FACTORS INFLUENCING ADOPTION OF AGROFORESTRY PRACTICES AMONG RURAL HOUSEHOLDS IN NAMBALE DIVISION, BUSIA COUNTY, KENYA

BY

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DECLARATION

Declaration by the Candidate

This thesis is my original work and to the best of my knowledge, it has not been presented to any other University or institution for the award of a degree.

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DEDICATION

For you loving parents, Servas Sorre, Rita Sorre and Susan Ndanju, for your love and inspiration to pursue my studies.

To my husband, Dr. Benard Sorre, your footsteps have always guided me.

To my children, Clement Amalia and Steve Ndanju, your presence has always encouraged me.

For you brothers and sisters, you are worthy the dream.

ABSTRACT

The Kenyan government has throughout its history come up with ambitious agricultural policies and strategies seeking to enhance agricultural production and performance as a tool to improve the livelihood of majority of its citizens that are rural-based. After nearly 20 years of agroforestry research in the country, smallholder farmers that are often faced with low crop production, soil erosion, scarcity of fuel wood and fodder, would be expected to adopt agroforestry practices. However, there seems to be low rate of adoption. The main objective of the study was to examine factors that influence the adoption of agroforestry practices in Nambale Division, Busia County. More specifically, the study sought to examine the types of agroforestry practices that exist in the area, to assess farmer-oriented factors that influence adoption of agroforestry practices, to examine technical factors (biophysical conditions, tree varieties, skills, knowledge) that influence adoption of agroforestry, to assess community oriented factors (socio-cultural) that influence the adoption of agroforestry practices, and to evaluate the benefits of agroforestry farming practices to households in Nambale Division, Busia County. This study was guided by the Agroforestry Decision Making Theory by Rene Koppelman and James H. French (1996). According to the theory, adoption of agroforestry by farmers at the household level is a decision making process that is influenced by various sets of factors: on-farm and off-farm factors. The target population was the farmers while households were the units of analysis. Purposive sampling was used to select the study area and the key informants, while simple random sampling technique was used to select the 200 respondents that participated in the study. A semi-structured questionnaire, key informant interviews, informal discussions and direct observation were used for data collection. Data was analyzed both qualitatively (through descriptions and narratives) and quantitatively (through descriptive statistics). Results indicated that agrisilviculture, boundary planting and trees in homesteads were the common agroforestry practices; level of education, land ownership, land size, gender and household headship influenced the decision to adopt agroforestry practices; lack of technical information on agroforestry and/or contradicting information, land limit, limited sources of information including low extension services, and lack of seeds also influenced adoption of agroforestry practices at the household level. Results also indicated that belief and use of specific agroforestry species influenced their adoption. Results further showed that most household engaged agroforestry practices for environmental, medicinal, economic and livelihood benefits. The study concluded that although agroforestry benefitted farmers, they would gain more if they improved on the current agronomic practices. The study recommends provision of various information sources to farmers and training on agroforestry practices that would optimize benefits for the households.

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ACRONYMS

FAO	-FOOD AND AGRICULTURE ORGANIZAION
GOK	- GOVERNMENT OF KENYA
ICRAF	– INTERNATIONAL COUNCIL OF RESEARCH IN AGRO-FORESTRY
KANU	- KENYA AFRICAN NATIONAL UNION
KSB	- KENYA SUGAR BOARD
MDGs	-MILLENIUM DEVELOPMENT GOALS
NALEP	- NATIONAL AGRICULTURAL AND LIVESTOCK EXTENSION PROGRAMME
NASEP	- NATIONAL AGRICULTURAL SECTOR EXTENSION POLICY
NGOs	-NON-GOVERNMENTAL ORGANIZATIONS
NPV	- NET PRESENT VALUE
USAID	- UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discusses background to the study, statement of the problem, objectives of the study, research questions, significance, limitations and scope of the study.

1.1 Background to the Study

Agriculture is the backbone of the Kenyan economy. It contributes approximately 25% of GDP, 65% of export earnings, and employs 75% of the national labor force. Over 80% of the Kenyan population lives in rural areas and makes a living, directly or indirectly, from agriculture. The sector is important for poverty reduction since most vulnerable groups such as pastoralists, the landless, and subsistence farmers, depend on agriculture as their main source of livelihood. Growth in agriculture therefore, can be expected to have a significant impact on a larger section of the population than any other sector. Likewise, policies affecting performance of agriculture have important implications for the economy as a whole (Scherr, 1995).

According to the Vision 2030 economic pillar – Agricultural : The sector has for many years formed the backbone of Kenya's economy, contributing about 24 per cent of the Gross Domestic Product (GDP) and accounts for 80 per cent of national employment, mainly in rural areas**.** Agriculture also contributes more than 60 per cent of the total export earnings and about 45 per cent of government revenue, while providing for most of the country's food requirements. The sector is estimated to have a further indirect contribution of nearly 25 per cent of GDP through linkages with manufacturing, distribution, and other service related sectors. Thus, agriculture directly influences overall economic performance.

The Kenyan government has throughout its history, since independence, come up with ambitious agricultural policies and strategies seeking to enhance agricultural production and performance as a tool to improve the livelihood of majority of its citizens that are also rural based. Some of the practices that have come with these efforts include new methods of soil conservation, intensive cash crop farming, livestock production, changes in land tenure policies, and agroforestry among others. However, these practices have been received and implemented with various degrees of success and failure depending on the region of the country (Scherr, 1995). Studies by Dunn *et al*., (1990), Wannawong et al., (1991), Sullivan (1992), and Current *et al*., (1995) have reported higher net present values (NPVs) for agroforestry systems than for monoculture systems, yet farmers in developing countries show low rates of adoption of agroforestry.

The researcher conceptualizes agroforestry as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, and seeks to diversify and sustain production for increased social, economic and environmental benefits for land users at all levels.

After nearly 20 years of agroforestry research, smallholder farmers, that are often faced with low crop productivity, scarcity of fuel wood and fodder, would be expected to readily adopt agroforestry practices that enable them to increase yields with minimal external inputs. Adesina *et al*. (2000) and Mercer (2004) have indicated that adoption and diffusion of agroforestry technologies have lagged behind scientific and technological advances attained, thereby reducing their potential impacts.

In spite of the foregoing, the concern towards the rate at which agroforestry practices are being adopted by farmers is not unique to Kenya. In southern Cameroon, the spread of the technology to neighboring farmers has been low around Ebolowa and moderate around Yaounde. In Eastern Zambia, the increase in farmer participation has been rapid and the adoption potential is high (Franzel, 1999). In western Kenya, although farmers' interest to participate in agroforestry related practice has increased, the adoption potential appears to be moderate (Scherr, 1995).

In an effort to reconcile current food deficit against future environmental debt, most food deficit regions face the challenge to identify appropriate technological and policy approaches that are affordable, and best meet food security objectives and, provide opportunities for smallholder farmers to adapt to climate change. Sustainable agricultural development is widely acknowledged as an important component in a strategy to respond to the twin challenges of poverty and environmental degradation and adaptation to climate change (Antle and Diagana, 2003).

One of the sustainable agricultural practices is agroforestry and soil fertility practices (fertilizer tree/shrubs) that use natural resource management principles to replenish soil fertility. This is of critical concern to the study because Busia County, a high potential agricultural area and one that was once food secure, is currently classified as a food deficit area in Kenya. Therefore, while sustainable agricultural development practice of agroforestry is arguably feasible and technically sound in transforming the District, the level of uptake of the practice by farmers has been low and with little success whenever utilized (Scherr,1995).

In Africa, sustainable use of agricultural land is becoming increasingly important for maintaining capacity for food supply and livelihood of the agricultural sector. More information is needed the farm and household factors affecting adoption of the practice, on policy and institutional factors that contribute to adoption, on farmers' own assessments through participatory evaluation exercises, and on the characteristics of specific improved fallow practices that farmer's desire (Franzel, 1999) which may also apply to other agroforestry technologies.

Food security and income are among the primary motivations that influence farmers to adopt certain agroforestry systems. Brown (2003) observed that a farmer's adoption of agroforestry technology depends on the following criteria: food (supplying immediate household needs), income (providing cash to service other needs), future (providing savings for longer-term needs, such as, education for children), building (providing wood materials for construction of new house for instance), and erosion (activities that minimize soil loss). During lean months of crop production, farming households highly depend on the availability of livestock and poultry products such as eggs from chicken and ducks and the occasional meat from livestock. Poultry, livestock and fishery are important immediate sources of food and cash for the family. Increasing their production will supplement the households' food requirements. To mitigate this, several conservation approaches and technologies have been developed to address the persistent problem of soil erosion especially in sloping areas. Despite this, it must be recognized that the primary objective of farmers in adopting such technologies is the provision of food and income for the household over the conservation of their farms (Briones, *et al*, 2003).

In Busia County and Nambale Division in particular, findings of the Kenya Woodfuel Development Programme revealed that agroforestry is a traditional practice that has existed in these areas for many years. Further, most of the inhabitants of these areas practice three major agroforestry systems namely, agrosilvicultural, silvipastoral and agrosilviculture. Within these systems, five major agroforestry practices are widely undertaken. The most common practices are mixed farming, dispersed trees in crop lands, home gardens, trees along hedges, farm boundaries, woodlots and home compounds (Bradley, 1993).

It is against the foregoing background that this study was undertaken to assess the factors influencing the adoption of agroforestry in Nambale Division of Busia County.

1.2 Statement of the Problem

Despite the fact that agroforestry systems, which are capable of providing substantial net economic and ecological benefits to households and communities have been emphasized in a food deficit district that has a rich potential for the strategy, there seems to be a low rate of adoption of the same (Zinkhan and Wear, 1992; Lwayo and Maritim, 1999; Sorre, 2005).

According to proponents of adoption of new innovations, if agroforestry programs are to succeed, it is important to understand precisely what farmers want and what will lead them to adopt new technologies. According to ICRAF's (1997) vision and plan of action, "we also need to understand the processes that lead farmers to adopt or reject a new technology and we need feedback from users." These are key concerns of the study.

From a practical perspective, Busia County is food deficit and largely relies on the Uganda border for much of its food supply annually (Sorre, 2005). This not withstanding, agroforestry, if integrated well at the household level, has the potential to provide economic, social and environmental benefits that are capable of addressing household income, fuel, food supply and environment related challenges. Since independence, there have been several agroforestry-related activities initiated in Busia District through the various agricultural departments and recently, non governmental organizations. However, little seem to have been achieved in these efforts, especially when it comes to adoption of agroforestry (Scherr, 1995).

This study therefore, sought to assess factors that influence the adoption of agroforestry practices in Busia County, with special reference to Nambale Division. This is not just of critical economic concern in the study area, but also of environmental and social significance to the target population and the national economy at large.

1.3 Objective of the Study

The main objective of the study was to assess factors that influence the adoption of agroforestry in the study area. More specifically, the sought to:

1. Examine the types of agroforestry practices practiced in Nambale Division.
2. Assess farmer-oriented factors that influence adoption of agroforestry practices in Nambale Division.
3. Examine the technical factors (bio-physical conditions, tree varieties, skills, knowledge,) that influence adoption of agroforestry in Nambale Division.
4. Assess community-oriented factors (socio-cultural, political and economic) that influence the adoption of agroforestry practices in Nambale Division.
5. Evaluate the benefits of agroforestry farming practices to rural farmers in Nambale Division.

1.4 Research Questions

The study was guided by the following research questions:

1. What is the nature and types of agroforestry systems that exist in the study area?
2. How do farmer-oriented factors influence adoption of agroforestry systems and practices in the study area?
3. What technical factors (bio-physical conditions, costs, tree varieties, skills, knowledge,) influence adoption of agro forestry in the study area?
4. What are the community-oriented factors (socio-cultural, political and economic) that influence the adoption of agroforestry practices in Busia District?
5. What are the benefits of agroforestry farming practices to rural farmers in Nambale Division?

1.5 Justification and Significance of the Study

Busia County in which Nambale Division is located is described as one of the low-income and food-poor rural areas in the country (Poverty in Kenya, 2000). This study had double-edged dimensions namely intellectual and applied research work. In the intellectual sense, the outcome of the study is significant in the ongoing debate on the determinants of food shortage and poverty in rural households as well as environmental degradation in developing countries. The general assumption by rural development proponents has been that once a project or new idea has been communicated and implemented to a potential beneficiary group, it will be adopted, internalized and implemented by another group. However, the study sought to provide an opposing view from empirical evidence to show that this may not necessarily be the case. This is an important policy-related question because the reasons underlying the introduction of agroforestry practices and any future interventions may not be successful without such information.

In its applied dimension, the study will contribute towards enhancing the rate of adoption of new agroforestry ideas in the study area. The researcher will specifically delve in explaining what farmers want and what will lead them to adopt new technologies. Similarly, from local people's point of view, do the people think it is a worthwhile venture to devote their land to agroforestry and have they had a chance to rip any benefits accruing from the same? This is therefore, a good ground for testing the capacity of people to make decisions on issues affecting their lives and welfare, while fulfilling the local and national goals of self sufficiency, environmental consciousness and enhancing economic development.

1.6 Scope, Limitation and Delimitations of the Study

This study focused on Nambale Division in Busia County. However, in terms of knowledge, the researcher was mainly concerned with issues on types of agroforestry systems and practices that are practiced by farmers in the study area; farmer-oriented, technical and community based factors that affect adoption of agroforestry innovations in the study area and the benefits of agroforestry. The main limitation of the study was that it was biased towards qualitative methods of data collection and analysis. However, the researcher mitigated this through triangulation of methods of data collection. This involved collection of both qualitative and quantitative data; the researcher used descriptive data to clarify and confirm the quantitative one.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature as guided by the objectives of the study. The main themes discussed include the concept of agroforestry, factors influencing adoption of agroforestry technologies, and the benefits of agroforestry practices.

2.2 The Concept of Agroforestry

Agroforestry is a long-established farming practice in many parts of the world. Broadly defined, agroforestry refers to a land-use system in which trees are grown simultaneously, sequentially, or in conjunction with annual crops or livestock. The trees are cultivated primarily for agricultural uses, for example, to protect or enrich top soils for the benefit of crops or to provide browse and fodder for livestock (Otsuki, 2010).

Although the term "agroforestry" has been in use since the late l970s, experts still debate over a concise definition of the concept. For example, at least 11 definitions were discussed at the l979 International Cooperation in Agroforestry Conference sponsored by the International Council for Research in Agroforestry (ICRAF). The most cited definition of agroforestry is by ICRAF, which refers to agroforestry as a collective name for land use systems and technologies where woody perennials such as, trees, shrubs, palms, and bamboos are deliberately used on the same land management unit as agricultural crops or animals either in some form of spatial arrangement or temporal sequence (ICRAF,1997).

However, one of the most comprehensive definitions of agroforestry refers to it as a dynamic, ecologically based, natural resource management system, which involves the integration of trees on farms and in the agricultural landscape that seeks to diversify and sustain production for increased social, economic and environmental benefits for land users at all levels (Nair, 1993). This is a definition that considers agroforestry as justified for being beneficial to the environment, household income, productivity, and sustained development of the community.

The common element in the various definitions that have been used is that in each type of land use, naturally occurring or cultivated tree species constitute part of a mixed farming system. For the purpose of this study, agroforestry practices refer to activities intended primarily to encourage farmers to grow trees using species and techniques that can sustain or contribute to their crop or livestock production, and, in most cases, can also provide additional subsistence or cash crop. This is a practice that would be much beneficial in the African context where we have harsh environmental conditions, low technologies of agricultural production, fragmented land tenure system, and chronic food and nutrition insecurity.

2.3 Adoption of Agroforestry in Africa

Ideally, agroforestry systems, capable of providing substantial net economic and ecological benefits to households and communities, should be readily adopted by farmers. Despite this, many attempts to promote agroforestry have resulted in poor rates of adoption (Zinkhan and Wear, 1992). According to studies done by Dunn *et al*. (1990), Wannawong (1991), Sullivan (1992), and Current, Lutz and Scherr (1995), there are higher net present values (NPVs) for agroforestry systems when compared to monoculture systems, yet farmers in developing countries show low rates of adoption.

When adoption occurs, many farmers eventually abandon the new agroforestry system of production in favor of more traditional systems with lower NPVs. Why is this the case? According to Mercer and Miller (1998) shortcomings in our understanding of the contribution of risk and uncertainty in agroforestry adoption may explain the low adoption rates. According to Negatu and Parikh (1999), farmers' perceptions regarding new technologies make a difference: if farmers conceive agroforestry as a cost, they will be less willing to adopt it compared to those who see it as a potential. Ghadim and Pannell (1999) present theoretical results, which show learning over time to be a significant factor. As a result, for the farmer, investing in agroforestry entails undertaking an activity with an uncertain outcome. The incentive behind planting trees on farms is to diversify outputs, reduce the uncertainty associated with droughts, and increase cash income (Scherr, 1995).

Due to changes in environmental variables, the decline in soil fertility in smallholder systems is a major factor inhibiting equitable development in much of sub-Saharan Africa. In many areas, farmers periodically fallow their land, which is allowing it to lie idle for one or more seasons primarily to restore its fertility. As population increases, fallowing and fallow periods are reduced, continuous cropping becomes more frequent, and crop yields may decline. Meanwhile, cultivation is extended to marginal areas, causing soil degradation. The removal of subsidies on fertilizers in some countries has exacerbated these problems by causing fertilizer use to decline and consequently leading to reduced farm incomes. Thus, improved tree fallows, the deliberate planting of trees or shrubs in rotation with crops, have great potential for improving soil fertility in areas dominated by nitrogen deficiency (Kwesiga and Coe, 1994; Cooper *et al*., 1996; Kwesiga *et al.*, 1999). By providing nitrogen to crops, tree fallows can help farmers increase their incomes and help nations to improve their food security. They may also help reduce soil degradation, provide wood fuel, and curb deforestation (Jama *et al*., 1998).

For many years, farmers in Africa have been testing improved tree fallows in several countries including Kenya, Zambia, Cameroon, Tanzania, and Malawi, in collaboration with researchers at ICRAF and National Agricultural Research Systems (NARS). Crop improvement in on-station and researcher-managed on-farm trials at sites in Kenya, Zambia, Cameroon, Tanzania and Malawi have been encouraging (Kwesiga and Coe, 1994; Niang *et al.,* 1996; ICRAF, 1996, 1997). The challenge now is to assess whether more farmers can achieve similar crop improvement and whether they are able and willing to incorporate improved tree fallows into their farming systems.

Intensification, which involves the increase over time in the use of labor and capital per unit farm area is an important feature of many agricultural systems throughout the world. In developing countries, researchers often classify land-use systems according to their degree of intensification, showing the evolution of shifting cultivation systems to short fallow systems and through to continuous cultivation (Ruthenberg, 1971; Boserup, 1981).

Farming systems are thus often said to go through three phases: an extensive phase during which land is abundant and natural fallows restore fertility, an intermediate phase during which fallow periods are declining and yields may also decline, and an intensive phase during which continuous cropping becomes common. Boserup (1981) identified population pressure as a main driving force behind intensification. In an area of low population density natural fallows may be sufficient to restore fertility to the soil. But as population increases, cropping periods may increase and fallow periods decline. If fallow periods become too short to restore fertility, a 'degradation syndrome' sets in and yields may rapidly decline.

2.4 Adoption of Agroforestry Technologies

Adoption potential, from the farmer's perspective, can be considered to have three components: feasibility, profitability, and acceptability (Swinkels and Franzel, 1997). Feasibility concerns whether farmers are able to manage the technology, that is, whether they have the required information and resources and are able to plant and maintain the fallows. Profitability is whether, from the farmer's perspective, the financial benefits obtained from using the technology are higher than for alternative technologies, including the ones farmers use. Acceptability concerns whether farmers want to use improved fallows, that is, whether they perceive greater advantages than disadvantages from using them.

Acceptability thus includes a range of criteria in addition to profitability and feasibility, such as riskiness, suitability to accepted gender roles, cultural acceptance, and compatibility with other enterprises.

2.4.1 Farmer-Oriented Factors Affecting the Adoption of Agroforestry Practices

The critical premise here is that adoption of new ideas is a rational decision making process that begins with the individual farmer as the main actor and then is further influenced by factors beyond him/her. Previous studies (Ajayi *et al*. 2003; Thangata and Alavalapati, 2003) have shown a direct correlation between farmer-oriented factors and adoption of new innovations.

In Zambia, studies conducted in relation to adoption of agroforestry have looked at factors that influence farmers to initially establish an improved fallow, those that influence their decision to continue with the practice, and external factors that affect the decision to establish a fallow (Ajayi *et al*. (2003). Factors that were tested included wealth status, gender, age, education, labour (with household size used as a proxy for labour), farm size, uncultivated land, use of fertilizer, off-farm income, oxen ownership, and village exposure to improved fallows. It was found generally that wealth, labour, farm size, and ones exposure to improved fallows affected farmer decisions to initially establish improved fallows (trial) and to later continue with the practice (adopt), while use of fertilizer and oxen ownership positively influenced a farmer's decision to establish a fallow (ibid).

Other individual factors that influence adoption of new ideas include mental processes that are governed by a set of intervening variables such as individual needs, knowledge about the technology and individual perceptions about methods used to achieve those needs (Thangata & Alavalapati, 2003). This implies intrinsic and largely psychological stimuli available in the environment to motivate and persuade the individual into new ideas.

In an earlier study, Blaug, (1972) asserted that education improves one’s ability to capitalize on opportunities. The better educated are generally more flexible and more motivated, adapt themselves more easily to changing circumstances, benefit more from work experience and training, act with greater initiative in problem-solving situations, and, in short, are more productive than the less educated, even when their education has taught them no specific skills (Blaug, 1972). Similar findings revealed that education is positively associated with probability to adopt agroforestry technologies (Masangano, 1996). Later on, Blaug’s ideas were supported by Thangata (1996) who observed that the level of education of a household head is an important determinant of agroforestry adoption. This argument was based on the fact that formal and informal training has the potential to increase the rate of adoption by directly increasing awareness, imparting skills and knowledge of the new technology. A study done in Rondonia, Brazil and Campeche, Mexico indicated that exposure to information about agroforestry and the level of educational achievement all play significant roles in the decision to adopt agroforestry (Casey *et al*., 2000).

A study by Phiri *et al.* (2004) found an association between farmers’ wealth status and the planting of improved fallows, with the planting being higher among farmers that were classified as wealthier than among the very poor households. Similar results were obtained by Keil *et al*. (2005) who found that adoption of improved fallows increased with wealth levels, starting with those described as fairly wealthy, and decreased with well-off farmers. In addition these writers found a relationship between planting of improved fallows and the ownership of oxen. The ownership of oxen is an indicator of wealth status among rural communities. Farmers who own oxen are able to cultivate larger pieces of land within a short time or they would hire out oxen for extra resources to pay for labour or purchase other inputs. This in turn enables them to find time and resources to establish and manage improved fallows.

Similarly, earlier studies by Hoekstra, (1985) and CIMMYT (1993) indicated that high-income farmers may be less risk averse, have more access to information, have a lower discount rate and longer-term planning horizon, and have greater capacity to mobilize resources. Consequently, would be more willing to adopt agroforestry systems and practices that their poor counter parts.

In Africa, a study carried out in Kenya and Zambia showed that there was an association between wealth and use of improved fallows (Franzel, 1999). In both countries, community members in selected villages conducted a ‘wealth ranking exercise’ defining the different wealth groups and classifying households into the groups. In Zambia, improved fallows were planted by over half of the ‘well off’ farmers, but only 22% of the ‘poor’ and 16% of the ‘very poor’. In Kenya, there was a continuous decline in use from the second wealthiest group, with 58% planting improved fallows, to the poorest group, with 16% planting improved fallows. Among the wealthiest group only 30% planted, perhaps because these farmers had enough money to invest in fertilizer. The use of improved fallows by many poor and the very poor farmers suggests that there are no important barriers preventing them from doing so. Low-income farmers are more likely to adopt improved fallows than mineral fertilizers because the fallows require little if any cash input (Ibid).

Another individual factor that may influence the adoption of agroforestry is access to off-farm income. Access to off-farm income may conceivably enhance or reduce the adoption potential of an agroforestry practice. In an intensive system where land is limiting, farmers with off-farm income to purchase food during the fallow period would be more likely to take land out of production for improved fallows than farmers without off-farm income. Second, households with members working off the farm often lack labor and would be interested in an improved fallow rotation system as a way to save labor, as compared to continuous cropping (Ibid). In western Uganda, 68% of the farmers with off-farm income practice fallowing, whereas only 32% of those without off-farm income practice fallowing ($P < 0.003$) (Swinkels *et al*., 1997).

On the other hand, one could also argue that off-farm income may reduce adoption potential. Farmers with off-farm income may be less disposed towards new technologies because they are less concerned about food production than farmers who rely totally on their farm (Franzel, 1999).A research done in Western Himalayas showed that there was increased agroforestry adoption among households with higher off-farm income (Sood, 2006)

Perceived economic importance of agroforestry practice by individual farmers is considered key to adoption of any agroforestry practice (Sorre, 2005). Farmers will invest in improving their land for annual crop production only if that land is a critical part of their livelihood strategy and only if the investments compete favorably with alternative opportunities (Ibid). Comparatively, agriculture accounted for 84% of household income in eastern Zambia but only 40% in western Kenya (Celis *et al*., 1991; Crowley *et al*., 1996). Moreover, whereas Zambian farmers are eager to invest in improving crop production, as evidenced by past high rates of fertilizer use, farmers in western Kenya prefer to invest in livestock, education, real estate, and off-farm businesses (Crowley *et al*., 1996). These differences may in part explain farmers' greater interest in improved fallows in Zambia than in Kenya.

According to Thangata (1996), gender is also important in influencing adoption of agroforestry practices. The probability of adoption was higher for men than women farmers in the highlands of south western Uganda (ibid). the author further asserts that this is perhaps due to the gender-equity issues in the introduction of technology to farmers which include land tenure issues. The lower agroforestry adoption by women in Uganda was attributed to the fact that women still do not have secure land and tree tenure due to the largely patrilineal inheritance systems (Thangata 1996). Only old women, widows and female-headed households are often able to have access to more secure land rights. This is because the right to ownership of land by women in patrilineal societies is fully transferred to the woman in case the husband dies and/or when she takes the official household headship roles for the absentee husbands.

Studies conducted in Malawi by Thangata and Alavalapati (2003), and Kenya by Sanchez and Jama (2002) showed that the average female-headed household did not adopt agroforestry technology compared to the male-headed farm household. It is important to address this inequality by introducing women farmers to other technologies that do not require secure long-term land and tree rights (Thangata & Alavalapati, 2003). Gladwin *et al*. (2002) reported that what motivated the women farmers to establish an improved fallow was the realization that their soil was depleted; fertilizer was expensive and their maize harvests could not meet their yearly consumption requirement.

However, Quisumbing *et al*., (1995) argues that female farmers provide most of the labor for African food production, and many households are female-headed. The percentage of households that are female-headed ranged from less than 10% in the study villages of southern Cameroon to 30% in Zambia to about 50% in western Kenya (Swinkels et al., 1997; Phiri et al., 1999). One would expect that females' use of improved fallows would be lower than males for two reasons. First, female household heads tend to have lower incomes than male household heads (Quisumbing et al., 1995). Thus, females would be less likely to test and adopt improved fallows due to lack of wealth, which dictates the resources one will have. Second, those choosing participants for the experiments and distributing planting material, usually extension staff, tend to be biased towards men. Thus, even if the technology itself is gender neutral, adaptive research and dissemination mechanisms are often biased towards males (CIMMYT, 1993).

Study results from Tanzania, however, indicate that 30% of the males and 26% of the females in the selected villages drawn from farming communities in Kilimanjaro were testing improved fallows, and there was no significant difference between the two proportions. Moreover, whereas single females are often disadvantaged relative to female heads of household whose husbands live away (Bonnard and Scherr, 1994), results showed that the same proportions of these two groups were testing the technology (Phiri *et al*., 1999). This means that other factors, beyond gender, were responsible for the kind of findings observed.

