Differences in tree and shrub species on farms in the East Mau Catchment, Kenya

- considering agro-ecological zone and ethnicity

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I dedicate this work to my parents, Anna und Erich for their unending encouragement, support and motivation.

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Abbreviations

ET - Evapotranspiration

GPS ï Geographical Positioning System

GL-CRSP ï Global Livestock ï Collaborative Research and Support Program

ICRAF ï International Centre for Agroforestry Research

KFWG ï Kenya Forest Working Group

LEISA ï Low external input and sustainable agriculture

masl ï Meters above sea level

MEA ï Millennium Ecosystem Assessment

OAT ï Organic Agriculture with Trees

SUMAWA ï Sustainable Management of Watersheds

UN ï United Nations

1 Introduction

1.1 Statement of the Problem

Rapid population growth in the East Mau Catchment has led to expansion of cultivation, deforestation through logging, charcoal burning, firewood collection and overgrazing. The removal of vegetative cover from unprotected slopes leaves the soil highly vulnerable to erosion during heavy rains. In view of the increasing scarcity of arable area relative to population, the long periods of natural fallow for regeneration of soil fertility are no longer possible. The productivity of agricultural land is rapidly declining. Possibilities of increasing soil fertility by applying mineral fertilizers are limited for both ecological and economic reasons. There is therefore an urgent need to develop alternative strategies to mitigate these problems. Although strategies such as agroforestry, agro-biodiversity and organic farming are envisaged to provide some resilience, these technologies have previously been promoted in many parts of Kenya, but their adoption is still limited. Maintenance of a highly diversified crop, trees and livestock on-farm is one important aspect in these technology packages. However, this approach to conserving agricultural biodiversity remains unfamiliar, ambiguous, and controversial to many people. There has been little exploration of farmersô knowledge on tree and shrub species in the East Mau Catchment.

The aim of this study was to record the differences of preferred tree and shrub species among farmers of three different agro-ecological zones and among three ethnic groups, settled in the East Mau Catchment. This also looked at how these farmers maintain and cultivate their most important woody species.

1.2 Justification

Agroforestry is identified as an alternative way for sustainable agriculture (Collins and Qualset 1999; McNeely and Scherr 2003; MEA 2005) and has a high potential to prevent soil degradation (Okoba *et al.* 2005). Agroforestry can serve to bridge the conflict between the need for conservation of biodiversity (Atta-krah *et al.* 2004) and provision of needs of human society (McNeely and Scherr 2003).

The East Mau Catchment is inhabited by five Ethnic groups, who live mainly as farmers and have to cope with a high rate of soil degradation due to land cover changes (Baldyga 2007). Through their diverse cultural backgrounds farming systems might be different and their knowledge on plants varies. Woody plant species are perennials and need special maintenance and a specific site on the farm, in order to avoid competition between trees and planted crops on the field.

Other studies done by Kindt *et al.* (2002) identified species and use groups but didnœt consider cultural backgrounds and gender of the farmers. This study aims at filling this gap by analysing and documenting the variety of farmerœs knowledge on their use and preferred species while considering their cultural background, gender and agro-ecological zones, which indicate the farmersô base conditions.

2 Literature Review

This chapter gives an overview of the region with its natural assets, its environmental, economic and social problems and how the Mau Catchment area can be restored. A short history will give an idea how the land use has changed in the past to understand the necessity of environmental conservation and improvement.

2.1 *Characteristics of the Region*

It is necessary to consider the characteristics of the research area and to understand the problems which are occurring in the region. The discussed problem is occurring in many tropical regions as the initial conditions are the same.

2.1.1 Kenya

The Republic of Kenya is situated at the equator in East Africa between 5°S- 5° N and 34° - 42°E, bordering the Indian Ocean to the east and Lake Victoria in the West. Due to a well-developed tourism sector Kenya is well known for its unique wildlife reserves.

The highlands of Kenya cover an area of 85 000 km^2 and accommodate 8-10million inhabitants, corresponding to 15% of Kenyaôs total land area and 40-50% of its total population (Kindt 2002). The Population of Kenya in 2006 is estimated to be 36,5 million with an annual population growth rate of 2,7% (UN 2009). The land area is 569 140 km^2, whereof only 6% is covered by forests (UN 2009). ñVision 2030ò is the countryôs new development blueprint for the period 2008 to 2030. It aims to make Kenya a ñmiddle income country providing high quality life for all its citizens by the year 2030ò (UNEP 2009).

Although Kenya is situated close to the equator the climate is not too characteristic for tropics, due to the relatively high elevation. (Nairobi 1700masl). The average annual rainfall in Nairobi is about 900mm, showing annual variations between 500 and 1 500mm. It has to be considered that various climate zones exist between the coastal region and the highlands.

It needs to be considered that the rainy seasons are very variable and canôt be well defined (Meteo.go.ke). Long-term mean annual rainfall varies from 1 200mm in the upper catchments of river njoro to 800mm at Lake Nakuru (this covers the study area *Figure 4)*

There are **two rain seasons**, the long rains from mid-March to end of May and short rains from mid-October to mid-December. In the Highlands above 1 800masl the nights are relatively cool.

The coolest period is between July and August with temperatures around 10°C and the warmest period stretches from January to February with temperatures around 26°C. Especially in the Highlands high fluctuations between day and night temperatures can be observed.

The temperature regime in the upper catchments is considered suboptimal for the current maize-dominated agriculture production system, because the annual potential evapotranspiration, estimated at 1 150 mm/year, exceeds rainfall infiltrations capture and supply regulation to the semi-arid valley below (Jenkins *et al.* 2004). Some boreholes dry up, resulting in public alarm and periodic water rationing by Egerton University located in the middle of the watershed (GL-CRSP 2006; Personal communication with students)

2.1.2 East Mau Catchment

The Mau Complex forms the largest closed canopy forest ecosystem of Kenya and covers an approximate area of 350 000 hectares (Sang 2002). The Mau Forest Complex is the single most important water catchments in Rift Valley (see *Figure 1*) and western Kenya, and considered one of Kenyaǿs five major ñwater towersò (KFWG 2006) next to Mt.Kenya, Aberdares, Cherangani Hills and Mt.Elgon. Through the ecological services provided by its forests, the Mau Complex is a natural asset of national importance that supports key economic sectors in Rift Valley and western Kenya, including energy, agriculture (cash crops like tea and rice; subsistence crops; and livestock), water supply also for urban centres and tourism being critical water catchments to major conservation areas like South Turkana National Reserve, Kerio Valley National Reserve, Lake Nakuru National Park, Lake Baringo, Lake Natron, Maasai Mara National Reserve, Serengeti National Park, Kakamega Forest National Reserve (UNEP 2008).

Despite its critical importance for sustaining current and future economic development, the Mau Complex has been impacted by extensive illegal, irregular and ill planned settlements, as well as illegal forest resources extraction (UNEP 2008). Eastern Mau Forest Reserve is located in Nakuru District and managed by the Kenya Forest Service. It is the main upper catchment of the four rivers (Makalia, Naishi, Nderit, Njoro) flowing into Lake Nakuru (UNEP 2008).

Figure 1: Map of Kenya - Rift Valley **Source: Kenya view 2009**

It was one of the two largest forest blocks in the Mau Complex, covering 65 921 hectares, of which 35 301 were excised starting mainly from 2001. Representing 54% of the dense vegetation cover, including forest, has been lost in the catchment of Lake Nakuru between 1973 and 2003. Largest contributor to this loss has been the 2001 forest excision (see ñPortion Kò in *Figure 2*). There are still some indigenous forest areas with very low settlement density near and over the summit of the Mau Escarpment that should be preserved (see ñPortion Lò in *Figure 2*).

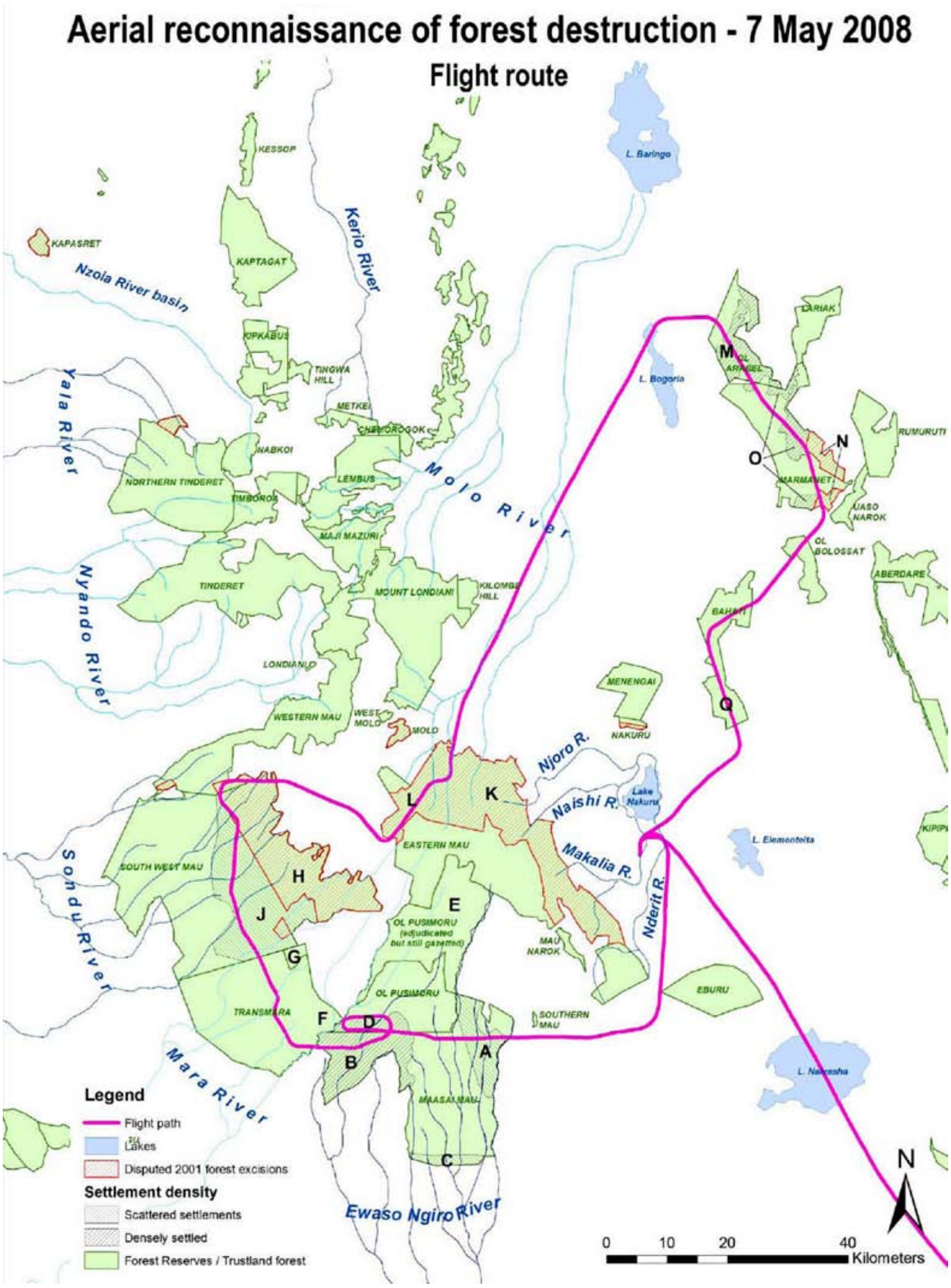

Figure 2: Mau Forest Complex - Flight path of aerial reconnaissance. Source: UNEP 2008

The excised area is the main catchments for Lake Nakuru and covers main ridges and peaks along the top of the Mau Escarpment, including areas between 2 800 and 3 000 masl that were covered with bamboo forests, a vegetation cover with high catchment values. Upper ridges, summits, hilltops and steep slopes along the Mau Escarpment are not suitable for settlements. These areas are critical catchment areas with very high soil erodibility (high risk of soil erosion and siltation of rivers and lakes) and should be preserved. The low settlement density and large parcels of land in some exercised areas, some being wheat farms as revealed by the aerial point sampling, suggest that people settled in those area may not be genuine land less people. (UNEP 2008).

