 C (Owuor, 1999).

A significant section of households in Kadibo Division are engaged in agropastoral practices and fishing as the main stay economic activity. Some of the commercial crops predominately grown in this division include; rice (O*ryza sativa l.*), cotton (*Gossypium barbadense L.*), sugarcane and a variety of horticulture crops such as tomato (*Solanum lycopersicum L.*), water-melon, butternuts amongst others. Subsistence crops are mainly Maize (*Zea mays L.*,) sorghum (*Sorghum bicolor L*), green grams (*Vigna radiate L.*) and cowpea (*Vigna unguiculata L.*) amongst others. While on the other hand, the small-scale pastoralist keeps cattle (*Bos Taurus*), goat (*Capra hircus*), sheep (*Ovis aries*) and pigs (*Sus scrofa*). In addition, indigenous chicken (*Gallus gallus*) and muscovy ducks (*Cairina maschata*) are breed for subsistence purposes by nearly all the households in Kadibo Division.

3.1.5 Population and settlement

Kadibo Division has a human population of about 73,227 persons, which translates to a population density of 450 persons per km^2 (KEDDP, 2008). The human settlement is generally sparse in Kadibo and represents the rural population in Kisumu East District. The human settlement is generally denser along the Kisumu-Nairobi highway and around the major shopping and market centers such as Rabuor, Nyang'ande and Korowe. In addition, there is denser settlement in areas around the major Lake Victoria beaches such as Nyamware, Obange, Nduru, Riat and Ogenya.

3.2 Research approach

This study utilized a mixture of qualitative and quantitative information solicited from the targeted community and relevant agroforestry extension providers in Kadibo Division. A mixed method approach was adopted in this study because of its importance in: triangulation and ensuring validity of the data; provisioning of complementary information for clarification or elaboration of given factors; and also as a guide to collection of preceding data. Mixed research design approach draws from the strengths and maximizes the weakness of both quantitative and qualitative information in a single research study and across studies (Burke and Onwuegbuzie, 2004).

3.3 Study population

The study population was of 127 farmers but the sample comprised of both male and female residents practicing agroforestry in Kadibo either as a primary or secondary source of livelihood and the extension providers. Only the research subjects who met the criteria overleaf were interviewed during this study;

3.3.1 Inclusion criteria

- Farmers who have positively embraced agroforestry practices in the study area.
- Agencies providing or which had provided agroforestry, environmental or natural resource management extension services in the study area.
- Provincial administration representatives in the study area.
- Representatives from community based agriculture and forestry groups.

3.4 Sample design and size

3.4.1 Sampling design

The research sites for this study were selected by stratification of the 8 locations based on levels of adoption of agroforestry by farmers in Kadibo. Four out of the eight locations in Kadibo division namely; Bwanda, Kochieng' East, Kochieng' West and Kombura were selected for this study using stratified sampling design (Mugenda and Mugenda, 1999). At least 20 agroforestry practicing farmers from each of the four locations were randomly selected for household interviews taking into account the variances in sub-populations (Israel, 1992) within the four locations.

3.4.2 Sample size

The appropriate sample size for this study was calculated from an inventory 127 farmers practicing farmers within the division. This inventory was acquired from extension providers. Yamame (1967) simplified formula for small population sample size calculation was adopted for the study. The formula states:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = The desired sample size

N= Population of farmers practicing agroforestry 127

e = Margin of error 5 %

From the formula:

$$n = \frac{127}{1 + 127 (0.05)^2}$$

The calculated sample was 96 farmers

However 92 farmers were selected for the actual study given the financial and logistic constrain of accessing the desired sample of 96 targeted farmers. About the same sample size or even less has been used elsewhere to conduct agroforestry adoption studies and produced scientifically valid results (Imo et al., 2005; Pisanelli et al., 2001). The respondents were drawn from an inventory of agroforestry practicing farmers in the four pre-selected locations provided by extension agents.

This study further benefited on information solicited from nine purposively selected agroforestry extension agents from different institutions within Kadibo Division. The information from the extension agents was instrumental particularly in triangulating information provided by the interviewed farmers.

3.5 Research instruments

All research in the social sciences represent an attempt to provide warranted assertion about human beings (or specific groups of human beings) and the environment in which they live and evolve (Biesta and Burbules, 2003). In this study, the following tools were employed to achieve this:

3.5.1 Interview schedule

This benefited on information collected by use of the interview guide attached as Appendix (3). Prior to commencement of this study, the interview guide was pre-tested in Kanyagwal location (a pilot site identified in Kadibo Division). The pre-test subjects comprised at least 10% of the total sample size. Necessary adjustments to the interview guide were made following a successful pre-test in Kanyagwal location.

The interview schedule is divided into four major sections. The first section was meant to obtain background of the respondents while the second section inquired how farmers have managed to acquire and sustain agroforestry practices. The third and fourth sections on the other hand inquired on factors motivating farmers to adopt agroforestry and the role of extension services in dissemination of agroforestry practices, respectively. Prior to commencement of the interviews, four field assistants were hired and trained on basic data collection principles.

3.5.2 Observation checklist

The observation checklist shown as Appendix 4 was used to solicit on-site information on characteristics of farms and types of agroforestry technologies adopted by various

farmers. In addition, information on status of agroforestry practices within Kadibo was collected using this tool.

3.5.3 Questionnaire

This study benefited from knowledge of relevant key informants in Kadibo Division. For this purpose an open-ended questionnaire was issued to the nine pre-selected agroforestry extension service providers in the division. In some cases, in-depth interviews were conducted to get an understanding of extension agents' contributions, experiences, important lessons and opportunities learnt for improvement of agroforestry activities within Kadibo Division. The open-ended questionnaires used for key informant interviews are presented as Appendix 5 and 6.

3.5.4 Focused group discussion

A focused group discussion was conducted in Kadibo with participants being selected amongst farmers who have embraced agroforestry within the division. Three successful farmers from each of the four locations assessed were invited for the group discussions. The discussions revolved around farmers' attributes, motivations/ de-motivations, social-economic and environmental situations e.t.c. The aim of these discussions was to triangulate information from the interview schedules and questionnaire survey.

3.5.5 Photography

This was extensively used to capture visual images of relevant farm sites. These images complemented observed information and at the same time were instrumental in ascertaining the exact agroforestry technology adopted by farmers when performing site analysis.

3.5.6 Case study approach

This was one of the instruments used in assessing the key research problems. The characteristics of a case study are; a small number of units of analysis, a labour intensive approach, more depth than broadness, a selective or strategic sample, qualitative methods and data , and an open observation on location (Mitchell, 1983 as quoted by Mango, 2000). Case study approach was therefore found appropriate in obtaining an in-depth insight into individual farmers attributes that has enabled them succeed where their colleagues appear not to be unsuccessful. The cases provided an opportunity for intensive analysis of specific cases.

3.6 Data Analysis and Presentation

The analysis of quantitative and qualitative data generated on this study was done concurrently since the information solicited from the research subjects expected to complement each other. But ideally, Statistical Package for Social Sciences (SPSS) was used to perform the analysis of all the quantitative data. Descriptive statistics such as percentages, frequencies, mean and percentiles were explored during analysis of the quantitative data using SPSS. Logistical regression models were also used in analysis of the factors influencing some farmers' to adopt agroforestry practices and role of extension in promotion of agroforestry in Kadibo Division. On the other hand, context analysis formed the basis of analyzing qualitative data from this study. The results were then presented in form of ratios, tables, figures, plates, case studies and discussions.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Overview

This chapter presents and discusses the results from the positive deviants in the adoption of agroforestry technologies in Kadibo Division, lower Nyando river basin, in Western Kenya. For this purpose, the chapter is divided into three sections. The first section entails a background of the respondents with an overview of *gender proportions, household sizes, ages and educational level of respondents*. It has been revealed in different studies that farmer's socio-economic characteristics have much influence on the adoption behavior regarding new practices (Jamal, 2005).

The second section on the other hand, focuses on the key findings that are presented in three themes, each denoting the stated research objectives and are as follows:

- ***Theme 1*** identifies :
    - the *specific agroforestry technological packages* being promoted in Kadibo Division by various agencies;
    - the *governmental and non governmental actors disseminating* specific agroforestry packages and
    - the *reasons* for some farmers' preferences of mentioned technological packages.
- ***Theme 2*** highlights the *means used by some farmers to acquire and sustain agroforestry* practice in Kadibo division. Herein, information is provided on

access to planting material, farmers' strategies, sources of agroforestry in-put and means used to manage agroforestry seedling shortage within the division.

It is worth noting that additional information aimed at enriching this theme such as the number of fast and long term maturing woody perennials owned by individual farmers, the agroforestry components interactions and out-put, and the means used by farmers to manage various challenges are therein included.

- ***Theme 3*** *presents information on the sources of farmers' motivation*. This information has been presented in four sub-themes:

  The first sub-theme is on *agroforestry produce marketability* with regard to an exploration of the factors that have influenced the adoption of agroforestry practices such as the sale of farm produce, the place of marketing the farm produce and the changes in numbers of marketable farm products. The second sub-theme, however, enumerates on the *changes in farm produce quantities as* a factor influencing farmers' decision to adopt agroforestry practices. The third sub-theme, on a different note, analyses the *satisfaction with farm produce quality and variety after adopting agroforestry practices as a factor motivating adoption of agroforestry practices*, whilst the fourth sub-theme analyses *daily changes in number of meals consumed by household members as a motivation to farmers' up-scaling agroforestry practices*.

The last section of chapter four presents summaries of the discussion, which is followed with conclusion and recommendations that are presented in chapter five.

4.2 Background information

4.2.1 Gender proportion

This study revealed that a slightly higher percentage of male respondents fifty six point six percent (56.6%), constituted the majority of farmers who have embraced agroforestry practices in Kadibo Division (Table 4.1) in comparison to the women. Furthermore, as shown in Table 4.1, it was only in Kochieng' West Location (out of the four locations studied) that a slim majority of the respondents (53.8%) were females.

Table 4.1: Respondents distribution by gender in four locations assessed

Location	Gender				Total	
	Male		Female			
	n	%	n	%	n	%
Kochieng' West	12	46.2	14	53.8	26	100
Kochieng' East	14	66.7	7	33.3	21	100
Kombura	12	52.2	11	47.8	23	100
Bwanda	14	63.6	8	36.4	22	100
Total	*52*	*56.5*	*40*	*43.5*	*92*	*100*

Source: Questionnaire interview 2008

The uptake of agroforestry practices by both men and female members of society is an important step to enhancing their social, economic and ecological well being. Elsewhere it has been revealed that farmers can achieve this through integration of trees in agricultural landscape (Leakey, 2001). In such a system trees provide fuel-wood, fodder, fruit (productive function) as well as fencing and shade service function (Mugendi et al., 2007).