Although Keil *et al*. (2005) found land to be a limiting factor to increasing the size of portions allocated to improved fallows, Styger and Fernandes (2006) allude that in Central America, planted fallows even get adopted in areas where land is limited since farmers have to intensify their production and are forced to improve the only available pieces of land. Opio (2001) contents that lack of security of tenure affects establishment of any agroforestry practices. For instance, lack of security of tenure was hampering female farmers from participating in the establishment of *Sesbania sesban* fallows in Katete District of Zambia. Equally a synthesis by Ajayi *et al*., (2003) revealed that three (3) studies had found farm size to have a positive association with farmers' decisions to plant and even continue with improved fallows although the latter finding is not associated with gender. Nearly all small-scale farmers in many African societies fall within the customary tenure system whereby families depend on acquiring land through ancestry accession. This implies that each family is restricted to sharing land that belongs to their forefathers. Therefore, as family size increases, their share of land gets smaller since they have to pass on portions to the younger generation. This implies restrictions and decisions that do not favour agroforestry practices in such households due to competition for land and complicated hierarchy in terms of household decision making.

Some farmers end up cultivating on borrowed or rented land (Sorre, 2005). As a consequence, long term investments in land would not be feasible for them. In communities where potential adopters cultivate such land, adoption of agroforestry is expected to be low. As a result, the extent to which smallholder farmers depend on borrowed or rented land for their agricultural activities is not well known. There is need to establish the minimum required land size for a farmer to be able to engage in agroforestry practices and the percentage of farmers above that threshold. Equally important is the examination of whether the customary tenure system is sufficient in itself to support agroforestry.

In spite of the foregoing, there are no other reports apart from Opio (2001) that reports on insecurity of tenure as a hindrance to adoption of agroforestry in Africa. This is partly why the current study is important in filling the existing knowledge gap using the Kenyan experience, since it is about a decade after the findings by Opio were published. A study done in Haiti revealed that a formal title is not necessarily more secure than informal arrangements; informal arrangements based on tradition social capital resources assure affordable and flexible access to land for most people; and perceived stability of access to land-based on stability of personal and social relationships are more important determinant of technology adoption than mode of access (Smucker *et al*., 2000).

Another factor influencing farmers' decisions to get involved with agroforestry include availability of labour supply (Ajayi *et al.*, 2006). Keil *et al*. (2005) reports that only 14% of the farmers adopting agroforestry were willing to expand beyond the experiment size, citing limited land and labour as constraining factors to expansion. The limitation of labour is supported by Styger and Fernandes (2006) who allude that improved fallows get adopted where labour and technologies are readily available. A study done in Western Himalaya showed that there was increased agroforestry adoption among households with less labor available for agriculture than among households with more household labor available for farming (Sood, 2006).

Levels of poverty could also explain the low rates of adoption of agroforestry. According to Keil *et al*. (2005) farmers that were classified as poor and very poor had lower rates of adoption. Considering that farmers have to wait longer periods of time to see the benefits of agroforestry technologies means that a farmer would need to have other ways of survival during the establishment stage of improved fallows. As a result, farmers adopt diverse strategies to overcome such challenges.

Farmers have different livelihood strategies in rural areas. Some sell their labour to other farmers as means to earn income or simply work for food on a daily basis. All this is done at the expense of them working on their farms. According to Ajayi *et al*. (2006), such farmers perpetually remain food insecure as much of the food production resources are diverted yet they also have low income to access adequate food from the market.

Labour is considered a limiting factor, not only to a farmer's decision to practice agroforestry (Ajayi *et al*., 2003), but also to the expansion of agroforestry practices adopted (Keil *et al*., 2005). Ajayi *et al*. (2003) propose a study to provide detailed information on the extent and exact nature of the relationship between sale of household labour, food security and farmers' decision to test improved tree fallow technology. According to Thangata (1996), the size of family labour force has a positive impact on adoption of agroforestry practices. Combining tree resources and food crops on the farm is labour demanding and families with low labor force may not be able to practice agroforestry. As a consequence, only labour-saving agroforestry practices will be adopted.

The age of the household heads is also an important factor in the adoption of agroforestry practices. A research done in Western Uganda showed that younger heads of households are more likely to adopt agroforestry practices compared to the older farmers (Thangata 1996). This is probably because the younger households are ready to take risk relative to older households and are thus likely to adopt agroforestry practices. This finding is consistent with previous studies (Adesina *et al*., 2001), which reported that adoption decreases with advanced age. Despite this, age has only been found to be significant in deciding whether to continue with the technology or not (Ajayi *et al.*, 2006). Hence, older farmers were not willing to continue with the technology as compared to younger ones.

2.4.2 Technical Factors and Their Influence on Adoption of Agroforestry Practices

Adaptability of agroforestry techniques to site conditions, choice of tree species, source of germplasm and availability of technical assistance to farmers (Chew, 1989) are technical issues which must be considered in the adoption of any agroforestry practice. For example, farmer awareness of a problem with land productivity encourages them to seek possible solutions to address it.

Franzel (1999) observed that when farmers are aware they have to improve their soil in order to increase production, and if their obvious alternative of inorganic fertilizer was not available, they were likely to take up improved fallows as the option. Farmers have several soil fertility improvement technologies to select from such as agroforestry technologies, crop rotation, animal manure, inorganic fertilizers and conservation farming. Place and Dewees (1999) indicated that competition exists between all organically-based soil fertility replenishment systems and mineral fertilizer options, and a fertilizer subsidy acts as a disincentive to using organic-based systems. Keil *et al*. (2005) also concluded that improved fallows could only be suitable in situations where there was inadequate access to markets for fertilizer, but that this result also depends on the wealth status of a household. Sometimes fertilizers could be available but farmers may not have the cash to purchase it. This finding corroborates with that of Kwesiga *et al*., (2003) who reported improved fallows as a technology for farmers that cannot afford fertilizer and have no access to animal manure.

In eastern Zambia, between 1988 and 1993, over 80% of the farmers used fertilizer on annual crops (Chinene *et al.,* 1994). But because the fertilizer subsidies were removed in the early 1990s, fertilizer use drastically decreased (Howard and Mungoma, 1997).

Farmers' knowledge of the usefulness of improving their soil fertility and their eagerness to find a substitute for fertilizer has contributed greatly to their enthusiasm for improved fallows. However, in western Kenya, fertilizer use has always been low, ranging from 0% to 41% of farms, depending on the particular year and area surveyed (David and Swinkels, 1994; Niang *et al*., 1996). In southern Cameroon, fertilizer is rarely used on annual crops. Adoption may also be constrained because improved fallows alone do not comprise a sustainable cropping system. Even where improved fallows increase crop yields, deficits of other nutrients over time, are likely to limit response and thus adoption. Therefore, efforts are needed to model and assess the long-term effects of improved fallows and, when necessary, to supplement them with other nutrients (Sanchez *et al*., 1997).

Therefore bio-physical factors play an important role in determining the type of soil fertility management technology that a particular farmer gets to use. Besides this, farming systems are also constrained by socio-economic as well as cultural factors (Giller *et al.*, 2009). According to Giller *et al*. (2009) lack of uptake of some of the soil fertility management and productivity options result from farmers lacking the resources required to use a new technology and not due to technical problems with the new options. Marenya and Barrett (2007) also found that resource constraints were limiting many smallholder farmers in Kenya from adopting integrated soil fertility management techniques.

Sometimes, farmers do not adopt because the technology does not fit with existing practices. Farmers' involvement in new technologies requires tradeoffs with other activities from which they currently generate their livelihood (Giller *et al.*, 2009) and if the new technology does not fit with them, they will hesitate to take it up. This does not however, imply that technology-specific factors would not influence adoption. Doss and Morris (2001) have indicated that there are certain technology specific factors that influence adoption decisions. For instance, the cost, level of skills needed, and minimum requirements for specific agroforestry practices like lank size, limit adoption of agroforestry practices.

Franzel (1999) asserts that a particular technology being tested may be unsuitable for farmers and specific characteristics of the technology thus influence adoption. Agroforesters need to develop improved fallow technologies that are appropriate for farmers. This requires enhancing the partnership between research and farmers. Researchers and farmers together need to understand the circumstances, problems, and preferences of rural households and how these vary among different types of farmers. Participatory techniques are available to ensure that farmers take the lead in this diagnostic process (Chambers *et al*., 1987). Farmers that are involved in on-farm experimentation of agroforestry technologies with the researchers are more likely to adopt agroforestry practices than those who are not (Phiri *et al.*, 2004; Keil *et al*. (2005). Keil *et al.* (2005) reported a 75.5% adoption rate of improved fallows among experimenting farmers in India. This means that the technology could be available and viable, but the way it is communicated can influence its adoption or not.

According to Matata et al., (2008), lack of awareness and poor knowledge on improved fallow is most critical compared to other problems. In western Tanzania, lack of knowledge by farmers was followed by lack of interest to plant trees, and the long time it takes to realize benefits from trees as farmers have to wait for two years before getting benefits from improved fallow and lack of seeds/seedlings in. A similar study carried out in Zambia revealed that the major constraints to planting an improved fallow were lack of awareness, lack of seeds/seedlings, and unwillingness to wait for two years before realizing of the benefits of the technology (Ajayi *et al*., 2003). Lack of access to extension services is also an important factor in agroforestry adoption. Evidence by Omoregbee, (1998) Adesina *et al*., (2001), and Boahene *et al*., (1999) has shown that farmers with higher extension contact are more likely to adopt agroforestry practices than those with limited or no access to it.

Information and knowledge about a given technology is considered key to the adoption of agricultural practices. Knowler and Bradshaw (2007) have underscored the importance of information, and that its availability has been found to positively correlate with the adoption of conservation agricultural technologies. The foregoing authors show that information becomes important with increase in degree of complexity of the technology. Agroforestry technologies have been acknowledged to be knowledge intensive and therefore require extensive exposure to farmers in order to promote their adoption (Ajayi, 2007; Place *et al.*, 2002). Farmers could be exposed to such technologies through involvement in on-farm research, field days, training at a farmer training centre or field schools as well as through arranged farmer exchange visits. When farmers are exposed, they learn visually and easily get convinced of the benefits in a way that is different than when they are told theoretically.

According to Franzel (1999), farmers need to play a lead role in the development and testing of improved fallow technology, assessing on-station trials, conducting researcher-designed and farmer-designed trials, and providing feedback to researchers on their experiences. Researcher-designed and -managed trials are important for assessing biophysical response; researcher-designed, farmer-managed trials are important for conducting economic analysis; and farmer-designed and -managed trials are useful for examining how farmers modify and adapt technologies to their needs and circumstances. According to Matata *et al*.,(2008), lack of awareness on improved fallows, unwillingness and lack of inability to wait two years were found to be the major limiting factors of improved fallow adoption in western Tanzania.

Farmers need to have a basket of options to choose from, as different farmers in the same area may adopt different practices, depending on their preferences and circumstances. For example, in eastern Zambia, farmers choose among six different improved fallow practices, with labor requirements varying from 60 to 460 h ha–1 (Franzel et al., 1999). The practice with the lowest labor requirements is the direct seeding of tephrosia into a maize crop. The one with the highest labor requirement involves sesbania bare-root seedlings transplanted in pure stand. Preliminary information showed that some farmers prefer the practices that economize on land and labor but give a relatively low crop response; while others prefer the practices with higher land and labor requirements but give greater yield response (Ibid).

Pretty (1995) contents that farmers do learn more from what they see than just what they get told. Also, farmers may want to adopt more than one of the agroforestry practices because diversification is an important measure for reducing risk. Second, researchers can never be sure that the technology they consider ‘best-performing’ is the best one from the farmers’ perspective (Thangata and Alavalapati, 2003). Ghadim and Pannell (1999) have also shown how learning over a given period of time is a significant factor in the adoption process of technologies. The assumption therefore is that farmer’s exposure to agroforestry technologies would reduce their uncertainty and improve chances of adoption of agroforestry. Glendinning *et al*. (2001) found access to information as an important factor that influences adoption decisions in India.

Warner (2006) recognizes the social learning processes as best means to implement agro-ecological strategies and concludes that such an approach would require active participation by farmers and not just the passive receiving of expert knowledge. The author also proposes that extensionist’s should rethink their role as experts. How then can researchers and extensionists of agroforestry help farmers to learn about new technologies in order to enhance the adoption of agroforestry? Both Warner (2006) and Conley and Udry (2001) studied social learning as a means for extending farmers’ knowledge and found it to be an important factor in influencing farmer involvement in agroforestry practices. Current extension systems that include farmers as extension agents have their own shortcomings. Kiptot *et al*., (2006) noted that not all farmers receive technical information that is required to implement agroforestry practices and that in cases where some information was given, its quality was not of the expected standard. Generally however, provision of information about a particular technology improves its adoption ability.

Agroforestry technologies require access to germplasm, specific skill and knowledge, and according to Styger and Fernandes (2006) these often limit the adoption of such technologies. Peterson (1999) found a lack of germplasm (seed and seedlings) as one of the reasons for farmers not practicing improved fallows. Ajayi *et al*, (2006c) also list access to good quality seeds as one of the factors affecting adoption of agroforestry in Zambia. When farmers do not have planting material, they would not consider establishing a fallow or any tree crop. Lack of germplasm remains a challenge to adoption of agroforestry (Kwesiga *et al*., 2003). When farmers get exposed to agroforestry during field days or through testing different species on their farms, they eventually select which species best suit them. Farmers have their own criteria for testing which species are suitable for improving soil fertility, availability of fodder, and fuel wood requirements (Kuntashula *et al*., 2004). Therefore, this puts pressure on available seed for favoured species. In Zambia for example demand for *Gliricidia sepium* seed surpasses that of other agroforestry species. However, the provision of free seeds/seedlings and other equipment might not guarantee tree planting (Matata *et al*, 2008).

Mercer & Miller (1998) have suggested that perceived risk and uncertainty about agroforestry could explain the low adoption rates. According to Pannell (2003) uncertainty is one of the key factors inhibiting uptake of land conservation practices in Australia, but also a factor which has not been extensively researched by agricultural related adoption studies. Pannell (2003) attributes the under-recognition of uncertainty to the focus of adoption studies on short-term productivity oriented practices. When farmers invest in planting trees, they involve themselves in an activity that has uncertain outcomes, and one that requires them to wait longer before they can yield results. Even when farmers are presented with information about the benefits of the technologies, they still consider the labour investment for planting trees and the non-immediate returns before they could consider planting. So instead of putting land to tree fallow, they would rather grow crops even without fertilizer as they feel this reduces the uncertainty.

Planting trees is labor intensive, returns are not immediate, and tree planting may be a new activity for the farmer. Therefore, even though farmers are presented with information pertaining to the long-term benefits of planting trees, they may not adopt this due to lack of relevant information they possess and the set of skills they have for agroforestry. According to Ellis (1988) peasant skepticism about innovation is thought to be largely related to imperfect knowledge of innovations and agronomic practices appropriate to them. For subsistence farmers, uncertainty has a serious inhibiting effect on production, for they cannot afford to suffer setbacks, which might mean deprivation or even starvation. Agroforestry innovations often introduce more uncertainty to the farmer than traditional methods of production. This uncertainty inhibits the diffusion and adoption of innovations, which could potentially improve the output and incomes of peasant farm families (Low 1974). Despite this, Schultz (1964) argued that farmers with greater human capital are better able to utilize new technology.

Negatu and Parikh (1999) suggest that farmer's perceptions regarding new technologies make a difference on whether they will adopt it or not. Zubair and Garforth (2006) attribute the low uptake and lack of people's participation in farm forestry activities to very little or no emphasis being placed on understanding the perceptions of local people or potential beneficiaries of projects. Similarly, Keil *et al.* (2005) established that the probability of improved fallow adoption increases when farmers perceive low soil fertility as their current problem. However the limited acceptance of agroforestry activities may also be attributed to lack of attention that researchers and extensionists give to the farmer's views on the factors that influence their decision such as local conditions, cultural values, people's needs and the importance of local participation (Zubair and Garforth, 2006).

It is envisaged that farmers who practice natural fallowing would easily adopt improved fallows. This would entail farmers planning for their fallows and determining beforehand which fields to set under which type of fallow. However, Franzel (1999) and Place and Dewees (1999) found that farmers rarely plan for fallowing the land but are forced to fallow when the harvests get too low, and when they cannot afford mineral fertilizers. If farmers do not plan for establishment of improved fallows they would be prolonging their waiting time to achieve benefits. The inability to wait two years to see benefits hinders the establishment of improved fallows (Peterson, 1999). However, if the benefits of improved fallows among adopting farmers have demonstrable and measurable impacts, other farmers could be convinced to test the technology. Based on the findings of Keil *et al*. (2005) of 75.5 percent adoption rate among experimenting farmers in India, then overall adoption would increase. Farmers' planning time horizons are usually and short planning spans influence how well environmental practices are fitted with other farm decisions (Vosti and Witcover, 1996).

From the above literature, it is evident that technical factors influence farmer's choice of an agroforestry technique, practice or technology depending on the environmental conditions of the farm, and also the knowledge and information one has about a specific agroforestry practice.

2.4.3 Community Oriented Factors and Their Impact on the Adoption of Agroforestry Practices

Decision-making concerning tree species and techniques to be promoted should take into account farmers' preferences and customary beliefs and practices that might discourage farmers from growing trees in general or certain tree species (Chew, 1989).

Small scale farmers do not wish to grow trees exclusively for wood, but prefer species that serve a variety of other purposes as well, such as providing food, fodder, extracts, shade, or fertilizer or serving as a hedge. Moreover, the preferences of male and female farmers concerning tree crops often differ, reflecting their respective interests and roles in the farming system (Chew, 1989). The level of participation in any production or farming activity is considered to be linked to the diversity of economic and other farming conditions in a farming community at any given time. Many expert-designed agroforestry programs are either adopted unevenly or not at all by the intended beneficiaries, especially in developing countries, because they are not built on existing experience with adoption of traditional agroforestry systems (Sood, 2006).

Farmer's membership to local organizations influences adoption of agroforestry technologies. A research done in Western Tanzania revealed that formation of farmer groups and policy emphasis to create awareness were suggested as the way forward to enhance the use of improved fallows (Matata *et al*., 2008).

Decentralized, community-based germplasm strategies influence farmers to adopt agroforestry practices. The most successful approaches to supplying and distributing planting material are those involving community-based seed stands and nurseries managed by individual farmers or groups. Seed and nursery enterprises can also help to increase incomes. Efforts are therefore, needed to ensure the quality and diversity of planting material (Current and Scherr, 1995; Franzel, Cooper and Denning, 2001).

Secure land tenure and exemptions from government ordinances is a major factor influencing adoption of agroforestry practices. Farmers with insecure land rights are unable or unwilling to plant trees. However, formal land registration is not always necessary, as some traditional forms of tenure provide the security to plant trees (Place, 1995). A critical constraint, especially in semiarid and arid zones, is that livestock often graze freely, feeding on or trampling on newly planted trees. In some communities, restrictions now prevent this practice, and lessons need to be shared to address the problem elsewhere. In many countries, bans on cutting down trees are a disincentive for farmers to plant them. Therefore, mechanisms are needed to exempt trees on farms from such ordinances (Current and Scherr, 1995).

Successful efforts to introduce agroforestry often combine modern science and traditional knowledge (Franzel, 1999). Experience has also shown that individual preferences, adaptations and entrepreneurial skills make a big difference and that communities need help to document and spread innovations of farmers. To minimize risk, farmers prefer to choose from different options to solve a problem rather than have to rely on a single approach (Franzel and Scherr, 2002).

There is also the influence of other people as opinion sources, whom Errington (1986) referred to as "significant others" or "trusted people". The relative importance of these opinion sources is said to increase in strategic, large financial or risky operations, and also in long term decisions.

From the above literature, it is clear that community oriented factors influence adoption of any agroforestry practice farmers in any community setting.

2.5 Benefits of Agroforestry Practices

In both developed and developing countries, agroforestry is not generally recognized as a science or a distinct practice and is rarely featured in development strategies (Garrett and

Buck, 1997; Williams *et al.,* 1997). Policymakers need to be informed about the benefits of agroforestry so that they can use it to support rural development and provide environmental services (Current and Scherr, 1995). In developing countries, local authorities and traditional leaders are in a good position to promote agroforestry.

Research over the past 20 years has confirmed that agroforestry can be more biologically productive, more profitable, and be more sustainable than forestry or agricultural monocultures (Matata *et al.*,2008).However, the benefits of agroforestry practices may not be clearly known to farmers (Matata *et al.*,2008). Compared to single output systems, agroforestry systems have a number of advantages as reported by landowners in certain areas. Owners have reported financial, as well as non-financial benefits (Zinkhan & Wear 1992). Some of the sources for the increased financial benefits are (1) more intensive use of the available land, (2) reduction in time between cash flows and (3) sharing of costly resources, such as fertilizer and herbicides between multiple outputs. In addition to these financial benefits, agroforestry is also considered to be more compatible with society's ecological and environmental goals than conventional agriculture (Zinkhan and Wear 1992). Agroforestry, in this respect, may contribute to (1) increasing species diversity, (2) reforestation, (3) reducing the use of chemical agents on the farm, and (4) improving soil fertility and stability, hence making a claim to being more sustainable than traditional monoculture agricultural systems (Casey, 2000).

2.5.1 Fodder

Farmers and pastoralists have long used fodder trees and shrubs to feed their livestock, but traditional practices tend to be extensive, with farmers lopping off branches or allowing their animals to browse. Integrating trees into systems where they can be planted close to each other and pruned or browsed intensively can help increase economic benefits. In the highlands of central Kenya, for example, farmers plant fodder shrubs, especially *Calliandra calothyrsus* and *Leucaena trichandra*, to use as feed for their stall-fed dairy cows (Franzel, *et al*., 2003). The farm-grown fodder increases milk production and can substitute for relatively expensive purchased dairy meal, thus increasing farmers' income. Fodder shrubs also conserve the soil, supply wood fuel and provide bee forage for honey production. Rather than cash outlays, farmers only need small amounts of land and labour to plant them. Some farmers also earn money by selling seeds.

In Cagayan de Oro, in the Philippines, a combination of improved fodder grasses and trees (*Gliricidia sepium*) has helped farmers increase income from livestock production, increase crop production and reduce farm labour, especially for herding and tethering (Bosma *et al*., 2003).Agroforestry systems for fodder are also profitable in developed countries. In the northern agricultural region of western Australia, tagasaste (*Chamaecytisus proliferus*) planted in alley farming and plantation systems has increased returns to farmers whose cattle formerly grazed on annual grasses and legumes (Abadi *et al*., 2003).

2.5.2 Timber and Wood Fuel

Agroforestry produces timber and fuelwood throughout the world. For example, intercropping of trees and crops is practiced on 3 million hectares in China (Sen, 1991). Farmers intercrop *Paulownia* spp. (primarily *P. elongata*) with cereals over a wide expanse of the North China Plain. The tree is deep rooted, interferes little with crops and produces high quality timber (Wu and Zhu, 1997). In Minquan County (Henan Province), 30 years after the introduction of agroforestry, two-thirds of the 46 000 ha of farmland were intercropped with trees of this genus. In one commune, *Paulownia* spp. accounted for 37 percent of farm income (Wu and Zhu, 1997). In addition to timber, these species provide excellent fuelwood, leaves for fodder and compost fertilizer and protection against wind erosion and evapotranspiration (Wu and Zhu, 1997).

In Tabora District in the United Republic of Tanzania, about 1 000 tobacco farmers have started *Acacia crassicarpa* woodlots to produce fuelwood for tobacco curing, intercropping the trees with maize during the first two years (Ramadhani, *et al.*, 2002). Growing wood on farms prevents the felling of trees from the forest, reducing forest degradation and saving costs of transporting fuelwood. In Uttar Pradesh, India, 30 000 farmers grow poplar (*Populus deltoides*) on woodlots that average 1.3 ha to sell to the match box industry and intercropping is common, especially in the first two to three years (Jain & Singh, 2000; Scherr, 2004).

In the United Kingdom, a range of timber/ cereal and timber/pasture systems has been profitable to farmers. McAdam, *et al.*, (1999) found that ash trees intercropped with ryegrass pastures did not influence the pasture yields for the first 10 years of the 40-year rotation. Incentives to increase biodiversity in pastoral systems and the uncertainty of meat prices versus timber prices further encourage farmers to practice agroforestry.

Environmental services: windbreaks, carbon sequestration, influence climate mitigation and biodiversity conservation Studies of the environmental benefits of agroforestry are far fewer than those related to economic benefits, and studies seeking to monetize such benefits are almost non-existent.

2.5.3 Windbreak

Windbreaks are one of the oldest agroforestry systems in North America. In the Canadian prairies, more than 43 000 km of windbreaks have been planted since 1937, protecting 700 000 ha. In 1987, approximately 858 000 windbreaks in the United States, mostly in the north central and Great Plains areas, spanned 281 000 km and protected 546 000 ha (Williams *et al.*, 1997). Kort (1988) estimated the yield increase of crops sheltered from wind to be 8 percent for spring wheat, 12 percent for maize, 23 percent for winter wheat and 25 percent for barley. In addition, windbreaks improve crop water use and protect livestock and homesteads.

Several examples exist of private companies supporting agroforestry in exchange for carbon benefits. In the Scolel-Té pilot project in southern Mexico, 400 small-scale farmers in 20 communities are converting from swidden agriculture to agroforestry, either by intercropping timber trees with crops or by enriching fallow lands (de Jong, *et al.*, 2000). The International Federation of Automobiles has purchased the resulting 17 000 tonnes of carbon offsets for US$10 to $12 per tonne of carbon. Sixty percent of the revenues have gone to farmers. However, the question remains whether returns from agroforestry will be sufficient for farmers to maintain the practices once carbon payments have ended (Ibid).

In the highlands of Ecuador, farmers participating in a carbon trading project are planting mixed woodlots of pine, eucalyptus and indigenous species. Pine and eucalyptus are profitable, but the slow growing indigenous species offer negative returns. This again puts into question sustainability of carbon-trading tree projects involving activities that are not in themselves profitable (Smith and Scherr, 2002). Gockowski *et al*., (2001) compared the environmental benefits of the most prevalent cropping practices around Yaoundé, Cameroon with emphasis on cocoa agroforests and food crops rotated with short or long fallows. Cocoa agroforests ranked first in carbon stocks, numbers of plant species and degree of plant biodiversity. They also ranked highest in terms of social profitability – the economic returns from society's perspective, not taking into account the effects of taxes, subsidies and distorted exchange rates. However, with regard to the most important criterion to farmers pertaining to net returns to labour, there was little difference among the alternatives.

2.5.4 Carbon Sequestration Services

Agro forestry-based land use practices provide ecosystem services such as carbon sequestration and storage, biodiversity conservation and protection of watershed among other services that help to adapt to and mitigate climate change effects. One of the most important contributions of agro forestry in general is to respond to climatic change through sequestration of carbon in above-ground plant biomass and the soil (Unruh *et al*., 1993; Kaonga, 2005; Verchot *et al*., 2007). The analysis of carbon stocks from various parts of the world shows that 1.1–2.2x1015 g C could be removed from the atmosphere over the next 50 years if agroforestry systems are implemented on a global scale (Albrecht and Kandji, 2003).

Average carbon storage by agro forestry practices, of which fertilizer trees is an integral part has been estimated as 9, 21, 50, and 63 Mg C ha-1 in semiarid, sub humid, humid, and temperate regions respectively (Montagnini and Nair, 2004). Based on assessments of national and global terrestrial carbon sinks, two primary beneficial attributes of agro forestry have been identified (Wise and Cacho, 2005). The first is direct near-term carbon storage in trees and soils through accumulation of carbon stocks in the form of live tree biomass, wood products, soil organic matter and protection of existing products. The second involves potential to offset greenhouse gas emissions through energy substitution (e.g. fuel wood from woodlots) and fertilizer substitution (through biological nitrogen fixation and biomass production). Agroforestry can also have an indirect effect on carbon sequestration when it helps decrease pressure on natural forests, which are the natural sinks of terrestrial carbon.