2.2 History and "Status quo"

This chapter gives an overview on socio-political events in the research area. Historical and political forces influenced settlement patterns and therefore the farmers' perceptions and management of natural resources in the research area. The current problems of deforestation, land use changes and land degradation are discussed.

2.2.1 History of the Research Area

During the pre-colonial time, pockets of the forest were inhabited by the semi-nomadic Ogiek peoples, who have lived in the area for hundreds of years (Sang 2002) subsisting by hunting, gathering, and collecting honey from beehives placed high in forest tree branches (Obare *et al.* 2009). Interested in the extraction of forest timber resources, and to a lesser degree in the establishment of settlements in the fertile valley and lower slopes of the watershed, the arrival of the British forever changed the Eastern Mau landscape (Krupnik *et al.* 2006). The British were already aware of the important ecological and hydrological services of riparian vegetation and enforced forestry policies prohibiting the felling of these areas.

Until the 1960s the traditional system was mainly based on self-sufficiency. Increasing population growth and new settlers resulted in high land pressure. Food shortage resulted in need for an intensification of the production. Forest and woodland was converted in farmland (Freyer 2007). In the 1970s the Green Revolution was imposed on the system from the outside (Chapman 2002). External inputs are too costly for small scale farmers and therefore not sustainable (Sanchez *et al.* 1997). The natural fertility declined rapidly probably due to toxicity problems of chemical fertilizers (Freyer 2007). The collective sense of responsibility for the conservation of natural resources such as forests, biodiversity and soil fertility was lost with the exception of some forest dwelling groups. The focus in the farming system shifted to cash generation (Kindt 2002), dependent on the external developments and based on the money economy in combination with population growth. To cover the nutritional needs of the growing population, the pressure on the land increased (Boserup 1975). The green revolution leads to a social, ecological and economic disaster (Chapman 2002). Farmers could not afford the green revolution packages and the reduction of biodiversity and the over intensification lead to human and environmental damages. Since the 1980s there was the attempt to counter this development through the introduction of the LEISA system and the reintegration of agroforestry (Freyer 2007).

The most recent phase of large-scale deforestation began in the early 1990s when the Government of Kenya began allocating forested lands to the landless culminating with the decision to de-gazette significant portions of the Mau Forest (KFWG 2006). In this current phase higher elevation portions in the upper catchment have come under cultivation by relatively poor immigrant farmers settling on clear-cut areas (Krupnik *et al.* 2006).

2.2.2 Deforestation, Land Use Changes and Land Degradation

Deforestation

The destruction of the Mau forests threatens the livelihood of many people. The loss of the forest results in a change of the micro-climate in the region. It generates high runoff rates, soil erosion, low water storage capacity, declined agricultural productivity (degraded soil and natural resource base), food insecurity, exhausted soils, low water table and decreased or dry water flow in the rivers during the dry season. The research area is an upper water catchments area and the use of land, water and other resources can affect the quality and availability of water, and in turn the livelihood options, available to people living downstream (CIAT 2005). Degazettement of forest reserves (excisions) and continuous widespread encroachments have led to the destruction of some 104 000 hectares representing over 24% of the Mau Complex area over the last 10 years. In 2001, 61 023 hectares of forest in the Mau Complex were excised. In addition, some 43 700 hectares have been encroached in the remaining protected forests of the Mau Complex (UNEP 2008). The Mau Forests continue to be destroyed at an alarming rate (UNEP 2008). Over 9000 ha, almost exclusively indigenous forest, were cleared between 2003-2006 showing a decrease compared to deforested area between 2000 and 2003. Another disturbing observation from Mau is that there are a number of new sites that show deforestation (KFWG 2006).

Land Use Change

The demand for more land for settlement as well as other socio-economic activities such as grazing, mining, collection of firewood, timber and non-timber forest products have greatly contributed to reduction in natural habitat and decimation of forest cover and biodiversity

(Holmgren *et al.* 1994, Imbernon 1999, Jama *et al.* 2008, Kibet et al..2006). The changes in land use have been dramatic rapid, spanning little more than a decade. For five land use types (indigenous forest, exotic trees, grazing land, deforested areas and agricultural land) Onyando *et al.* (2005) analysed soil erosion and surface runoff. Soil erosion is highest for grazing land, deforested area and agricultural land, while surface runoff is highest for deforested areas, agricultural land and grazing lands. Lowest rates appear within indigenous forests.

These alterations in land uses, most notably the decline in forest cover (*Figure 3*), may be impacting hydrological functioning at the landscape scale and compromising water quantity and quality services within the Njoro Watershed (Shivoga *et al.* 2002). Riparian forests are declining due to increased settlement where people need to meet their needs for firewood. The upland land uses are as important as near-stream land uses. Therefore it is necessary to preserve intact riparian corridors along the river as they provide natural purification and recovery of the ecological integrity of the River Njoro (Shivoga *et al.* 2005).

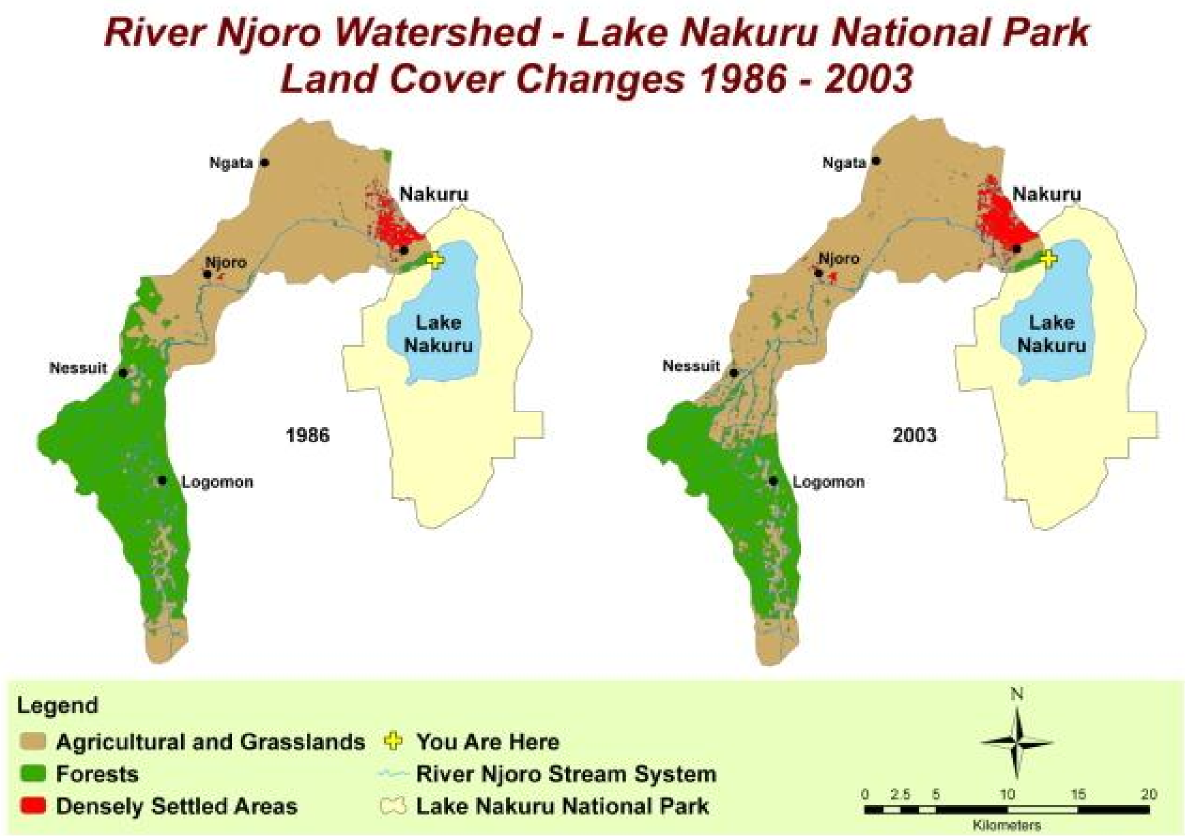

Figure 3: River Njoro Watershed - Land cover changes 1986-2003 Source: SUMAWA

Land Degradation

Deforestation accelerates land degradation in different ways. It leads to changes in the hydrologic cycle which further leads to flooding, increased soil erosion (Pimentel 1999) , and can eventually lead to desertification. This slow process caused by natural resource degradation is resulting in decreased land productivity (Baldyga *et al.* 2003; Aboud 1993)

Deforested land is prone to erosion, which means considerable nutrient movement. Most of the loss is attributed to continued irrational settlement of people within Mau in areas including those which are prone to erosion and unsuitable for agriculture (KFWG 2006). The result of intensive cultivation of steep slopes without adequate soil conservation measures is soil impoverishment through soil erosion (Khroda 1988, UNEP 2008). Wôangôati (2006) argues that the spiral of land degradation, reduced productivity, reduced farm incomes, and mining of the land resources has reduced the once prosperous highland communities to poverty and food insecurity.

The lack of fuel wood, which is also a gender issue, results in further reduction of soil fertility as farmers are increasingly using crop residues as fuel in order to meet their energy needs (Amede 2003; Anderson and Fishwick 1984; OôKneefe *et al.* 1985; Sanchez 2002; Kituyi 2004).

Although several technologies and management measures are in place to reduce soil erosion, conservation programs in Kenya have produced only patchy and unsustainable conservation of soil and water resources (Pretty *et al.* 1995). A lack of appreciation of Kenyan farmers' knowledge and their perceptions of soil erosion and soil conservation measures is the reason for low adoption of these technologies (Okoba *et al.* 2005). Paradoxically, tree density and diversity on farms is high (Kindt *et al.* 2006) - a phenomena Bradley *et al.* (1988) described as ómore people, more treesô. There is increasing evidence that as natural forests recedes or get degraded, farmers in many situations have historically taken up planting and managing of trees on their lands to provide the needed outputs. These trends have been observed in Kenya (Pretty *et al.* 1995, Holmgren 1994).

The trees, however, are typically planted for specific purposes, including fuel, food, shade, medicine, ornamentals, timber, boundary, soil fertility, construction, fodder, cash (Kindt *et al.* 2002). Through different ethnicities and geographical location of farms these purposes and therefore the use and preferred tree species on the farm might be diverse.

2.2.3 Traditional Knowledge

Local knowledge related to agriculture can be defined as indigenous skills, knowledge and technology accumulated by local people derived from their direct interaction with the environment (Altieri. 1990). Traditional farming system based on indigenous knowledge become a research topic for agriculturalists, who are increasingly interested in using and integrating indigenous knowledge into the development of current agricultural systems (Freyer 2007, Roling *et al.* 1999). Increased application of indigenous knowledge to rural research and development can be attributed to the need to improve the target of research to address client needs and thus increase adoption of technological recommendations derived from research (Walker *et al.* 1995). There is a wide diversity of local knowledge on natural resource management from the 42 indigenous communities in Kenya that can be relied for maintenance of healthy ecosystem (Mathiu *et al.* 2007).