Apparently, the entry into agroforestry practices by slightly more men than women in as shown in Table 4.1 can be explained by the fact that more men own land as compared to women. It follows that men can freely dispose of, use and carry any such matters as it pertains to the land without having to seek permission because they hold entitlement unto the land. This confers an additional advantage to men whilst hampering successful agroforestry crop production by women. It is not surprising then that elsewhere studies have shown that by 2004 in Kenya, only 1% of land titles were held by women and 5-6% was owned jointly (International Women Human Rights, 2008). This form of gender inequality undermines economic growth and social development (Institute of Economic Affairs, 2008).

Moreover, discrimination against women in land ownership presents itself in customs and traditions of most ethnic groups in Kenya. These results in a gender imbalance which exhibits itself in the belief that women are not supposed to own land and those women have no right to make decisions on the use of land. This discrimination occurs even though more women work on land as compared to men. In fact, women provide up to 80%-90% of labour in subsistence production in Kenya (Republic of Kenya, 2006). It is therefore a positive step to realize that women members of society are actively engaged in agroforestry practices as shown in Table 4.1. Perhaps this is possible due to a fading of culture that prohibited women from planting trees and certain shrubs amongst the Luo community who predominate Kadibo. Replicated of such behaviour in other sections of the society where majority of women wallow in poverty and are destitute due to a lack of tangible economic activities my increase society well-being.

4.2.2 Household Size

The respondents were from relatively large household comprising 6.77 approximately 7 members (Table 4.2), which is high up against a predicted district average of 5 members (KEDDP, 2008). Nonetheless, it is worth to note in results presented in Table 4.2 that there exist a large deviation from the 6.77 calculated mean. This perhaps was influenced by time of the year when data was collected. Essentially, the data collection was in the month of December, a time when both usual and unusual members of households were present given the long holidays. This could have been part of the cause of the extraordinary household size observed. On the contrary, Kenyan government *de facto* population census whose statistic infers population trends is often conducted in the month of August when there are relatively fewer household members.

Table 4.2: Average household size and distribution of members by sex

Location		Cell statistics				
	Sex	Mean	Std. Dev	Minimum	Maximum	n
Kochieng' West	Male	3.48	1.711	1	7	25
	Female	3.60	1.708	1	8	
	Total	7.08	2.414	4	13	
Kochieng' East	Male	3.57	1.805	1	8	21
	Female	3.33	2.671	0	13	
	Total	6.90	3.961	3	21	
Kombura	Male	3.57	1.674	0	7	23
	Female	3.61	2.039	0	9	
	Total	7.17	3.084	1	14	
Bwanda	Male	2.91	1.231	1	5	22
	Female	2.95	1.495	1	7	
	Total	5.86	3.084	1	14	
Site Mean	Male	3.38	1.618	0	8	91
	Female	3.38	1.993	0	13	
	Total	6.77	2.906	1	21	

Source: Questionnaire interview 2008

As shown in Table 4.2, slight variations exist on gender composition of the households assessed. The proportion of female household members were slightly higher than that of male members in Kochieng' West, Kombura and Bwanda Locations in contrast to gender proportions in households found in Kochieng' East Location. Once more in this particular scenario there is relatively large deviation from the mean, which meant that female distribution was even. This entails that at the time of the study, some households in Kochieng' East had either too few or far more female members of households than the average mean observed. World Fact-book (2009) has shown the number of female being generally larger than that of male in an average social set up all over the world.

4.2.3 Age

Majority of farmers practicing agroforestry in Kadibo were above 36 years of age. Table 4.3 indicates that more than three quarters of the active farmers assessed (82.6%) were 36 and above years of age. The results in Table 4.3 further reveal that nearly all the respondents ninety eight point nine percent (98.9%), owned land used for agroforestry related activities given the long-term nature of the practices.

Table 4.3: Ownership of farm by age stratum of respondents

		Age stratum								Total	
		< 20years		21-35 years		36-50 years		50+			
		n	%	n	%	n	%	n	%	n	%
Whether farm is	Yes	1	1.1	15	16.3	37	40.2	38	41.3	91	98.9
	No	0	0	0	0	0	0	1	1.1	1	1.1
Total		1	1.1	15	16.3	37	40.2	39	42.4	92	100

Source: Questionnaire interview 2008

The dominance of the older generation in agroforestry related activities as shown in Table 4.3 is an indication that few youths in Kadibo Division get involved in agroforestry practices. The factors hindering the youths from practicing agroforestry include a lack of land and resources. This is a big draw back considering that youth unemployment has become a major challenge in the 21st century and that sub-Sahara Africa is one of the regions in the world highly affected by youth unemployment. Unemployment in sub-Sahara Africa is estimated to be more than 21% (ILO, 2003 as quoted in Odeny, 2006).

4.2.4 Education

This study revealed that a majority of the respondents (46.2%) had only basic primary level of education as summarized in Table 4.4. However, there were about one third of the respondents (39.6%) who had secondary level of education while a minority had tertiary education. As shown in Table 4.4, respondents who have relatively higher education were also mostly engaged in multiple income generating activities such as business and formal employment unlike those with neither formal nor none formal education.

Table 4.4: Education Level versus Primary Occupation of Respondents

Education level	Primary Occupation						Total	
	Formal employment		Business		Farmers			
	n	%	n	%	n	%	n	%
None	0	0	0	0	3	3.3%	3	*3.3%*
Informal	0	0	0	0	3	3.3%	3	*3.3%*
Primary	5	5.5%	4	4.4%	33	36.3%	42	*46.2%*
Secondary	6	6.6%	7	7.7%	23	25.3%	36	*39.6%*
Tertiary	4	4.4%	0	0	3	3.3%	7	*7.7%*
Totals	15	16.5%	11	*12.1%*	65	*71.4%*	91	**100%**

Source: Questionnaire interview 2008

The farmers with higher levels of education are perhaps exposed to more opportunities and a better understanding of innovative ways of increasing their income (often an important production safety net) unlike the less educated. Amir (2003) and Nkonya et al., (2004) reported that education was the main and vital weapon for bringing a positive change in the behavior of individual farmer, which develops knowledge and other desirable qualities of mind and general competence.

4.3 Technological packages

In this study, the first objective was to determine specific agroforestry technology (ies) being promoted by various agencies within Kadibo division. This objective was based on the fact that studies have shown the essence of active promotion of multi-species technologies. Thaman et al., (2009) observed such promotions as the most economical, cultural and ecological effective means of addressing the serious trends in deforestation, forest degradation and agro-deforestation.

4.3.1 Actors versus agroforestry package

The findings revealed that in the past decade, extension agents have been promoting at least nine (9) different types of agroforestry technologies within Kadibo Division (Table 4.5). As shown in Table 4.5 the agencies offering agroforestry related services to residents of Kadibo Division were classified into two distinct groups. The first group comprised of governmental agencies, which included government departments and ministries rendering agroforestry related services to local farmers, whilst the second group was mainly made of non-governmental agencies.

Table 4.5: Institutions and agroforestry package promoted in Kadibo

Governmental agencies		**Package promoted**
1	Kenya Forest Service	Commercial tree nursery establishment
		Farm forestry
2	Ministry of Agriculture	Fruit orchards
		Fruit tree nurseries (paw paw, citrus and mangoes)
3	Lake Victoria Environmental Management Programme	Tree seedlings production
Non Governmental agencies		**Package promoted**
1	Swedish Co-operative Centre Viagroforestry	Fertilizer tree system, Dairy goat farming (agrosilvipastoral), kitchen gardening, agroforestry crop seed bulking, apiculture, hedge row, boundary planting, dispersed tree on farm, wood lots, fruit orchards, shade trees, riparian buffer zones
2	Victoria Institute for Research on Environment and Development	Apiculture, riparian buffer and earth pan embankment

Source: Questionnaire interview 2008

In Table 4.5 it is worth noting that farmers within Kadibo have benefited from multi-sector approach to agroforestry dissemination, which develops a synergy between governmental and non-governmental agencies. In the strategy for revitalization of

agriculture (currently under implementation in Kenya), the government aims at reversing declining trends in agricultural productivity by introducing new approaches based on a paradigm shift (Republic of Kenya, 2006). These paradigm shifts include multi-stakeholder involvements to increase agricultural productivity as shown in Table 4.5.

But even if this is so, the findings presented in Table 4.5 reveal a share of shortcomings in multi-stakeholders involvement including obvious effort duplications in agroforestry practices, by some agencies spearheading agroforestry in Kadibo Division. Perhaps this resulted from inappropriate co-ordination amongst the key stakeholders offering agroforestry services to the local farmers.

4.3.2 Technological Packages

a) Nursery Technologies

The tree nurseries are the main sources of woody perennials planting material to local farmers and as such have been promoted by all the three governmental institutions shown in Table 4.5. Certain farmers are continuously being encouraged by the various institutions to establish the tree nurseries in order to ensure a constant supply of planting materials. Longman (1997) observes that many species were once self replenishing and there is usually little or no experience of propagating them. As such effort to conserve the existing species and preferably increase there abundance ought to be made. In order to realize this, there is need for formation of strong partnership between the promoting institution and respective local communities.

b) Technology Value to Farmers

The various agroforestry technologies being promoted within Kadibo have potential to avail varied benefits to local farmers other than lifting many out of poverty. The fertilizer tree system enhances soil nutrients replenishment. This has a great production advantage to the implementing farmer. Farmers' experience elsewhere has revealed that the productivity is restored on degraded lands and food security has been effectively achieved with these practices (Jama et al., 2006).

On the hand the wood lots being promoted for its potential to supply the local farmers with the increasingly scarce; fuel - wood, timber and construction poles amongst others. If leguminous trees/shrubs are used in the system the land area stands to gain an additional advantage of soil fertility improvement. The soil fertility depletion is the fundamental cause of food insecurity and low income in Africa (Jama et al, 2006). This problem is catalyzed by the seasonal tillage of soils without adherence to appropriate soil conservation measures. The magnitude of nutrient losses from agricultural soils is huge with annual average loss of 22 kg N, 2.5 kg P, and 15 kg K for the whole of Sub-Sahara Africa region (Stoorvogel and Smaling, 1990).

Agrosilvopastoral technologies have potential to improve community well being by enhancing livestock production. This is because fodder from shrubs are a good supplement to other livestock feed. However, in order for farmers to reasonably adopt the practices, they require considerable skills that most farmers do not have such as raising seedlings in a nursery, pruning trees, and feeding the leaves to livestock (Franzel and

Wambugu, 2007). This is what the actors promoting the practices need to pay keen attention to, since farmers empowered with skills are likely to advanced the practices and adopt them in meaningful way.

4.3.3 Technological up-take

Initial and subsequent promotion of agroforestry packages shown in Table 4.5 has bore positive response amongst some local farmers. This is because the promotions provide a critical avenue for information sharing between extension agents and farmers. The International Development Research Centre (2010) agrees that an agroforestry forum should be established and charged with promoting tree planting and integrating trees on the farm and co-ordinating all agroforestry-related activities.