Although pure forests sequest higher amounts of carbon per unit land area and contribute more to improved climate change, the opportunity cost in terms of food production of initiatives that take land out completely for forestation for many years may be high in some southern African countries that experience seasonal food deficit. Such initiatives may also not be attractive to smallholder farmers in countries such as Malawi where the average land holding per household is less than 1 hectare (Thangata, 1996).

2.5.5 Substitutes for Purchased Products.

Many farmers appreciate agroforestry because it generates cash income through the sale of tree products. It also provides products that the farmer would otherwise have to purchase – an important consideration, given the lack of working capital in many farming systems. For example, farmers substitute nitrogen-fixing plants for mineral fertilizers, fodder shrubs for expensive dairy meal and home-grown timber and fuelwood for wood bought off the farm (Scherr, 2004).

2.5.6 Soil Conservation and Fertility Improvement

The growth of agricultural productivity in Africa has been remarkably low in the past decades (Tsunehiro, 2010). Low soil fertility is a major problem to food production and one of the key biophysical constraints to increase agricultural growth in sub-Saharan Africa (Sanchez, 2002; Kwesiga *et al*., 2003; Vanlauwe and Giller, 2006). According to the estimates reported by Smaling *et al*. (1997), soils in the sub-Saharan African sub-continent are depleted at a rate of 22 kg/ha of nitrogen, 2.5 kg/ha of phosphorus and 15 kg/ha of potassium annually.

In Malawi, over US$ 6.6 million worth of nutrients are estimated to be lost each year through soil erosion (Bojo, 1996). The decline in soil fertility has been caused by two main reasons: the breakdown of the traditional natural fallow system that farmers used to naturally replenish the fertility of their soils and, low rate of use of mineral fertilizer due to unaffordability and lack of timely access of the inputs by most smallholder farmers. The problem of accessibility to fertilizers was more acute especially after the removal of fertilizer subsidies and the collapse of public farm inputs distribution channels. Kenyan farmers have gradually come to perceive the severity of soil erosion and resulting productivity decline (Amadalo *et al*., 2003).

The function of agroforestry in conserving soil seems to make it a promising alternative to the traditional fallow technique. With the help of the agroforestry extension program by the Kenya Forest Department and information dissemination by international non-governmental organizations, agroforestry has been implemented in several regions in Kenya (Scherr, 1995). Agroforestry contributes to soil conservation in several ways. Pattanayak and Mercer (2002) report that intercropped trees (contour hedgerows) successfully mitigate soil erosion by forming natural terraces in a sloping land and replenish soil fertility with prunings from the trees. Many scientific studies point out agroforestry's role in maintaining or improving soil fertility by preserving soil organic matter and physical properties of soil (Okoji and Moses, 1998).

Fertilizer trees/shrubs as an agroforestry-based soil fertility replenishment practices that was developed in the late 1980s in southern Africa in response to the declining soil fertility and low macro-nutrient levels prevailing in many sub Saharan African countries involves planting fast growing and nitrogen-fixing leguminous trees and shrubs whose biomass produce large quantities of biomass that easily decomposes and release nitrogen for crop growth (Kwesiga and Coe, 1994). The practice is based on the knowledge that nitrogen is highly abundant in the atmosphere but is the most limiting macro nutrient in the soil. Through nutrient recycling principles, leguminous trees are planted to capture atmospheric nitrogen and release it into the soil upon decomposition and subsequently nourish crops that are planted in the field.

There is a consensus in the literature reviewed that fertilizer trees/shrubs are sustainable, technically sound and ecologically relevant (Kwesiga et al., 2003; Akinnifesi et al., 2006; Mafongoya et al., 2006; Akinnifesi *et al.*, 2008). However, it was recognized that the benefits of planting improved fallow are not clearly known to farmers (Matata *et al*, 2008).

2.5.7 Reduction in the Rate of Deforestation and Increase in Forest Integrity

Field trials carried out in Zambia in the early years of the development of agroforestry practice show that tree species used as fertilizer trees can provide up to 10 tons of wood biomass per hectare (Kwesiga and Coe, 1994). It has been hypothesized that the additional fuel wood that households obtain from shrub fields could lower the amount of wood that farm households would have sourced from communal forests and thus offer potential opportunities to reduce deforestation.

Total annual deforestation for some southern Africa countries is estimated at 55,000 ha for Malawi, 323,000 ha for Tanzania, 264,000 ha for Zambia and 50,000 ha for Zimbabwe (Geist, 1999). In addition, the ready availability of fuel wood reduces the burden and the time that household members especially women, would have spent walking long distances in search of fuel wood in forests.

Evidence suggests that where farmers have incentives to plant trees and have access to information and planting material, they depend less on neighbouring forests and are less likely to damage them. Sound policies and extension programmes, as well as effective forest management mechanisms, can significantly enhance the impact of agroforestry on forest protection (Murniati, *et al.*, 2001).

Available information indicates that agroforestry can provide a greater range of environmental benefits than conventional types of annual crop cultivation. Murniati *et al*., (2001) also found that in areas adjacent to national parks in Sumatra, Indonesia, households with diversified farming systems, including mixed perennial gardens, depended much less on gathering forest products than did farms cultivating only wetland rice.. The findings suggest that promoting diversified farms with agroforestry in buffer zones can enhance forest integrity.

2.5.8 Improvement in Soil Health and Biodiversity

Fertilizer trees/shrubs improve the physical properties of soils. In particular, soil aggregation is higher in fields where fertilizer trees are grown, and this enhances water infiltration and water holding capacity of soils thereby reducing water runoff and soil erosion (Phiri *et al*., 2003). As a result, fertilizer trees/shrubs have the potential to help reduce the impact of droughts, a common seasonal phenomenon in southern Africa where agriculture is mainly rain-fed. The repeated application of tree biomass increases the soil organic matter that leads to increases in soil water retention capacity.

The tree biomass and roots also provide favorable environment for soil microbes and fauna which in turn break down the biomass and release plant nutrients. Fertilizer trees/shrubs enhance soil activity of soil fauna and flora that perform important ecosystem functions (Sileshi and Mafongoya, 2006). In some cases, fertilizer tree systems harbour almost the same diversity and abundance of soil invertebrates as the miombo woodland. This diversity can, in time, provide ecological resilience and contribute to the maintenance of beneficial ecological functions such as pest suppression. Fertilizer trees also help to reduce incidence of noxious weeds such as *Striga* and termite problems (Sileshi *et al*., 2005) which become more serious under conditions of low soil fertility.

Analysis of the benefits of agroforestry practices is important if they have to be taken up by small holder farmers and also have an impact on farmer' livelihood. It is hoped that with increased awareness of the agroforestry benefits, many farmers would adopt agroforestry technologies as a means of improving their livelihoods.

2.5.9 Livelihood Benefits

A study done in Taita hills in Kenya showed that most of the respondents agreed that agroforestry practices increased soil fertility, farm income and reduced the chances of complete crop failure (Sherr, 1995; Soini, 2005). Households realized that plantation of tress on underutilized portions of farmland had not decreased in the overall output of the farmland. Sequential or simultaneous production of fodder and grass crop and vegetable and livestock contributed to increases in the overall household income (Soini, 2005).

Maintenance of mixed trees on farmland made household resilient to cope with uncertainty and risk, especially when insect or disease outbreak occurred in one species; they can meet their needs from other species. The respondents strongly agreed that agroforestry practices improved the surrounding conditions of the forest and saved time on collecting fodder and firewood from the forest. Agroforestry practices also opened avenues for other farming activities such as vegetable farming. It is worthy noting that these households have experienced improved greenery and seen the increased role of farm trees to meet their need for fodder and firewood. Despite this, respondents disagreed on the statement that it takes along time to get income from agroforestry practices. This is due to the fact that households have cultivated fast growing trees that are able to accrue benefits especially fodder in short period of time.

2.6 Theoretical Framework

This study is guided by the Agroforestry Decision Making Theory advanced by Rene Koppelman and James H. French (1996). According to Koppelman and French, adoption of agroforestry by farmers at the household level is a decision making process that is influenced by various sets of factors encompassing on-farm and off-farm factors. Using the household as the unit of analysis, they argued that each household has a unique set of socioeconomic and biophysical conditions. The authors suggest that agricultural investment and production decisions are evaluated by farmers, landowners and agricultural entrepreneurs based on key external factors including: 1) availability and access to markets; 2) availability and access to support services; 3) availability and access to scientific and indigenous knowledge; and 4) existence of policies, rules and regulations.

It should be noted that the household is not the only level or unit in a hierarchy of decision making. For example, if one desegregates the household into individual members, it is possible to analyze gender roles and their impact on decision making. This is because the household is the level at which all farm resource allocation decisions are made. Therefore, the decision to adopt a new idea at the household level requires a holistic perspective, since many factors play a role. Within the farm household *On Farm Factors* (farm household, socio-economic conditions and biophysical conditions) play an important role in the decision making process. These decisions are called *Farm Management Decisions* and entail investment and marketing decisions, and production and conservation decisions. A large spectrum of *Off-Farm Factors* among them markets, support services, technical information, and policies, rules and regulations) can influence this decision making. This framework can be a guideline for analyzing farm household decisions and promoting agroforestry development. Figure 2.1 below gives a summary of the theory.

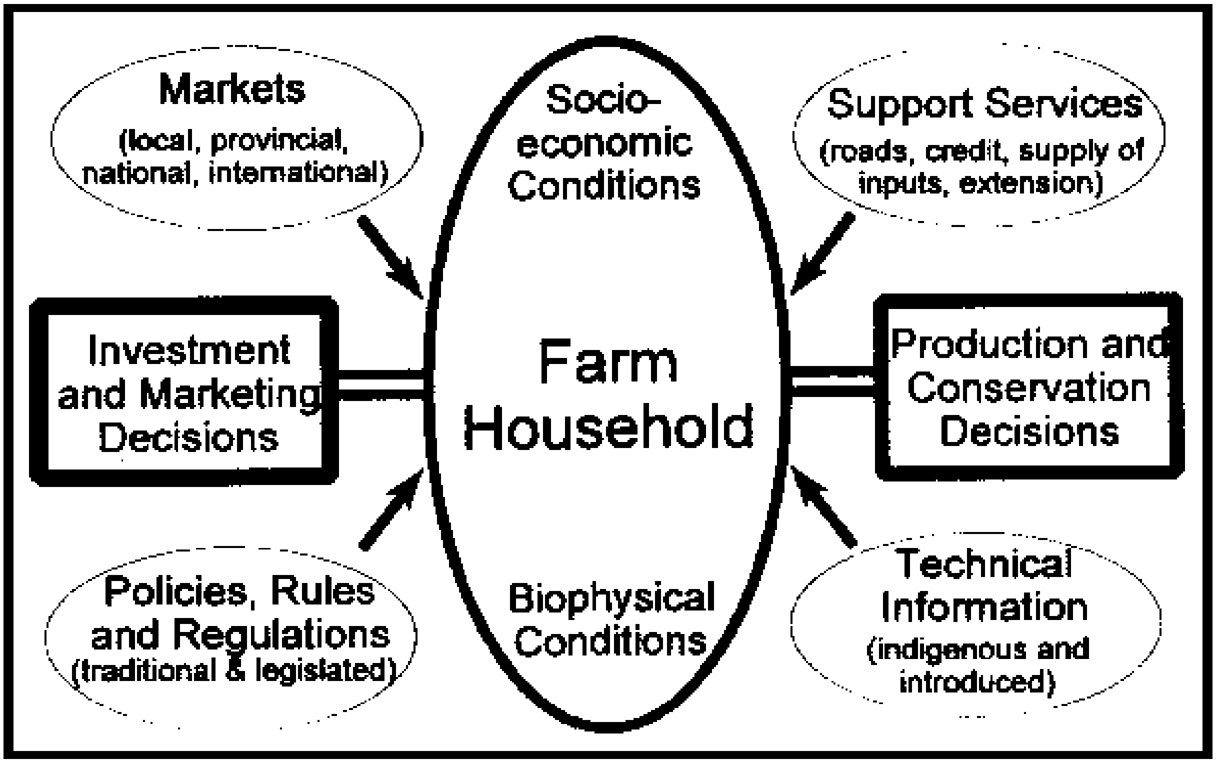

Figure 2.1: Decision Making Model

Adopted from Rene and French (1996)

In relation to the current study, this theory directly address the issue of factors that influence decision making by farmers that also determine whether they engage in agroforestry related practices or not. It therefore, provided a clearer guideline on which factors should the researcher focus on when conducting the study. It also provides a methodological significance by detailing the meaning and definition of each set of factors that made questionnaire development easy and focused

2.7 Conceptual Framework

The researcher argues that adoption of agroforestry cannot be restricted to a specific set of factors. Therefore, on the minimal grounds, there is a combination of factors that would influence a people's attitude, knowledge, decision making and engagement in a given activity. This study also holds that these factors may be within or beyond the actors' control. It is therefore, within this understanding that the researcher looks at the independent variables in terms of farmer oriented factors (level of education, size of land, land tenure, income, age, marital status, size of household,); community factors (cropping trend, policies, initiatives, social roles and status, beliefs, legal issues, attitude,); and technical factors (skill/knowledge, time to get benefits, costs, variety of crops, land space/size, extension services,). The dependent variable is therefore, the status and adoption of agroforestry (agroforestry practices adopted or not, beneficial or not) among the target population. However, the link between the independent and dependent variables may either be strengthened or weakened by the intervening variables (internal and external pressure).

It is however, important for one to note that the conceptual framework used in this study is like a grand hypothesis that diagrammatically illustrates the link between the independent and dependent variables of interest to the study. It is therefore, wholly developed from the study variables. Figure 2.2 below illustrates the conceptual framework that guided the study. In the figure, the arrows are used to show the direction of causal relationships that exist among the study variables.

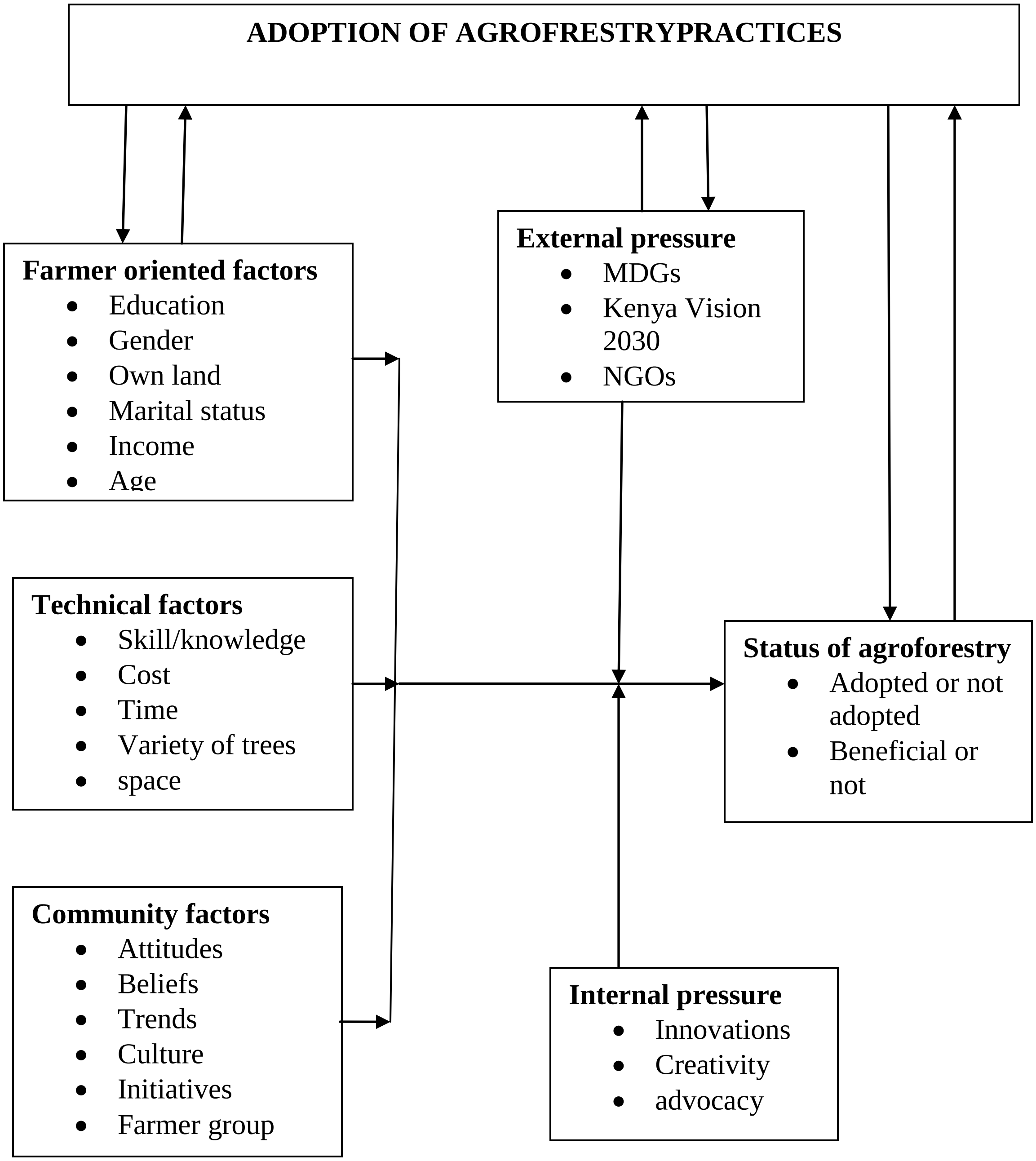

Figure 2.2: The Conceptual Framework

Source: Author, 2011

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter focuses on the methodological procedures used to carry out the study. The chapter is divided into the following sections: study area, the study design, study target population, data collection methods, research instruments, and data analysis and presentation procedures. The researcher used photographs, graphs and tables to present the findings.

3.2 Study Area

3.3.1 Location for Nambale District

Nambale District, which is one of the Districts in Busia County, is the indigenous home of the Bakhayo people. Other district that borders Nambale includes Butula, Amukura, Busia Municipality, and Bungoma. Nambale district borders Uganda to the East, Bungoma County and Teso District to the Northwest, Kakamega County and Mumias-Butere District to the Southwest.

Topographic profile

Nambale District falls within Lake Victoria basin. The altitude varies from 1130m on the shores of Lake Victoria to 1375m. The District lies between latitude 0° and 0° 25° North and the corresponding longitude 34° and 54° East, respectively. It covers a total area of 1262 square kilometres, with 137 square kilometres under permanent water surface. The district has 924,200 hectares (924 sq. km) of agricultural land but only 40,000 hectares is under crop production. The high potential parts are found in Nambale, Matayos and Butula divisions (GoK, 2005).

The county occupies a plain characterized by low flat divides of approximately uniform height. These are often capped by laterite soil and a shallow incised swampy drainage systems. The flat plains provides soils suitable for growing cereals like maize, sorghum, millet and rice; roots and tubers such as sweet potatoes and cassava; vegetables like *kales*, and cow peas; and cash crops like sugarcane, coffee and cotton among other crops.

Many permanent rivers dissect Busia County, and flow southward into Lake Victoria. The County has got two main rain seasons. The long rains begin at the end of March and last until May, while the short rains start in September and end in November. An average of about 1500 millilitres of rainfall is received annually. The mean annual temperatures range between 26° and 30°. There is a dry spell between December and February. The evaporation in the district is between 1800mm and 2000mm per year (Ibid).

Demographic and Administrative Profile

Busia County has a total population of 769,459 people with a growth rate of about 2.95%. The population in the age brackets 0-40 forms about 50.3% of the total population. 60% of the population is below 20 years while those over 60 years of age constitute only about 5%. This is indicative of a predominantly youthful population with a relatively short life expectancy. Such population structure has the tendency of having a high dependency ratio and therefore, difficult to provide it with basic nutritional and other needs and it is not surprising that Busia County is listed as poverty stricken.

Busia County is divided into six administrative districts namely Nambale, Butula, Funyula, Budalang'i Matayos and Busia Township. Nambale District, Nambale Division was the main focus of this study and is divided into five locations namely, Nambale Township location, Bakhayo East location, Bukhayo North location, Bukhayo Central location and Walatsi location.

3.3.2 Nambale Division

The focus of this study was on Nambale Division. The Division occupies plains characterized by flat low divides of approximate height. The flat plains provides soils suitable for growing maize, sugarcane, sorghum, millet, cotton, rice, coffee, sweet potatoes, cassava, and a variety of vegetables among other crops. Nambale division is transversed by two main rivers: River Walatsi and River Sio all flowing into Lake Victoria. Nambale Division consists of five administrative locations namely: Nambale Township, Bukhayo East, Bukhayo North, Bukhayo Central and Walatsi location.

Nambale Division has got two main food production seasons. The April to August season (during long rain season), and September to November (during the short rain season). There are several welfare facilities in the division. There are healthcare facilities including a hospital, clinics, nursing homes, and several chemists. There are several secondary schools, primary schools and nursery schools in the division. Nambale division has a relatively good road network and traversed by the Busia-Mumias and Busia-Bungoma highways. The division has got electricity along the highway and a mobile phone booster at Nambale township location. There are several shops, small open-air markets and water points. There are also administrative offices for the division, with a police patrol base. There are also several agroforestry initiatives by both government agencies and the civil societies in the area.

3.3.3 The Bakhayo People

The Bakhayo people are the indigenous people of Nambale division (GoK, 2001). The Bakhayo are a sub-ethnic group of the Luhya who belongs to the Bantu Linguistic family. They are one of the seventeen sub-ethnic groups of the large Luhyia ethnic community. All the seventeen Luhyia sub-ethnic groups share a common descent, customs, and language, although their respective dialects vary according to their localities. The Bakhayo just like other Bantu communities are organized into clans, lineages and villages. These clans include Abaguri, Abamenya, Abamutu, Abatachoni, Abatelia, Abamalele and Marachi (Ochieng', 1990). From a mythical perspective, the Bakhayo people believe that they originally came from a place called *Misri*, which is thought to be the present day Egypt (Ochieng, 1990).

In terms of residence, the various clans do not have specified territorial locations. Members from one clan stay in the various villages with neighbors from other clans. The clans are exogamous in nature and one cannot marry from his own clan. For instance, a man from Abaguri clan cannot marry a woman from the same clan, but is free to do so from the rest of the clans. The same applies to women at marriage age.

The Bakhayo people are agriculturalists and grow both food and cash crops. Their staple foods are cereals (maize, millet and sorghum) and root tubers (cassava and sweet potatoes) and a variety of vegetables that go along with these staples. Cash crops like cotton, sugarcane and coffee are grown, although not on large farms because of the nature of their land fragmentation tenure system. They also keep livestock alongside crop farming. These include cattle, goats, sheep, and pigs for meat supply as well as a security in terms of income generation. For instance, most farmers would sell their cattle to get cash in order to pay school fees for their sons and daughters. A few other people of this community are self-employed as business people while other are employed in civil service as well as in the private sector through such organs as the Non-Governmental Organizations.

3.3 Study design

The study utilized the descriptive survey research design. A survey research design according to Mugenda and Mugenda (1999) is a self-report study, which requires the collection of quantifiable information from a sample. A survey is a method of collecting information by interviewing subjects/respondents or administering a questionnaire to a group of individuals who constitute the sample that provide data useful in evaluating present practices and improving the basis for further decisions. For the purpose of this study, the descriptive survey design was suitable for data collection since it assisted the researcher to gather qualitative and quantitative data from the target population.

3.4 Target Study Population

The target population for the study was farmers in Nambale division. This was because it is the farmers who engage in both livestock and crop farming that also practice agroforestry. Consequently, farmers are the main actors, beneficiaries and decision makers with regard to adoption of agroforestry practices.

The units of analysis were household heads. In this context, household heads who practiced farming were the respondents since they are the decision makers on how land should be managed and therefore, agroforestry being one of the land management systems, the household heads were of great importance. Therefore, farmers who were the household heads were the respondents.

3.5 Sample Size

The basic unit of analysis for the study was the household. The study had a sample size of 200 respondents. The residents of Nambale division have similar lifestyle experiences and also engage in similar economic livelihood activities. Therefore, because of lack of variations, the 200 respondents were selected using simple random sampling from the various locations of the division. According to Fischer (1982), 200 is the minimum sample size one can use for studies focusing on households in communities.

3.6 Sampling Techniques

The researcher employed various sampling procedures that included:

3.6.1 Purposive Sampling

In purposive sampling, the researcher using her experience and judgement selected the most desirable respondents as her key informants. They were the most knowledgeable people with information on the topic of study by virtue of their status in Nambale division. They provided an in-depth understanding on most of the issues of concern to the study. These included 4 leading farmers with exemplary agroforestry activities, 1 divisional agricultural officer, 2 Kenya Forest Service officers, 1 chief and 2 representatives from non-governmental organizations working in the study area.

3.6.2 Simple Random Sampling

This method involved giving all the members in the target population an equal chance of being selected to participate in the study, the researcher sought assistance from the local administration and the village heads. For the five locations covered in the division, a list of household heads was requested from the village heads. Respondents were chosen randomly from the list and the name of the household head chosen was marked until the entire sample required was exhausted. Simple random sampling was used because it gave each of the total sampling units of the household heads an equal chance of being selected. Through the simple random sampling, a sample of 200 respondents was picked. Out of the 200 respondents interviewed in Nambale Division, 50 were from Nambale Township Location, 50 from Bukhayo East Location, 40 from Bukhayo Central Location, 30 from Walatsi location and 30 from Bukhayo North Location. The sample size from each location was selected depending on the number of households it has.

3.7 Data Collection Methods

The main techniques of data collection used included:

3.7.1 Documentary/Secondary Data

This was employed at the first phase of the study particularly during proposal development and especially in the development of the problem statement. Secondary data was important for identification of gaps in knowledge and verification of previous studies on the similar topic. More secondary data was collected from various sources including personal and institutional libraries, archives and information offices at the district levels. This involved going through books, journals, dissertations, thesis reports, policy documents, reports and other articles in order to gather relevant data. The method provided factual and authoritative information on what other studies have done in relation to the study problem.

3.7.2 The Survey Method

Being the main method that was used, it involved conducting semi-structured interviews using a semi-structured questionnaire. Semi-structured interview elicited both qualitative and quantitative data. In an effort to focus on the household heads, the researcher administered the questionnaire to the male spouse that was also the household head. However, in households with absentee male heads, like those working in town, the female spouse was interviewed instead. Likewise, in households where both male and female spouse were available, the one said to be the household head was given the priority but the other could chip-in once in a while. The questionnaire was structured according to the objectives of the study. This method produced a more focused and relevant data for the study on farmers own factors, technical factors, community factors and the benefits they experienced from agroforestry practices.

3.7.3 Direct Observation

This was an important technique for the study and it involved careful watching, analysis and recording of whatever the researcher was interested in for the purpose of answering the main research question. In this approach, the researcher maintained presence in

Nambale Division and visited various villages. During these visits, she observed what was on the farms (crops grown on the farms), the status of households (types of houses they stay in), agroforestry systems, types of trees grown ,location of the trees, and in general, how land was utilized. The method was important since it was used to verify some of the information collected during the questionnaire survey, and it also generated detailed qualitative data.

3.7.4 Key Informant Interviews

Key informant interviews were held with leading farmers with exemplary agroforestry activities, the Divisional Agricultural Officer, the Kenya Forest Service Officers, a chief and representatives from non-governmental organizations working in the study area. The Key informant method took the form of day-to-day conversation between the researcher and the informants. The key informants provided critical information and even expounded precisely on most of the issues such as how agroforestry is perceived by most farmers in the area, the perception of planting trees on the farm, types of trees preferred and the reasons behind their preference, perceived benefits of agroforestry and trees in particular, and the challenges facing the adoption of agroforestry by farmers in Nambale Division.