It must be understood, that local perceptions of environmental processes can at times be inaccurate and differ from outside perception (Adams, 2003). Without scientific input, local knowledge systems may not be able to cope with changing environmental circumstances (Barrios and Trejo 2003). This can result in ecological degradation beyond the point of recovery for existing environmental services (Krupnik *et al.* 2006). By the green revolution the development of agriculture was shaped by governmental programs. Not only the local indigenous knowledge has either diminished in its status or it has been suppressed (Freyer 2007) but also local seeds got lost and therefore accelerates biodiversity loss (Shiva 1996). Freyer (2007) argues that purposeful application of tools and methods such as mulching, composting, cultivation of legumes, agroforestry, water harvesting and dripping irrigations is found to be uncommon in these regions (sub tropics) and it remains open, which of the traditional methods, developed in certain specific ecological and social circumstances in the past would be applicable to the present requirements. Over centuries farmers developed a diverse and locally adapted agricultural system conserving agro-biodiversity (Altieri 2004). But it needs to be considered that traditional agriculture was developed in a time when there was still much more cultivable land per person available and the pressure on land intensified until today (Freyer 2007).

2.3 Constraints, Potentials and Solutions for Reforestation

To conserve the natural assets and the environmental services of the Mau Catchment area it is necessary to restore the forest habitat. The loss of the forest and settlement in unsuitable areas lead to tremendous environmental, social and economic problems. The efforts of nature conservation programmes face different constraints. As potential solutions agroforestry and organic farming are discussed.

2.3.1 Constraints to Nature Conservation and Environmental Improvement

Kenya faces serious environmental challenges due to previous forest mismanagement, and deforestation is a key symptom of environmental damage. Up to date information on the condition of the forests is often lacking, limiting the ability of concerned stakeholders inside and outside government to lobby or direct actions against illegal exploitation and destructive development (KFWG 2006). Kenyanós livelihoods are closely linked to their access to natural resources. As Kenyan population increases and environmental quality continues to decline, there is an increased risk of social and economic destabilization, which will have significant impacts on overall national security. Rural people are among the most vulnerable and insecure in terms of poverty, health, food security, economic losses, and conflicts resulting from competitive access to natural resources, among other factors (UNEP 2009).

Socio-political tensions weaken the efforts of improvement strategies, but in many researches conservation areas are misrepresented as ecologically and socially homogeneous, as well as politically neutral (Daniels and Bassett 2002). Both biophysical restrictions and socio-political forces impact farmersô attitudes towards the performance of their cropping systems and the use of local resources. Ignorance of historical and political issues undermines the potential to develop successful conservation interventions (Krupnik *et al.* 2006).

An organic agriculture-forestry land use system like discussed in Freyer (2007), will only work out if the farmers perceive the system as advantageous for them and if they adjust it to the environment while taking into consideration their own socio-cultural traditions.

On the one hand insecure land tenure system in the Lake Nakuru Basin is a constraint to environmental improvement, because it undermines the efforts of conservation organisations attempting to implement resource management plans (Daniels and Bassett, 2002). Rights over trees are often distinct from rights over land (Fortman 1985). On the other hand farmers plant trees around their property to strengthen the claim for their property rights (Krupnik *et al.* 2006). Presence of trees may have a role in securing or maintaining rights of use or tenure. Sanginga *et al.* (2007) argues that land tenure system constraints natural resources management and conservation. There are other challenges to the implementation of sustainable farming systems, like manual work is less respected in the society than the application of pesticides.

2.3.2 Goals of Nature Conservation and Forest Restoration

It has to be recognized that small scale farmers are the main actors for the conservation of natural base. Proper land use management and a high variety of species on the farm reduce farmersô vulnerability (UNDP 1992) against poverty resulting of low yields due to soil erosion and drought. Nature conservation doesnôt need to exclude human beings from an area. But a land use system need to be implemented which increase small scale farmersô income and protect the environmental resources at the same time (Freyer 2007). Farmersô awareness of the problem is necessary to implement measures against soil degradation (Egger *et al.* 1995). The ecological land use system incorporates agroforestry systems, forestry systems and elements of the LEISA or conservation agriculture system, all based on biodiversity (Freyer 2007).

The forest ecosystem of the Mau Complex provide invaluable ecological services, in terms of river flow regulation, flood mitigation, water storage, recharge of groundwater, reduced soil erosion and siltation, water purification, promoting biodiversity, micro-climate regulation, nutrient cycling and soil formation (UNEP 2008). The importance of the conservation and reforestation of the Mau Complex is generally recognized, not only by directly affected stakeholders, but also by the government. To attain sustainable development in Kenya environmental stability and secured provision of ecological goods and services will remain essential (UNEP 2009).

A society relying on a traditional agricultural system has to produce as much for their self-support which leads to species diversity, due to heterogeneity in species traits, characteristics of the environment and the relationship between species and environmental characteristics (Kindt 2002; Freyer 2007).

To gain an insight on the farmersô view of their environment and to discover their motivation to participate in conserving their environment is necessary for further projects in this area. Ownership and participation of the stakeholders is identified as the main objective for successful development project (Chamber 1995). Farmerõs livelihood strategies need to be considered to understand how they can meet their needs by improved management practices. Nyssen *et al.* (2009) argue that improvement is not only an outcome of intervention but also of innovation and adaptation processes.

Unfortunately the driving force to develop organic farming is mainly relied on exports, rather than an internally driven bottom up development (Freyer 2007). The increased export of products leads to a new constellation of the nutrient and humus balance to a higher dependency on external sources of nutrients and increased technical requirements (Freyer 2007). In Kenya the organic production is a fast growing sector, although the domestic markets are still rather small (Eyhorn *et al.* 2002). It should be in the interest of the farmers in a sustainable management of their own resources, in self-sufficiency as well as in the supply of the local and national markets with healthy food.

2.3.3 Agroforestry and Organic Farming

Agriculture is the management of the basis of life. Population pressure and inappropriate land use result in low yields and poverty. Conventional agriculture is not appropriate as it leads to dependency on fertilizers, which are not affordable for small scale farmers. Alternative farming strategies, like organic farming or agroforestry, and the awareness of the importance to treat the natural resources with respect are crucial to increase productivity without degrading the soils, which display the basis of farmersô livelihoods.

Agroforestry

Blume (1998) offer definitions and discuss the potentials of agroforestry. ICRAF (1993) defines agroforestry as follows:

óAgroforestry is a collective name for land-use systems and technologies, where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components'.

Agroforestry contributes to nature conservation especially for resource-poor farmers in tropical regions and offers economic and socio-cultural potentials (Blume 1998; Schroth *et al.* 2004; ICRAF 2008). Farmers have been increasing the number of trees on their farm to obtain critical consumption goods, to diversify the sources of income and to protect food security in the face of declining crop yields (Scherr 1997). They gain economic and environmental benefits by agroforestry, especially for crop and forestry production in tropical regions (Pimentel 1999). Farmers tend to grow trees as a security reason to lower vulnerability of food insecurity and poverty, but the tree density on the farms in the research area can't be considered as an agroforestry approach.

Nevertheless trees in agroforestry can affect rates of erosion in several ways: trees act as semipermeable barrier which slows the velocity of surface runoff; increase infiltration by the same mechanism and through improvement of soil structure; protect the soil from the impact of rainfall by production of litter layer; act as a sieve barrier to eroding soil and hence change the particle size composition of eroded sediments. (McDonald *et al.* 2003)

Because forest canopies intercept raindrops before the strike the ground, the kinetic energy intensity of drops is reduced (Stocking 1996) resulting in a more gentle impact on the soil surface than might have been if the rain path were uninterrupted, or interrupted by spotty crop cover (McDonald *et al.* 2003). Reduced raindrop impact assist in increased infiltration of water into the soil subsystem by reducing the potential for splashing, crusting and compaction of the soil surface (Krupnik *et al.* 2006).

Under some circumstances trees can increase the potential for forceful raindrop impact ï called ñBucket Phenomenonò ï but this is more an exception than the norm (McDonald *et al.* 2003; Stocking 1996). Without forest cover precipitation is less likely to recharge soil subsurface storage and is more likely to result in increased runoff during and immediately after storm periods if no land management measures are taken (McDonald *et al*. 2002). The consequences are downstream riparian flooding during rainy season, and a reduction of base stream flow during the dry season, both of which are serious concerns when understood from environmental and economic production perspectives (Krupnik *et al.* 2006).

Organic Farming

Sustainable farming system would help to reduce poverty and food insecurity which result from low agricultural productivity. Organic agriculture offers alternative sustainable measures to increase soil fertility as it is considered being the most important factor for crop production (Egger *et al.* 1995; Eyhorn *et al.* 2002). Due to the discussed socio-political tensions, organic farming has a high potential as it is an ethically independent and world-wide oriented movement, it is more robust, interactive and open for innovations as well as for learning processes (Freyer 2007). Organic agriculture includes all agricultural systems that promote the environmentally, socially and economically sound production of food and fibres with a greater emphasis on soil fertility (Sanchez 1997).

Organic farming can be seen as an option as it helps to recover soil fertility. It helps to increase farmersô income due to additional value by certificates, which is considered as incentives for farmers following Egger *et al.* (1995). Organic agriculture, which is based on guidelines by IFOAM, works in a cyclic system approach, land is cultivated all the time and legume fallows in the short rain season increase yields in the long rain season for nitrogen fixation in the soil (Lelei 2004). It needs to be stressed that the natural resources are saved for the long term by organic farming, while the yields are the same compared to conventional production (Parrot *et al.* 2003).

The absence of chemical does not characterise an organic farming system, as it doesnǿt include sustainable measures. Freyer (2007) describes this as organic agriculture by default. Many farmers lack knowledge on sustainable farming systems, like green manuring, composting, nutrient cycling, the organic sector is relatively small in Kenya, although the absence of intensive chemical inputs due to economic reasons would facilitate the conversion to organic farming system (Sanchez *et al.* 1997). However, this sector is growing very fast, led mainly by NGOs and private sector (companies growing organic produce for export). Freyer and Bett (2007) give an overview on the history of organic farming sector in Kenya, which is a fast growing.

Arnold *et al.* (1999) argues that tree growing by farmers may be a direct or indirect response to deforestation, and can create additional supplies of wood and other products, but it does not recreate forests. Trees on the farm should be seen as farm household and livelihood strategies, which provide important farm level environmental services, like maintaining soil nutrients and limiting soil erosion. Environmental benefits should be seen as a by-product of farmersô pursuit of their livelihood goals. On the other hand remaining forest is more likely to be conserved if the local population can supply their needs on their farm without extracting from the nearby forest.

3 Conceptual Framework

3.1 Objectives

The general objective is to determine differences in tree and shrub species diversity among small holder farmers of three different ethnicities and located in two different agro-ecological zones in the East Mau Catchment.

The specific objectives include

1. To identify tree and shrub species on small holder farms and how farmers use them for medicine, food, fodder, domestic purpose, firewood, timber, etc.
2. To identify farmersô knowledge on maintenance of trees and shrubs.
3. To identify farmersô perceptions concerning biodiversity conservation and the relation of the trees on their farm and the Mau WaterCatchmentArea.