The findings reveal that the farmers have taken up about 10 different types of agroforestry technologies as shown in Figure 4.1. The reasons presented for preference of specific technology varied across board, but ideally revolved about attached economic, aesthetic and ecological values. As shown in Figure 4.1 eleven percent (11%) of the respondent's who have taken up wind break technology, which protects their property including crops against damage by the frequent strong winds in Kadibo. In this system, trees are planted in single or multiple rows along the edge of a field to reduce wind effects on crops or livestock. Windbreaks have been shown to reduce wind impact over a horizontal distance equaling at least ten times the height of the trees (Beetz, 2010). The wind break system therefore minimizes wind erosion, adverse damage of crops and creates a suitable micro-environment for favorable for crop growth.

The study revealed that the intersperse droughts frequenting Kadibo Division has influenced acquisition of shade tree technologies by 20% of the farmers. The shade trees have specifically been preferred for the aesthetic and ecological values alongside the long term economic values that they provide to the farmers. Ruark, 2003 agrees that agroforestry has the ability to provide short-term economic benefits while the farmer waits for traditional longer-term forestry products). The longer term economic benefits may accrue to the farmers after harvest of woody products from such plantations of woodlots as the one shown in Plate 4.1.

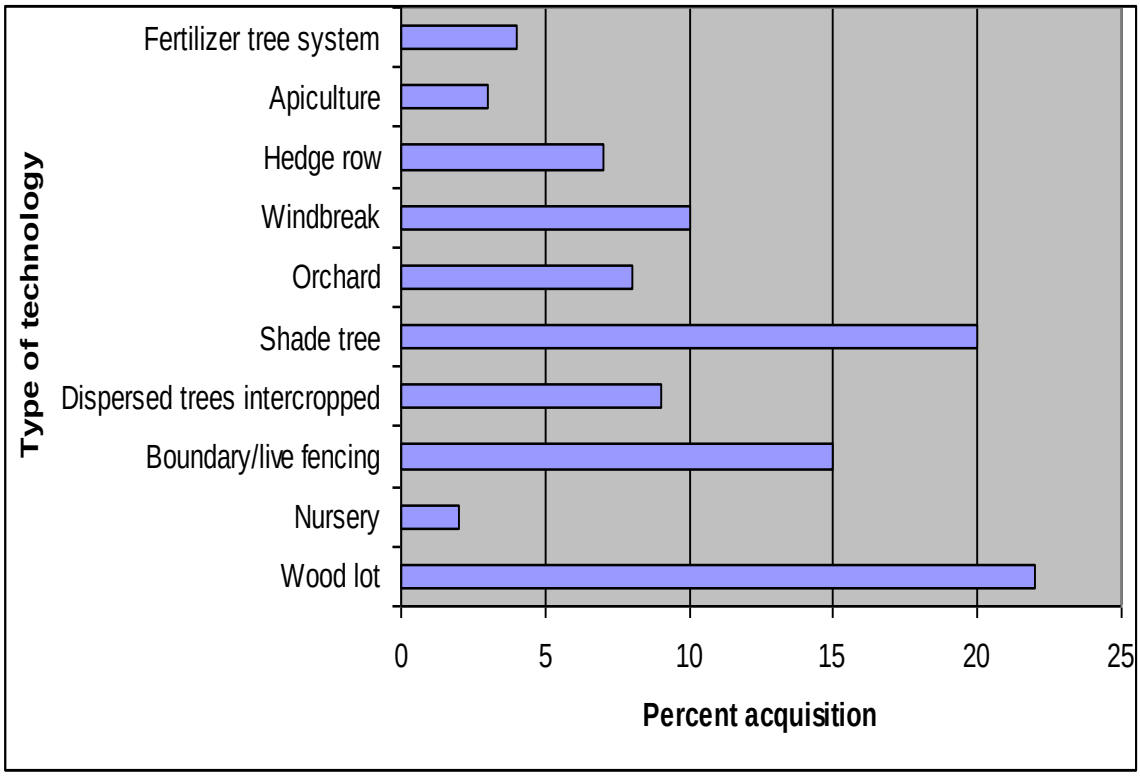

Figure 4.1: Agroforestry technologies and percent acquisition by respondents

Source: Questionnaire interview 2008

Plate 4.1: A planted woodlot in Kochieng' East

(Notice the scenic environment created by the woodlot that also serves as windbreak)

(Photo by Ken K'Oyooh on 3rd /01/2009)

The following is a highlight, on a scenario of a farmer who has diversified her farm crop production by up taking the agroforestry technologies being promoted by extension agents in Kadibo Division.

Case 1:

Success through diversification

Ms. Mary Odhiambo's story

Sector: Agroforestry (Kitchen garden and shade tree)

Location: Okana village, Kisumu East District, Kenya

Mary is a 45 years-old female agroforestry practicing farmer. Mary's household is comprised of about 15 members and her 1.25 acres farm is under assorted agroforestry crops. Visible from far were a woodlot of *Grevillea robusta* at the entrance of her compound and numerous *Flamboyant delonix* shade trees in the midst of her compound. This is what Ms. Mary Odhiambo had to tell me after an exchange of proper greetings.

"I began this practice around the year 2000 following discouraging experience with floods and drought on my farm crop and livestock production"

This was in apparent reference to agroforestry practice. Mary continued

"The grevillea robusta wood lot that you have by pass near my gate serves as a windbreak to protect against damage of my property, I have also planted traditional vegetables beneath the woodlot for my household consumption and I do occasionally sell the surplus".

The woodlot - traditional vegetables relationship in Mary's farm is such that woodlot provides shade that prevents excessive moisture loss from the undergrowth while leguminous vegetables contribute soil fertility improvement for robust crop growth.

"I also have oranges, pawpaw (Carica papaya L.), lemon (Citrus hystrix DC) and passion fruits in my kitchen garden that supplies my household members with the required nutrients. The windbreak function of the woodlot has been important in moderating damage to my crops previously occasioned by strong winds,"

"Planting of indigenous vegetables under the trees and shrubs that you are seeing in this farm has helped me to readily supply my household with food. Nearly all the meals that we take in this household do have a composition of exotic and indigenous vegetables harvested from my farm. The shade provided by the trees and shrubs to the pumpkins and the assorted underneath growing indigenous vegetables has enhanced the survival of this species in dry period and thus supply us with basic nutrition almost throughout the year" said Mary

As we toured Mary's farm she showed *me* a near half-full rain fed water pond. Pointing at it she said

"On realizing that the highly saline borehole water available in this village is not sustaining healthy growth of some agroforestry crops, I decided to excavate this water point"

"The water point has enabled me store and access rain water for irrigating vegetables and younger tree/shrubs in my farm. So far this has enhanced survival of the system".

She said that the abundant fodder from her farm has now encouraged her to venture into dairy goat farming in order to maximize on farm vegetation output

Later on Ms. Mary Odhiambo takes me round her well done kitchen garden and shows me a variety of planted exotic and traditional vegetables. As she is still showing me round her farm one of the villagers in need of traditional vegetables interrupts. I excuse myself to allow her sell vegetables

Mary's case is one of a farmer whose strong will power to earn a decent living in a disadvantaged environment has acted as an impetus towards her ability to modify her biophysical setting through farm crop diversification to meet her needs. The decision by Mary to engage into multiple farm crop production has not only furnished her with nutritional needs, but also enabled her be in possession of woody perennials, which have potential long - term benefits. Other studies have revealed that presumably, any idea, innovation or farm practice is easily adopted if there is a positive attitude towards the practice; otherwise it is not adopted (Kamal and Mitchell, 2004). Besides, we can infer that Mary's case is that of a farmer who has turned the prevailing biophysical environment constraints into an opportunity to improve her social status.

4.4 Acquisition

The second objective in this study sought to assess the means that some farmers have used to acquire agroforestry technologies within Kadibo Division. In determining this objective certain sub-questions relating to: agroforestry learning by farmers; seedling propagation and access; and seedling shortage management were analyzed.

4.4.1 Agroforestry acquisition

a) Learning

The production of agroforestry crop was first learnt from various sources by the farmers interviewed in the study. Figure 4.2 presents the sources where farmers from within Kadibo Division first learnt of agroforestry practices. As shown in Figure 4.2, most of the farmers interviewed first learnt of agroforestry practices from either Non Governmental Organization agents (43%) or lead farmers (32%) found within Kadibo Division. These two agents do play a critical role in influencing farmers' decision and providing options

necessary to acquisition of the practices by the farmers. The rise in NGOs in the global context has been identified as an important phenomenon, which has implication for the development prospects of the poor (Naznin and Natid, 2005).

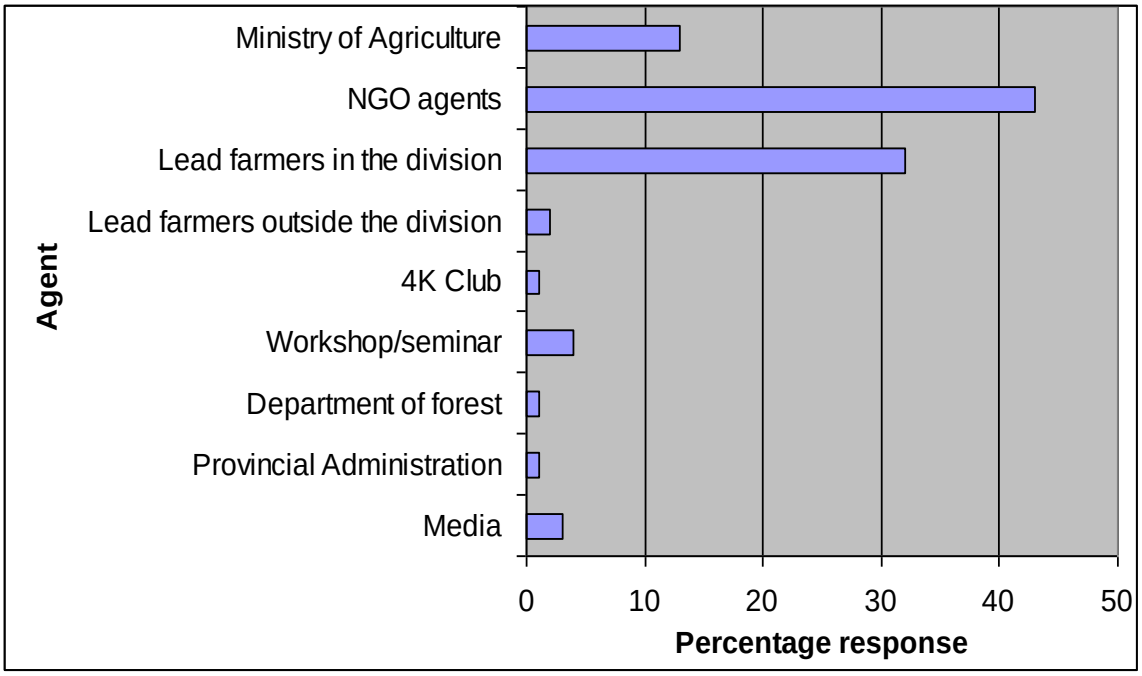

Figure 4.2: Where agroforestry was first learnt from

Source: Questionnaire interview 2008

Figure 4.2 further shows that other farmers (14%) first learnt of agroforestry practices from extension agents drawn from the Ministry of Agriculture Extension Department. This ministry plays a vital role in ensuring secure food production in Kenya by posting extension agents at division level who discharge services at local levels. The importance of agriculture extension in rural development is widely acknowledge, particularly in developing countries where a majority of the population lives in rural areas and agriculture is the main source of livelihood (Wanga, 1999).