3.7.5 Informal Discussions

This method took the form of casual interactions between the researcher and member(s) of the target population. The researcher engaged in discussions with individuals met during their day-to-day activities without prior arrangement with them and in a casual manner. At times, the researcher would visit a household and look around probing on what land management practices are adopted at the household level. This method was used to verify some of the responses given by use of other methods of data collection, with the view of understanding the perception of agroforestry among the respondents in Nambale Division.

3.8 Data Analysis Techniques

Both quantitative and qualitative data analysis techniques were employed. Qualitative analysis involved the derivation of explanations and making of interpretations of the findings based on respondents' description of issues. The concern was on description of patterns, singularities or uniqueness in the data collected. Qualitative information was mainly presented through explanations and photographs.

Quantitative analysis on the other hand involved analysis of data using inferential statistics that rely on numerical values. Data from the field were first coded and frequency tables prepared using the Statistical Package for Social Sciences (SPSS) computer package. This led to production of descriptive statistics that was presented in the form of frequency scores, percentages and graphs. Cross tabulation, which enhanced Chi square testing, was the major statistical tool in the study. Chi-square test was used to indicate associated between the adoption of agroforestry and education level, cropping pattern, land ownership and cash cop farming.

3.9 Field Experience and Problems Faced During the Study

Carrying out this study was faced with a number of challenges. Due to long distances between households, coupled with poor road network, the researcher had transportation problems: moving from one household to another. There were cases of absentee respondents and the researcher had to visit the same household several times to interview the household head. This was because worsened by the fact that some of the spouses particularly the female had to wait for their husbands who had travelled to come back for the researcher to carry out an interview and fill the questionnaire.

Finally, some of the respondents were not honest. For instance, they could cheat on amount of land dedicated to cane farming and other crops. In other cases, some respondents tried to exaggerate the information, gave ambiguous responses or omitted certain parts of the questions. In some cases, respondents were suspicious of the researcher and hesitated in giving information. In all these scenario were handle by the researcher through triangulation of methods of data collection, where several methods were used to check and countercheck the kind of information that the respondents provided.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is divided into five sections according to the objectives of the study. These include: farmer oriented factors, technical factors, community oriented factors and benefits of agroforestry,

4.2 Characteristics of Farmers

4.2.1 Gender of Respondents

From the findings, 118 (59%) of the respondents were males, while 82 (41%) were females (Table 4.1).

Table 4.1: Gender of respondents

Responses	Frequency	Percent
Male	118	59.0
Female	82	41.0
Total	200	100.0

Cultural factors were important in explaining why more males than females were interviewed. This was mainly due to the fact that the Bakhayo like most other African communities are patriarchal and males are the *de facto* heads of households. The study established that males (husbands) are the household heads and since this study was concerned with gathering information on the household's demographic and socio-economic issues, men were the ones in the right position to speak on behalf of the household on the various asked. During data collection, the researcher interviewed any one of the spouses that was available at the household. However, in situations where were available, the one willing to talk on behalf of the rest was given the chance to participate as the other chipped once in a while. However, the researcher found out that in situations where both spouses were around, the male did the talking as the female took a low profile in the whole session.

One of the impressions that this study got about the Bakhayo culture was that whenever men were around, women would take a very low profile of any discussions or decision making. During the study, it was found that in households where both the wife and husband were around, the woman would insist that the husband was in a better position to give the research team information about what was wanted and more so if the matter was about land where the man is the overall decision maker.

4.2.2 Age of the Respondents

Table 4.2: Age of the Respondents

Age brackets	Frequency	Percent
20-39	71	35.5
40-59	98	49.0
60-79	28	14.0
>80	3	1.5
Total	200	100

From the findings, respondents were drawn from diverse age bracket indicating that the sample was representative of the target population. 71 (35.5%) respondents were aged between 20-39 years, 98 (49%) were in the range of 40-59 years, 28 (14%) were aged 60-79 yeras, while the remaining 3 (1.5%) in the age bracket of 80 and above (Table 4.2). Results showed that people aged between 40-59 years formed the majority of respondents interviewed. All age groups in this survey were active and had the potential of participating in agroforestry. This is contrary to other studies that young people participate more in agroforestry due to their ability to acquire and use information about new technology faster than old people (Sonii, 1992).This could be explained by the fact that most of the people aged 40-59 were the household heads and therefore participated in the study. Other findings on the adoption of social forestry in India by (Alavalapati *et al*., 1995) and live hedge in Burkina Faso

(Ayuk, 1997) indicated that younger farmers are more likely to adopt agroforestry. In most cases and among the Abaluhya, parents and married sons stay in one homestead and therefore whenever there was something to enquire about, the parent who is the household head is given priority to speak. The presence of people aged 20-39 could be explained by the fact that in some families, whenever a son marries, he is given a piece of land where he should settle with his wife and start a family. Many of the people aged 20-29 had moved into their current homesteads less than two years when the study was done.

4.2.3 Marital Status

Table 4.3: Marital Status of Respondents

Responses	Frequency	Percent
Married Widows/widowers Total	186 14 200	93.0 7.0 100

Most of the respondents were married, and the few that were not, they were widows. From the results, 186 (93%) respondents were married, while 14 (7%) of them were either widowers or widows (Table 4.3).

The study results showed that that majority of the respondents (93%) were married, while only 7% were widows/widowers whose spouses had died. The high percentages of married headed families observed in the study suggest that participation of farmers in agroforestry in the study area depends on the perception of the technology by the male members of the community because most of the women did not own land. This is in agreement with (Phiri *et al*., 2003), in his study found that proportionately more men planted improved fallow than women primarily because married women need consent of their husbands before planting trees. Similar results were found by Matata *et al*, (2008) on adoption of improved fallows in Tanzania.

In sub-Saharan Africa, conventional methods of agricultural extension have traditionally tended to be geared towards men while ignoring women (Saito *et al*., 1990). The authors noted that the bias against women is manifested in the delivery of the extension message itself. The message is generally provided by male extension agents to men with the implicit assumption that it will “trickle down” to women.

4.3 Adoption of Agroforestry Practices

4.3.1 Agroforestry Systems

One of the objectives of the study was to find out the nature of agroforestry in the study area and more specifically, the types of agroforestry. Study results showed that all the respondents practiced agrisilviculture which involves growing trees and crops, while 78.5% practiced agrosilvopastoral (growing trees, crops and pasture on the same piece of land. Respondents in the study area reported that decision to keep livestock affected land size. Reasons given were that animals need an area for rearing and also space to plant fodder and would also require labour which may strain the available in the household. Increased in livestock holding has been reported to impact negatively the decision to plant trees and the amount of trees to be planted in Northern Ethiopia (Zenebe *et al*, 2010).

4.3.2 Environmental Problems Experienced

Environmental problems experienced by a farmer can influence one to adopt agroforestry to manage the problem. Due to the above assumption, the research was concerned with identifying the environmental problems experienced by the households. 96% of the households experienced shortage of fuel wood, 93% experienced scarcity of land, 40%

had low crop yield, 35% reported about shortage of fodder, 90% stated soil erosion, 64.5% cited hot weather and 15% indicated strong winds (Table 4.4).

Table 4.4: Environmental Problems Experienced by Respondents

Environmental problems experienced	Frequency Yes **n=200**	Percent 100%	Frequency No n=200	Percent 100%
Shortage of fuel wood	192	96	8	4
Scarcity of land	186	93	14	7
Low crop yield	80	40	120	60
Shortage of fodder	70	35	130	65
Soil erosion	180	90	20	10
Hot weather	192	64.5	8	35.5
Strong wind	50	15	150	85

NB: *This is a multiple response and each variable is out of 200(100%)*

From the results, majority of the respondents (96%) experienced shortage of fuel wood. Fuel wood is the major source of energy in many rural households and is not a renewable source of energy. In developing countries, woodfuel is the major source of cooking and heating where about 2 billion people rely solely on fuel wood for cooking (FAO, 2005).

It is estimated that about 90% of Kenyan rural households use woodfuel either as firewood or charcoal (Ministry of Energy, 2002); It is universally accepted that fuelwood shortage is a very serious problem affecting not only individual households, but also national and international resource use and conservation (Nair, 1993). Respondents reported that fuelwood sources have reduced since fallow land has been cleared for cane farming and other farming practices. One of the respondent reported that fuel wood has become scarce and at times he uses balls made of cow dung and soil to cook.

Nair, (1993) contended that local people often may not consider fuelwood scarcity as an existing or impending problem, because in deficit areas, fuelwood is replaced by such alternatives as crop stovers, dung, twigs, bark, and so on. Study results indicated that fuel wood scarcity has become severe forcing people to use lantana camara which was rarely used in the study area. However, the Government of Kenya has been involved in promoting tree planting at the farm level with the aim of increasing tree cover to 10% by the year 2030 (Republic of Kenya, 2007).

Scarcity of land was reported by 93% as a problem. This can be explained by the fact that majority (70%) of the respondents have less than 7 acres of land and plant cash crops leaving little land for other uses. The bulk (98%) of the farm holdings in Kenya are small (<10 ha) and nationally, the average farm size is about 2.5 ha (Kamau, 1998). Soil erosion was also reported to be a problem (90%) and since the study area’s soil profile is sandy and it is therefore prone to erosion which takes fertile top soil making it infertile.

Hot weather was also reported to be a problem by 64.5% of the respondents. This could be explained by the fact that traditional house in the study area are have been grass thatched until recently where people are using iron sheets due to modernization. As farmers work towards reducing the above problems, they contribute to adoption of agroforestry practices to solve any of the problems.

Nair, (1993) added that a number of factors have contributed to a rising increase in agroforestry since the 1970s and these are deteriorating economic situation in many developing countries, increased deforestation and scarcity of land because of population pressures, interest in farming systems, intercropping and the environment.

4.3.4 Adopted Agroforestry Practices

Agroforestry practices in the study area are the basis of this study. The researcher therefore wanted to find out the adopted agroforestry practices among the respondents. 96.5% had adopted boundary planting, 90% homestead tree planting, 86% live fencing, 81% wind breaks, 76% practiced mixed cropping, 50% animal manure, 2.5% fodder trees and 2.5% trees for soil conservation (Table 4.5).

Table 4.5: Responses on Agroforestry Practices Adopted by Respondents

Agroforestry practices	**Frequency Yes N=200**	**Percent 100%**	**Frequency No n=200**	**Percent 100%**
Boundary planting	193	96.5	7	3.5
Homestead tree planting	200	100	0	0
Live fences	172	86	28	14
Windbreaks	30	15	170	75
Trees in crop land	152	76	48	24
Fodder trees	5	2.5	195	97.5
Trees for soil conservation	5	2.5	195	97.5
Animal manure	50	25	150	75
Alley cropping	4	2	196	98

***NB**: This is a multiple response and each variable is out of 200(100%)*

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Nair, (1993), also indicated that there are different types of agroforestry practices that can be used, these includes improved fallow, taungya (systems consisting of growing annual agricultural crops along with the forestry species during the early years of establishment of the forestry plantation), home gardens, alley cropping, growing multipurpose trees and shrubs on farmland, boundary planting, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pastures and apiculture with trees.

The different types of agroforestry technologies have been found to address specific human and environmental needs. From the study results, choice of agroforestry practice to adopt is influenced by problems experienced by farmers (Mutambala *et al*, 2012). Emtage and Suh (2004) investigated the socioeconomic factors affecting smallholder tree-planting and management intentions in four communities of Leyte province, the Philippines. They found the primary purpose was to meet household needs for timber, house construction materials, and other household consumption. They argued that household circumstances, rather than community circumstances, are more important influences on tree planting and management activities. This would explain the high rate of boundary tree planting, homestead tree planting and trees in crop land and the low rate of fodder trees, trees for soil conservation and alley cropping in the study area. , However, study results indicated that farmers adopted certain agroforestry practices for various reasons and to solve many problems at a go.

Boundary planting was the most commonly adopted agroforestry practice (96.5%) in the study area to maximize the limited land space and solve fuelwood and soil erosion problems. Therefore, trees are planted at the unexploited areas of the land.

Study results indicated that all the respondents had planted trees in their homesteads. Tree growing in homesteads is a very common practice in most parts of Kenya (Tengnas, 1994).and the reason given was that homestead tree planting provides the basic needs to the households, firewood, shade, fruits, and at the same time saves time for fuelwood collection.

Live fences are long lasting and can perform several functions on the farm among them control soil erosion and animal movement, deter animals, can be used for firewood, and beautification. Lantana camara, kie apple and finger euphorbia are the most commonly used trees and shrubs in live fencing. Only 15% of the respondents reported planting windbreaks in their farms to prevent crops, houses and to act as animal sheds and prevent them from being destroyed by wind. Trees in crop land were practiced by 76% of the respondents. Trees (*makhamia lutea*, croton,) are mixed with food crops such as (cassava, maize, millet, groundnuts, and sweet potatoes) due to their properties (their leaves act as mulch for crops and they take long to grow big).

Animal manure was used by 25% of the respondents to enrich soil in their farms and they got it from their own animals. Despite this, the study found out that animal manure from the respondents was not enough to improve soil fertility and therefore inorganic fertilizer was commonly used and animal manure was only removed when the animal shed needed to be cleared.

However, the study found out that fodder trees and trees for soil conservation were the least adopted among the respondents. Leucaena tree was planted by 2.5% of the respondents for fodder and mulch. Reasons given were that Leucaena produces seeds which sprout forming dense thickets which are hard to remove and this reduces land for other crops. In fact, all the farmers have abandoned it for the above reasons. These results are in line with those of ICRAF (1995) which indicate that Leucaena has been reported as a weed in over 20 countries.

According to the Global Invasive Species Programme, the problem is that Leucaena sets seed and spreads by itself, forming dense thickets. This makes land inaccessible, and sometimes threatens areas of natural indigenous vegetation, full of rare plants that grow nowhere else. Because the tree resprouts from cuttings, the thickets are very hard to remove. In an attempt to bring this weedy tree under control, the South African government has introduced an American beetle, which feeds on Leucaena seed. Because Leucaena is a good fodder plant, farmers often have mixed opinions about efforts to limit its spread. Most of the farmers said that they do not plant fodder trees but mainly plant nappeir grass which is viewed by many as the best fodder for animals and can also act as a catch crop (ICRAF, 1995).

4.3.5 Location of Trees on the Farm

Location of trees on the farm is an important factor in understanding how trees are planted in relation to crops. From the results shown in figure 4.1, 96.5% of the respondents planted trees along the farm boundary, 76% planted trees on crop land, 86% as live fences, 2.5% in woodlots, 5% in pasture land and 100% in homesteads.

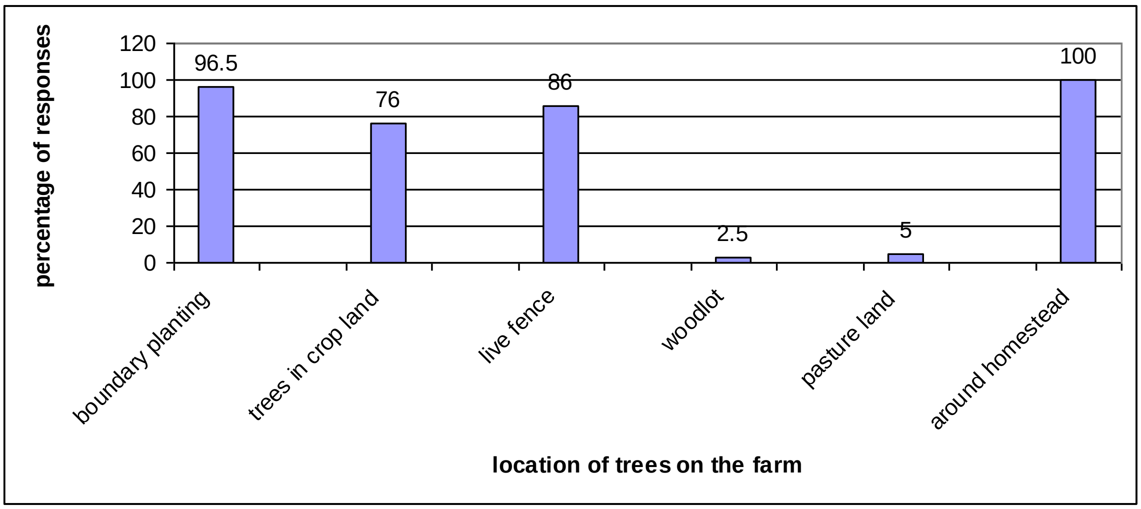

Figure 4.1: Location of Trees on the Farm

Source: Field Data, 2011

From the results, majority of the respondents had trees planted in their homesteads (100%). Tree planting in homesteads is a traditional practice among the luhyia community. For example makhamia lutea (*Olusiola)* was a sacred tree and was planted in an open area directly to the main house (Barasa, 2011). From the study, it was found out that trees marked a home and trees fulfilled many needs of a household. Some of the reasons given included trees providing shade for people during the day when was hot, it is a good reception place for visitors and a good place to relax when charting and also when doing domestic chores, meals were also taken from outside under a tree especially among children and provision of fruit trees.

Tree growing in homesteads is a very common practice in most parts of Kenya. Spatial arrangements vary, but mostly the trees are scattered and of many different species. Homesteads have other specific advantages for tree growing. They are near where people live and thus can easily be looked after. The harvest of products is accessible to all family members, e.g. fruits can be picked even by small children who otherwise do not go very far away from their houses. Proximity is also an advantage from the point of view of labour since even short periods between other work can be used to work in the homestead. The homestead is well suited for production of fruits and nuts, for example, and such valuable production should be given priority in the homestead. Shade and ornamental trees are also important (Tengnas, 1994). Salam *et al*. (2000) also linked tree planting, particularly homestead agroforestry to improvement of overall household income and alleviation of rural poverty Trees also provide poles for putting clothe lines and shade for the livestock present in a homestead.

Boundary planting is also a common practice among the respondents (96.5%). High boundary planting was also reported in Central Kenya (Githiomi *et al.* 2012). Traditionally, boundary tree planting was done to mark demarcation between sub-clan lands (Leakey, 1997). Githiomi *et al* (2012) observed that the practice has been adopted even when dividing different cropping systems in the same farmland. Boundary areas are unexploited and making them common areas for planting trees if land is small or has been allocated to other crops. Internal boundary planting involve trees planted within the farm to subdivide land into portions for easy land allocation to different crops and users of the farm while external boundaries marked the size of ones land and separated different land owners. Sisal and euphorbia tree are the only traditionally accepted boundary markers among respondents in the study area. However, other Grevillea tree species was also common as a boundary marker as long as coppicing is done to reduce crop shade

Fencing is an old culture in any community and more so among the Bakhayo people. Most of the respondents (72.5%) reported to have fenced their homesteads and or their farms. Live fencing was a common practice among the respondents where live trees were used as poles for holding barbed wire. The favorite tree for live fencing was *cassia spectabilis* which is known to be ant resistant and anti termite and therefore acts as a permanent pole for fencing. Fencing also played a role in providing only one entry route to the homestead or compound. This was said to ensure that everyone one who comes in to the homestead is easily spotted, and also to avoid intruders. Fencing also confines livestock to the homestead reducing chances of getting lost, being stolen or destroying crops. Fencing is also done near the farm boundaries to prevent crops from being stolen, livestock from destroying crops or trespassers.

Only 2.5 % of the respondents reported to have woodlots in their farms. Study results revealed hat people (98.5%) do not have woodlots because woodlots require trees to be planted together and therefore would require more space allocation in the farm. Those who had woodlots stated that they planted them on non productive parts of their farms which were either waterlogged or landlocked and were not fit for food crops. Woodlots planted in the area were mainly of eucalyptus for timber and pole production to generate income.

Those who planted trees in crop land mainly intercropped them with bananas, maize or cassava. Among those who intercropped trees with crops said that this happens where some portions of land are less productive and therefore trees are planted to occupy space incase the food crops do not do well.

4.3.6 Common Tree Species Planted

Farmers were asked to list tree species they planted on their land. All the respondents ported they had planted grevillea in their farms, 40% had eucalyptus, 60% had planted makhamia lutea, while 75% had planted *cassia spectabilis* (figure 4.2).

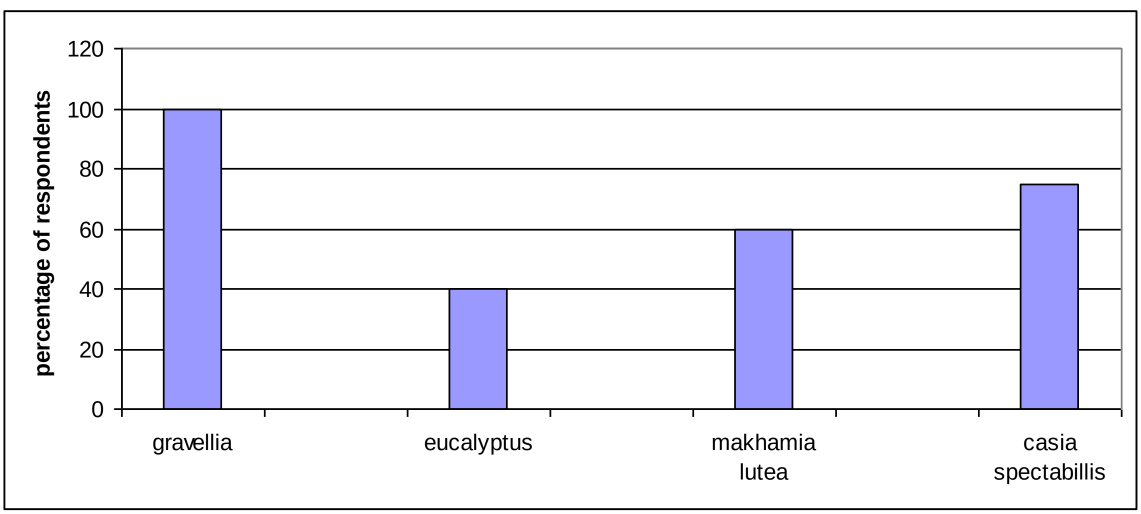

Figure 4.2: Common Tree Species Planted

Source: Field Data, 2011

From figure 4.2, Grevillea was the most planted tree species as reported by respondents. Similar results were reported in Central Kenya (Githiomi *et al*. 2012) and by Hiromi (1999) who stated that grevillea is a highly planted species in Bonga village Tanzania. Grevillea is known to mature faster after around 3 years and is therefore sold as building poles, does not break easily and therefore can be planted in homesteads near houses, does not harbour insects and hence suits any part of the land, and also has a lot of branches for firewood. It is worthy noting that most of the respondents reported that grevillea does not make soil infertile and therefore can be intercropped with crops as long as coppicing is done during cropping seasons. This is in line with a study done in semi-arid Kenya found that farmers preferred *G. robusta* for planting with crops as it was a relatively fast growing species and did not compete too much with other crops for water.(Tefera *et al* 1999)

The findings of the study also agreed with Franzel *et al* (1995) who indicated that Grevillea was ranked as the most compatible with other crops. However, a study done in Burundi indicated that that grevillea was the second most preferred species after *Maesopsis eminii*. But farmers were also willing to test grevillea on their own farms (Franzel *et al.*, (1995). Oginasoko *et al.*, (2006) carried out a study on the status of indigenous and exotic species in Eastern and central Kenya and found out that there were about 200 grevillea trees per 0.50 ha. farm in the cotton zone of Meru central district and was used as boundary tree A study by Tyndall and Franzel (1998) looked at *Grevillea* as a boundary tree on maize and beans farms in Kirinyaga district Kenya, was the most important for coffee shade (Baggio *et al* (1997) and yielded the highest returns per household. (Carsan and Holding 2006)

Casia spectabbillis was the second common planted tree specie. This was because its poles are anti termite and planted by people (75%) along farm boundaries, fences and was used building traditional houses

Makhamia lutea is preferred by people as a homestead tree (60%) for shade. This is a common tree in the study area and is known to grow naturally.. *Makhamia lutea* was intercropped with crops because it takes long time to mature and does not grow tall as such hence does not give shade to crops. This is in line with a It is the most commonly used tree in homesteads for making traditional chairs and building traditional houses because it bends easily and also produces many coppices. It is also used for charcoal making because it is a hard wood.

Eucalyptus was the least commonly planted tree among the respondents (40%). However, it is planted in established woodlots for sale as poles. Contrasting results were observed in Central Kenya where, Eucalyptus species were the second preferred species due to their fast growth with coppicing ability and also being a good timber species. Similar observation was also reported in a study done in Kilosa District, Tanzania where another agroforestry species Senna spp were the most popular followed by Eucalyptus species (Aalbaek, 2000). An earlier study in Kakamega district in Western Kenya also found Eucalyptus tree species to be the most preferred species within that district due to similar characteristics (Van Gelder and Kerkhof, 1984). Eucalyptus has also been reported to have over 20% returns to investment by farmers in Northern Ethiopia which makes it economically viable to plant (Jagger and Pender, 2003). However, it is not preferred in the study area because it is believed to make soil infertile affecting crop production.

According to Kenya Forest Service, (2009), Eucalyptus spp is known to exudates allelopathic chemicals that inhibit undergrowth regeneration while planting Eucalyptus on farm and along road reserves, ensure that the trees are planted at least six (6) meters from the boundary. In view of this requirement, planting of Eucalyptus in land sizes of less than quarter (1/4) of an Acre is not recommended. Planting, near buildings is not recommended as branches/stems of some species break off easily. However, those who plant it appreciate its high economic returns in the study area.

4.3.7 Number of Trees on the Crop Farm

The researcher also wanted to find the number of trees on the crop land of the respondents. Asked how many trees they have planted on their land, 30(15%) respondents had < 10 trees, 160(80%) had 10 -30 trees while only10 (5%) had over 30 trees.

Table 4.6: Approximate number of trees planted on respondent's crop land

Responses	Frequency	Percent
<10	30	15.0
10-30	160	80.0
>30	10	5.0
Total	200	100

Table 4.6 shows that, majority of the respondents had 10-30 trees on their crop land. Study results indicated that location of trees, crops grown and size of land influences number of trees in a farm. Farmers make decisions of how many trees to plant depending on crops they plant, tree species and land size. Farm size was one of the variables that were found to be statistically significant in explaining the size allocated to planting trees. As the size of the land increases, the acreage allocation to tree planting increases. Farmers with large farm size will spare larger portions of land to plant trees compared to their counterparts with small parcels of land (Kinuthia, *et al*., 2011). Table 4.14 shows results of how land influences number of trees.

4.3.8 Livestock Keeping by the Respondents

Despite the fact that Bakhayo people are an agricultural community, most of them keep a variety of livestock at their farms to supplement crop husbandry. Livestock keeping is one of the various modes of livelihood that is also important in the understanding of a people's way of life in relation to the practice of agroforestry. However, what is important for this study is whether the respondents keep livestock or not, and if yes, for what purpose are these livestock kept. Out of the 200 respondents, 157 (78.5%) keep livestock, while the remaining 43 (21.5%) did not have livestock. The types of livestock kept 2 had grade/cross cattle (1.3%), traditional/indigenous cattle (40.1%), goats (5.1%), sheep (2.5%), pigs (0.6%) and a combination of more than one species of animals (50.5%).

Table 4.7: Animals Kept by the Respondents

Responses	**Frequency N=157**	**Percent**
Grade/ cross cattle	2	1.3
Traditional cattle	63	40.1
Goats	8	5.1
Sheep	4	2.5
Pigs	1	6
A combination of more than one type of animals kept	79	50.3
Total	**157**	100.0

Table 4.7 indicates that goats, sheep, poultry and pig were the common animals reared in the study area. Similar results were reported that agroforestry systems in Busia District are integrated with livestock, particularly goats, birds, cattle and sheep (Basamba *et al,* 2012). Traditionally, the Bakhayo people kept cattle and goats for various reasons. According to one of the key informants, cattle and goats were used as the main object in bride wealth. For instance, a certain number of cattle would be given to the bride's family plus a he-goat. The he-goat was customarily used as a seal of the covenant between the two families.