3.2 Research Questions

Use of Tree and Shrub species

- Which tree and shrub species are grown on small holder farms for which purposes?
- To what extent does the cultural background/agro-ecological zone affect usage or preference of different species?
- Is the farmerös production adequate for their use (self-sufficiency)?

Farmersô knowledge

- How do farmers grow and maintain their seed/seedling of tree and shrub species?
- Is a high biodiversity of tree and shrub species on small holder farms of the farmersô interest?
- Do farmers have access to seeds/seedlings in the community (Tree Nursery)?

Farmersô perception:

- Which further species would farmers prefer on their farm?
- What are the constraints/preferences for more trees and shrubs?
- Do farmers consider tree and shrub biodiversity as important concerning the conservation of the Mau Water Catchments Area?

3.3 Thesis Structure and Working Steps

This thesis begins by presenting the statement of the problem (Chapter 1). This is continued with a review of literature (Chapter 2) on the study area, a description of the present situation and the historical development of the current problems in this area due to changed land use systems. This chapter also includes a discussion on the constraints, potential and possible solutions for reforestation. Hence the conceptual framework of the thesis is explained (Chapter 3). Chapter 4 gives details on the methodology, the selection of sample farms, the development of the questionnaire and data analysis. The results (Chapter 5) are separated in four subchapters: the description of the interview situation, demographic analysis, analysis of the plant identification and the farmerôs constraints, knowledge and perception. Next to the presentation this chapter also includes interpretation and discussion of the results. The findings from the interviews lead to the conclusions on the situation in the East Mau Catchments area and several recommendations for stakeholders in this area.

In the following the working steps and the work plan are displayed. While the literature review was done in Austria, the planning of the field work was done at Egerton University in Kenya, where the OAT co-ordinator Rhoda Birech, the specialist for agroforestry Shadrack Inoti and the botanist S.T. Kariuki assisted. Eric Bett and Daniel Kyalo assisted with their expertise on the interviewing process and the analysing software. The work plan is displayed in Appendix *Table 11.5*. Due to the different situation in the field and time restrictions, it was not possible to follow the work plan exactly and some changes occurred in the practical field work. In *chapter 4.2* is also referred to this issue.

- Literature review
- Preparing a standardized questionnaire and planning of the field work
- Pre-testing of the questionnaire
- Interviews with farmers ï prepared questionnaire
- Plant survey on the farms during interview
- Further interviews with tree nursery ï triangulation and verifying
- Coding the interview protocols and analysing the interviews and plant lists
- Description, presentation and interpretation of the results

4 Methodology

This cross-sectional study tries to explain how far the different geographic location and various ethnicities influence the occurrence of used tree and shrub species on small holder farms in the East Mau Catchment. This chapter describes the study area, sample selection, the development and the structure of the required **standardised questionnaire** with closed- and open-ended questions and the difficulties which occurred concerning **language and formulation**. The structured interview with open-ended questions is conducted with specifically selected **samples** of 60 small holder farms. Further it describes the interview processes in the field and how the data is analysed and presented. The focus is on the farmers emic view and the plant identification is done along the farmerõs behavior intention. Only plants which are of the farmerõs interest are identified.

4.1 Site

The research area is divided in two agro-ecological zones (see *Results 5.2.1*) whereof each zone 30 samples are chosen (*Table 4.1*). These agro-ecological zones were identified and defined for prior studies of the OAT-project in the East Mau Catchment and are related to the elevation of the area. To define the location of sample farms GPS data is collected and a map (*Figure 4*) shows the exact position of the farms.

4.2 Sample Selection

The research tried to follow a planned itinerary (see *Research Matrix 11.1*), but this was not always possible in the field and different trade-offs were necessary. Reasons were the changed situation in the field, time restrictions and the necessity to hand over the sample selection to local guides. The research design was a parallel quantitative-qualitative design as described in Kelle (2008).

Primary data was collected with questionnaires from the field. In each household the person who is responsible for fields and garden was interviewed, if available. Situational the family decided who is qualified for doing the interview. The location of the farm was determined with GPS data collected at each farm. Within the single cultural group and Agro-ecological zone gendered knowledge is collected and compared, but the main objective is to interview the person of the household with the most knowledge on plants grown on the farm.

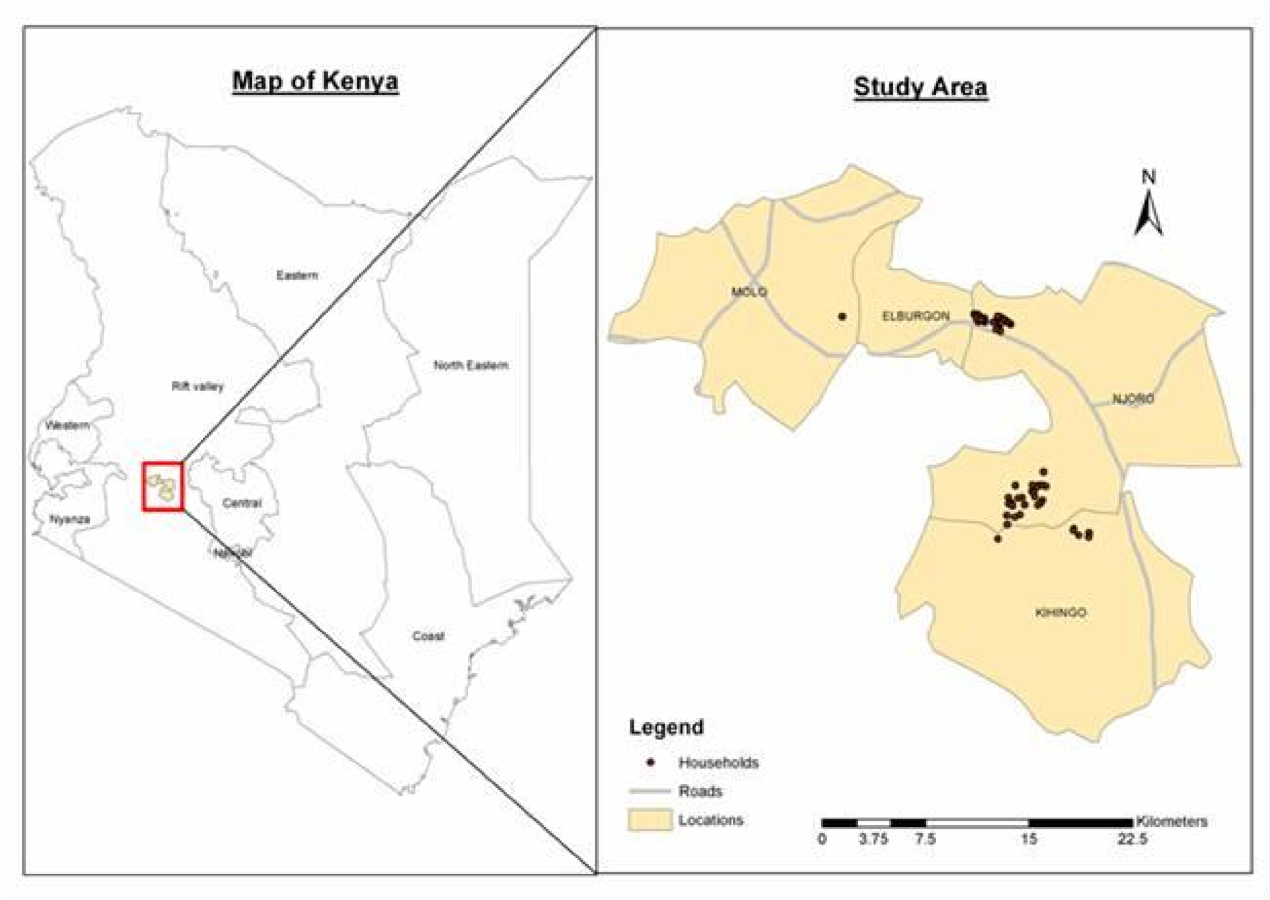

Figure 4: Study area **Source: Own data**

The population in the study area is not homogenous concerning the research interests of agro-ecological zone and ethnic group (see *Results 5.2.3*). Therefore the process of **stratified sampling** (Bortz & Döring 2006) is used. Agro-ecological zone and ethnic group were used to define the four strata. The problems of bias and further influencing factors are considered and tried to be avoided as possible (Mason 2002; Lamnek 2004; Atteslander 2006).

In this study farms are chosen in a very specific way. In two agro-ecological zones 30 small holder farms are chosen. In each agro-ecological Zone, farmers of two ethnic groups were interviewed to ensure a comparability of the collected data (Mason 2002). The samples in the lower zone cover two major ethnic groups, Kalenjin and Kikuyu, which cover about 80% of the inhabitants of the East Mau Catchment. In the upper zone Ogiek and Kalenjin households are interviewed, as they are the main groups in this zone. In a total 60 structured interviews with open ended questions were conducted with men and women of different ages.

Interviews were conducted with 60 small scale farmers between December 2008 and January

2009. Two weeks were spent in the upper zone, one week with each guide. Another two weeks were spent in each of the two villages in the lower zone. Three to six interviews were conducted per day, starting at 8 am, depending on time spent for each interview and the distance between the farms (between five minutes and one hour). With small holder farmers 30 interviews are carried out in each agro-ecological zone. Two different ethnic groups are interviewed in each zone, Kalenjin and Ogiek in the upper zone, Kalenjin and Kikuyu in the lower zone (see *Table 4.1*). Therefore a comparison of the agro-ecological zones without cultural influence is possible within the Kalenjin community and a comparison of preferences within different ethnical groups can be done without influence of elevation in each agro-ecological zone. Due to availability of farmers and time restrictions in the upper zone 14 interviews are conducted with Ogiek farmers and 16 with Kalenjin farmers. In the lower zone 16 interviews are conducted with Kikuyu farmers and 14 interviews with Kikuyu farmers.

Table 4.1 Sample Selection

Agro-Ecological Zone	Ethnic Group and Sample size (Number of Farms)		Villages
Upper Zone 2350 ï 2640masl	Kalenjin (16)	Ogiek (14)	Nessuit, Sigotik
Lower Zone 2130 ï 2250masl	Kalenjin (14)	Kikuyu (16)	Sosiot, Kamwaura

Source: Own data

In the upper agro-ecological zone, Nessuit and Sigotik, two local guides (see *Interview team 4.4*) of each specific ethnic group were identified to select farms. This facilitates choosing target farms.

In the Lower Agro-ecological Zone farms are chosen by ad-hoc-sampling and snowball sampling (Bortz & Döring 2006). Kamawaura is a Kikuyu village. During the colonial time it was a big stately home and later on sold as smaller plots to Kikuyu families (Personal communication). The farms border each other and it is easy to orientate.

In Sosiot Kikuyu and Kalenjin people live shuffled and the farms are slightly bigger than in Kamwaura. Due to farm characteristics like big dense fences and cropping systems like pasture area for cattle it was not difficult to identify targeted interview partner. For validation interviewed farmers identified following households of the same ethnic group and a member of the family showed us the way.

4.3 Language and Formulation

The Questions are formulated in **English** and in a way that they are easy understandable for the interview partner. English is next to Swahili an official language in Kenya. Although most interviewees speak English they choose to do the interviews in Swahili, which is also not their mother tongue, but a language they use in their everyday life, communicating with members of other ethnic groups. The translator is not able to understand the farmersô mother tongues, which is no barrier. Protocol notes of each interview were written down in English by the interviewer. Also for the interviews done in Swahili the translator wrote down the protocol notes in English. Because of the translation a pre-coding appeared as different words were translated in similar English terms.