Along with the agents earlier mentioned, positive farmers within Kadibo have explored other important channels of learning more about agroforestry practices. These channels include; the media, the provincial administration and lead farmers outside the division. This is especially important given that agroforestry as a concept requires multidimensional approach for meaningful adoption by local farmers. The essence of extension is actually to achieve positive out in the system by linking researchers, government planners, non-governmental organizations, community based organizations and the private sector with farmers and offering an open platform for the exchange of ideas and services (Farrington, 1995).

The following is an extract on a scenario of a young farmer who has acquired apiculture and has managed to move the practice forward by employing modern skills after inheriting the practices.

Case 2

Moving forward through reinventing

Story of Dominic Okwaro Oloo

Sector: Agroforestry (Apiculture)

Location: Kadete village, Bwanda Location, Kisumu East District

Dominic Okwaro Oloo is a 20 year old, last born orphaned male, from a polygamous family of 44 members. Okwaro who was barely 1 year old on the demise of his re-known apiculture farther in 1989; never got an opportunity to closely interact and learn the practice from his father. He had to learn apiculture through his elder brothers who were fortunate to inherit the practice from his late father in a hard way. Here is how:

"W*ith a sting of a bee, my elder brothers could wake us up in the middle of the night to help them in harvesting honey from the old beehives*" said Okwaro in apparent reference to the hard way he was introduced into apiculture at an early age in life.

"I have a total of 18 brothers including step brothers, out of this number only two of us developed interest in apiculture but the rest totally disengaged in the activities" said Okwaro.

As Okwaro was growing up his elder brothers kept on encouraging him to take apiculture more seriously.

"In addition, when in primary school my agriculture teacher occasionally asked me to demonstrate to my classmates how honey is harvested from a beehive. This further made me develop interest in science and agriculture as subject in primary school that I eventually emerged the top KCPE student in our school".

This motivated Okwaro to learn more about apiculture at a tender age. Okwaro has so far boosted his honey production by investing in modern beehives.

"My father left behind about 20 Kenya top bar hives type most of which I have so far replaced by the langthroth beehives type that have better production ability. In total I have 40 beehives in my apiary"

"*I am also a community contact person for apiculture farmers. They do contract me to inspect their hives in apiary and assist in honey harvesting'.* Said Okwaro

The chairman of a local wetland conservation group Mr. Ken Obura later on confirmed that Okwaro has been rendering them a helping hand at a small fee.

*"Our earnings from apiculture activities have drastically increased ever since we contracted Okwaro to supply us with; bee hives; inspecting them and helping us in harvesting," s*aid Ken Obura.

Initially Ken's group could harvest nothing from their hives either because of poor timing or departure of bees due to poor maintenance of the hives but this changed for the better when they sought Okwaros' services.

I later learnt from Okwaro that he has been saving money earned from apiculture activities to pursue a degree course in community development.

He further told me how the income earned from bee keeping has enabled him buy a motorbike locally known as *peng'* for transportation services within the village.

Okwaro later on equates apiculture which most young people in his village despise, to the work of a mortuary attendant whom he claims earns 'easy' money from peoples' fear of corpse. He said

"Just like the way people fear corpse, most of my age-mates fear bees. They don't realize the 'easy come money' that lay in apiculture. Bee keeping does not need much supervision. It is an activity to be undertaken alongside other economic engagements.

Furthermore, you can choose to do your inspections at night like I do, if you have tight working schedule by day".

"*This is where I defer with most of the youths who prefer boda boda (transport by bicycle); they think that apiculture is highly demanding and less rewarding. The irony is that most of these youths do often beg for my money" said Okwaro*

I further learnt that Okwaros' future plan is to buy a one acre parcel of land, plant appropriate shrubs and trees and site beehives. He says that by doing so he will be able to continue earning 'free' money that his village-mates have refused to earn.

Okwaros' story is one of a youthful farmer who has utilized locally available opportunities to shape his destiny unlike most of his peers. The fact that master Okwaro was left an orphan at infancy has not daunted his quest to exist amongst elitist members of society by modernizing an age long practice. His action has encouraged maintenance of local trees and shrubs such as *acacias* as shown in Plate 4.2.

Plate 4.2 Apiculture farmer inspecting his Kenya top bar beehive in Kadibo

(Notice how apiculture has made the farmer maintain tree and shrub species in his farm)

(Photo by Ken K'Oyooh on 4rd /12/2008)

b) Access to Planting Materials

In this study, more than half of the farmers interviewed (56.5%) asserted that their sources of planting materials are reliable. These findings were also evident in the focused group discussions where participants revealed that except for some exotic seedlings varieties, the farmers have been able to access high quality planting materials from extension agents and lead farmers. Seeds of poor quality are widely known to be susceptible to pests and thus have low survival rates. Other study agrees that such seeds are often of low production yield (Odame et al, 2003). The findings further revealed that affordability of planting materials at the local market has been an opportunity capitalized by some farmers to advance agroforestry practices.

One important revelation made in this study was the various means used by 43.5% of the respondents to overcome the challenges of unreliability of planting materials in Kadibo Division. A discussion with the farmers revealed that some of them have ventured into their own seedling production (a technical process that requires mastery of seed propagation techniques). They do produce the seedlings primarily for use in their farms. Mr. Lumumba Ochango, from Alendu village in Kochieng' West location is one of such farmers' producing seedling. In an interview with Mr. Lumumba, he said:

"I do harvest the seeds from healthy looking Sesbania sesban and Carica papaya crops, dry and then store to plant on my own farm at appropriate time". The appropriate time according to Mr. Lumumba, was during the wet season when weather conditions are favorable for seedling germination**.**

The strategy of using native planting material is one of the positive things that some farmers in Kadibo Division are doing. Experience from tree planting projects has demonstrated that a project can fail if it uses seed or seedlings that were gathered from trees growing too far away from the project site where they were finally planted (Robinson and Johnson, 2006). Based on this realization, some farmers from Kadibo Division locally harvest seeds from healthy agroforestry crops, nurture the seeds in established tree nurseries and later sell the seedlings.

"I have been adequately trained on the methods of nurturing seedlings' in a nursery and marketing my farm produce" said Mr. Opiyo.

Mr. Opiyo is one of the farmers with an established commercial tree nursery in Kadibo Division (Plate 4.3). He asserted that by having close ties with the extension providers and applying the best nursery management practices, he has been able to avail seedlings to a significant proportion of farmers within the division.

Plate 4.3: A typical Tree nursery maintained by a farmer to help produce seedlings

(Photo by Ken K'Oyooh on 17th /01/2009)

The following is a highlight on a scenario of a farmer who has adapted to the environment after failing in traditional farming within Kadibo.

Case 3

Adapting to the environment

Opiyo's Story

Sector: Agroforestry (tree nursery)

Location: Kombura

Opiyo is a 29 years old farmer from Kombura location. He has turned to production of tree and shrub seedlings for commercial purposes. Having lost opportunity to join secondary school after his Kenya Certificate of Primary Education, Opiyo was stranded on what to do for a long time. He tried several unskilled jobs before settling down to farming.

"At first I concentrated on the traditional grains (maize and sorghum) that are common in this place," said Opiyo, a father of four

However, this did not work out for him like it seems not to work to many other farmers in Kadibo given the erratic rain. It is after successive failure that Mr. Opiyo tried tree/shrub nursery. Opiyo said

"It was a challenge, we were faced with a lot of uncertainty that included; unreliable sources of water. The highly saline water that is readily available had increasingly frustrated efforts to maintain seedlings. The other challenge was of the high labour intensity and that of marketing the produce".

Opiyo learnt to introduce the locally available salty water on the seedlings in nursery when they are young and surprisingly the plants are able to adapt to high saline levels. This art of using salty water in seedlings has enabled him to be less dependent on rain water for nursery maintenance. So far Opiyo has made a big network of client and occasionally do deliver seedlings at the doorstep of his local customers. Income earned from tree nursery has enabled Opiyo to become self reliant.

4.5 Sustaining Agroforestry practices

The third objective of the study sought to assess how some farmers within Kadibo do sustain agroforestry technologies despite the reigning challenges. In determining this objective the sub-questions answered related to farmers' strategies on agroforestry practices.

4.5.1 Farmers Strategy

a) Planning

Proper planning of agroforestry activities by some of the successful farmers in Kadibo Division is one element that has greatly contributed to sustaining the practices. The farmers revealed how they have learnt to complement production of fast maturing shrubs/ tree with that of long term maturing ones presented in Table 4.6. Studies elsewhere have revealed that most agroforestry systems are also complementary to other crop production enterprises, as they provide green manure, fodder, and fuel (Wiersum, 2006).

Table 4.6: Fast and Long-term maturing tree/shrub species

	Fast maturing Shrub/Trees species		*Long term Maturing shrub/ Trees Species*	
	Local name	*Botanical*	*Local name*	*Botanical*
1	*Asao*	*Sesbania sesban* (L)	*Grevila*	*Grevillea robusta* (A cunn.)
2	*Kaliandra*	*Calliandra calothyrsus* (Meissn)	*Aliyo*	*Casuarina junghuhniana* (Miq.)
3	*Lusia*	*Leucaena leucocephala* (Lam)	Bao	*Eucalyptus saligna* (Sm.)
4	*Moringa*	*Moringa Oleifera* (Lam)	*Bao*	*Eucalyptus grandis* (W.Hil)
5			*Obolobolo*	*Annona senegalensis* (Pers.)
6			*Ober*	*Albizia coriaria (Oliv)*
7			*Bongu*	*Flamboyant-delonix regia*

Source: Questionnaire interview 2008

The average number of long and short term maturing species owned by the farmers is presented in Table 4.7. As shown in Table 4.7 majority of the respondents had more than 40 long-term and short-term maturing trees/shrubs, integrated into their means of agricultural crop production.

Table 4.7 Number of short and long term trees grown by respondents

No. of trees owned	Maturity time and respondents by percentage	
	Short term trees/shrubs	Long term trees/shrubs
Less than 10	17%	18%
11 to 25	19%	20%
26 to 40	16%	18%
> 40	48%	44%

Source: Questionnaire interview 2008

The respondents revealed how they are investing income earned from short-term maturing crops into management of long-term woody perennials. This act has enable them uphold and progressively expand farming practices. Pretty (1998) consider as sustainable any system of food or fiber production that, pursues a greater productive use of local knowledge and practices, including innovative approaches not yet fully understood by scientists, or widely adopted by farmers.

This study further revealed that some farmers' steadfastness on best tree crop management practices has enable survival of some tree and shrub species. As shown in Figure 4.3, the prosperous farmers in Kadibo have mainly watered and weeded tree crops grown on their farms to enhance robust growth. The undertaking by these farmers to

maintain trees species is one important element of agroforestry practices, which has greatly improved tree crop performance a great deal.