Cattle are also slaughtered in any feast or family functions especially those concerning rights of passage like during birth, weddings, funerals and other importance ceremonies. Among the Bakhayo and by extension the Luhyia, a bull is slaughtered during the funeral of a married man with children and a cow for a married woman with children. The number of animals killed and even the size is very important in symbolizing how big the occasion was or how important the person was in the community. Goats and sheep are also vital especially for ritual purposes. For instance, one would pay a number of goats or sheep as a fine for contravening some of the taboos of the community.

However, key informants interviewed cautioned that due to changes that have been taking place in our society and the integration with other communities, most of these functions for which the animals were kept for have been either transformed or even completely changed in some of the cases. For instance, a key informant cited the introduction of the monetary economy as having transformed the payment of bride wealth in terms of cattle to money or both. He noted that today, most people keep livestock for financial security in that they can dispose them at any time when they are financially strained, and get cash or even use them as a security to get one or two things done for them. All the 157 respondents who kept livestock alluded that livestock belonged to men who make decision on when to dispose the animals and animal products and for what reason. However, women would look for customer to buy milk while men take the income or decide on how the money will be spent.

The Bakhayo people are associated with poultry and more specifically chicken. Chicken is valued in the community and it is slaughtered for a special visitor and any occasion must have chicken as part of the food. It was found that all the 200 homesteads had reared traditional chicken. From informal discussions held, it was found out that the poultry and chicken in particular belonged to women and children in the homesteads.

These findings are consistent with Bradley, (1993) findings in western Kenya that large animals were the domain of men and unmarried boys while women owned and cared for poultry and only men took animals to market. Women keep chicken to slaughter to a visitors, to give it as a token of treasure to visitors when they are leaving the homestead and for food security incase there are vegetables especially during the dry season. Chicken also fetch a lot of money especially during any festive season because many people in the community believe in eating chicken during that time.

One of the respondents contended that a cock cost around Ksh 700 during the festive season Easter or Christmas, and therefore money from sale of chicken supplements other sources of income. Most of the respondents reported that chicken are also sold for emergency and mostly to pay school fees when there is no other source of income. Therefore, animals act as a living bank in homesteads and are disposed when money is needed.

4.4 Farmer Factors that Influence Adoption of Agroforestry

4.4.1 Household Headship

During data collection, the study focused on the households but more specifically, interviewed one of the spouses that were available, and if all were around, the one that was ready to respond on behalf of the rest was given the chance. Results reviewed that out of the 200 respondents interviewed 187 (93.5%) reported that the husband was the household head, while 13 (6.5%) stated the wife was the household head. From table 4.8, husbands were the household heads in the sample population. For the 13 respondents that had the wife as the household heads, these were widows whose husbands had died

Table 4.8: Household head in the sample population

Responses	Frequency	Percent
Husband	187	93.5
Wife	13	6.5
Total	**200**	**100**

Study results showed that the household headship was an important variable in relation to decision making process at the household level, control and allocation of resources, and the general management of the household's affairs which includes land use. Results on household headship and land ownership are shown in table 4.9.

Table 4.9: Household headship and land ownership

Responses			**Who owns the land**		**Total**
			Husband	**Wife**	
Household Headship	Husband	count	187	0	187
		% within household head	100.0 %	0%	100.0%
	Wife	count	0	13	13
		% within household head	0%	100%	100.0%
Total		count	187	13	200
		%within household head	93.5%	6.5%	100.0%

From table 4.9 indicate that, land ownership is related to household headship. 93.5% reported that men are the household heads and the owners of land. These findings are consistent with the fact that the Bakhayo community is a patrilineal and patrilocal community (Ochieng' 1990). In a patrilineal and patrilocal society, land and other property are inherited or transmitted from one generation to the next through the male offspring. Land ownership rights by the male offspring have put men in the forefront of making decisions about land use and also by the fact that men are the household heads in the general management of household affairs. It was found that men made decisions on how land will be used and the use of the land products and in some cases consults their wives for approval which does not change their decision as final decision makers.

Lack of land ownership rights has also affected women as decision-makers and therefore affects their decision to plant and own tree in that land. This affects tree tenure which could partly explain why women in a family where men are the household heads are less involved in tree planting, especially where land ownership dictates tree tenure. Staudt, (1975) indicated that women work on land but with little or no power in decision making on utilization of land resources.

4.4.2 Education Level of the Household Head

The level of formal education is an important variable in any given population. Since it not only influences the demographic but also socio-economic characteristics of the population. The 200 respondents interviewed had varied levels of education. 117 (58.5%) had reached primary level, 54 (27%) had reached secondary level, 16 (8%) had reached tertiary level, while 13 (6.5%) had no formal education (Table 4.10).

Table 4.10: Level of Education of the Household Head

Responses	Frequency	Percent	Cumulative percent
No formal education	19	9.5	9.5
Primary level	105	52.5	62.0
Secondary level	37	18.0	80.5
College level	36	18.5	98.5
University level	3	1.5	100.0
Total	**200**	**100**	

From table 4.10 above, most of the respondents, 62% in the sample population had reached the primary level of education. This manifests a cohort of low educational level among the members of this community, which translates into a semi-skilled labour force that is largely confined to the rural settings. This could explain the choice of agroforestry systems which do not require a lot of knowledge and skills (homestead, boundary, live fence) against alley cropping, improved fallow, woodlot method and other soil conservation agroforestry methods as shown in table 4.5**.** Level of education could also explain why reading materials were the least used sources of information to respondents as shown in figure 4.5 on sources of information**.** Blaug, (1972) asserted that education improves one's ability to capitalize on opportunities. Similar findings revealed that education is positively associated with probability to adopt agroforestry technologies (Masangano, 1996).Table 4.11 shows results of the cross tabulation to show the relationship between education level and number of trees planted by respondents.

Table 4.11: Cross Tabulation Results on Level of Formal Education and the Number of Trees Planted on the Farm

Variables		**Approximated number of trees on land**			**Total**
		<10	10-30	>30	
Highest level of formal education attained	None count % within highest level of formal education reached	13 68.4%	6 31.6%	0 .0%	19 100.0%
	Primary level count % within highest level of formal education reached	24 22.9%	80 76.2%	1 1.0%	105 100.0%
	Secondary level count % within highest level of formal education reached	4 10.8%	33 89.2%	0 .0%	37 100.0%
	College level count % within highest level of formal education reached	0 .0%	31 86.1%	5 13.9%	36 100.0%
	university level count % within highest level of formal education reached	0 .0%	1 33.3%	2 66.7%	3 100.0%
	Total count % within highest level of formal education reached	41 20.5%	151 75.5.0%	8 4.0%	200 100.0%`

Table 4.11 above shows that there is a strong relationship between education level of the household head and tree planting. This is represented with chi square values((x^2 =81.213, df=8, p=0.000). significant at 0.05 level and therefore a strong evidence that number of trees is related to household head level of education. Household heads education level may influence tree planting. Similar results were observed in Zimbabwe (Mutambara *et al*. 2012). Study results indicated that majority of the farms with <10 trees did not have any formal education or had reached primary level, while those with > 30 trees had

formal education in college or university level. This implied that the more educated the head of household, the more the likelihood that the household will adopt. This is in contrast to the findings by Jera and Ajayi (2008), where they found out that farmer's level of education was not a significant determinant of adoption of technology. However, the findings of the study agreed with Boateng (2008), where the high level of literacy rate would result in increase of technical efficiency and decreased conservationism among farmers.

Men being the household heads and the decision makers, their education as the household head influences decision to adopt agroforestry by helping them to make informed decisions on land use. A study by Bradley, (1993) showed that men cleared fields, but women usually prepared soil, planted, weeded, and harvested. Only men planted trees, although women cared for them. This could mean that if men as the household heads are not educated, it negatively affects tree planting. Education also helps one to interpret and understand extension information and at the same time think logically and critically about agroforestry information. This could help farmers to scrutinize the attitude that trees compete negatively with crops and could be also used as a contact farmer by the extension service providers. Casey *et al,* (2000) indicated that level of educational achievement play significant role in the decision to adopt agroforestry.

4.4.3 Occupation of Respondents

From the results, 8 (4%) of the respondents were public/government employees, 3 (1.5%) were working in parastatals, 140 (70%) were subsistence farmers, 6 (3%) were commercial farmers, 6 (3%) were self-employed, while 37 (18.5%) had a combination of these occupations (Table 4.12).

Table 4.12: Occupation of Respondents

Responses	**Frequency**	**Percent**
Public sector	8	4.0
Private sector	3	1.5
Subsistence farming	140	70.0
Commercial farming	6	3.0
Self employed	6	3.0
Multiple occupations	37	18.5
Total	200	100

From table 4.12 above, it is evident that most of the respondents were subsistence farmers, while only 5.5% of them were in formal employment in private and government sectors. Subsistence farming in this community involves small-scale production of a variety of staple crops and or sugarcane either on the same piece of land or different portions. However, due to the prevailing economic hardships in the study area, some of the households are forced to sell part of their food harvest in order to get cash to meet other household needs. The few respondents that were employed by the government are mainly working at the divisional administration office, within the various departmental offices, as well as at the town council.

For those involved in commercial farming, they mainly grow sugarcane, and most of them devote most of their land and income resources in sugarcane farming. They raise sugarcane both on their farms as well as on leased plots, with the main aim of getting cash profit from the crop. For instance, one of them had over 60 hectares of sugarcane that earn him over 1 million shillings in one harvest. This explains why the number of commercial farmers is small. Majority of the farmers in the study area merged their plots in order to raise a block so as to qualify to be accepted to farm sugarcane which does not qualify them to fall under the operational definition of commercial farming for this study. Farmers indicated that sugarcane does not allow tree planting and with the belief that trees destroy soil and compete with food crops for nutrients, trees are planted in unexploited areas of the farm.

For those that are self-employed, some of them run small business stalls that sell consumer foods, while others do the bicycle *(bodaboda)* transport business. Because of the various factors that affect or limit each occupational category, some of the respondents venture into a number of occupations from time to time. For instance, one has a small business and at the same time he is a transport (*bodaboda)* man or a subsistence farmer. The study also observed that most women do their farming work in the morning hours and then later in the day go to the market places to sell foodstuff, milk, fish products, vegetables, and paraffin among other goods in small quantities. Men on the other had do activities like charcoal burning, brick making and jaggery making which involve tree products and more cash which supports the argument that men have a greater share in decision making towards land use and its products.

The fact that most farmers(70%) were subsistence farmers could explain why tree planting is not yet incorporated in their farming systems because of fear of taking risks having in mind that trees take long to mature and the benefits take long to be realized in terms of food security. Farmers may not be willing to wait for long to get the financial benefits of agroforestry and therefore cannot be relied for household food security.

4.4.4 Land Ownership and its Impact on Adoption of Agroforestry

Land ownership does not only refer to one having the title deed of that land, as the legal bearer of the land but also having the powers to control the use and disposal of the land. Therefore, ownership of land has a bearing on ones productivity, especially in a farming community. From the data collected, all the respondents owned land.

However, for all the respondents, the land sizes varied. 63 (31.5%) respondents had land size between 1-3 acres, 77 (38.5%) had between 4-7 acres, 31 (15.5%) had between 8-11acres, 19 (9.5) had over 11 acres, while 10 (5%) had land but did not know how many acres it was (Table 4.13).

Table 4.13: Land Ownership and its Impact on Adoption of Agroforestry

Responses	Frequency	Percent
1-3	63	31.5
4-7	77	38.5
8-11	31	15.5
>11	19	9.5
Unspecified	10	5.0
Total	**200**	**100**

Results indicate that majority of the farmers (70%) have less than 7 acres which is relatively small given their household size and the fact that most of the respondents are subsistence farmers. The land tenure in this community is in the form of individual land holding. Men being the household heads are the ones that have the title deeds to the household's land, which makes them have both usufractory and disposal rights to it. The implication of individual land ownership and the specific control of land resources by men in this community meant that men make most of the important decisions when it comes to issues of how to use or dispose the household land.

Out of informal discussions, the study found out that some of the men could even sell land without the knowledge of the wives or children. When it comes to decision making on what to plant, the wives would have to consult the husbands before they can know which crop to grow that season. For instance, one of the women said that they did not have sugarcane on their farm because her husband was in town and yet he was the one to approve whether to plant sugarcane or not, a decision he could not have taken when in town without coming back to see the situation on the ground, and also could not be convinced by the wife's justification for the same. This means that women are generally reduced to making proposals whose decisions are ratified by men, and after such decisions, women again implement the decisions by working or managing the farms through provision of labour.

The study wanted to find out whether land size influence tree planting. This is shown in the following cross tabulation. Opio (2001) notes that lack of security of tenure affects establishment of any agroforestry practice. However size of land impacts greatly on farmers decision to plant trees. A study done in Nyeri showed that farm size was one of the variables that were found to be statistically significant in explaining the size allocated to planting trees. As the size of the land increases, the acreage allocation to tree planting increases. Farmers with large farm size will spare larger portions of land to plant trees compared to their counterparts with small parcels of land. Table 4.14 shows results of the relationship between land size and number of trees planted.

4.14: Cross Tabulation Results Between Size of Land and Number of Trees on the Farm

Variables x		Approximated number of trees on land			Total
		<10	10-30	>30	
Size of land (Acres)	1-3 count	28	36	0	64
	% within size of land	43.8%	56.3%	.0%	100.0%
	4-7 count	4	71	2	77
	% within size of land	5.2%	92.2%	32.6%	100.0%
	8-11 count	1	29	0	30
	% within size of land	3.3%	96.7%	.0%	100.0%
	>11 count	4	9	6	19
	% within size of land	57.9%	15.8%	26.3%	100.0%
	Unspecified count	4	6	0	10
	% within size of land	40.0%	60.0%	.0%	100.0%
	Total count	41	151	8	200
	% within size of land	20.5%	75.5%	4.0%	100.0%`

From table 4.14, there is a strong relationship between size of land and the number of tree planted on the farm. represented with a chi square value (x^2 =82.890, df=8, p=0.001). Significant at 0.05 level and therefore a strong evidence that number of trees is related to size of land. Table 4.14 above shows clearly that those with 1-3 acres of land had the majority (43%) with <10 trees on their farm, while those with >11 acres had the majority (26.3%) with > 30 trees on their farm. Therefore, land size had a positive influence on adoption of agroforestry practices. As the land size increases, adoption of agroforestry technologies also increases. Ajayi *et al*, (200l) revealed that land size has a positive correlation with farmers decision to plant improved fallows in Zambia. This could be because farmers with extra land are likely to use it for experimenting new technologies.

Study results are in tandem with what Jera and Ajayi (2008) found that land size has a positive effect on adoption because farmers with more cultivatable land are more likely to set aside a piece of land for fodder trees without impacting much negatively on land available to grow food crops or disturbing household food security. This is in contrast with a study done in Muranga in 1995, which observed that despite the pressure of land, trees were grown in 5 to 10% of the agricultural land (Dewees, 1995). Another study done in Kakamega district in western Kenya showed that 80% of the rural household had planted trees on 25% of their farms despite the small household land sizes in the district (Van Gelder and Kerkhof, 1984).

Study results are also consistent with the findings of Collier *et al.*, (2002) who found out that as parcels of land increases, more land will be allocated to tree planting Mercer, (2004) noted that tree growing awareness through extension services related positively to tree growing in the fields. Study results indicated that there was high awareness on tree growing in Nambale Division, but tree growing was limited by sugarcane farming which does not allow intercropping with perennial crops and more so trees. However, the findings of the study agreed with what was reported in Zimbabwe, Philippines and Ethiopia where land size of household was positively correlated with number of trees planted by individual household (Zenebe *et al.*, 2010). Therefore, size of land limits farmers to certain agroforestry practices which depicts the number of trees planted

4.4.5 Household Decision Making

Respondents were also asked who makes decisions to undertake the various activities on their farms. This question was intended to find out how decision making in a household can influence the adoption of agroforestry practices depending on who makes decisions. Nair, (1993) noted that gender related decision making which is often related to intrahousehold resource allocation is an important determinant of the adoption of agroforestry practices. Figure 4.3 shows the responses given.

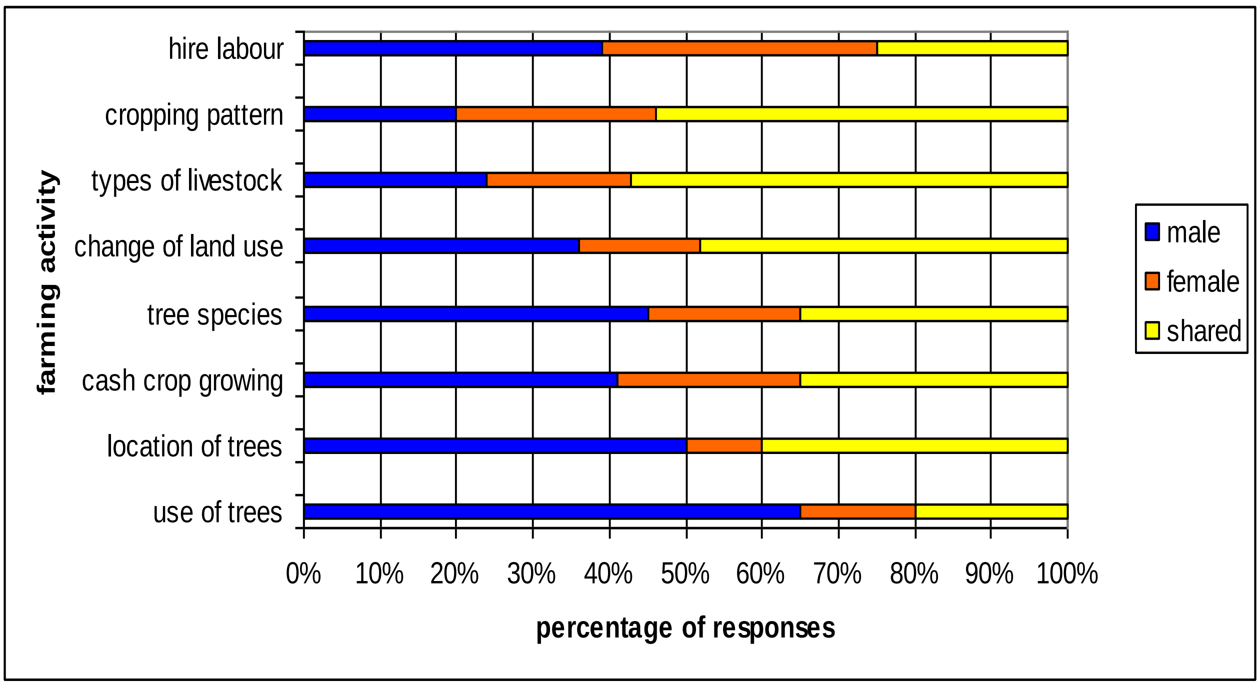

Figure 4.3: Household Decision Making on Farming Activity

Source: Field Data, 2011

Study results indicated that decision to hire labour, choice of tree species, cash crop growing, location of trees and use of trees was majorly done by men. Shared decisions are made on cropping pattern, types of livestock and change of land use and mainly because in involves food security of the household which needs the contribution of woman of the household. Similar results were recorded in Ukambani where 65.5% of the decisions were made by men, 21.1% were shared decisions and only 14.4% were done by women (Nair ,1993).

Abbas, (1997) noted that women's decision making power in household is limited to by products of men's trees and subsistence crops that have low cash returns on labor and women have obligations to provide labor for male controlled fields. The study results are in line with Nair, (1993) who indicated that in western Kenya, the general understanding among the Luhyia community, for instance, is that the husband as the head of household has the overall control of the household resources and in that capacity everything in the household is viewed as belonging to him. A study done among the Akamba indicated that men as the heads of households are the main decision makers on matters of tree planting. In Malawi, decisions on harvesting of tree products was dependent on the part of the tree: women's influence on harvesting decisions decreased with corresponding increases in men's influence in decisions moved from twigs to the trunk (Nair, 1993).

Decisions on labor had nearly 1:1 ratio between men and women making individual decisions and considering that hiring labour is cash based, a role associated with men, the study found out that labor was divided depending on the work to be done.

Men made a sole decision to hire labour towards cane farming which required more cash, while women made a sole decision to hire labour for other crops apart from sugarcane. Results indicated that many women belonged to farmer groups and therefore had ready labour from the members of the groups who organize to provide labour to each group member at different days

Study results indicated that choice of tree species to be planted in the farm was a male issue and women would be required to provide labor. Similar results were given by Abbas, (1997). A study done in Rwanda showed that men's knowledge related to big trees such as Eucalyptus, Grevillea and *Makhamia lutea*, the planting and management of trees, introduction of new species and or varieties of trees and decision making aspect related to species choice, placing, timing and harvesting trees for timber, fuelwood or stakes, while women knowledge focused on species identification and naming, utility of the species for seasoning, medicine, love portions and fuelwood qualities (Biggelaar 1996).

4.5 Technical Factors that Influence Adoption of Agroforestry

4.5.1 External Factors Influencing Adoption of Agroforestry

Factors that influenced farmers' decision to adopt agroforestry practices were categorized as external factors because they were subject to external influence. Figure 4.4 indicates that lack of information and land limit influences agroforestry practices more than other factors do. Each of the other factors influence accounts for below 20 percent each.

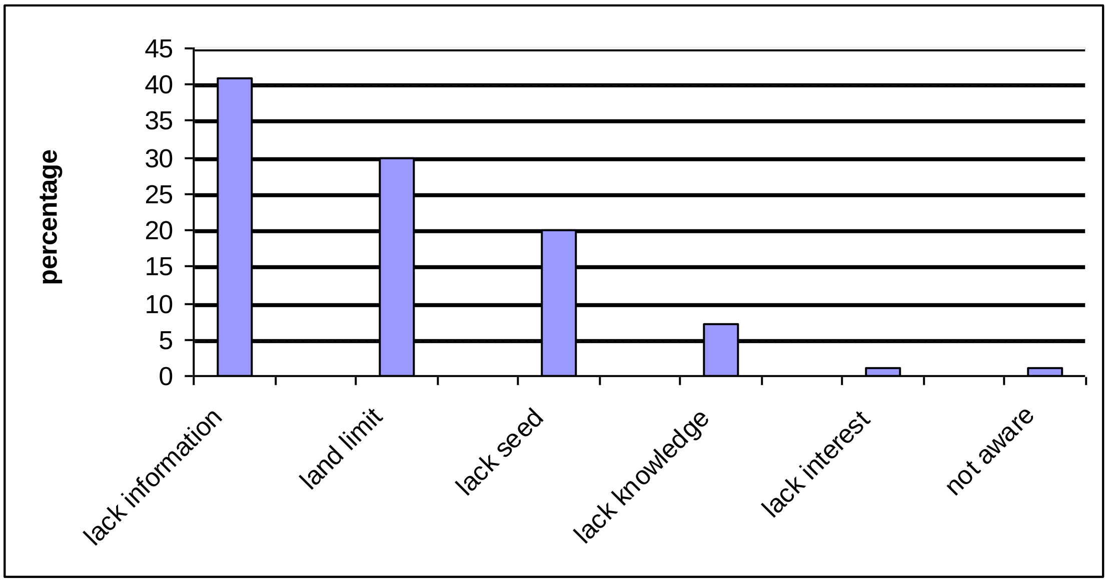

Figure 4.4: Technical Factors that Hinder Adoption of Agroforestry

Source: Field Data, 2011

From the responses in figure 4.4, it can be inferred that the level of awareness with regard to agroforestry technologies was very high and farmers had the interest to plant trees. The number of farmers that identified lack of awareness and lack of interest as factors influencing adoption of agroforestry practices was less than 5% each (Figure 4.4).

Lack of information was viewed as a major factor limiting the adoption of agroforestry in the study area. This agrees with Govere (2003) when he noted that although agro-forestry is an age-old practice, many farmers are yet to receive communication about the technologies. The ineffectiveness in communication could have been due to farmers' attitude towards the agro-forestry technologies; they tended to seek information on technologies with immediate benefits that could not be the agro-forestry technologies. In support of this, Ajayi and Kwesiga (2003) noted that for several years, there have been structural shifts towards quick fixes technologies. Place *et al,* (2001) contended that farmers need more information and training for agroforestry relative to other agricultural activities, which limits the spread of some practices.

Studies from several countries in Africa have shown that sustainable land management practices such as agroforestry are not sufficiently known by extension agents and much less likely to be disseminated to farmers (Place *et al*, (2001). This creates an information bias towards other types of practices. Indeed, the transmission of new management practices to frontline extension workers has long been acknowledged as a difficulty, especially in Africa. Some agroforestry practices are knowledge intensive and thus do not diffuse as quickly as other technologies. Part of the explanation for this with respect to agroforestry is that silviculture is the domain of forestry officers and agricultural extension messages emphasize conventional crop husbandry methods. Even where extension agents are trained, they often are understaffed and cannot easily meet the time commitments required to fully train farmers on new farming methods like agroforestry (Place *et al*, (2001).

Study results indicated that farmers do not have the necessary information about some agroforestry practices for soil improvement like alley cropping, fodder trees and improved fallows which would be handy in a food deficit county. Place *et al*, (2001) contended that many recently developed agroforestry systems are novel in terms of management compared with conventional practices which farmers are more familiar with and which they have received training for a longer period and in Africa, much more attention to dissemination of knowledge needed to be given to new practices such as fodder and fertilizer tree systems.

Lack of seed was a challenge among farmers in adopting agroforestry practices. Similar results were reported by Dewees, (1995) where good quality seeds were an important factor in adoption of agroforestry practices. Lack of seed emerged as one of the important reasons for farmers not trialling and adopting both improved fallows and biomass transfer technologies (Kabwe, 2010). According to Ajayi (2007), seed availability, in sufficient amounts and of good quality, constrains the widespread uptake of improved fallows. This would also affect any other agroforestry practices. Farmers in the study area reported that they are willing to try any agroforestry tree species which have been researched and are seen to be compatible with the existing practices. However, they do not get the seeds and the available ones in various tree nurseries are the commonly used tree species like grevillea, eucalyptus, cassia spectabilis. However, they acknowledged that other tree species seedlings are available in the forestry department but at a higher cost than they would have got from local tree nurseries.

The introduction of agroforestry technologies in Zambia started with ICRAF distributing seeds to the interested farmers mostly through extension and farmer groups(Kabwe, 2010). Theses groups were established particularly to promote agroforestry and the members of the groups were called farmer trainers (Kabwe, 2001). The role of the farmer trainers was to receive training from researchers and other technocrats in agroforestry and later train their fellow farmers from their communities of residence. They were also the major distributors of seed. In addition to free distribution of seed by ICRAF through the

Ministry of Agriculture and the farmer trainers, ICRAF also promoted the establishment of group nurseries (Kabwe, 2001)

Kiptot *et al*. (2006) reports similar seed distribution arrangements in Kenya whereby ICRAF collaborated with other research and extension organisations to provide seed to the first generation farmers, i.e., farmers who had direct contact with them. However, farmers reported that such kind of arrangement existed, but farmers gave up when they experienced challenges with Leucaena. However, this could be attributed to mens' reluctance in joining agroforestry farmer groups or such groups do not exist in the study area. Farmers reported to have mixed reactions about Eucalyptus and Leucaena tree species, but they have never been given the right information. This is because even the extension agents seem not to have the right information or agroforestry information is not a priority.

As Place *et al*, (2001) noted, there are references to agroforestry in forest acts in Kenya), but often it receives minor attention with natural forests and plantations receiving the most attention. Thus, when it comes to tree germplasm, there is inadequate attention paid to the needs of farmers and agroforestry trees. Agroforestry is also appearing more in agricultural strategies, but often merely in a list of options for addressing sustainability (Place *et al*, (2001)

Land limit was a factor for adoption of agroforestry because much of the households land is dedicated for cane farming and therefore land left for food crops is used for food crops while tree growing is limited to unexploited areas of the farm. Ajayi *et al*, (200l) revealed that land size has a positive correlation with farmer's decision to plant improved fallows in Zambia. This could be because farmers with extra land are likely to use it for experimenting new technologies. This is in tandem with what Jera and Ajayi (2008) found that land size has a positive effect on adoption because farmers with more cultivatable land are more likely to set aside a piece of land for fodder trees without impacting much negatively on land available to grow food crops or disturbing household food security. Opio (2001) added that lack of security of tenure affects establishment of any agroforestry practice.