The language is a major problem for the validity of the data, as two different languages (English and Swahili) are used. There may be a different understanding of single terms in each language and information might be lost due to translation mistakes (Maybin 1994). The conditions are for each interview partner the same and it was beneficial that the translator accompanied me for all 60 interviews.

To use a language and a formulation which is understandable, scientific terminology is paraphrased (Lamnek 2005). Expressions like ñBiodiversityò or ñFarming Systemò were rephrased (see *appendix 11.2.2 ï Questionnaire* for exact formulations). Nevertheless problems occurred with single questions, e.g. concerning future expectations, imaginations and perceptions. These questions needed further situational explanations by the translator.

4.4 Interviewer Team

A translator[1], who is familiar with and qualified for interview situations, accompanied me for all 60 interviews to give the farmers the choice whether to do the interview in English or in Swahili. This is important to get farmersô subjective answers. He introduced the researcher and explained the research background. This was important due to major conflicts between ethnic groups and an unsettled political situation in the Mau Forest. The government was doing interviews in the area at the same time. Three respondents refused to do the interview due to slight uncertainty. During the planning phase of the research, there was also a security aspect to find a translator, who

[1] James Kioko Paul is a former student from Egerton University. His cultural background was beneficial for the research as he was not a member of a target ethnic group. He assisted already for previous researches as interviewer.

accompanies me for all interviews, but after the first day in the area, this issue wasnôt considered as necessary. The gender aspect was considered why a male translator accompanied me.

In the **upper Zone** a **local guide**[2],[3] deemed to be necessary due to unsettled political situation in the area. The local guides live in the research area and were already recruited for earlier research on medicinal plants, supervised by Dr.S.T.Kariuki (Guide A) and researches of the SUMAWA-project (Guide B).

The guidesô functions are to lead the researchers around in the villages and to choose farms of the targeted ethnic groups. Another important function was the orientation in the field. The guides were asked to choose farms which are reachable within a circuit-walk on a daily basis, starting from Nessuit. According to themselves they selected households according to the varieties of shrubs and trees on their farms, in order to capture a broad variety of households. They also tried to select farmers who are more likely to participate in the interview and who have a sense for environmental conservation. With most farmers the guides are familiar with.

Guide A explicitly didnôt lead us to his farm, ñI already know the interview questions and many purposes for plants I heard the last days, would influence my answersé ò. Guide B lead us to her home, where an interview was done with her mother.

It was important to have a separate guide for each targeted ethnic group. In some cases the guides wouldnôt accompany us to households of the neighbouring ethnic group due to tensions which are still in place since the post-election violence 2008 (Thilke 2008). The guides introduced us to the farmers. During the interview the guides had no specific role and didnôt influence the farmersô answers. They kept themselves in the background, except the farmers asked them specifically for advice on plant names. In the **lower Zone** a local guide was not necessary, because the two ethnic groups lived quite separated in two villages (Kamawaura and Sosiot) and the farms were more clearly arranged. Only for two days guide C showed us around as many people were not at home when we reached the farms[4]. After conducting an interview at her place we asked for help,

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2 (Guide A) belongs to the Ogiek community and is farmer in Nessuit. He understands some English, but seems to be shy of speaking it, when swahili-speaking persons are around. He is around 30 years old and knows many plant species. On the last day of the interviews, he took us to the weekly held market in Nessuit, where many people are gathering in the village. Many people know him.

3 (Guide B) belongs to the Kalenjin community and lives with her sister and her mother in Sigaon and belongs to the Nandi, a Kalenjin-community. She is around 22years old. She knew most of the farmers we interviewed, as friends or neighbours. I was invited to her place for a circumcision ceremony, which took place at her neighbourôs, who belong to the Ogiek community.

4 (Guide C) is 29 years old, belongs to the Kikuyu community and lives in Kamwaura at her familyôs place. She

because many households were empty (community meeting and funeral). She directed us to the households, where she expected people to be available.

4.5 Structure of Questionnaire

The structured interview with open ended questions (Bortz, Döring, 2006) is suited for this research, as the answers are expected to be diverse. Although the pre-testing leads to some specific expectations, a multiple choice design is expected to affect the answers in a negative way. Different cultural groups use different expressions for similar meanings. For gaining an insight into farmersô perspectives it is important to allow their own expressions. The questionnaire is not a testing. There are no wrong answers, because any answer is part of the farmersô view.

Table 4.2 Methodology - standardized questionnaire ï includes closed- and open-ended questions

<table>
<tr><th>Question Type</th><th>Situation</th><th>Topic</th><th>Analysis</th></tr>
<tr><td rowspan="6">Closed-ended questions</td><td rowspan="4">Starting of the interview - mainly outside</td><td>- demographic data</td><td>Descriptive statistic along groups*</td></tr>
<tr><td>- GPS data - Zone</td><td>Map</td></tr>
<tr><td>- farmers knowledge on maintenance of trees and shrubs</td><td>Descriptive statistic and summarizing</td></tr>
<tr><td>- responsibilities within the household related to tree and shrubs</td><td>Descriptive statistic along groups*</td></tr>
<tr><td rowspan="2">Circuit walk on the farm</td><td>- plant species</td><td>Descriptive statistics along groups*</td></tr>
<tr><td>- purpose of species</td><td>Descriptive statistics along groups*</td></tr>
<tr><td rowspan="2">Open-ended questions</td><td rowspan="2">outside after circuit walk</td><td>- Biodiversity and farmers perception</td><td>Qualitative analysis:
- distinctive arguments
- accepted trends
- polarizing answers</td></tr>
<tr><td>- MauCatchment</td><td>Qualitative analysis:
- distinctive arguments
- accepted trends
- polarizing answers</td></tr>
</table>

Source: own data * Results are analyzed along different groups: gender, agro-ecological zone or ethnicity

leads us around in her village for two days. One day there was a community meeting and the other day there was a funeral, where nearly the whole village was involved both times. Nancy showed us the households she expected to be available.

Table 4.2 gives an overview on the type of questions which is chosen for gathering information on the various topics, how they are going to be analyzed and in which situation the information is gained.

Situational after the interview there was time for some conversations about various topics. Notes on relevant topics are recorded in a field book and were used for identifying trends and contrary opinions as well as for triangulation of the standardized interview (*Table 4.3*).

The structured interview with open ended questions consists of **three sections**: the demographic information of the respondent, the plant identification and the farmersô knowledge, perceptions and constraints. Farmers and people who own land and produce crops for self-support or commercial purposes are interviewed. The Interview lasts between 30minutes and 1,5 hours, depending on the number of tree and shrub species on the farm.

Table 4.3 Methods used for triangulation of the standardized questionnaire

Method	Tool	Situation	Topic	Analysis
Narrative interview	conversation	Outside, occasional after interview	- MauCatchment - family situation - trees and shrubs	Used for triangulation Qualitative analysis: - distinctive arguments - accepted trends - polarizing answers
Participat. observation	Observation and pictures	various situations, during and between interviews	- farm characteristics	Used for triangulation Qualitative analysis: - distinctive arguments - accepted trends - polarizing answers description of pictures and notes

Source: own data

The **standardized questionnaire with open ended questions** is arranged along research objectives and research matrix (see *Appendix 11.1*) to cover all essential information for the survey. The ñfarmer interviewò in a thematically related research by Kindt (2002) is used as a guideline for the design of the questionnaire. Further Bortz & Döring (2006) offer a checklist for planning an interview.

Due to the standardised questionnaire an empirical trial of the **objectivity** is not necessary.

Beneficial for the objectivity of the performance is the interview experience of the translator. A research manual (see *Appendix 11.2.1*) indicates how specific information is gathered for each interview segment and which research questions are meant to be answered. This ensures the objectivity of the analysis (Bortz & Döring 2006). The objectivity of interpretation may be neglected as the goal of the questionnaire is to present the farmerôs emic view and knowledge. It has to be considered that traditional ecological knowledge (Huntington 2000; Chalmers *et al.* 2007) may diverge from scientific knowledge (e.g. ñTrees attract rainò).

Reliability of the questionnaire canôt be measured as the questions are open-ended and there is no scaling of the answers. The questionnaire canôt be handled like a testing with right or wrong answers, information needs to be gathered on the farmerôs emic perspective on specific topics.

A pre-testing is carried out at a farm in Egerton, close to the research area, to indicate the intelligibility of the formulations, this ensures the v**alidity**. As a result some questions were exchanged to gain a more fluent interview process. A pre-version of the questionnaire with a multiple choice design for the purposes of plants was changed. It is not possible to mask the questionnaire in front of the interviewee and possible answers would influence his/her response.

For triangulation and further verification of some issues standardised interviews are conducted in two local tree nurseries in Nessuit and Sigotik. These tree nurseries are run by a community group and one of the persons, who are in charge to look after the tree nurseries were interviewed.

4.5.1 Demographic Data - Position in Family and Household

The first section identifies the interviewee, including **demographic data** and his/her position within the household. Gender and age of household head and respondent are recorded as well as ethnic origin of the family. This information allows conclusions to what extent gender and ethnic origin influence the species composition on the farm. The distribution of responsibilities within the household is discovered concerning buying, planting, maintenance and harvesting of trees, to identify the responsible person for tree-issues. It is asked for the nearest tree nursery, where seeds or seedlings are purchased from in case of buying. Geographical data, northing and easting including elevation are collected from each household, to highlight the farms on a map (*Figure 4*).

4.5.2 Plant Identification - Field Walk

The second section of the standardized questionnaire with open ended questions (see *Appendix questionnaire 11.2.3*) covers a **botanical inventory**. The participatory standardized questionnaire is formulated according Kindt *et al.* (2002). During a circuit walk on the farm, shrub and tree species are identified by the farmer (Vogl *et al.* 2004). Plants which are identified as useful on the farm are inventoried. This botanical inventory is made by farmersô choices on plants bigger than knee-height (around 50 cm). Nearly all species were identified by the farmers and only few exceptions of plants without specific purpose on the farm occurred. Considering research questions and objectives, a full tree census (Kindt *et al.* 2006) was not required. The inventoried species include not only wooden plant species but also shrubs and big growing herbaceous plants. Farmers identify the purposes of the selected plants and show the identified species on their farm. Farmers offered the local, Swahili, English and/or scientific name of species, which caused some confusion due to the fact that three cultural groups had different local names for a single species and mostly an additional Swahili or English name exists as well (Maundu *et al.* 2005). To facilitate the plant identification, pictures are taken and specimens are brought to the botanic institute of Egerton University. Dr. S.T. Kariuki from Egerton University identified the plants, which were not identified with Maundu *et al.* (2005) once a week.

It will be taken into account where the inventoried plants are located on the farm, in order to identify different niches (see *Appendix questionnaire 11.2*). The position of plants within the farm is divided along following characteristics: homestead - area around the house; hedge ï separations within the farm, separating e.g. homestead and pasture; scattered - plants growing spread around e.g. on the pasture; boundary - fence around the farm area, separating the farm from the road or neighboring farms; woodlot - sub area on the farm, where trees are actively planted; riverbank - mostly belongs to the farm and is a piece of maintained but natural riparian vegetation; ornamental - plants grown for beautification along the entrance.

The origin of the trees was noted as well, whether it is actively planted by the farmer, grown naturally or retained on the farm. The way of planting was recorded in order to triangulate questions from section three concerning farmersô knowledge on maintaining trees.