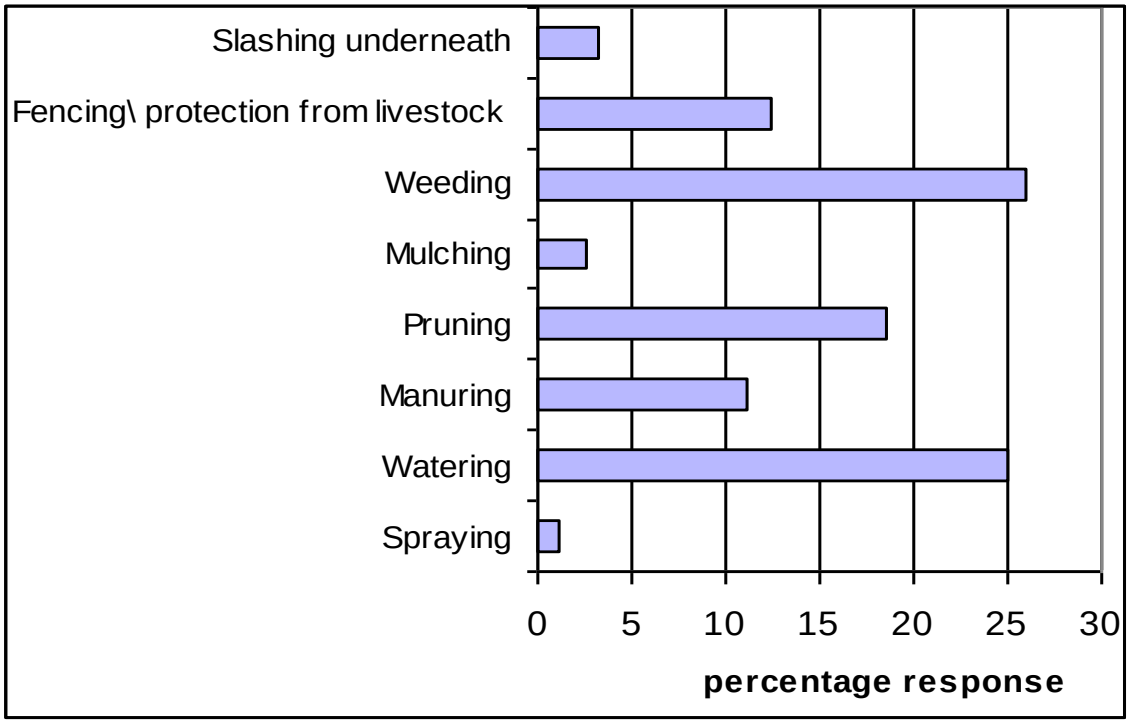

Figure 4.3: Management practices of agroforestry tree/shrubs in Kadibo Division

Source: Questionnaire interview 2008

b) Incremental Progress

Starting agroforestry practices in a small way and intensifying the activities in time is one of the strategies, which some farmers in Kadibo Division have explored to sustain agroforestry activities. One of these farmers is Ms. Catherine Akeyo from Mbega village. Catherine lacked initial capital but given her strength of will in agroforestry practices, she has grown big in the practice and now attracts admiration from her neighbors. Catharine's scenario is presented as Case 4.

Case 4

Starting small and growing big

Catherine' Story

Sector: Agroforestry (woodlot, orchard, mixed farming)

Location: Mbega village, Kisumu East District

Catherine is a 44 years old active female agroforestry crop farmer.

"I got married in this village in 1981 after unceremoniously terminating my education at primary level," said Catherine

This was after an exchange of friendly greetings and stating my purpose of visit. She invited me to take a seat under an umbrella tree *(Terminalia mentalis)* at the edge of her compound then continued

"For about 21 years I was just a homemaker dependent solely on meager remittance from my husband who had no stable job then. My life and that of my household members increasingly became unbearable with the growth in size of household membership. The economic and nutritional demands of my household members by then prompted me to attempt arrow roots farming".

I interrupted Catherine by asking her when this was and the outcome

"This was way back in the year 2002, and I want to acknowledge that my farm production was fabulous such that I sold surplus produce. Following the positive experience I got interested in other agricultural ventures since my low level of education could not guarantee me a decent white-collar job."
Ms. Catherine paused and sipped a mouthful of water and continued

"I have so far diversified my agricultural practices to enable me take control of the uncertainty of good harvest due to flood, drought, strong winds and crop disease that occasion this village".
I got interested in Catherine's explanation and then asked her how she has managed to stand out despite the wide failure by most of the farmers in Mbega village.

"My main difference with other farmers within this village is that I grow high valued short-term crops alongside long-term maturing crops. Specifically, I do cultivate butternut, watermelon, kales and arrowroots through irrigation in dry season. The sale of produce from these crops has provided me with the much needed income for my day-to-day survival and investment".

"Tell me more about the investment", I curiously asked Ms. Catherine

"I have invested the proceeds from this practice in maintenance of wood lots and orchard that take relatively longer time to mature. I have also invested in livestock. Such

diversification has enabled me manage some losses brought about by floods, drought or pest. It has also been helpful in educating my children one of whom is undertaking his undergraduate degree in University".

When I asked Ms. Catherine on the role of extension services, this is what she had to say

"I do frequently consult extension agents from the Ministry of Agriculture in Rabour, Care-Kenya, SCC-Viagroforestry and VIRED; on various issues regarding farm crop production and marketing. Advice from experts in these institutions has kept me going. My farm has also been of late utilized for demonstration by extension agents from SCC VI-agroforestry. They have further asked me to train fellow farmers from within Mbega village on ways of managing agroforestry practices in this harsh environment".

It is now around noon and Ms. Catherine daughter invites us for an early lunch. The meal is composed of corn cake 'Ugali", some boiled arrowroots and a mixture of traditional vegetables spiced with *Moringa oleifera (lam)* leaves (a delicious meal indeed). Catherine shares with me a papaya fruit and afterwards informs me that what I have consumed is from her small farm.

It is interesting to note from the foregoing story that Catherine's willpower to thrive in farming has enabled her carry on sound crop production practices. The case of Catherine is that of a farmer who has managed to diversify her crop production from a simple beginning. This implies that willpower to plays a critical role in enhancing adoption of agroforestry practices. The diverse products (fruits, vegetables, spices e.t.c.), which are available year-round in systems such as home gardens not only contribute to food security during the "lean" seasons but also ensure food diversity (Kumar and Nair, 2004).

Plate 4.4 depicts a section of Catherine's orchard. The orchard has supplied her with fruits for household members' consumption and sells at the local market. As shown in the plate, Ms Catharine is demonstrating to a visiting research assistant and an extension worker Ms. Beatrice Okello how she manages her orchard. Forums such as these have

been instrumental in idea exchange and experience sharing between Catherine and extension agents.

Plate 4.4: Extension worker and a research assistant in Catherine Akeyos' fruit Orchard

(*Note the healthy looking Carica papaya L. amongst other fruits produced by the farmer*)

(Photo by Ken K'Oyooh on 3rd /01/2009)

c) Components interaction

Multiple benefits enjoyed by farmers through the interaction of agroforestry components have been instrumental in sustaining agroforestry technologies within Kadibo Division. The findings show that shrub species such as *calliandra, leucaena, moringa* and *sesbania* grown on farms provide fodder mostly to goat and cattle. This has boosted individual farmers' production. These leguminous plants are also known to contribute to soil fertility improvement (Mugendi et al., 2007). The findings revealed that farmers

practicing agropastoral technology do acknowledge the importance of trees and shrubs to their livestock especially during dry periods.

"During the dry period when there is hardly any vegetation, I highly depend on undergrowth from my trees to feed my cattle and sheep" said one of the participants Mr. Lumumba.

Lumumbas' sentiments were echoed by a number of respondents who during the interspersed dry periods in Kadibo do source for livestock feed from *calliandra* and *sesbania* shrubs amongst others. Agropastoral systems have been recommended elsewhere in the world as efficient strategies to improve animal production in addition to avoiding pasture and soil degradation (Macedo et al, 2001).

4.5.2 Managing Challenges

This study revealed how some farmers in Kadibo Division have dealt with the trees diseases and water problems, which in the past have retarded development of agroforestry crop farming. The mode of doing this is herewith presented:

a) Tree diseases

In discussions with the farmers who have been able to adopt agroforestry practices, it was revealed that these farmers frequently seek expert opinion on management of tree crop diseases. Similarly, these farmers appreciate the importance of tree crops and have developed a habit of close monitoring of the tree crop health. Observation is the main method used by these farmers. While that is the local case, experiences from other parts of the world have demonstrated that even though community members may not be scientist, the data that they do collect on tree health are extremely valuable and has been used to successfully inform future management decision (Wilson et al, 2007).

A discussion with the farmers further revealed that by seeking experts' opinion and sharing out the detected problem with others has enabled some farmers to manage some crop pest. Local experts from the Kenya Forestry Services and those from Non Governmental Organizations operating in Kadibo confirmed this. However, they admitted that very few local farmers do seek their opinion on tree crop diseases, and conceded that they have witnessed higher success levels amongst farmers who promptly seek their opinion. The adoption of agroforestry has been found in other parts of Africa to be influenced by amongst others the contact with extension agent and the extent of social participation (Muneer, 2008).

Mr. Kenneth Omondi Nyang'wara an extension agent from Kenya Forestry services, whilst referring to two successful farmers (Mr. Samuel Opiyo and Mrs. Mary Orao) in Kochieng' West location, narrated the simple means used by these two farmers to control some crop pests.

"When the two farmers sought my opinion on what to do with the increasingly dying tree crops due to inversion by pests, I did advice them to uproot and burn the infected plants. After which I recommended a pesticide," said Kenneth

On their part, the two farmers uprooted and burnt the infected tree crops. But instead of spraying the infected crops with the fairly expensive pesticide recommended, the farmers prepared a concoction of fine ash and applied on the crops. These eventually restored the

plants health. The case demonstrates a perfect blend of indigenous technology with modern disease control system (an integrated pest management system).

b) Water problem

Farming in Kadibo Division has in the past been constrained by two main water related challenges. The first problem faced by farmers is that of excess water on their farms during the rainy season, brought about by flooding of Kano plains, whilst the second problem is that of agricultural drought where at certain times of the year there isn't sufficient moisture in the soil to sustain crops.

In an attempt to mitigate the negative effects of flood water (often an expensive exercise on a wider scale), some farmers in Kadibo, through organized community groups, have been able to make stride in flood water management. This study revealed that the government of Kenya, CARE-Kenya and VIRED – International, in joint initiative facilitated flood water management through community based organization in some quotas of Kadibo Division. This initiative facilitated good drainage in sections of the division. As a result, the findings revealed that (20%) of the respondents have been able to minimize flood induced crop losses by draining water out of their farm through the constructed water drains. This is agreeable with assertion that lands are drained primarily to insure agricultural productivity and increase efficiency of farming operations (Edminster and Reeve, 2010).