4.5.2 Sources of Agroforestry Information

Farmers identified various sources of agroforestry information. Agricultural extension officer was the common source of agroforestry information, followed by other farmer and radio came third. However, the role of agricultural extension officer in providing subsequent information on agroforestry reduced, while that of other farmer and radio increased (Figure 4.5).

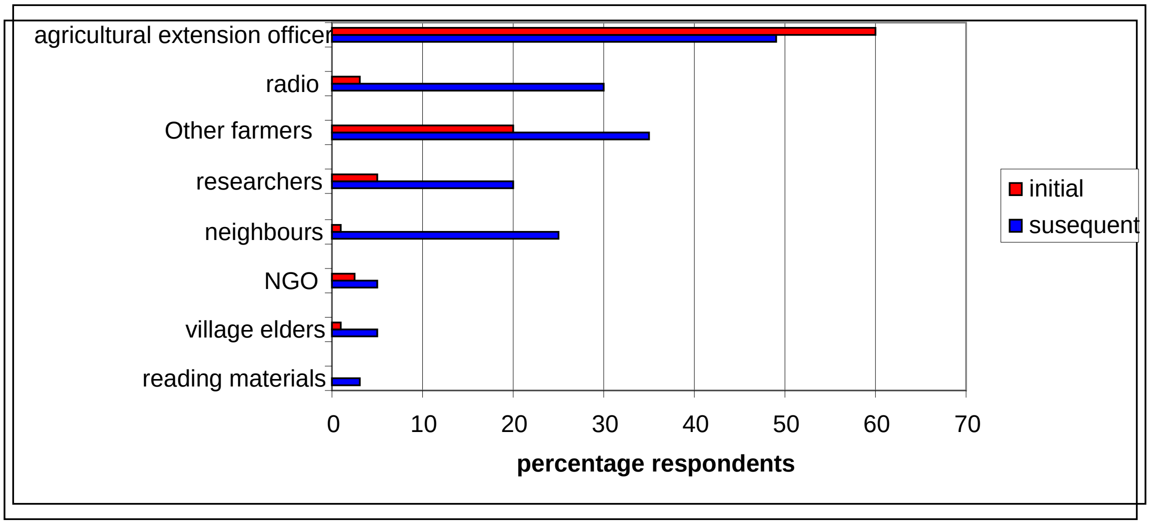

Figure 4.5: Sources of Initial and Subsequent Information

Source: Field Data, 2011

Results in Figure 4.6 indicated that although agricultural extension officer provided initial information on agroforestry, their role in providing subsequent information reduced. Similar results were reported in Zambia (Kabwe, 2010). It would appear that farmers trusted the information that they initially obtained through these technocrats as compared to other forms of information sources and generally, farmer's first contacts on agricultural issues are agricultural extension officers who are trusted as technocrats in this field. However, the situation is such that agricultural extension workers are not also sufficiently trained in agroforestry technologies and lack exposure to the technologies to enable them to confidently promote them amongst the farming communities.

Kabwe (2001) found that some of the extension workers were not confident in disseminating agroforestry technologies since they had not had any other training in agroforestry apart from what they had at college yet college curricula did not keep abreast of agroforestry innovations in the field. In fact, some of the extension officers indicated that research institutions were biased towards exposing farmers to the technologies. In some cases, it was observed that some farmers had been to more research station visits and exchange tours and visits than had extension staff. Some extension staff had not been on any such exposure visits. Place et al, (2001) indicated that even where extension agents are trained, they often are understaffed and cannot easily meet the time commitments required to fully train farmers on new farming methods like agroforestry Part of the reason could be that extension staff are expected to provide service on all aspects of farming and may not see agroforestry as an immediate solution to addressing farm productivity (Kabwe, 2010). .

Extension officers are also faced by other challenges which may hinder dissemination of information. Hedden-Dunkhorst and Mollel (1990) reported on how the unfavourable structures and lack of financial resources, skills and motivation of extension personnel negatively affect agricultural development in Southern Africa. The survey further highlighted the negative perceptions farmers held on extension officers, although they acknowledge the difficult conditions under which they operate. The extension officers are demotivated lacking resources and support (Matata *et al*, (2012). Other findings revealed that extension staff experienced many constraints in their daily operations, such as lack of: transport, spare parts, stationery, teaching aids, fuel and finances (Matata *et al*, 2012) Such findings are supported by the study done by Katanga *et al*. (1999) who concluded that these limitations affected training of farmers on new technologies.

The role of other farmers in providing agroforestry information in the study area was also rated among the common disseminators of agroforestry information. Other farmers are also considered as farmer trainers and are members of a farmer group in the study area. Similar results were reported in Tanzania, where 76% of the farmers felt that farmer trainers were more effective than government extension staff in disseminating improved fallows (Place *et al*, 2001). Other similar results indicated that trained and experienced farmers are currently considered for agroforestry information dissemination. The greatest strength of farmer trainers is their ability to try out technologies with farmers that is effective in technology promotion. Farmer trainers have become more convincing to farmers than extension staff.

In a monitoring exercise in Uyui district, it was observed that farmer-trainers who had prior experience of planting improved fallow on their own farms had influenced more farmers to plant fallows compared with newly trained farmers, this was noted by Katanga *et al.* (1999). They can reach more farmers as they are widely spread out, even in remote areas where agricultural extension services do not exist. Their word carries more weight than government staff as they live with farmers and speak the same language as their colleagues (Scarborough *et al.*, 1997).

Given the limited number of government extension staff, upscaling has tended to emphasize models that rely on farmers and farmer groups to help disseminate information. The farmers are in turn trained and supported by resource persons that are normally paid by a project or programme (Place *et al*, 2001). This approach is very cost effective, as farmer trainers often train many other farmers (Franzel and Wambugu, 2007). Moreover, those who have been trained, often pass on information. The concern with such an approach is that the farmer trainers are not remunerated well (or at all) and therefore their commitment may be expected to wane over time (Place *et al*, 2001).

Use of local leaders was the least method in the study area since they were not seen to hold any valuable information on agroforestry and were better placed to mobilize people to attend meetings.. This is in line with a study in Tanzania which revealed that While farmers appreciated the involvement of local leaders in decision-making by virtue of their authority over the land, their role as disseminators was considered less effective (Matata *et al*, 2012).

4.5.4 Access to Extension Services

Farmers were asked about their contact with extension services. The proportion of farmers that did not visit the extension officer/station and did not receive any extension visit was high 62% and 59% respectively, 38% visited extension and 41% received extension visit as shown in figure 4.7.

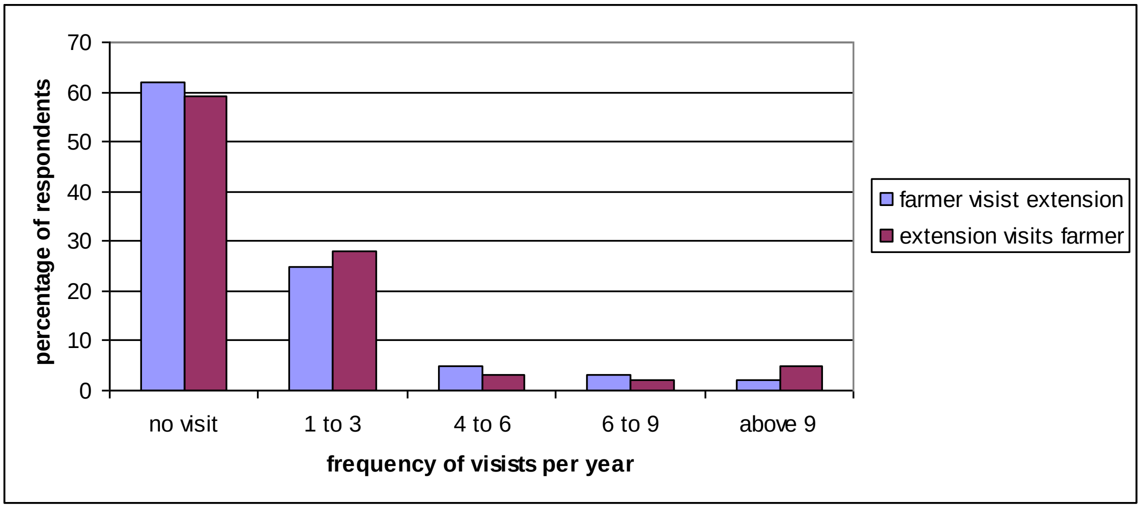

Figure 4.7: Frequency of Extension Visits Per Year

Source: Field Data, 2011

Those who received extension visits were mainly in groups and those who visited extension were individuals. National Agricultural Sector Extension Policy(NASEP) (2007) affirms that extension providers are required to promote demand driven and beneficiary led selection of technologies; encourage formation and working with clientele groups based on common interests, resource endowment and agro ecological zones; encourage farmers to form extension groups; training clientele on "farming as a business" as an integral part of service delivery (Republic of Kenya, 2005)..

NASEP policy on funding of extension services says that, services delivered to individuals producing at subsistence level and are not in a group will be provided at a cost to encourage group approach; extension services delivered to groups of small holders or individuals ,producing at commercial level will be provided at a cost; and extension services delivered to groups of smallholder producing at subsistence level will continue to be free ,however, partial or full cost recovery will be introduced overtime as the enterprise become commercialized. (Republic of Kenya, 2005).

Study results indicated that 160 (80%) belong to a farmer group, while 40(20%) did not belong to any farmer group and were mainly men. Some women belonged to more than one women group and therefore received more visits in their different groups. Men who were in the groups reported that their group activities involved livestock breeding, new crop species, fish keeping, bee keeping and rarely on agroforestry practices. However, a key informant reported that Leucaena was introduced as a soil fertility tree in the study area, but farmers dropped them because the Leucaena trees produced a lot of seedlings forming dense thickets which was a challenge to the farmers. Women groups in the area were mainly merry go rounds or involved agricultural activities and not agroforestry. Therefore, women and men access to agroforestry information was limited by the group activities.

.However, women groups are more organized are mainly used as contact groups for farming by extension providers in the area and therefore the women groups have become multipurpose This has therefore put women at the forefront in agriculture activities mainly for food crops, and since men groups are not well organized, , getting information about cash crops which includes tree planting becomes a problem. This is because the provision of extension services to clientele groups is demand driven (Republic of Kenya, 2005) and if tree planting is not a demand in those farmer groups, it is hard for it to be discussed. Since men who are mainly interested in tree planting are not in groups as it was established, information, knowledge and skill on tree management is limited and therefore tree planting remains under subsistence farming with low production of tree products.

Flower, *et al,* (2005) contended that membership and involvement in local organizations has previously been found to have a positive relationship with the adoption of agroforestry. A study done in Nigeria on willingness of farmers to pay for extension services indicated that 43% were willing to pay for extension services providing information on women activities, 33% on advice on agricultural problems, and 8% on learning new ideas in agriculture, 16% on providing specialized information for production and 34% on liason with farm machinery (Oladele, 2008). This could mean that farmers are not still informed about productive agroforestry practices and therefore are not willing to pay for any new idea, but are willing to pay to upgrade what they already have. This could also be limited by the size of land which is already occupied with sugarcane for majority of farmers (55%), and therefore a new idea will not have space for implementation. According to Rogers (2003), “getting a new idea adopted, even when it has obvious advantages, is difficult”

Flower, *et al,* (2005) noted that membership and involvement in local organizations has previously been found to have a positive relationship with the adoption of agroforestry. The study found out that most of the respondents who visited extension wanted to get first hand information on a new crop variety or to enquire about any new development in agriculture and afterwards, they rely on other sources for information since getting extension service as an individual has become expensive. Farmers raised sentiments that nowadays, field visits and demonstration farms are no longer there but farmer to farmer contact is highly used. Kiptot *et al*. (2006) suggested that scaling-up of extension programs in Kenya is dependent on using farmers as principal agents-of-change

4.6 Community Factors that Influence Adoption of Agroforestry

4.6.1 Factors that Encourage Agroforestry

Despite the fact that land use is an individual decision, the way of life and a common practice among members influence decision on land use which influences tree planting. When asked whether there is a common practice which encourages agroforestry and tree growing in the area, 100(41%) said that trees mark a homestead, 50(25%) said that firewood has become scarce, while 68(34%) said that there is high market for tree products (Table 4.15).

Table 4.15: Community Factors that Encourage Agroforestry

Responses	**Frequency**	**Percent**
Trees are associated with homesteads	82	41
Demand for firewood	50	25
High market for wood and charcoal	68	34
Total	**200**	**100**

Tree growing in homesteads is a very common practice in most parts of Kenya (.Tengnas, 1994). Spatial arrangements vary, but mostly the trees are scattered and of many different species. Homesteads have other specific advantages for tree growing. They are near where people live and thus can easily be looked after. The harvest of products is accessible to all family members, e.g. fruits can be picked even by small children who otherwise do not go very far away from their houses. Proximity is also an advantage from the point of view of labour since even short periods between other work can be used to work in the homestead. The homestead is well suited for production of fruits and nuts, for example, and such valuable production should be given priority in the homestead. Shade and ornamental trees are also important (.Tengnas, 1994)

Study results indicated that trees especially Makhamia lutea (Olusiola) is culturally associated with homesteads and is planted outside the main house among the Luhyia community for ceremonial purposes. However, other multipurpose tree species like grevillea which mature early than the makhamia lutea and have broad market are being planted near houses. Trees around homes play a significant role in providing serene environment. Demand for firewood has continued to increase being the only cheap source of energy to most households in Kenya. Firewood sources have reduced with natural forests shrinking and the government putting astringent measures on exploitation of natural forests. Fallow land which had trees have been occupied with sugarcane where any intercropping or mixed cropping is not allowed in the cane farms.

To find out the demand of fuel wood in the area, respondents were asked their source of energy. All the respondents, 200(100%) said that they use woodfuel as their main source of energy and despite the fact that some said that they use charcoal in exchange with woodfuel, and firewood is the raw material for charcoal making. Firewood as a source of energy have become scarce and in-fact one of the respondent said that they use a mixture of cow dung and soil due to lack of firewood. The respondent had planted 19 tree seedlings near the land boundary 5 months before the research because the household has struggled to get firewood for its use. The researcher also observed that, Lantana camara stalks which have grown along most of the roads have been used as firewood by many people in the area since they are available as wild shrub.

Market for timber and charcoal has also been pointed to encourage tree growing in the area. From the study, farmers used their trees domestically: For individual use to make modern houses than buying expensively from their neighbours or sell to neighbours and traders who come to their farms. Trees are sold to any willing buyer at an agreed price. Government policy on timber trade has discouraged many farmers to produce tree for external markets and therefore poor management of trees.

4.6.2 Factors that Discourage Agroforestry

The study also wanted to find out what may be limiting farmers from adopting certain agroforestry practices in the area.120(60%) of the respondents blamed sugarcane farming for low adoption of agroforestry practices, 30(15%) blamed lack of tree tenure, while 50(25%) said that belief that trees compete with food crops limit tree planting.

Table 4.16: Factors that Discourage Agroforestry

Responses	**Frequency**	**Percent**
Sugarcane farming	80	60
Tree tenure	70	35
Trees competition with food crops	50	25
Total	**200**	**100**

From table 4.16, most of the respondents,120 (60%) said that sugarcane farming has taken a bigger portion of their land limiting the remaining land to food crops only and therefore other farming activities including tree planting is seen as a waste of land which could be used for food crop production. Study results indicated that sugarcane farming which is the major cash crop is not allowed to be intercropped with other crops apart from legumes and specifically beans and yet it takes a larger portion (48%) of respondents land.

Tengnas, (1994), indicated that Sugarcane is strongly light demanding, so intercropping trees and sugarcane cannot be recommended when sugar cane is commercially grown. Sugar-cane growing areas are often those where severe shortages of wood are experienced, so establishment of woodlots and intensified tree growing around homesteads are recommended to meet the needs for wood. However, Tengnas, (1994) further noted that under small-scale irrigation in the Kerio Valley sugar cane is sometimes grown with *Ficus sycomorus* and *Acacia tortilis*. Therefore, tree species that can be compatible with sugarcane growing in the study area should be provided

Trees are believed to compete with food crops (50(25%) in terms of land space and soil nutrients reducing crop yield. Tree planted together with crops are believed to compete with crops for soil nutrients and therefore reduce food crop production. This makes people not to intercrop trees with crops and therefore trees are planted on the unexploited areas of the farm like near boundaries and in homesteads. Eucalyptus trees is believed to completely make soil infertile and therefore are planted in woodlots and not near crops.

Tengnas, (1994) indicated that competitive trees like *Eucalyptus* spp. may not be accepted by the farmers even if they are fast growing and have valuable production.

Trees compete with crops in terms of land allocation and are believed to reduce space for crop production and therefore intercropping tree with crops is not commonly practiced by the community. Leucaena tree for soil fertility was initially adopted by some of the respondents but later neglected because it is believed to produce a lot of tree seedlings when planted as hedge therefore reducing space for crop production. Uprooting the Leucaena seedling adds labour to the farmers and therefore its perceived disadvantages limit their inclusion in the farming system of many farmers. According to Tengnas, (1994) Leucaena definitely qualifies as a weed in certain situations and in warm areas with sufficient rainfall, Leucaena spreads very effectively if it is allowed to produce seeds, and thus it adds to the weed flora in fields. He further noted that along the Kenya coast the spread of Leucaena has been very conspicuous.

Most of the respondents practice monoculture and therefore trees are likely to be neglected or are planted on the unexploited areas of the land. Trees provide shade to crops if not well pruned and especially grevillea which leads to conflicts among neighbours. One of the farmers said that a neighbour threaten to cut his trees claiming that they shade his crops reducing crop production. This also limits tree planting to internal boundaries limiting the number of trees.

Tree tenure and gender was also blamed 30 (15%) for limiting trees on crop land and adoption of certain agroforestry practices. Land ownership and land rights dictate and limits land use. The situation regarding tree tenure and gender varies in different parts of the country: in some areas tree planting is clearly dominated by men (justified by the fact that men are the owners of the land), and trees are markers of ownership (Fortmann, 1985). In many African communities, land use is decided by men who are the household heads and owners of land. Therefore, tree planting being long-term and involving land use is controlled by the household head. Women and children can only plant trees on permission from the household head and can only own the trees by association but cannot decide on when to cut the trees and how to use the tree products.

The planted trees can only be used when they are still on the farm for woodfuel in the household but cannot be cut without permission from the household head who are men. This therefore limits tree planting by other members of the family who may be willing to plant trees for their own benefits. In Kakamega a lack of women's participation in tree planting is sustained through various taboos and beliefs. Examples are beliefs that if a woman plants trees her husband will die, or that she will be barren. Since traditionally childbearing is the only guarantee of stability in marriage, no woman would dare plant trees for fear of becoming barren (Tengnas, 1994). Similarly the life of a widow is difficult and no woman would plant trees if doing so is seen as a threat to her husband's life. Older women who already have the number of children they want can, however, plant trees and often do so (Chavangi, 1989). However, with modernization, these taboos and prohibitions are overtaken by events and as Ipara, (1993) reported, of the 25% who braved and planted trees in Western Kenya, non reported receiving any repercussions

Tree is a valuable resource especially nowadays where tree products are on high demand and income from trees is higher than other crops. One of the key informants from the Kenya Forest service said that they have witnessed conflicts among members of the same family fighting over ownership of trees especially after land is subdivided or when the parent who was the household head dies. Women who belong to women groups/farmer groups are advised on how to intercrop trees and crops but they cannot make sole decision to implement and they resolve to limit their implementation to food crops and some animal only.

4.8 Benefits of Agroforestry Practices

This study sought to find out whether people understand and are aware of the benefits of agroforestry. Agroforestry has a "proven or perceived ability to meet the following needs: product diversification, environmental impact mitigation, land rehabilitation, land use conversion (from annual to timber crops), increased or decreased food production, sustainable use or retirement of marginal or fragile land, habitat enhancement, and aesthetic appreciation." (Buck, 1995) The benefits of agroforestry are usually measured through economic gains and/or improved environmental conservation. To answer this, espondents were asked whether they are aware of the benefits of trees on the farm under agroforestry. It was surprising that all the respondents (100) said that they know the benefits of agroforestry especially the multipurpose benefits of trees. However, the researcher wanted to find out whether there are those who have already realized the benefits directly if they have planted the trees or have directly benefited from the tree products.

4.8.1 Economic Benefits of Trees in Agroforestry

During the study, the researcher observed that trees were an important aspect of agroforestry in the study area. This was attributed to the multiple uses and benefits realized from different tree species by the farmers. The study observed that all the respondents (100%) had trees in their farms, but only (60%) had benefitted from Grevillea, (5%) from eucalyptus, and 1 (80%) from *makhamia lutea*), (3%) form lantana camara) and (75%) from nappier grass (Table 4.17).

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Table 4.17: Economic Benefits of Agroforestry Trees and Shrubs

Responses	Frequency and %	Use	Frequency and %
Grevillea	200 (100)	Poles, timber, firewood	120 (60%)
Eucalyptus	80 (40)	Poles, timber,	10 (5%)
Makhamia lutea	120 (80%	Poles, timber, firewood and home implements	120 (80%)
Lantana camara	24 (12%)	making home implements	6 (3%)
Nappier grass	150 (75%)	Fodder for animals	150 (75%)

The need for timber and poles for construction purposes is one of the most common reasons for people to plant and grow trees in Kenya (Tengnas, 1994). From the table 4.17 all the respondents who planted *makhamia lutea* have realized the economic benefits of the tree species. *Makhamia lutea* is an indigenous tree among the Luhya community which grows naturally and therefore it is taken care off wherever it grows or is transplanted to a better place. Being a traditional and indigenous tree, it has many uses like building traditional houses and chairs because it bends easily, it is a hard wood and therefore preferred by many people for timber and poles and also is commonly used for firewood and charcoal. 80% of the respondents who have realized the economic benefits of Makhamia lutea said that they benefit by saving the cost of buying timber, firewood, poles for their own household use or sell the tree products as timber or poles and charcoal. In fact, Makhamia coppices are the only ones used for building traditional houses and chairs because it bends easily and therefore its demand is high.

Grevillea is the most common planted tree among the respondents. However, 60% have realized the benefits of grevillea specie, while 40% have not because their trees have not matured to be sold or used as timber or poles or have not reached pruning time to get firewood. Grevillea provided poles, timber, and stakes for sale by the farmers to pay school fees or supplement household income in the study area. One of the respondent said that he sold grevillea poles worth Ksh 20,000 as timber and used to pay schools fees for his son. A study done in Kirinyaga District revealed that one hectare with 150 Grevillea trees grown with crops was estimated to give the farmer a net income of KSh 2,800 annually from the Grevillea trees alone (M'Mutungi, 1991)

Eucalyptus tree is believed to be the most lucrative tree specie because it is a hard wood and its poles and timber have a ready market. . One of the respondents said that he had sold poles worth K.Sh400,000 to Kenya power and lighting company which has motivated people to plant eucalyptus on unexploited and unproductive areas of their farms. A study in Vihiga Division, Kakamega District, found out that Eucalyptus wood fetches an average of KSh 210 per cubic metre when the buyer does the harvesting,. fuelwood prepared for sale in small bundles fetches Sh 1,200 per cubic metre, timber fetches Sh 600 per cubic metre and each farmer saved Sh 5,000 annually when he was self-reliant in fuelwood (Gustavsson and Kimeu 1991) Gross-margin calculations showed that growing Eucalyptus was very profitable, with only tea exceeding it. The cash income from Eucalyptus is most important on farms that are less than 2 ha and where other crops cannot be produced on a sufficient scale (Gustavsson and Kimeu 1991) However, the limitation to planting Eucalyptus is its allelopathic characteristics (KFS, 2009).

Eucalypts are commonly grown for poles since they are fast growing, straight, easily split and the wood is reasonably durable. In some areas, where the pressure on land is very high, farmers have, however, started to phase out the Eucalyptus since the trees are regarded as too competitive with crops. In such cases Grevillea is often found to be a good substitute. Grevillea has the advantage of not being very competitive and has timber that is well suited to sawing, hence it has more uses than Eucalyptus (Tengnas, 1994)..

Lantana camara was planted by 24(12%) of the respondents as a live hedge and 6(3%) used lantana stems to make home implements like traditional luhyia basket which is common in every homestead. Lantana grows naturally as a wild shrub and therefore it is not planted by many for economic use, but people get the stems along the road to make the baskets for sale.

Nappier grass is used as fodder and all the respondents who planted it, 150(75%), used it to feed their animals and only bought when it was not enough while others sell the surplus. However the study found out that there are some of the respondents who plant nappier grass for sale because it is the common fodder used by people and therefore there is ready market.

Asked how they use the money they get from the sale of the tree products, those who sell timber and poles said that they pay school fees since the trees are sold when there is no other source of income, while money from firewood, charcoal, baskets and fodder is used to buy food and other uses which do not require a lot of money at once.

4.8.2 Social Cultural Benefits of Agroforestry

Apart from the economic benefits, the study wanted to find out whether respondents plant trees because of their social benefits .All the respondents who planted grevillea, 200(100%) benefitted from shade, 120(80%) who planted *Makhamia lutea* benefitted from shade and 24(12%) who planted lantana benefitted from its use as a fence or ornamental.

Table 4.18: Social Cultural Benefits of Agroforestry Trees and Shrubs

Responses	**Frequency and % of who planted**	**Benefits**	**Frequency and % of who benefitted**
Grevillea Lantana camara Finger euphorbia Makhamia lutea	200 (100%) 24 (12%) 182 (88%) 120 (80%)	Shade for people, animals, house Contain livestock, ornamental Boundary marking Shade for people and animals	200 (100%) 120 (80%) 24 (12%) 120 (80)

Multiple responses given

From table 4.18, grevillea was the favorite tree among the respondents as discussed earlier and its properties (having many branches, matures faster, do not break, is tall and do not harbor pests) makes it a favorite and is planted in homesteads for shade to people and to animals if planted near animal husbandry. It was found out that during the dry period when it is hot, houses roofed with iron sheets are normally hot and therefore visitors are welcomed under a tree. People also take day meals under a tree or relax after work doing other household chores. Grevillea grows tall and therefore makes the houses cool during the day and that is why they are planted near houses. Grevillea has many uses and as Tengnas, (1994) noted, it was very important in Meru during the 1984 drought: it was largely due to Grevillea leaves that the livestock in the area survived. Even during normal years Grevillea is used as fodder in some areas, but it is a poor-quality fodder. He further indicated that Grevillea was originally introduced as a shade tree for coffee and is still the most popular tree in coffee growing areas

Lantana camara is planted by 24(12%) of the respondents as a live hedge to contain or keep out livestock. Lantana when planted closely forms a thick hedge, has small thorns and easily controls animals. Lantana is also planted in the compound in a line and is used to tunboid the compound especially when it flowers hence ornamental. Its other uses include, making baskets and temporary shelters and fuel for cooking and heating (Tengnas, 1994).

Trees also have cultural benefits. *Makhamia lutea* which is an indigenous tree is planted near house traditionally for shade to people and animals. *Makhamia lutea* being a traditional tree is strategically located in homesteads and therefore it is commonly found near houses and near animals grazing or feeding area for shade. From the focused group discussions, Abaluhyia people offered their prayers under a tree they considered very sacred called *Makhamia lutea* (*Olusiola)* and prayers were led by the father of the home. They would ask God for blessings, food and protection from any sufferings. It is also under the *Makhamia lutea (Olusiola)* tree where special prayers were offered for instance if they faced drought, famine or any outbreak of diseases.

These prayers were led by a special elder chosen from other elders and he had to be the most disciplined, straight forward, respected and the one who followed strictly the customs of the community. *Olusiola* was planted in an open area directly to the door of the main house. It was surrounded by three stones, one for the father another one for the mother and the remaining for the children. This place was also used to curse people who had gone against ethics and rules of the tribe and it was done after serious consultations. In situations like prolonged drought seasons, the whole clan would gather under

(Makhamia lutea (Olusiola) in the morning and a sheep slaughtered. It was found out that trees and especially *Makhamia lutea (Olusiola0* is associated with homesteads among the luhyia. Apart from the economic and social benefits, the researcher wanted to find out whether the respondents are aware of the role of trees for environmental benefits.