Further the source of seeds or seedlings (e.g. own farm, neighbour, forest, tree nurseryé) and the purpose of the specific species on the farm was identified. The main interest was on the purpose of plants, how these are used for medicinal, domestic, commercial, construction purposes, etc. (see *Appendix coding book 11.3*). Therefore a complete inventory count of biodiversity in the agro-ecosystem (Kindt 2002) was not made, as many smaller species are not recognized by farmers for any purposes and therefore they are not used in a specific way and without value to the farmer.

The respondent ranks the five most important species and the reason for the specific importance. This ranking is done after the interviewee reflected all species on his farm due to the on-going species inventory.

4.5.3 Constraints, Knowledge and Perception

The third section of the questionnaire identifies the farmersô **constraints, knowledge and perceptions** concerning trees on their farm. The open ended questions give an idea of the farmerðs understanding of biodiversity and for what reason a high number of different plant species on the farm is considered to be important. The farmers are asked to identify the actions they take for maintaining trees, seedlings or seeds. The origin of seedlings gives an idea of the farmerðs knowledge on handling seeds and growing trees. Farmers identified the following categories: tree nursery, neighbour, forest, seed ï originate from own seedbed and riverside.

In order to collect information on the farmersô values and perceptions, they are asked which other trees they would like to grow on their fields. The reasons for failure are discovered, why seedlings do not survive on the farm. In opposite farmers also specify actions they take to maintain, protect and nurse seeds and seedlings in order to improve their chance to survive.

The goal of this section is to gain an insight in the farmersô emic views on their situation and goals in the near future. Socio-cultural and geographical background can be neglected as the target is to capture the farmersô opinions in general. Constraints which can't be influenced by human beings like drought or climate are the same for all farmers anyway. Their personal perspectives on how trees on their farms are related to the whole Mau Water Catchment Area are discovered.

4.6 Data Analysis and Presentation

For further plant identification pictures and specimens were collected. The information recorded during the interviews, the protocol, is feed into, analyzed and presented with the statistical analyzing program SPSS 15.0 and Excel. Answers of closed-ended and open-ended questions are fed into SPSS. To allow the analysis with SPSS, the various answers are sorted, coded and collected in a coding book (see *Appendix Coding book 11.3*).

4.6.1 Plant Identification

The plant species growing bigger than knee-height (around 50cm) were identified by the respondents during a circuit walk on the farm. During the interview at each farm pictures were taken and specimens were collected and captured in the protocol. For further plant identification these samples were taken to a botanist at Egerton University. Dr. S.T.Kariuki identified the species once a week.

4.6.2 Descriptive Statistics and Coding of Closed-ended Questions

For the analysis descriptive statistics are used. The frequencies of variables were analyzed along similarities and dissimilarities within gender, agro-ecological zone or ethnic groups. The questionnaire is analyzed and results are presented along the three sections: demographic data, plant identification and farmerôs constraints, knowledge and perceptions.

The particular answers are coded into variables, which are translated into numbers in order to be fed into SPSS. The Variables are listed in the research manual which corresponds with the coding book (see *Appendix Coding book 11.3*).

For some interviews an unavoidable double-stage coding appeared. After approximately 25-30 interviews a bias through coding by the translator emerged as he heard and translated the answers by the farmers many times and kept some phrases. The interview protocols of interviews conducted in Swahili were taken from a ñblack boxò, the translator, while interviews in English were more transparent reproducible. As the translator assisted for all interviews the effect of bias can be seen as a pre-coding.

The final coding was done by listing all answers entered in SPSS. Similar answers are recoded with the use of SPSS into same or new variables. For example ñbrother/sisterò and ñgrandparentsò are put together with the variable ñother relativesò. For maintaining trees, ñirrigatingò is coded with the same number as ñwateringò as the variables are identical in the meaning, but different terms have been coded with different numbers in a previous draft. Concerning farmersô constraints the variable ñseed(lings) not availableò include answers like ñimmature seedsò and ñno tree nurseryò and the variable ñlack of informationò included ñlack of information exchange between farmersò. The variable ñdomestic useñ include utilities like ñsoapò, ñropesò, ñtoothbrushò, ñbroomò, ñglueò, ñoilò and others. (see *Coding book 11.3*).

For analyzing demographic data, like cultural background, age and gender distributions, **descriptive statistics** is used and the frequencies of occurrence, similarities and dissimilarities along agro-ecological zones and ethnicities are presented as tables. To facilitate a clear representation of the gained data, particular tables are arranged with SPSS 15.0 and Excel. To emphasize the most important topics and information only a selected number of answers or a selected number of variables is used for the representation. For example in *Table 5.3 Tree species identified by farmers along Agro-ecological* Zones only an extract of the twelve most frequently mentioned species is shown in this table.

For the analysis mainly relative percentages are used to allow comparisons. Eg.: For each species between one and five purposes were recorded. Therefore it is necessary to use the relative percentage of each purpose within the agro-ecological zone for example (*Figure 8*)

4.6.3 Analyzing of Qualitative Data

For qualitative analysis the whole data set is used, without separation by gender, agro-ecological zone or ethnicity. Qualitative analysis is done by selecting outstanding, distinctive arguments and by identifying accepted trends through organizing the topics in groups and use descriptive statistics. Further contrasting answers were identified and compared. Open-ended questions were also used for triangulation.

4.6.4 Data Presentation

Quantitative data is presented in graphs and tables with SPSS 15.0 and Excel. Qualitative data on the farmersô constraints, knowledge and perceptions is described and also presented as tables to stress out the most important statements. The location and geographical data of villages and farms are presented on maps (see *Map* Figure 4). To underline cultural differences, particular observations concerning specific farm characteristics are presented with pictures made during the interviews.

5 Results

This chapter describes and presents the main outcomes of the analysis of the 60 interviews. The interview protocols were coded (see *Appendix 11.3 - Coding book*) and entered in the statistical analysing software SPSS 15.0. At the beginning of this chapter the **interview situation** is explained, as it influenced the data and gives an idea, how the information was collected in the field in particular and which social interactions occurred during the interview. The results are structured in following subchapters:

Demographic analysis ï describes the demographic characteristics of the interviewees, gender distribution, the characteristics of the agro-ecological zone and the ethnic communities;

Plant identification ï discusses plant species, which are used on the farm for a variety of purposes, and compares the answers by agro-ecological zone and ethnicity;

Farmersô constraints ï identifies farmersô knowledge on maintaining trees and their constraints they are facing considering growing more trees on their farms;

Farmersô perceptions ï discovers how far farmers are aware of the importance of biodiversity and how they see their trees related to the entire Mau Catchment Area.

5.1 Interview Situation

Different factors influenced the interview situation. This chapter describes the social interactions and group dynamics, which occurred around the interview situation. The color of my skin appeared to raise the interest of all family members and sometimes also of neighbors. Therefore difficulties occurred concerning face-to-face interviews as they easily turned out as group interviews within the household. Although only one respondent was chosen by the family members on the farm, depending on knowledge, time and workload, most of the time other family members were asked for expert knowledge and advice by the respondent him/herself. The inclusion of not family members, like neighbors, contributing to the interview was avoided as possible. Gender and age of the respondents needed to be considered, because due to the diverse social positions within the family and life situations, different priorities and perspectives existed.

5.1.1 Social Interactions during the Interview

The first intention was to gather background information for an ongoing research a year before. The contacts of respondents of this study were used as orientation for the selection of interview partners, but this trial did not work out. The list of respondents was shown to the local guides, who looked for the households they recognized. To follow the list for all interviews was inapplicable, as many former interview-partners were displaced or resettled during the post-election violence 2008. A pre-testing of the questionnaire was done at a farm outside the research area to ensure the feasibility of the method.

In general all farmers were very interested in helping with the interview and seemed to be very honest and serious, as their trees and the deforested area are one of their major concerns. They were very curious to contribute for restoring the forest and their harmed environment.

Three farmers refused to do the interview for different reasons. One farmer was busy, another one couldnôt be convinced, that the questionnaire was not related to the research by the government, which was conducted a month earlier, and a lady refused, as she wanted to confer with her husband first.

The interview situation was a casual situation on the farm, which is important for gathering information on farmerôs reality (Lamnek 2005). The farmers were doing different works on their farm when they were asked to take some time off for the interview. To reduce the interruption, the respondents were not asked to stop their work, while doing the interview, except for the circuit-walk around on the farm. Farmers were not contacted prior. The questionnaire was not shown to the respondents. Bortz & Döring (2005) discussed another issue of effects based on the interviewerôs appearance. This effect was for all interviews the same, as interviewer and translator conducted all 60 interviews together.

Participatory observations discussed by Lamnek (2005) were made during the interviews in an unstructured manner. These observations were recorded in a hand written research diary between the single interviews. Other sources of information were situations and occasions in the research area, but outside the interview periods (e.g. Ogiek-Circumcision-Ceremony, invitation at Chepkemoiôs family, invitations for breakfast/lunch, conversations at local market,é). During these occasions a small insight in culture, gender roles and family life was obtained. Somehow the gained information and the stories could be described as narrations like discussed by Snow *et al*. (1986; Bryman 2001). Lamnek (2005) described this situation as ñparticipator as observerò. Different contact persons of various ethnicities like guides, translator, colleagues at the university, supervisors, people at the market, bus station, etc. were conducted for triangulation, discussions and further explanations of observed situations and issues.

Also Situations as ñobserver as participatorò (Lamnek 2005) occurred, as the complexion always identified me as an ñoutsiderò, not as a community member. The different roles of researchers conducting field work were also discussed by Gold (1985, Bryman 2001). In most cases this had a positive effect, as people spoke more frankly to me, as I was not part of their society. As I obviously didnõt belong to the society, it was easier for me to overcome social structures and rules. I was allowed to ask questions, which would not be possible for a Kenyan, as I was clearly outside the social codex within and amongst the ethnic groups. It was possible to talk about taboos, by expressing my interest for some issues I didnõt understand, due to my different culture as a European. Therefore people tried to explain these issues to me, without further concerns. Being a student was also beneficial as it was clear for the farmers that I wonõt bring money and whatever they answered has no consequences concerning income or political issue like eviction. Only few interviewees had expectations of getting a monetary benefit, but many were expecting knowledge and expertise. More people asked for know-how as for money.

In most cases there was enough time for a **narrative interview** (Flick 1995; Schütze 1983) that followed the structured interview. Information gathered in these casual conversations was written down with other participatory observations (Flick 1995) in a personal research diary, right after each interview.

One outstanding effect was the colour of my skin, which had an impact on the introduction as it produced interest from the very beginning (Bortz & Döring 2005). Like Lamnek (2005) discussed the relation between interviewer and respondent, the issue of colour influenced the interview situation. The main consequence was a higher investment of time, to overcome the asymmetry to the interview partners. These external attributes were also discussed several times in various situations in ethnological researches (Dürr 2002; Fischer 2002).

On the other hand it helped to appear as a neutral person concerning the political situation in the research area (see *Introduction 2.2*). Some hindrance occurred as neighbours, especially children, were curious and followed us. There was no negative impact on the interview content.

5.1.2 Group Dynamics around Interview Situation

In most cases the mother and the children were around at the farm and welcomed us for the interview. After the respondent was identified, interviewer and respondent walked around on the farm to identify and recorded the tree and shrub species growing on the farm, its purposes and the niche, where the plants were growing.