The joint flood water management project has enabled some of the farmers to manage agriculture drought frequenting Kadibo Division. A few farmers are now able to water

their crops in dry periods and get better returns as opposed to earlier periods when farmers could hardly harvest anything from their farms. Plate 4.5 shows a constructed flood water harvesting pond in sections of Kadibo Division that has been adopted by an individual farmer. Some farmers have adopted such mini water systems within their compounds for availing rain waters.

Plate 4.5: Sample flood water harvesting technology seen in Okana Village
(Photo by Ken K'Oyooh on 10th /01/2009)

In recognition of the uneven distribution, and inadequacy of community water harvesting pans in Kadibo Division, some farmers have innovatively excavated mini water harvesting ponds on their own farms. These ponds have supplied irrigation water to the farmers in dry periods. This is positive step considering that for along time majority of farmers in Kadibo have waited for government aid, which has been a precursor of dependency syndrome hence low productivity.

4.6 Motivating factors

The fourth objective in this study sought to assess the motivating factors to successful adoption of agroforestry technologies by some farmers in Kadibo Division. To ascertain this; the quantitative data gathered was subjected to statistical analysis using a linear logistic regression model and results presented in Tables 4.9, 4.11, 4.13 and 4.15. Conversely, explanatory variables used in the regression model are presented in Table 4.8, 4.10, 4.12 and 4.14. The farmers' motivations were determined in relation to their experiences with farm produce before and after adopting the practices.

4.6.1 Produce marketability

In this study, a Linear logistic model on individual farmers' experience with income earned from increased marketability of farm produce identified two significant variable at p=0.05 (Model 1, Table 4.9). This implies that farmers are now able to cultivate and harvest products that can attract better market prices (See Table 4.8). The improved economic reward has been a motivation to the farmers due to the tendency for improved economic rewards. Elsewhere in the world, research studies have revealed that trees grown along with crops could give better economic returns as compared to agricultural crops (Wasif et al, 2008).

It is also worth noting that strategies in agriculture have centered on promoting increases in productivity and access to markets as means of poverty reduction (Republic of Kenya, 2001). An improvement of farmer's economic well-being such as an increase in the production of marketable products by the farmers acts as an impetus to agroforestry advancement within the study area and beyond.

The Table 4.8 further depicts that the local farmers mainly sell their produce to their neighbors. This is challenge considering that that the neighbors can only purchase only of proportion of the produce and in most cases at lower prices. This is in agreement with studies that revealed that in agroforestry, marketing is unique for several reasons: many products typically lack established marketing institutions, market information, and grade or quality standards (Gold et al, 2004). However, the challenges notwithstanding, the farmers affirmed that they are better of as compared to days prior to agroforestry adoption.

Table 4.8: Variables used in model for assessing motivation by produce market

Variable	Group	No. of farmers	Percentage
Marketability of agroforestry product	Yes No	79 13	85.9 14.1
Selling of agroforestry produce	Yes No	71 20	78 22
Market of agroforestry produce	Neighbors Local market Outside market Institutions	45 18 6 2	63.4 25.4 8.5 2.8
Total No. of farmers		80	Sample mean[@]
No. of marketable agroforestry produce			3.04(1.479)

@ Standard deviation of the mean is in parentheses

Table 4.9: Estimated parameters of regression model for assessing produce market as a motivation to farmers' adoption of agroforestry.

Variables/ model types	Model 1: Income from produce after adoption
	Linear-Logistic
Constant	*0.9401(0.6679)*
Produce marketability	0.007(0.007)***
No. of observations	*89*
Constant	*3.8064(0.1591)*
No. of marketable agroforestry produce	0.084(0.092)*
No. of observations	*78*
Constant	*1.0361(0.5624)*
Whether agroforestry produce is sold	0.044(0.044)**
No. of observations	88

Predicted probabilities are in parenthesis

*Significant at p=0.10, **Significant at p=0.05 and ***Significant at p=0.01

4.6.2 Produce Quantity

The linear logistic model on farmers' income in relation to satisfaction with produce quantity on adoption of agroforestry practices identified only one significant variable at p= 0.01 (Table 4.11, Model 1). The findings show that before adoption of agroforestry practices, most respondents were not satisfied with quantity harvested from their farms (Table 4.10). However, farmers' satisfaction with produce quantities changed positively after adopting the agroforestry practices. The increase in produce quantity that has been brought about by engagement into diverse crops production has reinforced farmers' interest in the practices.

The result in Table 4.10 shows that the quantity of fuel wood produce increased after adoption of agroforestry practices by the local farmers. This has resulted to a direct increase in tangible financial benefits from the sale of surplus produce, or accrued intangible benefits especially to women who are charged with the donkey work of searching for the increasingly scarce fuel-wood. This is in agreement with other studies that have revealed that income from forest products can be more important to women than to men. In western Niger, for example, income from products of the commons was found to represent 27% of women's local non-farm income, as compared with 10% for men (Hopkins et al., 1994).

Table 4.10: Variables used in model for assessing motivation by produce quantity

Variable	*Group*	*No. of farmers*	*Percentage*
Rating satisfaction with	Highly satisfying	1	1.1
produce quantity before	Moderately satisfying	29	31.5
adoption of	Lowly satisfying	59	64.1
agroforestry	No. Change	3	3.3
Rating satisfaction with	Highly satisfying	57	62
produce quantity after	Moderately satisfying	30	32.6
adoption of	Lowly satisfying	3	3.3
agroforestry	No. Change	2	2.2
Rating fuel wood	High	9	9.9
quantity produced	Medium	0	0
before agroforestry	Low	70	76.9
adoption	No change	12	13.2
Rating fuel wood	High	55	60.4
quantity produced after	Medium	14	15.4
agroforestry adoption	Low	2	2.2
	No change	20	22

Table 4.11: Estimated parameters of regression model for assessing produce quantity as a factor motivating farmers to adopt agroforestry.

Variables/ model types	Model 1: Income from produce after adoption
	Linear-Logistic
Constant	*2.7079(0.1445)*
Satisfaction with quantity of produce before	0.816(0.843)
No. of observations	89
Constant	*1.0874(0.7299)*
Satisfaction with quantity of produce after	0.008(0.005)***
No. of observations	89
Constant	*2.8118(0.1304)*
Quantity of fuel wood before adoption	0.051(0.063)
No. of observations	87
Constant	*1.7220(0.3479)*
Quantity of fuel wood after adoption	0.689(0.739)
No. of observations	87

Predicted probabilities are in parenthesis

**Significant at p=0.05 and ***Significant at p=0.01

4.6.3 Produce quality and variety

The linear logistic model on income earned by farmers in relation to quality and variety of produce identified one variable at p=0.01 (Model 1, Table 4.13). Farmers satisfaction with produce variety after adoption of agroforestry (positive effect, p=0.001) was a significant motivation. The farmers appeared to appreciate the variety of produce that they were harvesting from their farms as shown in Table 4.12. The produce ranged from fruits, vegetables and wood products. This has had an influence in adoption of the practices by the local farmers. This is because agroforestry increases the variety of products over forestry or farming alone. It can provide a more stable income (Jordan, 1995), which is a key determinant in adoption of the practices by local farmers.

Table 4.12: Variables used in model for assessing motivation by produce variety

Variable	Group	No. of farmers	percentage
Rating satisfaction with quality of farm produce before adoption of agroforestry	Highly satisfying	1	1.1
	Moderately satisfying	15	16.3
	Lowly satisfying	73	79.3
	No Change	3	3.3
Rating satisfaction with quality of farm produce after adoption of agroforestry	Highly satisfying	59	64.1
	Moderately satisfying	30	32.6
	Lowly satisfying	2	2.2
	No Change	1	1.1
Rating satisfaction with variety of farm produce before adoption of agroforestry	Highly satisfying	0	0
	Moderately satisfying	36	39.1
	Lowly satisfying	54	58.7
	No Change	2	2.2
Rating satisfaction with variety of farm produce after adoption of agroforestry	Highly satisfying	59	64.1
	Moderately satisfying	28	30.4
	Lowly satisfying	2	2.2
	No Change	3	3.3

Table 4.13: Estimated parameters of regression models for assessing produce quality and variety as a factor motivating farmers to adopt agroforestry in Kadibo, Kisumu East district.

Variables/ model types	Model 1: Income from produce after adoption
	Linear-Logistic
Constant	*2.6934(0.1461)*
Satisfaction with quality of produce before	0.141(0.169)
No. of observations	89
Constant	*1.2395(0.6109)*
Satisfaction with quality of produce after	0.234(0.219)
No. of observations	89
Constant	2.4061(0.1894)
Satisfaction with variety of produce before	0.053(0.070)
No. of observations	89
Constant	*0.9652(0.8211)*
Satisfaction with variety of produce after	0.001(0.001)***
No. of observations	89

The predicted probabilities are in parenthesis

*Significant at p=0.10, **Significant at p=0.05 and ***Significant at p=0.01

4.6.4 Nutritional Security

The linear logistic model for assessing income in relation to the changes in meals consumed by successful farmers' household members identified one significant variable at p=0.01 (Model 1: Table 4.15). There were not only positive changes in the number of meals consumed on daily basis, but also of the type of meals consumed by household members (Table 4.14). The increase in number and types of meals accessed by household members is an indication of possible improvement in nutritional intake.

At the same time nutrition intake impacts on human health. An improvement of human health as a result of engagement in agroforestry is thus a positive change. The successes of any new agricultural technologies is judged ultimately by its adoption and acceptance by farmers and consumers and the positive changes it brings about at household, local, national and regional level (Sonia, 1997; Kabwe, 2001).

Table 4.14: Variables used in model for assessing motivation by produce nutrition

Variable	Group	No. of farmers	Av. percentage
Changes in type of food	Yes	89	96.7
	No	3	3.3
Changes in number of meals per day	Yes	74	80.4
	No	18	19.6
No. of meals consumed by adults before adoption of agroforestry	One	15	16.9
	Two	40	44.9
	Three	32	36.0
	More than three	2	2.2
No. of meals consumed by adults after adoption of agroforestry	One	0	0
	Two	4	4.5
	Three	48	53.9
	More than three	37	41.6
No. of meals consumed by children before adoption of agroforestry	One	8	9
	Two	39	43.8
	Three	39	43.8
	More than three	3	3.4
No. of meals consumed by children after adoption of agroforestry	One	1	1.1
	Two	3	3.4
	Three	42	47.2
	More than three	43	48.3

Table 4.15: Estimated parameters of regression models for assessing number of meals consumed as a factor motivating farmers to adopt agroforestry in Kadibo, Kisumu East district.