Other trees which are useful include *Croton megalocarpus and* as Tengnas , (1994) noted, it is commonly used for hedges, especially in Kiambu. It is often interplanted with other trees within a hedge *Euphorbia tirucalli* and *Lantana camara.* When it is very dry, goats may eat the Croton leaves but otherwise the main uses of the leaves are to ripen bananas and as mulch. The trees can also provide good banana props and other staking material if allowed to grow a bigger.

4.8.3 Environmental Benefits

All the respondents 200(100%) who planted grevillea tree said that the trees reduce soil erosion, those who planted lantana, 24(12%), 18(9%) realized controlled soil erosion, while those who planted Napier grass, 150(75%), 142(71%) realized reduced soil erosion.

Table 4.19: Environmental Benefits of Agroforestry

Responses	**Frequency and % of who planted**	**Use**	**Frequency and % of who benefitted**
Grevillea	200(100%)	Control soil erosion	200(200%)
lantana camara	24(12%)	Control soil erosion	18(9%)
Napier grass	150(75%)	Control soil erosion, reduce water logging and enrich soil and as catch crop	142(71%)

Those who planted grevillea said that it holds soil together and Nambale district being an area of sandy soil, people experience a lot of runoff during rainy season. Grevillea was planted in homesteads, near boundaries and was also used to subdivide land into portions since it is known not to interfere with soil nutrients and soil properties. Therefore, the respondents said that planting grevillea reduced soil erosion and those with small seedlings, planted them multipurpose benefits, where soil erosion control was among the intended benefits.

Lantana Camara was planted by 24(12%) of the respondents and 18(9%) said that they have realized reduced soil erosion in their homesteads since lantana was commonly planted as alive hedge around homesteads. Lantana is a live shrub and when planted closely it holds soil together.

Napier grass was planted by 150(75%) of the respondents and 142(71%) realized that napier grass controlled soil erosion. Napier grass was intercropped with potato vines, cassava which is tubers for control of soil erosion. Napier grass was also planted along the boundary in water logged areas to reduce water and allow crop production. It was found out that Napier grass is planted in a deep hole with manure and after some years, the soil is enriched for among the respondents improved crop production when intercropped with crops or when it is uprooted and replaced with food crops. When intercropped with maize, Napier grass is used as a catch crop for stalk boller disease which attacks maize.

Environmental benefits include: soil stabilization and soil erosion reduction through either wind speed reduction or reduction of run-off potential, reduction in soil compaction, carbon sequestration, pest management by providing habitat for predators and parasites of pests, water conservation through reduction in evaporation and protection of waterways from agricultural runoff, and increased wildlife habitat which provide food, cover, and travel corridors (Williams *et al,* 1997).

From the above, it is clear that trees and shrubs are also valued for their environmental benefits and that explains why eucalyptus was not found to be environmental rewarding. The researcher did not come across any of the respondent who realized the environmental benefits of eucalyptus.

4.8.4 Medicinal Benefits of Agroforestry Trees and Shrubs

In Kenya, herbalists are reported to handle about 88% of cases of sickness (Barnet, 2000), while traditional birth attendants play a key role in the provision of affordable health care services to majority of Kenyans. Besides, traditional medicine is regarded as effective and is the preferred cure for many illnesses (Fratkin, 1998). The drug plants are generally referred to as “dawa ya miti” (Shwahili) meaning “medicine of trees”, or colloquially as “miti shamba”. This clearly indicates how widely trees and shrubs are generally used as sources of local drugs (Kokwaro, 1976). Although the researcher was interested in finding out whether trees are also valued for their medicinal value, findings showed that trees with medicinal value were not planted necessarily planted majority of the respondents. Therefore, the researcher sought to know which trees are used for medicinal purposes and by who.

All the respondents (100%) reported that they have utilized the neem **(***mwarubaine***)** tree for medicine. The neem tree is known to cure forty diseases and the most commonly treated disease is malaria. The leaves are boiled and one adult person takes a glass of the bitter concoction three times a day. Some of the respondents reported taking the neem concoction for other ailments including stomach upsets skin disorders and when they experience a headache. The Neem tree is sometimes taken when a person feels dizzy and it is believed to cure the cause of dizziness among them malaria, flue, cough, typhoid.

One of the respondent stated that he has never gone to hospital and whenever he feels sick, he takes the neem concoction and recovers. He indicated that he believes the neem tree is a powerful tree. Asked why he has not planted the tree, the respondent said that the neem tree does not need to be planted by an individual as long as one can access it from any other person and it is a taboo to bar someone from picking tree products for medicinal purposes as long as the tree is not being destroyed.

Croton tree was also reported to have medicinal values. All the respondents alluded that the croton tree is useful for medicinal purposes while only 20 of the respondents contended that they have ever used it for medicinal purposes. A twig of the croton is known to stop a fresh wound from bleeding by forming a coat on the wound making the healing process faster. Tengnas, (1994) added that a tree called *mutwele* in Luhya provides a very good medicine for measles

Study results indicated that Aloe vera shrub was used for treatment of cold, flue, running nose, stomach upset, skin diseases and malaria. Similar results were reported by that in West Africa, the Senegalise are slowly returning to *aloe,* an ancient herbal medicine that has been used in Africa for more that 6000 years (Tengnas, 1994). Eucalyptus leaves were also reported to be used for the treatment of flu and cold when inhaled. Other medicinal plants used include the bark and root of *acacia nilotica* which is used for the treatment of venereal diseases by the Kamba, Maasai and Turkana (Maundu and Tengnas, 2004) and the back of *Prunis africana* is reported to widely used for the treatment of stomach ache (Kokwaro, 1976).

Lantana is mainly used as a herbal medicine and in some areas as firewood and mulch. In some countries it is planted as a hedge to contain or keep out livestock. Leaf extracts of Lantana exhibit antimicrobial, fungicidal, insecticidal and nematicidal properties. Verbascoside, which possesses antimicrobial, immunosuppressive and antitumor activities, has been isolated from Lantana. Lantana oil is sometimes used for the treatment of skin itches, as an antiseptic for wounds and externally for leprosy and scabies. Also, the plant extracts are used in folk medicine for the treatment of cancers, chicken pox, measles, asthma, ulcers, swellings, eczema, tumors, high blood pressure, bilious fevers, catarrhal infections, tetanus, rheumatism and malaria (Tengnas, 1993).

4.8.5 Livelihood Benefits of Agroforestry

Agroforestry has been praised world over as a major source of livelihood among rural households. During the study, the researcher found that farmers accrued several livelihood benefits from agroforestry practices. Trees are useful in livelihood and production strategies, especially among rural communities. Muok *et al*. (1999) noted that growing trees on farms is a very important livelihood strategy in rural communities of sub-Saharan Africa. Agro-forestry, as a science and practice, has the potential to contribute to the improvement of rural livelihoods due to the capacity of its various forms to offer multiple alternatives and opportunities to smallholders to enhance farm production and income, while protecting the agricultural environment In this section, the benefits towards the farmer's livelihood have been categorized as the produce from agroforestry (Table 4.20)

Table 4.20: Livelihood Benefits of Agroforestry

Produce from Agroforestry	**Who produce (n)**	**Use all produce at home**	**Use more at home than sell**	**Sell more than use at home**
Milk	70	12 (17%)	6 (9 %)	52 (74%)
Animals	157	8 (5%)	2 (1%)	147 (94%)
Bricks	80	3 (4%)	4 (5%)	73 (91%)
Firewood	200	120 (60%)	72 (36%)	8 (4%)
Poles/timber	160	12 (8%)	23 (14%)	125 (78%)
Fodder	136	123 (90%)	11 (8%)	2 (2%)
Home implements	200	193 (96.5%)	5 (2.5%)	2 (1%)
Fruits	192	120 (62%)	40 (21%)	32 (16%)
Raw materials for Construction	200	192 (96%)	6 (3%)	2 (1%)
poultry	200	10(5%)	48 (24%)	188(71%)

Multiple responses given

Results from table shows that milk sale (74%), animal sale (94%), bricks sale (91%), poles/timber sales (78%) and poultry (71%) were considered to be very important addition to household income.

Cross breed cattle were the major producers of milk for sale, while local breed produced milk for home consumption. Goats, pigs cattle and sheep were the animals reared for sale by the farmers. Basamba, *et al*, (2012) found out that goats and birds are the most commonly sold livestock by agroforestry farmers, followed by pigs, cattle, and sheep Results further indicate that milk (3.1%) was the only livestock product sold by farmers.

Napier grass is the most commonly used fodder grass and is mainly consumed at home through stall feeding. Bricks were made using firewood to cure them and they are the most commonly used for building permanent houses in the study area and therefore there is always a ready market for the bricks.

The most common tree species for timber, poles, raw material for construction of traditional houses and firewood sales were Grevillea robusta, makhamia lutea, *cassia spectabillis* and eucalyptus. This is in line with Basamba et al, (2012) that farmers mostly sell firewood and poles which are got from various agro-forestry tree species, including *Eucalyptus species*, *Markharmia lutea*, *Artocapus heterophylus*, *Milicia excelsa*, *Calliandra calothyrsus* and *Sesbania sesban.*

Some studies have suggested that eucalyptus trees, which are relatively fast growing, are particularly profitable in northern Ethiopia. They often found rates of return for farmers' investments in eucalyptus above 20 percent (Jagger and Pender 2003). Kidanu (2004) showed that planting eucalyptus as field (plot) boundaries leads to stabilizing the livelihoods of resource poor farmers and could help smallholder farmers increase their income and achieve food security. Kidanu, (2004) also suggested that a short rotation of a eucalyptus-based agroforestry system could be practiced in the seasonally-waterlogged highland vertisols of Ethiopia to meet wood demand, without inducing significant nutrient depletion and crop yield loss.

Holden *et al*. (2003) analyzed the potential of tree planting to improve household welfare in the poorer areas of the Amhara region of Ethiopia, using a bio-economic model. They particularly considered the potential of planting eucalyptus trees as a strategy to reduce poverty in a less-favored area of the Ethiopian highlands. They found that planting eucalyptus on private lands unsuitable for crop production can substantially contribute to poverty reduction in these areas.

Mangifera indica, persea Americana and carica papaya were the most important to yield fruits for sale and home consumption. Similar results indicate that fruits from tree species such as *Persea americana* , *Artocapus heterophylus* and *Mangifera indicia* are also sold by farmers (Basamba, et al, 2012). Fruits were used as food and also for nutritional security among households and more so,for nutritional security of children. Home implements include traditional chairs and baskets, are made from makhamia lutea and lantana camara respectively. However, the greatest proportion of firewood, fruits and raw materials (*fito*) for construction of traditional house and granaries are used at home.

Salam *et al*, (2000) also linked tree planting, particularly homestead agroforestry to improvement of overall household income and alleviation of rural poverty. In fact, they contended that tree planting on homesteads could increase overall household income twofold, relative to arable crops. Arnold *et al,* (2006) argued that fuelwood production, selling, and trading represents a significant part of household income for many people and can be the main source of income for others. They observed that commercial activity with wood fuels provides supplemental, transitional, or seasonal/occasional source of income for some and their main source of income for others. In some cases, it generates working capital to start up new agricultural or other business. Besides generating income, it also meets the subsistence requirement for fuelwood

Place *et al* (2003) observed that various agroforestry technologies adopted have increased farm yields, raised household incomes, and improved food security and the ability to mitigate vulnerable situations. Research conducted by Boateng (2008) found that a greater proportion of households (97%) had improved food security after adopting agroforestry. This was partly due to the fact that most farmers used money accruing from the sales of tree crops/products in purchasing food items to supplement food in the household.

In a nutshell, majority of the agroforestry units are also major sources of livelihood to the households as evident in milk, bricks, poles, timber, animals and poultry. The produce supplements household income and especially during emergency need for cash or when there is food shortage after the previous harvest is exhausted.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter summarizes the salient findings of the study based on each objective and on the basis of these, recommendations are made. Comments on areas that need further research are highlighted.

5.2 Summary of the Findings

The first objective of the study was to find out the types of agroforestry practices adopted in the study area. Agrisilviculture which is the growing crops and trees on the same piece of land was the most common. However, some respondents kept animals (agrosilvopastoral). Boundary tree planting, trees around homestead, live fencing, and trees on crop land were adopted by over 50% of the respondents. Planting trees around homesteads and in compounds was found to be a traditional practice in the community and is commonly practiced by majority of the respondents. Grevillea tree is the most commonly planted tree due to its properties: since it matures faster, have many branches, does not break easily, does not harbour pests, does not destroy soil, adds mulch to the soil and therefore can be planted in any location in the home and farm. . Majority of the respondents had planted 10-20 trees on their farms which is an effort to achieving the 10%tree cover on smallholder farms

The second objective of the study was to establish farmer oriented factors that influence adoption of agroforestry practices in the study area.. It was established that education level of the household head, land size and gender in relation to household head influenced adoption of agroforestry. Decision making at the household level influenced land management and therefore agroforestry practices.

The third objective was to determine the technical factors that influence adoption of agroforestry practices in the study area. Lack of information , land limit and lack of seeds hampered adoption of agroforestry. Agricultural extension officers are the main sources of agroforestry information. However, agricultural extension officers cease to be subsequent sources of information and other farmers and the radio play an important role as subsequent sources of information. Farmers receive extension services and therefore have a chance to enquire about agroforestry.

The fourth objective of the study was to establish community factors that influence adoption of agroforestry in Nambale Division. It was established that planting trees around homesteads is a traditional practice which encourages agroforestry practices in the study area. Demand for fuel wood and rising demand for tree products in Nambale Division encourages tree planting. Sugarcane farming, tree and land tenure and the people’s attitude towards tree as a competitor with food crops on land and soil nutrients affects tree planting in the study area.

In relation to the benefits of agroforestry, it was established that agroforestry tree products have economic, social, cultural, environmental, medicinal and livelihood benefits to farmers. However, it was found out the trees with high economic and environmental benefits such as grevillea are more preferred. It was also established that agroforestry produce from the different farm units acts as a source of livelihood for majority of households in the study area, either as a substitute for what farmers would have bought, or for cash income to supplement other sources of income for the household.

5.3 Conclusions

Following the foregoing e findings, the study concludes that farmer factors, technical factors and community oriented factors affect the adoption of agroforestry practices in the study area. Different agroforestry practices are adopted depending on the needs of the farmer for economic gains, food security, or for other benefits and the management of the adopted agroforestry practice depends on the benefits targeted. Household decision making affect land management and therefore limit agroforestry adoption.

Lack of information on the different agroforestry practices like improved fallows and alley cropping and the contradicting information on some tree species such as eucalyptus, leuccaaena, are some of the challenges to the widespread uptake of agroforestry.

The culture of tree planting in homesteads influence tree planting while the culture of sugarcane farming affect tree planting and therefore limit adoption of agroforestry practices. Agroforestry practices provide economic, social, environmental and medicinal benefits and act as a source of livelihoods for people in the study area.

5.4 Recommendations

From the study, the following recommendations are made.

It was established that soil improvement agroforestry practices are the least adopted and yet soil infertility is a major problem. Therefore, more information on soil fertility methods like soil fertility trees and improved fallows should be provided in the area and more tree species compatible with the existing land management practices should be disseminated through farmer groups in the study area.

Since there is no demonstration on agroforestry practices in the study area, demonstration plots in farmer farms to serve as a reference point for the farmers is highly recommended.

Finally, sugarcane contracting company policy should be in line with agricultural and government policies and should be geared towards achievement of millennium development goals. Therefore, consultation is important to ensure that cane farming policy allows and encourages tree growing compatible with cane farming in order to ensure 10% tree cover on farms.

5.5 Suggestion for Further Research

The study was limited to determining factors affecting the adoption of agroforestry practices. The study recommends that further research should be done on the costs and benefits of agroforestry practice.

REFERENCES

Aalbaek A (1997). Farmer tree planting in Tanzania. Proceedings of a workshop held in Arusha, Tanzania. The African Academy of Sciences (AAS). pp. 156 – 170.

Abadi, A., Lefroy, T., Cooper, D., Hean, R., and Davies, C. (2003). *Profitability of medium to low rainfall agroforestry in the cropping zone*. Barton, Australia, Rural Industries Research and Development Corporation Publication No. 02.

Abbas, J. (1997). Gender asymmetries in intra-household resource allocation in sub-Saharan Africa: Some policy implications for land and labour productivity: Models, methods and policy. Baltimore, MD: Johns Hopkins University Press for the International Food Policy Research Institute.

Adesina A., Mbila D., Nkamleu G., and Endamana D. (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agriculture, Ecosystems and Environment* 80: 255–265.

Adesina A., Mbila D., Nkamleu G., and Endamana D. (2001). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agriculture, Ecosystems and Environment* 80: 255–265.

Ajayi, O., Franzel, S., Kuntashula, E., and Kwesiga, F. (2003) Adoption of improved fallow soil fertility management practices in Zambia: synthesis and emerging issues.*Agroforestry Systems* 59 (3), 317-326.

Ajayi, O., Masi, C., Katanga, R., and Kabwe, G. (2006) Typology and characteristics of farmers testing agroforestry-based soil fertility management technology in Zambia. *Zambia Journal of Agricultural Sciences* (in press).

Akinnifesi, F., Kwesiga, F., Mhango, J,. Chilanga, T., Mkonda, A., Kadu, C., Kadzere, I,. Mithofer, D., Saka, J., Sileshi, G., Dhliwayo, F., and Swai R. (2006). Towards Developing the Miombo Indigenous Fruit Trees as Commercial Tree Crops in Southern Africa. *Forests, Trees and Livelihoods 16:103-121.*

Alavalapati, J., Luckert M., Gill O. (1995). Adoption of Agro forestry practices: a case study from Andhara Prades, India, *Agroforestry system*. 32: 1-14.

Amadalo, B., Niang, A., Gathumbi, S. ,and Jama, B. (2003) Using short duration improved fallows in western Kenya for soil fertility and crop improvement. A research report. Regional Agroforestry Research Centre, Maseno, Kenya.

Antle J. and Diagana, B. (2003) Creating incentives for the adoption of sustainable Agricultural practices in developing countries: the role of soil carbon sequestration *American Journal of Agricultural Economics* 85 (5): 1178–1184

Arnold, J. (2006). Woodfuels, Livelihoods, and Policy Interventions: Changing Perspectives. *World Development* 34(3): 596–611.

Ayuk, E. T. (1997). Adoption of agroforestry technology: The case of live hedges in the central plateau of Burkina Faso. *Agricultural Systems, 54*(2), 189-206.

Baggio, A. (1997). Productivity of southern Brazilian coffee plantations shaded by different stockings of Grevillea robusta. Agroforestry Systems 37: 111–120.

Basamba, T., Kiiza, B., Mayanja, C., Nakileza, B., Matsiko, F., Nyende, P., and Kukunda6, E. (2012) Linking Markets to Smallholder Agro-forestry Farmers as a Strategy for Poverty Alleviation in the Tropics.

Barasa,O (2011). Luhya Tradition:Origin, Culture and Tradition of the Abanyore/ Banyore of Western Kenya

Biggelaar, C. (1996). Farmer Experimentation and Innovation. *A Case Study of Knowledge Generation Processes in Agroforestry Systems in Rwanda*, Community Forestry Case Study No. 12, FAO, Rome

Blaug, M. (1972).Introduction to the Economics of Education. Harmondsworth: Penguin, Boahene K., Snijders T., Folmer H. (1999). An Integrated Socio Economic Analysis of Innovation Adoption: the case of Hybrid cocoa in Cohana. J. Policy Model 21,

Boateng, I (2008). The Impact Of Agroforestry On The Livelihood Of Rural Farming Households: A Case Study Of Selected Communities of Offinso, Afigya Sekyere And Atwima Districts Thesis

Bonnard, P. and Scherr, S. (1994). Within gender differences in tree management: Is gender distinction a reliable concept? Agroforestry Systems 25: 71–93

Boserup, E. (1965). The Conditions of Agricultural Growth. The Economics of Agrarian Change under Population Pressure. London George Allan and Unwin Limited

Boserup, E. (1981). Population and Technology. Oxford; Basil Blackwell Publishers

Bosma, R., Roothaert, R., Asis, P., Saguinhon, J., Binh, L, and Yen, V. (2003). Financial and social benefits of new forage technologies in Mindanao, Philippines and Tuyen Quang, Vietnam. CIAT Working Document No. 191. Los Banos, Philippines, International Center for Tropical Agriculture.

Brandle, J. (2004). Windbreaks in North American agricultural systems. Agroforestry Systems. 61:65–78.

Bradley, C. (1993). Bibliography of Western Province, Kenya. African Studies, University of Wisconsin

Briones, A.(2003). Food security perspectives: focus on Asia and the Philippines.

Brown, D. (2003). Considering the role of landscape, farming system and the Farmer in the adoption of trees in Claveria, Misamis Oriental Province, Philippines. Unpublished MS Thesis, University of London

Buck, L. E. (1995).“Agroforestry Policy Issues and Research Directions in the U.S. and Less Developed Countries: Insights and Challenges from Recent Experience.” *Agroforestry Systems* 30, no. 1-2(1995): 57-73.

Carsan, S. and Holding, C. (2006). Growing farm timber: practices, markets and policies. The Meru timber marketing pilot programme case studies and reviews. World Agroforestry Centre.

Casey, F. and Cavigilia, L. (2000).Deforestation and Agroforestry Adoption in Tropical Forests: Can we generalize? A paper presented at the Western Agricultural Economics Association Annual Meetings.

Celis, R., Milimo, J., and Wanmali, S. (1991). Adopting Improved Technology: A Study of Smallholder Farmers in Eastern Province, Zambia. International Food Policy Research Institute, Washington DC

Chambers, R., Pacey, R., and Thrupp, L. (1987) Farmer First: Farmer Innovation and Agricultural Research.Intermediate Technology Publications, London

Chambers, R. (1983). Rural development. putting the last first. UK: Longman

Chavangi, N.A. (1989). "Socio-economic issues in agroforestry." Paper presented at Agroforestry Seminar, Thuci River Lodge, November 1989. Nairobi: Ministry of Agriculture, 9 pp.

Chew S. (1989). Agroforestry projects for small farmers: A Project Managers Reference.

Chinene, V., Hansungule, M., Maimbo, F., and Place, F. (1994) Land Tenure, Tree Tenure, and Tree Planting in Zambia. Land Tenure Center, University of Wisconsin, USA

CIMMYT, (1993) The Adoption of Agricultural Technology: A Guide for Survey Design.Economics Program, International Maize and Wheat Improvement Center, Mexico City, Mexico

Cooper, P., Leakey, R., Rao, M., and Reynolds, L. (1996). Agroforestry and the mitigation of land degradation in the humid and sub-humid tropics of Africa. *Experimental Agriculture, 32*, 235-290.

Conley, T., and Udry, C. (2001). Social Learning Through Networks: The Adoption of New Agricultural Technologies in Ghana. *American Journal of Agricultural Economics, 83*(3)

Collier, P., Dorgan, J., Bell, P. (2002). Factors Influencing Farmer participation in Forestry. Coford, Dublin.

Crowley, E. (1996) Off-farm Income and Farming in Western Kenya. Consultancy report to USAID/Kenya, Nairobi, Kenya

Current, D. and Scherr, S. (1995). Farmer costs and benefits from agroforestry and farm forestry projects in Central America and the Caribbean: implications for policy. *Agroforestry Systems*, 30: 87–103.

Current, D. and Scherr, S. (1995), Costs, Benefits, and Farmer Adoption of Agroforestry: Project Experience in Central America and the Caribbean, World Bank Environment Paper Number 14.

David, S. and Swinkels, R. (1994) Socioeconomic Characteristics of Households Engaged in Agroforestry Technology Testing in Western Kenya. AFRENA Report No. 78. ICRAF, Nairobi, Kenya

Davison, J., (1988). Agriculture, Women and Land. The African experience. Boulder London: Westview Press

De Jong, B., Tipper, R., and Montoya-Gomez, G. (2000). An economic analysis of the potential for carbon sequestration by forests: evidence from southern Mexico. *Ecological Economics*, 33: 313–327

Dewees, P. (1995). Social Economic Incentives for Smallholder Tree Growing: A case study from Muranga District Kenya.

Doss, C. and Morris, M.(2001). How does gender affect the adoption of Agricultural Innovation? The case of improved maize technology in Ghana. Agric. Econ. 25, 27–39.

Dunn, W. (1990), Benefit-Cost Analysis of Fuelwood Management Using Native Alder in Ecuador. *Agroforestry Systems* 11: 125-139.

Ellis, F. (1988).*Peasant Economics: Farm Households and Agrarian Development.* Cambridge: Cambridge University Press, Emtage, N., Suh, J. (2004). Socio-economic Factors Affecting Smallholder Tree Planting and Management Intentions in Leyte Province, Philippines. Small-scale Forest Economics, Management and Policy 3(2):257–271.

Errington, A. (1986). The Delegation of Decisions on the Farm. *Agricultural Systems, 19*(4), 299-317.

FAO. (2005). *The State of Food Insecurity in the World: Eradicating World Hunger. Key to Achieving the Millennium Development Goals*. FAO, Rome.

Flower, T., Valdivia, C., Dorr, H. (2005). Habitus and Interest in Agroforestry Practices in Missouri. Paper for presentation.

Fortmann, L. (1985). The tree tenure factor in agroforestry with particular reference to Africa. *Agroforestry Systems* 2: 229-251.

Franzel, S., and Scherr, S. (1995) (eds), Trees on the Farm: Assessing the Adoption Potential of Agroforestry Adoption in Africa. CAB International, Wallingford, UK

Franzel, S. (1999). Socioeconomic factors affecting the adoption potential of improved tree fallows in Africa. *Agroforestry Systems, 47*, 305-321.

Franzel, S., Cooper, P., and Denning, G. (2001). Scaling up the benefits of agroforestry research: lessons learned and research challenges. *Development in Practice*, 11(4): 524–534.

Franzel, S., Wambugu, C., and Tuwei, P. (2003). *The adoption and dissemination of fodder shrubs in central Kenya*. Agricultural Research and Network Series Paper No. 131. London, Overseas Development Institute.

Garrett, H. and Buck, L. (1997). Agroforestry practice and policy in the United States of America. For. Ecol. Manage. 91:5-15.

Geist, H. (1999). Global assessment of deforestation related to tobacco farming. *Tobacco Control* 8: 18-20.

Ghadim, A. (1999), A Conceptual Framework of Adoption of an Agricultural Innovation. *Agricultural Economics* 21.

Giller, K. (2009). Conservation agriculture and smallholder farming in Africa: The heretics' view. *Field Crops Research*, *114*(1), 23-34.

Githiomi, J., Mugendi, D., Kung'u, J. (2012). Household tree planting and its related constraints in meeting woodfuel production in Kiambu, Thika and Maragwa Districts of Central Kenya Journal of Horticulture and Forestry Vol. 4(7), pp. 120-125,

Gladwin, C., Peterson, J.., Phiri, D., and Uttaro, R., (2002). The Quality of Science in Participatory Research: A Case Study from Eastern Zambia. *World Development*, *30*(4), 523-543

Glendinning, A., Mahapatra, A., Mitchell, C. (2001): Modes of Communication and Effectiveness of Agroforestry Extension in Eastern India. Human Ecology 29(3):283–305.

Gockowski, J., Nkamleu, G., and Wendt, H. (2001). Implications of resource use intensification for the environment and sustainable technology systems in the Central African Rainforest. Wallingford, UK, CABI.