The walk started where we met the respondent, trying to circuit the farm. After the plants were recorded section three about the farmerǿs preferences and perceptions, constraints and knowledge were conducted.

Independent of agro-ecological zone and ethnic group different situations occurred.

- Woman and her children were around and responded to the interview immediately after the background of the research was explained. Other relatives and neighbors were curious and came along to listen to the interview and sometimes to give advices, when asked for it.
- The children followed us to the neighboring households and many children (up to 16 children) were around. They didnǿt interfere in the interview content, just ran around and watched the interviewers on the farm.
- The whole family was around and the household head (mainly male) was responding while the other family members also followed the interview and gave advices on plant names and purposes. Or the respondent explicitly asked the spouse or some older family members for advice.
- The wife was around and looked for her husband to confirm the cooperation. After he knew the research background, he responded, in case he wasnǿt too busy.
- The household head was around but after explaining the interview background he was not interested or he was no longer available and he suggested his wife to respond to the questions.

The interview was finalized with an unconventional discussion, which can be regarded as a narrative interview in some cases. Issues, which were discussed during or after the interviews, which were not captured by the questionnaire, but still relevant for the results, or which could be seen as sources of background information, were written down as personal notes in the research diary.

5.2 Demographic Analysis

In this subchapter specific differences of the two agro-ecological zones and ethnic groups are discussed, as on-going data analysis and comparison is done along these variables. Further it contains results concerning gender distribution of the household heads and the respondents, age of household heads and how long the families lived on their farms.

5.2.1 Gender

As a result of participatory observation it could be stated that mostly women are working on the farm, as they were the first person to talk to, because they were around on the farms (Rocheleau *et al*. 1995). Although 56 of 60 households were headed by man, there were 41 women and 19 men responding the questionnaire. The share of female respondents was similar in both zones. 21 female respondents out of 30 were found in the upper zone (12 Ogiek, 9 Kalenjin women) and 20 female respondents on farms in the lower zone (10 Kikuyu, 9 Kalenjin women) (*Table 5.1*).

Table 5.1 Gender Distribution of Respondents

Gender of respondent ethnic community (total number)		Frequency	Percent
Kalenjin Upper Zone (16)	Female	9	56,3%
	Male	7	43,8%
Ogiek Upper Zone (14)	Female	12	85,7%
	Male	2	14,3%
Kikuyu Lower Zone (16)	Female	10	62,5%
	Male	6	37,5%
Kalenjin Lower Zone (14)	Female	10	71,4%
	Male	4	28,6%

Source: Own data

The *husband* was mainly responsible for planting, buying, maintaining and harvesting trees on the farm, between 49,2% (buying seedlings/seeds) and 35,6% (maintaining trees) (the other tasks were in between). This statement is triangulated with another question (ñwho planted the tree?ò), where 31,2% of all inventoried plant species (62,7% of all tree species) were planted by the husband. This says, mostly men were responsible to care for trees and grow them on their farm.

Between 27,6% (harvesting) and 15,3% (buying seedlings) (the other tasks were in between) were answering that *husband and wife* were sharing the responsibilities for the different tasks concerning trees equally. The share of *wife* being unaccompanied responsible for single tasks lay between 13,6% for planting trees and maintaining trees and 11,9% for buying seedlings/seeds.

Purpose of Plants analyzed along Gender of Respondent

The most frequently mentioned purposes (*Figure 5*) were medicine, firewood, food, building and construction, fencing and boundary. It was remarkable that modify climate was also mentioned already at the sixth position. ñOtherò purposes include beverages, attract birds, experiment, landscaping and harvesting seeds.

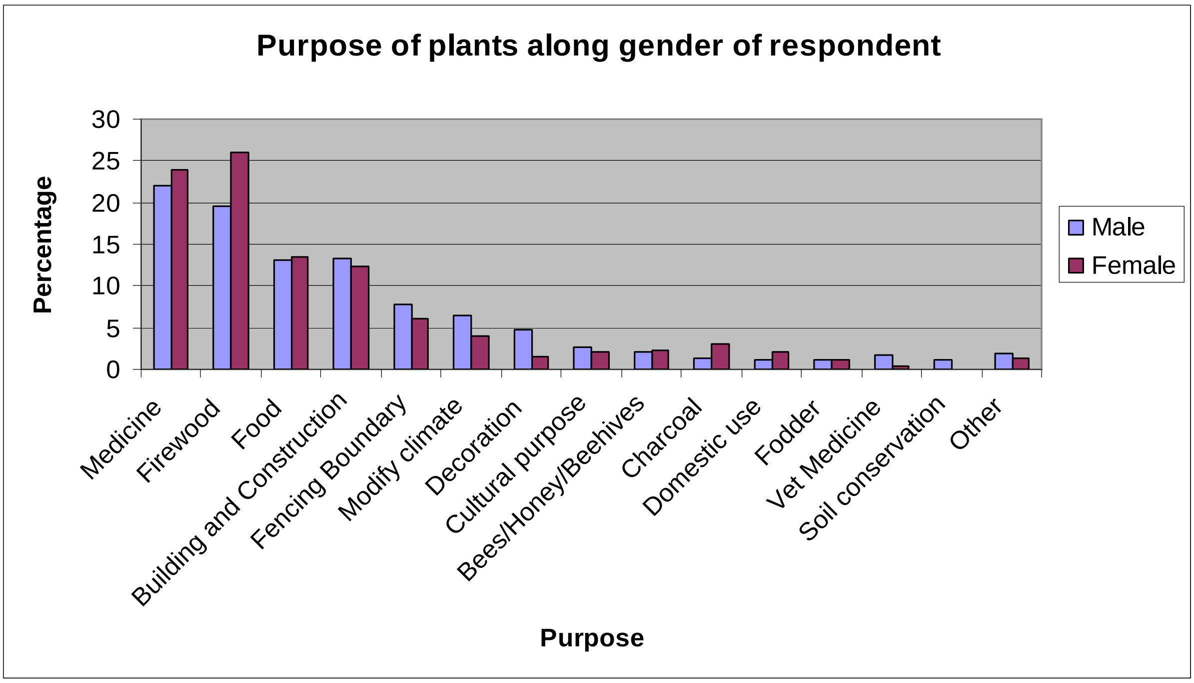

Figure 5: Purpose of plants along gender of respondent **Source: Own data**

There were only few remarkable differences when analysing the purposes along gender of the respondents (*Figure 5*). It was important to consider only the percentages within one gender group and not the number of counts, because around two thirds of the respondents were females. Differences between male and female respondents occurred for charcoal, firewood and domestic use, which include soap, washing utensil, glue and ropes. Firewood and charcoal was needed for cooking. Within the family, women and children were mostly responsible for washing, cooking and bringing up children. This constituted why women identified more plants used for these purposes. Further female respondents identified more medicinal plants. This was related to the womenôs task of taking care of children, who needed more often medicinal treatment than a grown up (Blume 1998). Men were more aware of plants being used for decoration, soil conservation, for veterinary medicine and for modifying the climate. These were mainly plants, which were not used in the everyday life in the household. Plants which were important for food, fodder and building and construction were identified by men and women with a similar share.

Household History

The majority of the interviews were not conducted with the head of the household. Only 16 interviews were conducted with the household heads as respondents, while data on age is only related to household heads. The age of the household head averaged 48,9 years, it varied between 20 and 87 years. While in the lower zone land tenure was relatively stable and farmers lived in the lower zone and owned their farms already for a relatively long period (see *Table 5.2*ï ñSince when did your family live here?ò). This table shows the average year families have lived already on their farm. The range of minimum and maximum values for all farmers spread between 7 and 68 years respectively. On average farmers lived on their farm since 22 years, but it has to be considered that the values are quite dispersed. Therefore itôs necessary to have a closer look.

Only for Kalenjin farmers in the upper zone the table shows an outstanding low maximum value of 13 years. In the upper zone farmers lived on their farms only since 17 years, ranging between 7 and 58 years. Ogiek farmers lived there on average since 25 years, but it has to be considered that the values are very disperse, showing a standard deviation of 21,23. Ogiek farmers used to live traditionally in the forests before it was cut down in the research area, about a decade ago. Many farmers argued that their families lived in this area ever since, but they had no houses and farms like they had nowadays, since the forest was gone. When they were asked, for how long their families have lived in the area, some answered since when they have built their houses, while others answered, when their families or clans have settled in this area longer time ago.

For Kalenjin farmers in the upper zone the situation was a different one. Many settled recently and got land from the government, after the forest was cut down. They lived in the area since 11 years on average, with a standard deviation of 1,67. The results are quite homogenous for this group.

The lower zone has been settled for a much longer period. The farmers have lived on their farms already for a long time, compared to farmers in the upper zone. Since 27 years on average, 33 and 23 years for Kalenjin and Kikuyu farmers respectively. It has to be considered that the values for Kikuyu farmers show a quite high standard deviation. Some Kikuyu families lived in the lower zone since 68 years; the minimum value is 7 years. Kalenjin families in the lower region have lived on their farms on average for the longest period, compared to the other groups, but still they grew the lowest number of tree species on their farms.

Table 5.2 Number of plant/tree species per household along ethnic group and agro-ecological zone[5]

Zone	Ethnic community		Number of different plant species per household.	Number of different tree species per household.	Since when did your family live here?
Upper Zone	Ogiek Upper Zone	Mean	16,93	7,36	25,18
		N	14	14	11
		Std. Deviation	4,83	2,34	21,23
		Minimum	11	4	9
		Maximum	27	12	58
	Kalenjin Upper Zone	Mean	21,50	11,00	10,93
		N	16	16	15
		Std. Deviation	5,34	3,41	1,67
		Minimum	9	6	7
		Maximum	31	16	13
	Total	Mean	19,37	9,30	16,96
		N	30	30	26
		Std. Deviation	5,53	3,45	15,28
		Minimum	9	4	7
		Maximum	31	16	58
Lower Zone	Kalenjin Lower Zone	Mean	14,43	6,71	32,58
		N	14	14	12
		Std. Deviation	3,99	2,16	4,68
		Minimum	8	2	28
		Maximum	22	10	40
	Kikuyu Lower Zone	Mean	17,81	11,88	22,63
		N	16	16	16
		Std. Deviation	6,12	4,47	14,07
		Minimum	9	6	7
		Maximum	31	22	68
	Total	Mean	16,23	9,47	26,89
		N	30	30	28
		Std. Deviation	5,43	4,39	12,00
		Minimum	8	2	7
		Maximum	31	22	68
Total	Total	Mean	17,80	9,38	22,11
		N	60	60	54
		Std. Deviation	5,66	3,91	14,44
		Minimum	8	2	7
		Maximum	31	22	68

Source: Own data

[5] This table shows that the analysis of pooled data along the agro-ecological zone canót be considered as the sample is not a random sample, but it gives information on ethnic groups.

5.2.2 Agro-ecological Zones

As mentioned above the research area was divided in two agro-ecological zones, which were primarily separated by the elevation (see *Site 4.1*). These two zones showed more differences, which are discussed in the following.

Upper Agro-ecological Zone

The two agro-ecological zones showed geographical and environmental differences. Interviews in the upper zone were conducted at households situated between 2350 ï 2640 masl. The slopes were considerable steeper and the farms, which were mostly bigger than 5ha, were situated quite remote at the edge to the forest (see *Figure 6*).