Variables/ model types	Model 3: Income from produce after adoption
	Linear-Logistic
Constant	*0.9353(0.6738)*
Changes of food type	0.009(0.009)***
No. of observations	89
Constant	*1.1197(0.4841)*
Changes in number of meals per day	
	0.521(0.521)
No. of observations	89
Constant	*1.9704(0.2987)*
Meals consumed by adults before	
	.096(0.078)*
No. of observations	87
Constant	*3.3079(0.0706)*
Meals consumed by adults after	
	0.606(0.608)
No. of observations	87
Constant	*2.1634(0.2451)*
Meals consumed by children before	
	0.091(0.080)*
No. of observations	87
Constant	*3.2194 (0.0779)*
Meals consumed by children after	
	0.114(0.118)
No. of observations	87

The predicted probabilities are in parenthesis

*Significant at p=0.10, **Significant at p=0.05 and ***Significant at p=0.01

4.7 Summary

This chapter presented and discussed the results from the study in Kadibo division of Kisumu East district. The study has revealed that:

- At least *nine main types of agroforestry technology packages are being disseminated to farmers in the division*. The packages include; the fertilizer tree systems, apiculture, hedgerows, orchards, shade tree system, dispersed trees intercropped on farms, boundary fencing, nursery system, woodlots and wind break technologies.
- *Five agencies advocated for the adoption of these technologies* by the local farmers. These agencies are *governmental* namely: the Kenya Forest Services, the Ministry of Agriculture and the Lake Victoria Environmental Management Programme-LVMP; and *non-governmental agencies* namely: SCC-Viagroforestry and Victoria Institute for Research on Environment and Development-VIRED).
- The *non-governmental agents and lead farmers* within Kadibo were the *key in advancing* agroforestry practices since as acknowledged by most of the farmers these agents have influenced their decision to acquire the practices.
- Given the largely unavailable planting material as asserted by 43.5% of the respondents, some farmers have gone out of their way to engage in seed bulking of various tree and shrub, which is a positive move.

On the contrary, the few local farmers within Kadibo Division who have acquired agroforestry practices did so for different reasons. For instance the acquisition of shade tree technologies was motivated by need to improve the quality of living environment, given the harsh sunshine that has scorching effects in Kadibo Division.

In the same vein, a significant proportion of the farmers interviewed singled out the high cost of building poles as a factor for adoption of woodlot agroforestry technologies.

The farmers employed different strategies in advancing their course. This included proper planning and incremental approach to advancement of the practices. For example, the handy cultivation of fast maturing shrubs species together with the production of long-term maturing trees by 40% of the farmers has provided in some cases the much-needed income for effective production. The positive results by some of these farmers have also been contributed by crop diversification, innovation and their strength of will to succeed.

The local farmers' motivations emanated from potential of harvesting high valued products given their engagement into agroforestry practices. The findings shows that more than three quarters of the farmers assessed asserted that marketability of agroforestry produce was a motivation to their adoption of agroforestry practices.

In concurrence with that, some farmers' satisfaction with produce quality, quantity and variety after adoption of agroforestry has motivated them not to relent on the practice.

Lastly, this study revealed that some farmers' nutritional intake has increased as a result of agroforestry adoption. There are clear indications that number of meals consumed by majority of the households that practiced agroforestry increased to about 3 from 1. Such nutritional gains and positive improvement in food access by the farmers has been instrumental in influencing decision to stick to the practices.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This study assessed uncommon behavior amongst few farmers in Lower Nyando River basin which has enabled them evolve better strategies of embracing agroforestry practices, given the envisaged challenges. It endeavored to show case success stories of farmers who have been relentless in their quest to succeed in adopting agroforestry practices even though they are faced with socio-economic and biophysical environmental challenges. The study specifically assessed: available agroforestry technologies to locals of Kadibo; how a few of them have acquired and sustained the agroforestry practices; and factors motivating them to positively adopt agroforestry practices.

5.1.1 Conclusion

It has been evident in this study that a few farmers, within Kadibo Division, have ventured into diversified agroforestry crop production technologies; following initial promotion of these technologies by government and non government agents. Therefore any effort to upscale the practices should explore a multi-stakeholder approach. Given that farmers mostly preferred the woodlot, shade tree and boundary fencing agroforestry technologies it imperative for extension agents to pay keen attention on these technologies to enhance quick spread of the practices.

Few low resource poor farmers in Kadibo Division have explored a set of interesting strategies to sustain agroforestry technologies. The behaviors of these farmers are important lessons for spreading the practices. The study showed how some of these

farmers have diversified their farming practices, whilst others have adopted a progressive increase, which has yielded some positive results. Besides that, some farmers have demonstrated relentlessness and reinvention, which has enabled them, sustain the practices. Such complimentary crop production system has supplied the low-resource farmers with resources highly needed for long term survival of farming practices.

Lastly, the study has demonstrated how farmers' motivation resulted from their experiences with: increased crop production; increased marketable products; high quality and variety of produce; and increased nutrition after adoption of agroforestry practices. In attempting to spread agroforestry practices, keen interest should be paid on the factors that driving other farmers elsewhere to adopt the practices.

5.1.2 Recommendations

a) Recommendations for the research

1. There is need for intensification of farmers exchange visits since significant proportions of the successful farmers' were found to be influenced by their colleague.
2. Due to the challenges faced by farmers in marketing some of the agroforestry produce, this study recommends establishment of additional interest groups to boost development of farm produce enterprises.
3. In view of challenges faced by governmental, non-governmental and community based institutions fronting natural resource management in Kadibo, there is need for capacity assessment of the existing institutions. The overall objective of such an assessment shall be to aid recommend appropriate intervention strategies for institutions development.

4. There is need to intensify floodwater management strategies in Kadibo especially harvesting flood water for use in farming. This will boost the survival of agroforestry crops in adverse times like the positive deviants in Kadibo have been doing. The rational for this is to ensure that the damages to agroforestry crop by flood water are arrested and to avail of water to farmers for irrigation of agroforestry crops in dry spell.

5. There is need to encourage resource poor farmers to diversify their farming practices and progressively combine short and long-term production practices to enhance their social and economic well being just like the positive deviant in Kadibo.

6. There is need for mutual collaboration amongst key actors in environmental conservation within Kisumu East district. This is necessary to optimize the scarce human and environmental resources within the district since much of this has been misused through duplication of efforts.

b) Suggestions for future research

1. There is need to further research on ways in which youths can be constructively engaged into agroforestry related activities since most of them do regard it as a preserve of elderly generation.

2. There is need to carry out further research on appropriate, and affordable agroforestry technology, which is also rewarding in the short run to resources poor farmers faced with seasonal flood and drought challenges.

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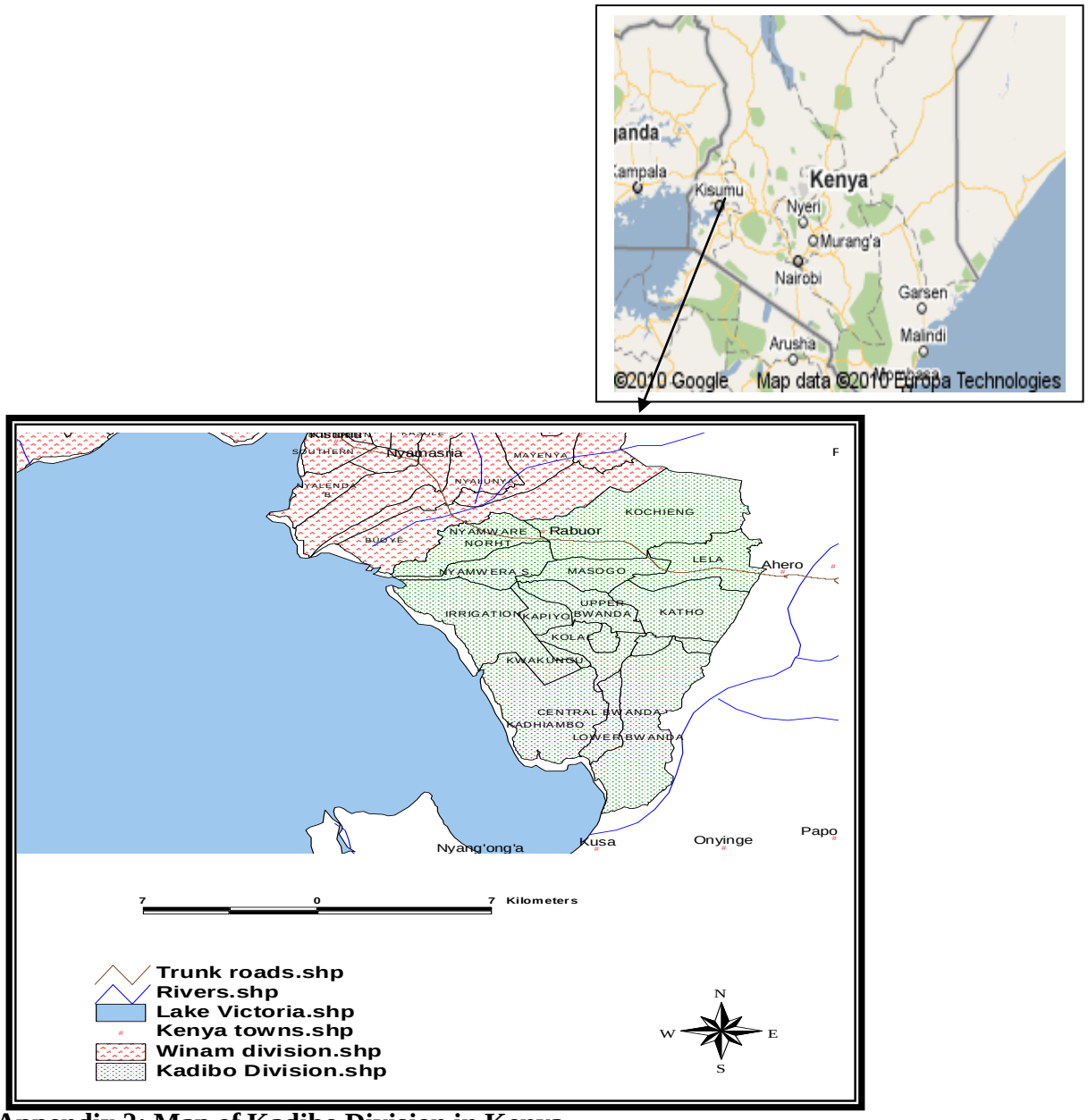
APPENDICES

Appendix 1: Work plan

Activity	**2008**			**2009**							
	Oct.	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar**	**Apri**	**May**	**June**	**July**	**Aug.**
Proposal review	x										
Reconnaissance		x									
Pretest		x									
Data collection			xx	xx							
Data cleaning and entry					xx						
Data analysis theses writing					xx	xx	xx	x			
Drafts submission								x	x		
Thesis submission										xx	xx



Appendix 2: Map of Kadibo Division in Kenya

Appendix 3: Interview guide

Interview date	
Enumerators' name	

Section A: Background characteristics of respondent

1	Name of respondent	
2	Gender	**1**= Male **2**= Female
3	Division	Kadibo
4	Location	1=Bwanda 2=Kochieng' East 3=Kochieng' West 4=Kombura
5	Sub location	
6	Village	
7	Household size	**Total**…….**Male**……. **Female**…….