Govere, E, (2003). (Ed), Policies for Agroforestry Development in Zimbabwe. Jongwe Press, Harare. Zimbabwe

Government of Kenya,

1977 Development Plan 1979-1983, Nairobi, Government Printers

1994 Busia District Development Plan 1997-2001. Nairobi: Government Printers

2000 Poverty in Kenya, 2000**.** Nairobi: Government Printers

2001 Busia District Development Plan 1997-2001. Nairobi: Government Printers

Gustavsson, S. and Kimeu, P. (1991). *Socio-Economic Evaluation of Eucalyptus Growing on Small-Scale Farms in Vihiga Division, Kakamega District.* Nairobi: Ministry of Agriculture, SWCB, 48 pp.

Hedden-Dunkhorst B, and Mollel NM (1999). Small-scale farming and extension in South Africans Northern Province. South Afr. J. Agric. Extens. 28:93-107.

Hiromi, Y. (1999). The Diffusion Process of Planting *Grevillea Robusta* Among Rural Households in North-Central Tanzania. African Study Monographs, 20(3): 119-145

Hoekstra, D.(1985). Choosing the discount rate for analysing agroforestry Systems/technologies from private economic viewpoint. Forest Ecology and Management 10: 177–183

Holden, S. T., Shiferaw, B. A., & Pender, J. (2003). Non-farm income, household welfare, and sustainable land management in a less-favoured area in the Ethiopian highlands. *Food Policy, 29*(4), 369-392.

Howard, J. and Mungoma, C. (1997). Zambia's stop-and-go revolution*: the impact of policies and organizations on the development and spread of maize technology* (Working Paper). East Lansing, Michigan: Michigan State University. (International Development Working Paper 61)

ICRAF. (1996). *ICRAF annual report 1995*. Nairobi, Kenya: International Centre for Research in Agroforestry.

ICRAF. (1997). *ICRAF Annual Report 1996*. Nairobi, Kenya: International Centre for Research in Agroforestry.

Ipara, H.I. (1993). Women and Agroforestry in Eastern Africa: Socio-Economic factors affecting participation of women in rural Kenya. African Caribbean Institute, Hanover

Jagger P, and Pender J (2003). The role of trees for sustainable management of less favoured land: The case of Eucalyptus in Ethiopia. Forest Policy and Economics.

Jain, S. and Singh, P. **(**2000). Economic analysis of industrial agroforestry: poplar (*Populus deltoids*) in Uttar Pradesh, India. *Agroforestry Systems*, 49: 255–273.

Jama, B., Buresh R., and Place, F. (1998) Sesbania tree fallows on phosphorus-deficient sites: Maize yield and financial benefit. Agronomy Journal (in press)

Jera, R. and Ajayi, O. (2008). Logistic Modeling of Smallholder Livestock Farmers' Adoption of Tree-Based Fodder Technology in Zimbabwe. *Agrekon,* 47: 379-392

Kabwe, G. (2001). *Dissemination Pathways for Agroforestry Technologies: the case for improved fallows in eastern Zambia.* Unpublished MSc Thesis, Stellenbosch University, South Africa, Stellenbosch

Kabwe, G. (2010). Uptake of Agroforestry Technologies among Smallholder Farmers in Zambia. Thesis

Kaonga, M. and Bayliss-Smith, T. (2009). Carbon pools in tree biomass and the soil in improved fallows in eastern Zambia. *Agroforestry Systems*, *76*, 37-51.

Katanga R, Lungo T, Phiri D, Laminaho A, Phiri S (1999). Farmer triners as dissemination pathway: Does it make difference. pp.162-164. Proceedings of 13th Southern African Regional Planning and Review meeting, SADC-ICRAF Zambezi Basin Project. 5-11 July 1999 Mangochi, Malawi. ICRAF Nairobi, Kenya.

Keil A., Zeller M. and Franzel S. (2005). Improved tree fallows in smallholder maize production in Zambia: do initial testees adopt the technology? *Agroforestry Systems* 64: 225-236.

Kenya Forest Servie (2009). A Guide to On-Farm Eucalyptus Growing in Kenya

Kidanu, S. (2004). Using Eucalyptus for Soil and Water Conservation on the Highland Vertisols of Ethiopia. PhD diss., Department of Environmental Sciences, Wageningen University, the Netherlands.

Kiptot, E., Franzel, S., Hebinck, P and Richards, P. (2006). Seed and knowledge sharing: farmer to farmer dissemination of agroforestry technologies in western Kenya. *Agroforestry Systems* 68 (3): 167-179.

Kinuthia, E. Owuor, G. Nguyo, W. Kalio A. and Kinambuga D.(2011). Factors Influencing Participation and Acreage Allocation in Tree Planting Program: A Case of Nyeri District, Kenya. Agricultural Science Research Journal Vol. 1(6), pp.129-133,

Knowler, D., and Bradshaw, B. (2007). Farmers' Adoption of Conservation Agriculture: A review and synthesis of recent research. *Food Policy, 32*(1), 25-48.

Kokwaro, J.O. (1979). *Classification of East African Crops.* Nairobi: East African Publishing House, 86 pp.

Kort, J. (1988). Benefits of windbreaks to field and forage crops. *Agriculture, Ecosystems and the Environment*, 22/23: 165–190.

Kuntashula, P.I.; Mafongoya, P.I.; Sileshi, G.; Lungu, S. World Agroforestry Centre (ICRAF), Chipata (Zambia) (2004). Potential of biomass transfer technologies in sustaining vegetable production in the wetlands (dambos) of eastern Zambia. *Experimental agriculture, 40*, 37-51.

Kwesiga, F., and Coe, R. (1994). The Effect of Short-Rotation Sesbania-Sesban Planted Fallows on Maize Yield. *Forest Ecology and Management*, *64*(2-3), 199-208.

Kwesiga, F., Akinnifesi, F.K., Mafongoya, P.L, McDermott, M.H. and Agumya, A. (2003) Agroforestry research and development in southern Africa during the 1990s:review and challenges ahead. *Agroforestry systems* 59 (3), 173-186.

Kwesiga F, Franzel S, Place F, Phiri D, Simwanza C. (1999). *Sesbania sesban* improved fallows in Eastern Zambia: their inception, development and farmer enthusiasm. Agroforest. Syst. 47(1):47-66.

Leakey L, (1997). The Southern Kikuyu before 1903. Academic press. London, UK

Lwayo, M. and Maritim K.(1999) Socio-Economic Factors Affecting Farmers Decisions to Adopt Farm Forestry: An application of Multivariate Logistic Analysis in Busia District, Kenya

Mafongoya, P. L., Kuntashula, E., and Sileshi, G. (2006). Managing soil fertility and nutrient cycles through fertiliser trees in Southern AfricaLondon, New York: Taylor and Francis.173-186.

.

Marenya, P. and Barrett, C. (2007). Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya. *Food Policy, 32*(4), 515-536.

Masangano C. (1996). Diffusion of agroforestry technologies. Michigan State University.

Matata P. Ajayi, O. Oduor P. and Agumya, A. (2008). Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania

Matata P. , Masolwa L. Ruvuga S. and Bagarama F. (2012). Dissemination pathways for scaling-up agroforestry technologies in western Tanzania. Journal of Agricultural Extension and Rural Development, Vol. 5(2), pp.31-36, Maundu, P. and Tengnäs B, (2005). Useful trees and shrubs for Kenya, RELMA Technical handbook No. 35, World Agroforestry Centre – Eastern and Central Africa Regional Programme, English press, Nairobi, Kenya.

McAdam, .H., Thomas, H., and Willis, W. (1999). The Economics of Agroforestry Systems in the United Kingdom and their future prospects. *Scottish Forestry*, 53(1): 37–41.

Mercer, D. and Miller, R. (1998). Socioeconomic Research in Agroforestry: Progress, Prospects, Priorities. *Agroforestry Systems, 38*, 177-193.

Mercer, D. (2004). Adoption of agro forestry innovations in the tropics: a review. *Agro forestry Systems*, *61*, 311-328.

Ministry of Energy (2002). Study on Kenya's Energy Demand, Supply and Policy Strategy for Households, Small scale Industries and Service Establishments. Kamfor Consultants, Nairobi, Kenya. p. 133.

M'Mutungi, K. (1991). Socio-economic Evaluation of Grevillea Growing on Small-Scale Farms in Kirinyaga District. Report from a minor field study. Nairobi: Ministry of Agriculture, SWCB, 36 pp.

Montagnini, F and Nair P. (2004). Carbon sequestration: An underexploited environmental benefit of agro forestry systems

Mugenda,, O. and Mugenda, A. (1999)Research methods: Quantitative and Qualitative Approaches. Nairobi African Centre for African Studies

Muok,B . Owour,B Dawson, I. Were, J. (1999). The Potential of Indigenous Fruit Trees: Results of a Survey in Kitui District, Kenya, Agroforestry Today,

Murniati, Garrity, D.P. and Gintings, A.N. (2001). The contribution of agroforestry systems to reducing farmers' dependence on the resources of adjacent national parks. *Agroforestry Systems*, 52: 171–184.

Mutambara, J, Dube I and Mvumi B (2012). Agroforestry technologies involving fodder production and implication on livelihood of smallholder livestock farmers in Zimbabwe. A case study of Goromonzi District.Livestock Research for Rural Development Newsletter

Mutoro, B. (1997). Women Working Wonders: Small scale Farming and the Role of Women in Vihiga Division, Kenya. *A case study of North Maragoli.* Amsterdam: Thela Publishers

Nair, P. (1993). An Introduction to Agroforestry. Dordrecht, Netherlands, Kluwer Academic Publishers.

Negatu, W. and Parikh, A. (1999). The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia. *Agricultural Economics*, *21*(2), 205-216

Neupane RP, Sharma KR, Thapa GB (2002). Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. Agric. Syst., 72: 177-196.

Niang, A., Amadalo, B., Gathumbi S. and Obonyo C.O.(1996). Maize yield response to green manure application from selected shrubs and tree species in western Kenya: a preliminary assessment. In Mugah J.O. (ed.), Proceedings of the First Kenya Agroforestry Conference on People and Institutional Participation in Agroforestry for Sustainable Development, pp 350-358. Kenya Forestry Research Institute (KEFRI), Muguga, Kenya

Ochieng, W. (1990). *The third World. Essays on Kenyan History and Societies*. Nairobi; University of Nairobi Press

Odada,J., and William,O.,Eds (1986).Incentives for Increased Agricultural Production. A case of Kenya Sugar Industry. Nairobi: Freidrich Ebert Foundation.

Oginosako, Z. Simitu, P. Orwa, C. and Mathenge, S. (2006). Are they competing or compensating on farm? Status of indigenous and exotic tree species in wide agro ecological zones of Eastern and Central Kenya, surrounding Mount Kenya. ICRAF Working paper No. 16. Nairobi: Worlds Agroforestry Centre.

Okoji, M. and Moses, J. (1998). Adoption of Agroforestry for Soil Conservation in Akwa Ibom State, Nigeria. *Journal of Sustainable Agriculture* 13(1): 5 – 13.

Okwako, J. (1997).Aspects of Socio-Economic Change in Independent Kenya: The Case of Muhoroni Settlement Scheme 1960-1990.M.Phil thesis, Moi University, Eldoret Kenya.

Oladele O. (2008). Factors Determining Farmers' Willingness To Pay For Extension Services In Oyo State, Nigeria Medwell Journals, Agricultural Journal, 3 (5): 409–413.

Omoregbee, F. (1998). Communication of improved farm practices rural women farmers in Benue State, Nigeria.Outlook Agric 27:53- 56.

Opio, C. (2001). Biological and Social Feasibility of Sesbania fallow practice in Small Holder Agricultural Farms in Developing Countries: A Zambian Case study. *Environmental Management*, *27*(1), 59-74.

Otsuki, T. (2010).Estimating Agroforestry's Effects on Agricultural Productivity In Kenya:An Application of a Treatments Effect Model

Pattanayak, S. and Mercer, D. (2002). Indexing soil conservation: farmer perceptions of agroforestry Benefits. *Journal of Sustainable Forestry* 15(2): 63–85

Peterson, J. (1999). *Kubweletza Nthaka: Ethnographic Decision Trees and Improved Fallows in the Eastern Province of Zambia* (Report to the University of Florida's ' Gender and Soil Fertility in Africa' Soils Management Collaboration Research Support Program (CRSP) and the International Centre for Research on Agroforestry): University of Florida and ICRAF.

Phiri, D., Franzel, S., Mafongoya, P., Jere, I., Katanga, R. and Phiri, S., (1999) Who is Using the New Technology? A Case Study of Wealth Ranking and Improved Tree Fallows in Eastern Province, Zambia. AFRENA report (in press), ICRAF, Nairobi

Phiri D, Franzel S, Mafongoya P, Jere I ,Katanga R, Phiri S (2003).Who is using the new technology? The association of wealth status and gender with the planting of improved tree fallows in Eastern Province, Zambia. Agroforestry Systems

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

Place1,.F. Ajayi1, O. Torquebiau,,E. Detlefsen, G. Gauthier, M. and Buttoud, G. .(2001) Improved Policies for Facilitating the Adoption of Agroforestry *World Agroforestry Centre, Nairobi*

Pretty, J. N. (1995). Regenerating agriculture: policies and practice for sustainability and self-reliance. London, UK: Earthscan Publications Ltd.

Quisumbing A, Brown L, Feldstein H, Haddad L and Pena C (1995) Women: The Key to Food Security. Food Policy Report. International Food Policy Research Institute, Washington DC

Ramadhani, T., Otsyina, R., and Franzel, S. (2002). Improving household incomes and reducing deforestation using rotational woodlots in Tabora district, Tanzania. *Agriculture, Ecosystems & Environment, 89*(3), 229-239.

Republic of Kenya.(2005). Draft National Agriculture Sector Extension Policy (NASEP). Ministry of Agriculture and Rural Development. Nairobi. July 2005

Republic of Kenya (2007). Ministry of Planning and National Development ; Kenya integrated household budget survey 2005/06 Revised Edition, Nairobi, Kenya. p. 96.

Rene, K. and French J. (1996) A Framework for Understanding Agroforestry Decision Making at the Farm Household Level

Rogers E (2003) Diffusion of innovation. The Free Press, New York, NY

Ruthenberg, H. (1971) Farming Systems in the Tropics. Clarendon Press, Oxford, UK

Saito KA, Weidermann CJ (1990). Agricultural Extension for Women Farmers in Africa. World Bank Discussion Paper No.103 World Bank: Washington DC.

Salam, M. A.; Noguchi, T. and Koike, M. (2000): Understanding why farmers plant trees in the homestead agroforestry in Bangladesh. Agroforestry Systems 50(1):77–93.

Sanchez, P. (2002). Soil Fertility and Hunger in Africa. *Science, 295*(5562), 2019 2020.

Sanchez, P.A., Shepherd, K.D., Soule, M.J., Place, F.M., Buresh, R.J., Izac, A.M., Mokwunye, A.U., Kwesiga, F.R., Nderitu, C.G. and Woomer, P.L.(1997). Soil fertility replenishment in Africa: An investment in natural resource capital, p. 1-46. *In* R.J. Buresh et al. (ed.) Replenishing soil fertility in Africa. SSSA Spec. Publ. 51. SSSA, Madison, Scarborough V, Killough S, Johnson DA, Farrington J (eds) (1997). Farmer-led Extension: Concepts and Practices. Intermediate Technology Publications Ltd. London, UK.

Scherr, S. (1995), Economic Factors in Farmer Adoption of Agroforestry: Patterns Observed in Western Kenya, *World Development*, Vol. 23, No. 5, 787-804

Schultz, T. (1964). Transforming Traditional Agriculture. New Haven: Yale University Press,

Sileshi, G., Mafongoya, P. L., Kwesiga, F., & Nkunika, P.(2005). Termite damage to maize grown in agroforestry systems, traditional fallows and monoculture on nitrogen limited soils in eastern Zambia. *Agricultural and Forest Entomology, 7*(1), 61-69

Sileshi, G. and Mafongoya, P. (2006). Variation in macro faunal communities under contrasting land-use systems in eastern Zambia. *Applied Soil Ecology, 33*, 49-60.

Smith,J.,(1978).The Development of Large Scale Intergrated Sugar Scheme in Western Kenya.I.D.S Working paper No.343.

Smith, J. and Scherr, S. **(**2002). Forest carbon and local livelihoods: assessment of opportunities and policy recommendations. CIFOR Occasional Paper No. 37. Bogor, Indonesia, Center for International Forestry Research.

Smucker, G. R.; White, A. T.; Bannister, M. (2002): Land tenure and the adoption of agricultural technology in Haiti. In: Meinzen-Dick, R. S. (ed.): Innovation in natural resource management. The role of property rights and collective action in developing countries. Baltimore Md.: Johns Hopkins Univ. Press: 119–146.

Sonii D (1992). Adoption dynamics incentives and constraints the case of Agroforestry. Paper presented at ICRAF DSO training course.

Sood, K. (2006) Do Soci-Psychological Factors Matter in Agroforestry Planning/Lessons From Smallholder Traditional Agroforestry Systems

Sorre, B. (2005). Effect of Sugarcane production on food security and nutritional status on Nambale Division, Busia District: Kenya

Styger, E., and Fernandes, E. (2006). Contributions of managed fallows to soil fertility recovery. London, New York: Taylor and Francis

Staudt, K., (1975). Women Roles and Gender Differences in Development Agriculture

Policy Implementation. *A case Study from Western Kenya*. West Hartford: Kamarian Press

Sullivan, G. (1992), Financial and Economic Analyses of Agroforestry Systems: Proceedings of a Workshop held in Honolulu, HI, USA.

Swinkels R, and Franzel (1997) The economics of short rotation improved fallows: evidence from areas of high population density in western Kenya. Agricultural Systems 55: 99–121

Swynnerton, R. (1953). A Plan to Intensify the Development of African Agriculture in Kenya. Nairobi: Government Printer

Tefera, A., Rao, M.R. Mathuva,M.N. and Atta-Krah K. (1999). Farmer-participatory Evaluation of grevillea robusta in Boundary planting in semi-arid Kenya. Forest, Trees and Livelihood 11: 13-27

Tengnas, B. (1993). *Guidelines on Agroforestry Extension Planning in Kenya.* Nairobi: SIDA/Regional Soil Conservation Unit.

Tengnas B. (1994). Agroforestry; communication; extension; multipurpose trees; land use Agroforestry extension manual for Kenya. Nairobi: International Centre for Research in Agroforestry

Thangata, P. (1996). Resource Poor Farmers' Perception of Agroforestry Practices—A Case Study of Malawi. MSc dissertation University of Edinburgh, Scotland, UK. (unpublished).

Thangata, P. and Alavalapati, J. (2003). Agroforestry adoption in southern Malawi: the case of mixed intercropping of Gliricidia sepium and maize. *Agricultural Systems*, *78*(1),

Tsunchiro, O. (2010) Estimating Agroforestry's effect on Productivity in Kenya. An Application of a Treatment Effects Model

Tyndall, B., and Franzel, S. (1998). Boundary Plantings of Grevillea Robusta: The Adoption of an agroforestry Technology. Paper presented at the National Agroforestry Project Research Symposium, 9-11 December, 1998, Embu, Kenya.

Unruh, J. (1993). Carbon storage in agroforestry: an estimate for sub-Saharan Africa. *Climate Research* 3: 39-52.

Van Asperen, P. and Mulolwa, A. (2006). Improvement of customary Tenure Security as Pro-poor Tool for Land Development*: A zambian Case Study*: UNZA. (TS 18.3

Van Gelder, and B, Kerkholf P (1984). The agroforestry survey in Kakamega District. Kenya Woodfuel Development Programme, working paper no.3. Nairobi, Kenya. Workshop held in Arusha, Tanzania. The African Academy of Sciences (AAS). pp. 156 - 170.

Vanlauwe, B.and Giller K. (2006). Popular myths around soil fertility management in sub-Saharan Africa. *Agricultural Ecosystem and Environment,* 116:34-46.

Verchot LV, Noordwijk MV, Kandji S, Tomich T, Ong C, Albrecht A, Mackensen J, Bantilan C, Anupama K, Palm C. (2007). Climate change: linking adaptation and mitigation through agroforestry. Mitigation and Adaptation Strategies for Global Change 12:901-18.

Vosti, S. and Witcover, J. (1996). Slash-and-burn agriculture: household perspectives. *Agriculture, Ecosystems & Environment*, *58*, 23-38.

Wannawong, S., Belt, G.. and McKetta, C.. (1991): Benefit-cost analysis of selected agroforestry systems in Northeastern Thailand. Agroforestry Systems 16: 83-94.

Warner, K. D. (2006). Extending agroecology: Grower participation in partnerships is key to social learning. *Renewable Agriculture and Food Sytems, 21*(2), 84-94.

Williams, A., Gordon, H., Garrett, E.,and Buck. L.(1997) Agroforestry in North America and its Role in Farming Systems, ed. A. M. Gordon, and S. M. Newman, CAB International, pp. 9-84

Wise, R, and Cacho, O. (2005). A bio economic analysis of carbon sequestration in farm forestry: a simulation study of Gliricidia sepium *Agroforestry System*

Wu, Y. and Zhu**,** Z. (1997). Temperate agroforestry in China. *In* A.M. Gordon & S.M. Newman, eds. *Temperate agroforestry systems*, pp. 149–179. Wallingford, UK,

Zenebe, G., Mekonnen, A., Kassie, M., Köhlin, G. (2010). Household Tree Planting in Tigrai, Northern Ethiopia *Tree Species, Purposes, and Determinants* Environment for Development Discussion Paper Series

Zinkhan, C., and Wear, D. (1992), Development of a Multi attribute Utility Approach for Evaluating Potential Agroforestry Systems in the South, Study Plan for USFS and Campbell University Cooperative Agreement.

Zubair, M., and Garforth, C. (2006). Farm level tree planting in Pakistan: The role of farmers perceptions and attitudes. *Agroforestry Systems, 66*, 217-229.

APPENDIX I: HOUSEHOLD QUESTIONNAIRE

Dear Respondent,
I am a student at University of Eldoret undertaking a Masters Degree in Environmental Studies (Human Ecology option). As part of the Degree requirements, I am undertaking a research study entitled "***Factors influencing adoption of agroforestry practices among rural households in Kenya: A case of Nambale division, Busia county*** You have been identified as one of the respondent to provide information for the study. This is therefore to request you to complete the questionnaire as honestly as possible. All information that you provide shall be treated with utmost confidentiality and will be used for the purpose of this study only.

Yours Sincerely,
Agnes Mugure
Tel. 0720567317

PART 1: RESPONDENT'S CHARACTERISTIC

1. **In which location do you stay**? ……………………….
2. **Gender** 1.male 2.female
3. **What is your age group?**

   1.18-25

   2.26-35

   3.36-45

   4.46-55

   5.56-65

   6. above 65 years
4. **Highest level of formal education reached?**

   1. No formal education

   2. Primary level

   3. Secondary level

   4. College level

   5. University level

5. **Household size?**

    1. 1-3 members

    2. 4-6 members

    3.7-9 members

    4. 10-12 members

    5. More than 12 members

6. **Marital status**?

    1. Single 2. Married 3. Separated/divorced 4.. Widowed

7. a**). What is your main occupation**?.............................

    b). **Do you engage in other forms of occupations to supplement your main occupation?** 1. Yes 2.No

    c) If yes, which ones? …………………………………………………………

8. **What is the average household income per month? K.Sh…………………..**

PART II: TYPES OF AGROFORESTRY IN THE AREA

9. a) **Do you plant trees** 1.yes 2. no

    b) **If yes, what kind of trees and how many?**

Types of trees	**Amount planted**
1.	
2.	
3.	
4.	
5.	
6.	

c).What is the main use of trees you have planted?
1. Income
2. Fuel
3. Building materials
4. Fruits
5. Fodder
6. Shade
7. Other (specify)

10. What is the location of trees on your farm?

Location of trees on the farm	**Can tick more than one**	**Tree species**
Alley cropping		
Fodder bank		
Boundary markers		
Live fencing		
Wind breaks/shelter belts		
Wood lot		
Dispersed trees(homesteads)		
Home garden		

11. a)Do you face any challenges in tree planting?
1. yes 2.no

b) If yes, what problems?

1. Lack of knowledge
2. Scarcity of seedlings
3. High price of seedlings
4. Draught
5. Other (specify)

12. a) What livestock do you have?

Type of animal	**Number of animals**	**use for which the animal is raised**
cattle		
goats		
sheep		
chicken		

b) What are your main challenges with livestock production?
1. Lack of grazing area
2. lack of feed
3. Diseases
4. Lack of land for growing fodder

PART III: FARMER FACTORS

13. a) Do you own the land you stay on? 1. Yes 2. No

b) If yes, how did you acquire it? 1. Bought 2. Inherited

3. Others (specify)……………………………………………

c) What is the size of the land? ………………..acres.

d) Are you satisfied with your land size?
1. yes 2.no

14. What is your cropping pattern?

1. Monocropping 2.mixed cropping

Monocropping	Mixed cropping	Both

15. What are the main cash expenditures of your household

Cash expenditure	Tick appropriately
Staple food	
firewood	
Building materials	

16. What are the main sources of cash (income) for your household?

1. Sale of cash crops
2. Surplus food crops
3. Sale of livestock or livestock products
4. off-farm employment
5. Other (specify)

17. What off-farm activities do you practice?

1. Charcoal making
2. Brick making
3. Bodaboda
4. Carpenter
5 others (specify)

18. Who in your household makes decision on the following farm activities?

Farm activity	Male	Female	Shared
Maize for sale			
Maize for home consumption			
Cash crop(cassava,sugarcane)			
vegetables			
Fruit trees			
Fodder and grass			
Soil fertility trees			
Woodlot establishment			
Labour recruitment			
Use of inorganic fertilizer			
Change of land use			
Boundary and live hedges			
Type of trees			
Livestock			
Other(specify)			

PART IV: TECHNICAL FACTORS

19. 17. Have you ever heard of agroforestry practices?

1. yes 2.no

Do you know any existing agroforestry programme in your area ?

1. yes 2.no

If yes, which one?

20. From whom did you first learn about agroforestry?

	From whom first learnt*(mark only one)*	**From who learnt(*mark all that apply)***
Fellow farmer		
Agricultural extension officer		
neighbour		
Radio programme		
booklets		
researchers		
friends		
Other(specify)		

21. How often did you receive a visit or go to visit extension officer in the last 12 months? (*Mark only one in each)*

Frequency of visits	**Farmer visits to extension officer**	**Farmer receive visits from extension officer**
No visit		
1-3		
4-6		
7-9		
10-12		
Above 12		

22. What is your main source of agricultural information?

Source	**Mark all that apply and rank them**	**Rank**
Farmer groups		
Village elders		
Researchers		
Neighbours		
Friends		
Extension officer		
Other farmers		
Own family		

23. What encourages you to engage in the existing agroforestry practices?

………………………………………………………………………………………
………………………………………………………………………………………
…………

24. What is the main challenge in practicing agroforestry?

CHALLENGE	**Tick appropriately**
tree species	
Cost of seedlings	
Market of products	
Land size	
Extension services	
Cash crop farming	

25. What do you think would improve the use of agroforestry practices
………………………………………………………………………………………
………………………………………………………………………………………
……………………………………………………………………………….

PART V: COMMUNITY FACTORS

26. . a).Do you have a common practice which encourage agroforestry in you area?

1. yes 2.no

If yes, which
……………..…………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
…………..

27. Do you have a common belief which discourages agroforestry?
1. yes 2.no

If yes, which one…………………………………………………………………..

PART VI: BENEFITS OF AGROFORESTRY

28. Have you realized any benefits of agroforestry?
1. yes 2. No
If yes, what are the benefits from the different tree crop?

29. Give the different products from the agroforestry practices and indicate how they are consumed.

APPENDIX 2. PLATES

Plate 1: Grevillea trees intercropped with bananas (Field data, 2011)

Plate 2: Grevillea Trees Seedlings Planted in Pasture Land (Field data, 2011)

Plate 3: Cured bricks ready for sale (Field data, 2011)

Plate 4: Trees around the homestead (Field data, 2011)

Plate 5: Animals grazing under trees (Field data, 2011)

Plate 6: Extensive land with sugarcane (Field data, 2011)