8.Age	**9.Education level**	**10. Marital status**	**11.Primary occupation**	**12. Secondary occupation**	**13. Period of residency in Kadibo**
1=<20 2=21-35 3=36-50 4=50+	1=None 2=Primary 3=Secondary 4=Tertiary 5=Informal	1=Single 2=Married 3=Separated/ divorced 4=Widowed	1=Formal employment 2=Informal employment (specify…	…….. ……..	□=<2yrs □=3-5yrs □=6-10yrs □=>10yrs

Section B: Acquisition and sustenance

1. Do you own a parcel of land? 1=Yes 2= No

2. If yes in qstn 1, how did you acquire the parcel of land?

1=Inherited 2=Purchased 3=Leased 4= Others specify…….

3. Indicate in the table below the size of your homestead, fallow and cultivated land?

	Fallow land	**Cultivated land**	**Homestead size**	**Total size**
Size in acres				

4. Do you practice agroforestry on your farm? 1=Yes 2=No

5. If yes in qstn 5, for how many years have you been practicing agroforestry?

1=<2 years 2=2-5 years 3=5-10 years 4=>10 years

6. From whom did you first learn agroforestry practices?

1= Ministry of agriculture extension agents

2=NGO extension agents (specify……

3=Lead farmers within the division

4=Lead farmers outside the division

5=Shows and exhibition

6=Workshop/seminar (specify organizer……..

7. How did the named persons influence your acquisition of agroforestry technologies?

……

……

8. What type(s) of agroforestry technology have you acquired so far? (Enumerator to observe)……..

9. Why do you prefer the acquired type of technology?

……

……

10. Who influenced you most to acquire this type of technology?

1= Ministry of agriculture extension agents **2**=NGO extension agents (specify……

3=Lead farmers within the division **4**=Lead farmers outside the division

5=Shows and exhibition **6**=Workshop/seminar (specify organizer…

7=Others specify……

11. Where do you get agroforestry crops? (seeds /seedlings)

1=Within village **2**=Neighboring village

3=Far from the village (…… **3**=From extension agent (specify….

12. Is the source of your seeds/ seedlings reliable? **1**=Yes **2**=No

13. If Yes (in qstn 13), why do you say so……

14. If not reliable why?……

15. If No (qstn 13), how have you overcome the unreliability of the seedlings/ seeds?

……

Sustain

16. What is the size of your farm under agroforestry crops?

1=<0.25 acre 2=0.25-0.75 acre 3=0.75-1 acres 4=>1 acre

17. Why did you decide to have agroforestry crop on this size of land?

……

18. How many long-term trees/ shrubs have you managed on your farm?

1=<10 2=10-25 3=25-40 4=>40

19. How have you managed to maintain the existence of long-term trees/ shrubs in your farm?……

…….

20. How many short- term trees/ shrubs have you managed on your farm?

1=<10 2=10-25 3=25-40 4=>40

21. How have you managed to maintain the existence of short-term trees in your farm?

……

……

22. Do you keep livestock? 1=Yes 2=No

23. If Yes (in qstn 23), give the numbers and rate the benefit levels of agroforestry practice to your livestock? 1=Very beneficial 2=Beneficial 3=Least beneficial 4=Not beneficial

	Type of livestock	**Number**	**Ratings**
1	Cattle		
2	Sheep		
3	Goat		
4	Poultry (specify……		
5	Others (specify……..		

24. In which specific ways have you integrated livestock and agroforestry crop production?

……

25. What are the challenges faced by you in this sought of arrangement?

……

26. How have you managed to maintain this type of arrangement despite the challenges faced?…….

……

Information

27. Do you normally seek market information on agroforestry produce? 1=Yes 2=No

28. If Yes (in qstn 28) rank in order of importance your sources of market information on agroforestry produce? 1=Very important 2=Important 3=Least important

	Source of information	**Level of importance**
1	Local traders	
2	Mass media (specify……	
3	Neighbors	
4	Ministry of Agriculture	
5	NGOs (specify…….	
6	Others (specify…….	

29. Has this source(s) of information helped you prefer production of given agroforestry crops? 1=Yes 2=No

30. If Yes (qstn 29), in what specific ways has market information influence your agroforestry production?……

31. If, No (qstn 29) why?……...

Section C: Motivating factors

1. Do you produce any marketable products from your agroforestry farm?

1=Yes 2=No

2. If yes in (qstn 1) which marketable agroforestry produce do you normally harvest from your farm?

No	**Marketable produce**
1	
2	
3	
4	
	Total Number

3. Do you normally sell your agroforestry produce? 1= Yes 2=No

4. If Yes (qstn 3), where do you mainly sell your produce?

1=To neighbors **2**=Local markets specify……

3=Outside markets specify…….**4**=Others specify…….

5. How do you rate your agriculture production before and after you adopted agroforestry practice? 1=High 2=Moderate 3=Low 4=No change

		Before agroforestry adoption	**After agroforestry adoption**
1	Produce quantity		
2	Produce quality		
3	Income from produce		

6. How do you rate the levels of satisfaction/ potential of satisfaction with the food variety, quantity and quality from your farm before and after agroforestry adoption?

1=Highly satisfying 2=Moderately satisfying 3=Lowly satisfying 4= No change

		Before adoption	**After adoption**
1	Variety of produce		
2	Quantity of produce		
3	Quality of produce		

7. Has there been any change or potential of change on the type of food consumed by you before and after adoption of agroforestry? 1=Yes 2=No

8. If Yes (in qstn 7), name the types of food that you are able to reliably consume or will soon consume as a result of adoption of agroforestry technology?

……

……

9. Has there been changes in the number of meals consumed by you per day as a result of adoption of agroforestry? 1= Yes 2=No

10. How many meals per day were/is being consumed by members of your household before and after adoption of agroforestry practices?

1=One 2=Two 3=Three 4=More than three

	Household members	**Number of meals consumed by households**	
		Before adoption	***After adoption***
1	Adults		
2	Children		

11. In what specific ways has the adoption of agroforestry technologies influenced the changes in the number of meals consumed by members of your household?

……

……

12. Has there been changes in the quantity of fuel wood harvested by you from your farm?

1=Yes 2=No

13. Indicate in the table below the quantity of fuel wood production from your farm

1=High 2=Medium 3=Low 4=No change

Before adoption	**After adoption**

Cultural aspects

14. What are the cultural factor(s) that have limited the successful adoption of agroforestry practices by farmers in this village? **.....**

……

……

15. How have you been able to overcome the cultural limitations?

……

……...

Section D: Agroforestry and extension

1. Has any institution(s) or individual(s) reached you with information on agroforestry?

1=Yes 2=No

2. If Yes (in qstn 1), name the institution and information received?

No.	Institution/ individuals	Information received
1		
2		
3		
4		
5		

3. Has the information(s) received been useful to you? 1=Yes 2 =No

4. If Yes (in qstn 3), how has the aforementioned information been useful to you?

……

……

5. If No (in qstn 3), why……

6. How would you rate your level of satisfaction with the contribution of each of the agencies /groups listed below in enhancing your adoption of agroforestry?

Rating options **1**=Highly satisfied 2=Moderately satisfied **3**=Lowly satisfied

No.	Representatives	Rating	Reasons for the rating
1	Ministry of agriculture (M.o.A)		
2	Kenya Forest Service (KFS)		
3	Researchers		
4	NEMA		
5	Local administration e.g. D.O, chief, asst. chief)		
6	CBO' groups……		
7	Lead farmers		
8	NGO's (specify……		

7. How many times in the past three years did you attend the following agroforestry related activities?

No.	Activity	2006	2007	2008
1	Meetings			
2	Field days			
3	Seminars /workshop/trainings			
4	Demonstrations			
5	Exchange programs			

8. How would you rate availability of each of the following agroforestry related services or goods to you?

1=Highly available 2=Moderately available 3=Lowly available 4=Not available

No.	Service	Rate	Reasons given
1	Trees/ shrubs seeds		
2	Trees/shrubs nurseries/seedlings		
3	Seminars /workshop/trainings		
4	Proximity to demonstration site		
5	Field follow up exercises		
6	Farmers information exchange		

9. Give general comment(s) on the reasons behind your adoption of agroforestry in this village despite resistance by most farmers?

……

……

Appendix 4: Observation Checklist

Village……..

Name of farm owner…….

1. Average size of farm under agroforestry crop?

1= <.5 2= .6-1.5 3=1.6- 4.0 4=4.1-10 5=10+

2. Type of agroforestry practiced

1=None 2=Home garden/orchards 3=Improved Fallow 4=Wind breaks 5=Hedge raw intercropping 6=Fertilizer tree system 7=Shade tree 8=boundary 9=Woodlot 10=Dispersed trees on farm 11=Others……..

3. Rating the intensity of practice

1=Highly intensive 2=Moderately intensive 3=Less intensive

4. Dominant tree/shrub species on farm

Indigenous		**Exotic**	
1	6	1	6
2	7	2	7
3	8	3	8
4	9	4	9
5	10	5	10

5. Signs of care for tree or shrubs? (weeding, pruning, watering etc)

1=Yes 2=No

6. If Yes (in qstn 5) describe……..

7. General appearance of the agroforestry shrubs or trees

1=Good 2=Fair 3=Poor

8. Type of food crops grown with trees or shrubs (ask)

……

9. Evidence of use of the trees or shrubs from the farm as fodder?

1=Yes 2= No

10. Evidence of tree? (nursery or seed bed)

1=Yes 2= No

11. General comment on agroforestry adoption in the area?

……

……

Appendix 5: Questionnaire to field worker

Institution……Name of the respondent……

Position in the institution……...Area of service……

1. What kind of training do you have on extension?

□=Formal □=On job training □=refresher courses □= None

2. How has your training been relevant in promotion of agroforestry in Kadibo?

3. Which are some of the agroforestry technologies that you have promoted in Kadibo division?

4. Which channels do you use in the dissemination of agroforestry technologies in this division?

5. In what ways do you involve farmers in your projects? (project cycle)

6. What factors has enhanced your field performance in Kadibo?

7. What factors has constrained your field performance in Kadibo?

8. How are you addressing these constrains?

9. How best do you think these constraints can be addressed?

10. Why have a section of farmers adopted the agroforestry technologies?

11. How frequent do you normally visit the farmers in your station of work?

12. Which opportunities exist in Kadibo division for adoption of agroforestry technologies by farmers?

13. Give any general comment on agroforestry dissemination in Kadibo?

Appendix 6: Questionnaire to division coordinator

Institution……Name of the respondent…….

Position in the institution……...Institution duration of service in Kadibo……

1. What are your main activities in Kadibo?

2. Which location is your institution serving in Kadibo division and why?

3. What agroforestry technology (ies) do you mainly promote in Kadibo and why?

4. Which channels do you use in the dissemination of agroforestry technologies in this division?

5. How do you ensure the participation of community members in your programme?

6. What are the problems faced by you when disseminating agroforestry technologies in Kadibo division?

7. What are the main reasons for a section of farmers adopting your agroforestry technologies?

8. Given your experience with the farmers who have adopted agroforestry in Kadibo do you think they can continue with the practices without external support? Why?

9. How best do you think agroforestry technologies can best be disseminated in Kadibo?

10. Which opportunities exist in Kadibo division for the successful adoption of agroforestry technologies by farmers?

11. Give any general comment on agroforestry dissemination in Kadibo?