Figure 6: Upper agro-ecological Zone 2350-2640masl **Source: Own data**

The close distance to the forest explained some characteristics of the single farms (see *Ethnicity 5.2.3*) and the composition of actively planted and found species on the farm (see *Figure 18*). The extraction of products from the forest was much easier due to the short distance. Some plants were more likely to be grown on farms in the upper zone, because the area was forested just a decade ago and many species grew as a result of natural rejuvenation. Farms in the upper zone were bigger and much more scattered, than in the lower zone, where households were very close to each other. This can be observed at *Figure 1* and *Figure 6*. Villages in the upper zone could only be reached by a very steep and bumpy gravel road. Especially during the dry season it became very dusty due to migration of cattle herds owned by Maasai nomads, who followed the Njoro River to find water and harvested fields or grassland, where they fed their cattle. During the rainy season the road was sometimes completely impassable due to erosion and heavy rains (statements of taxi and motorbike drivers)

Lower Agro-ecological Zone

Households in the lower Zone were situated between 2130 ï 2250 masl. It could be observed on the map (*Figure 1*) that the villages in the lower zone were much better connected to infrastructure and the local markets, as they were situated on the main tarmac road between Njoro and Molo.

Figure 7: Lower agro-ecological zone 2130-2250 masl **Source: Own data**

Figure 7 shows that the slopes were more flat and numerous trees were grown at the boundary to separate the farms from the nearby properties. This was a result of the small distance between the farms, which were significantly smaller than in the upper zone, mainly 1 or 2 ha and smaller than 5 ha. The farms were quite far away from the forest. The forested area in *Figure 7* was not natural forest but a commercial plantation growing mainly C*upressus lusticana* and *Eucalyptus camaldulensis*.

The following graph shows how the purposes of different plants were dispersed among the two agro-ecological zones. *Figure 8* shows very clear that in the upper zone much more medicinal plants were grown (see *Purpose of Plants unterhalb*) and the concern about the dry climate was much more a topic of the upper zone, where huge areas were deforested in the last years. The same could be observed for honey production. Plant species used for bee forage, constructing bee hives or producing honey were barely mentioned in the lower zone.

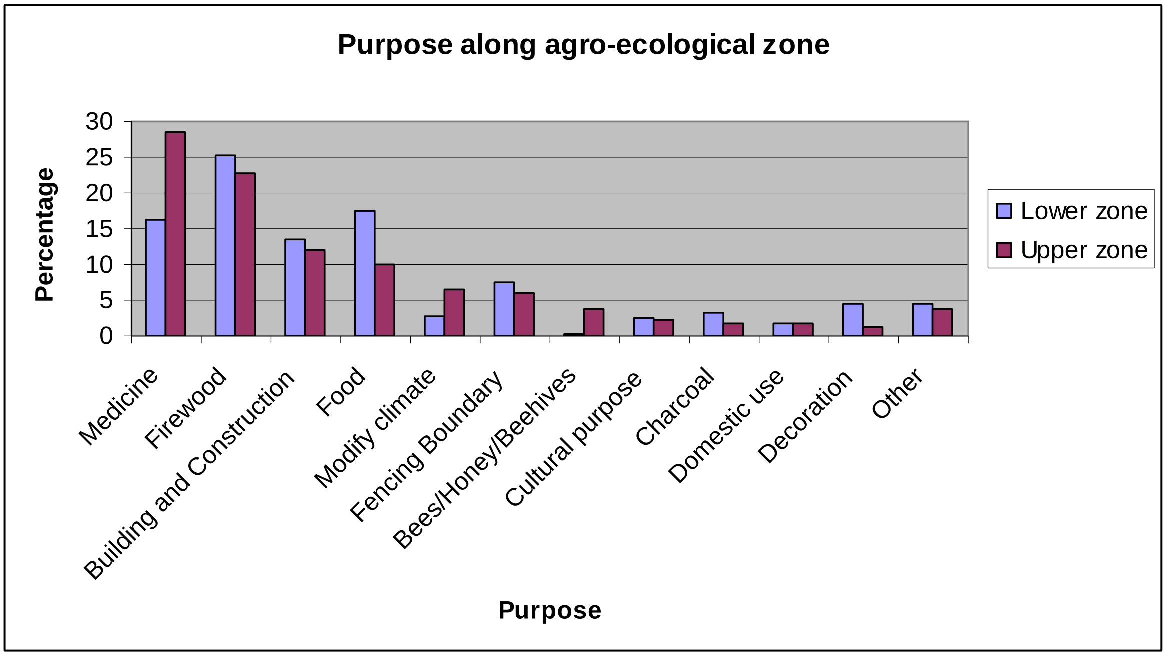

Figure 8: Purpose of plants along agro-ecological zone[6] **Source: own data**

In the lower zone many trees, grown on the farm, served for firewood or charcoal production, which was because of the long distance to the forest. Extraction of firewood from the forest was very arduous as the farmers had to walk a long distance. The same reason explained the importance of producing wood for building and construction on the farm. Another reason was

[6] This figure includes the whole data set of 60 interviews, because the analysis exclusively for Kalenjin households shows the same trends when comparing the agro-ecological zones.

that timber can be sold on the local market.

Numerous plant species used for fencing was explained by the short distance of the relatively small plots in the lower zone. Many plant species grown for food in the lower zone resulted from the better connection to the market due to better infrastructure (*Figure 4*). Plant species which were maintained for decoration and beautification could be neglected in the upper zone compared to the lower zone. Species identified for cultural purpose and domestic use were mentioned in both zones with the same frequency (see *Figure 13*). Analysis of different purposes by ethnicity gave further explanations.

5.2.3 Ethnicity

The issue of ethnical belonging was a very controversial topic in Kenya. On the one hand ethical ancestry was very important and played a significant role in everyday life, while on the other hand it was afflicted with many negative components, violence and in fact it became a very ôhotô political issue. The government recognised the importance of conserving and reforesting the Mau Catchment Area to restore water reserves and discussed plans to eject and displace new settlers from the area (Daily Nation July 29th 2009). It is very likely that this would lead to further violence in the Rift valley.

Although the tribal belonging was very important, it became a taboo since the post-election violence in 2008 (Thielke 2008). Already more than a year passed by but villages, which persisted over decades in peaceful co-existence, still remained separated by ethnical affiliation (Der Standard, February 3rd 2009; personal observation). Since then the situation was still difficult and there were many tensions between different ethnic groups. It might play a minor role in everyday life in bigger cities, but in rural societies, where the personal well-being and existence is strongly related to the family and therefore the ethnic group, it plays a major role in peoplesôlife.

Due to the fact that the agricultural performance is very strong related to ethnicity and even information exchange often exist only among farmers within the same ethnic group, this topic canôt be ignored, like it is the case in other studies conducted in the Mau Forest (Kindt 2002, Krupnik *et al.* 2006).

Five different ethnic groups settled in the Mau forest complex. Some have always been there, others settled in recent years. This study selected only three ethnic groups, Ogiek, Kalenjin and

Kikuyu. Due to a lack of proper literature the description of the ethnic groups is based on participatory observation and personal conversation. The cultural belonging and ancestry is very important in Kenyan rural society. It gives identity and is linked with numerous attributes in everyday life, especially with traditional knowledge and agricultural techniques. Agriculture is strongly connected with the tribal ancestry as it is embedded in the tribal traditions. Within the three different Ethnic groups a preference can be seen for certain species, as they are used for purposes, related to their cultural behaviour and their tradition. For example plant species, which were used to prepare a traditional drink called Mursik were very common within the Kalenjin community; plant species which were related to bee-keeping and honey production are nearly exclusively preferred within Ogiek community; Kikuyu communities had huge knowledge, compared to the two other communities, on farming practices like agroforestry, intercropping, organic farming, compostingé ; and had therefore a high variety of plants.

Kikuyu Community

The Kikuyu people were originally hunter-gatherers in pre-colonial times, but when they settled in the fertile Kenyan highlands around Mt. Kenya they started farming.

Figure 9: Kikuyu farm - lower zone **Source: Own data**

They are also the most economically active ethnic group in Kenya. Kikuyu farmers possess comprehensive knowledge on planting vegetables and farming in general (Egger 1995). Many are skilled with comprehensive knowledge on raising trees It was conspicuous that many Kikuyu farmers (8 farmers / 50%) possess their own seedbeds and therefore received seedlings from their own nursery on their farms. This gives a reason why Kikuyu farmers grew relatively more trees on their farms compared to others. Like

Figure 9 shows, the farms looked quite organised, well arranged and plants were put accurately on a place where they were likely to perform well. Kikuyu farmers seemed to be very productive on their quite small plots. Many Kikuyu farmers practiced intercropping and didnqt keep cattle on their farms. One farmer even knew about composting and asked for new species, which were suitable for agroforestry. Another characteristic were dense and high living fences with trees, which were primarily maintained for security reasons..

Figure 10: Kalenjin farm - lower zone **Source: Own data**

Kalenjin Community

In Kalenjin culture livestock farming played a central role. They were traditional pastoralists and milk was a significant component of traditional Kalenjin diet. The importance of cows was found throughout their culture and the open pasture (see *Figure 10*) was characteristic for Kalenjin farms. In the lower zone cows grazed next to the homestead and the farm was surrounded with a low living fence, but not as dense as at Kikuyu neighboursô.

In the upper zone Kalenjin farms also featured huge open pastures with few scattered trees. More shrubs and medicinal plants were scattered on the pasture. The farms were bigger and fences separated pasture, vegetable garden and homestead (see *Figure 11*). Fences were made of bamboo, as the farms were situated close to the forest.

Figure 11: Kalenjin farm - upper zone **Source: Own data**

ñMursikò, a very famous Kalenjin delicacy, is a sour milk drink which is produced amongst others with following plant species: ñCalabashò or ñSortetò scientifically Lagenaria siceraria is used as bin. ñSenetwetò scientifically Senna didymobotrya, ñSertwetò scientifically Acacia mearensii and ñSimotwetò scientifically Ficus thonningii are used for the preparation of this culturally important drink.

Ogiek Community

Ogiek culture is strongly connected to the forest. They lived as hunter gathering communities in the Mau Forest before huge areas were cut down in the last decade. These communities, who are famous for honey production in the Mau Forest, were forced to change their lifestyle in order to become settled farmers. The Ogiek people had a unique way of life, well adapted to the forest. Their adaptations and their traditions have made them successful foresters and greater environmentalists (Sang 2002).

Figure 12: Ogiek farm - upper zone **Source: Own data**

Just recently the Ogiek community decided to support the government with their environmental expertise and traditional knowledge to safe the Mau Forest (Daily Nation July 29th 2009). At the first view Ogiek farms looked very confusing and unorganised, because the farms were characterised by an absence of fences. Particular trees, shrubs and medicinal plants were scattered within an open pasture. Single trees were grown around the homestead to produce shadow. Very common were species on the farm, like *Dombeya torrida* and *Polyscias fulva*, which were used for honey production in different ways, as bee forage or to build beehives. Ogiek farmers possess comprehensive knowledge on medicinal plants and the preparation of the plants respectively parts of those. Frequently grown species were *Olea europaea spp. africana*, *Dombeya torrida*, *Plectranthus barbatus, Dovyalis caffra* and *Vernonia auriculifera*.

Figure 13 shows the preferences of single ethnic groups. Within the Ogiek community many medicinal plants were inventoried. This means that many plants, the farmers mentioned as valuable on his farms were grown, amongst other purposes for medicinal use. In comparison to the other ethnic groups a remarkable high portion of plants were identified for honey production. Slightly more species were identified for firewood.

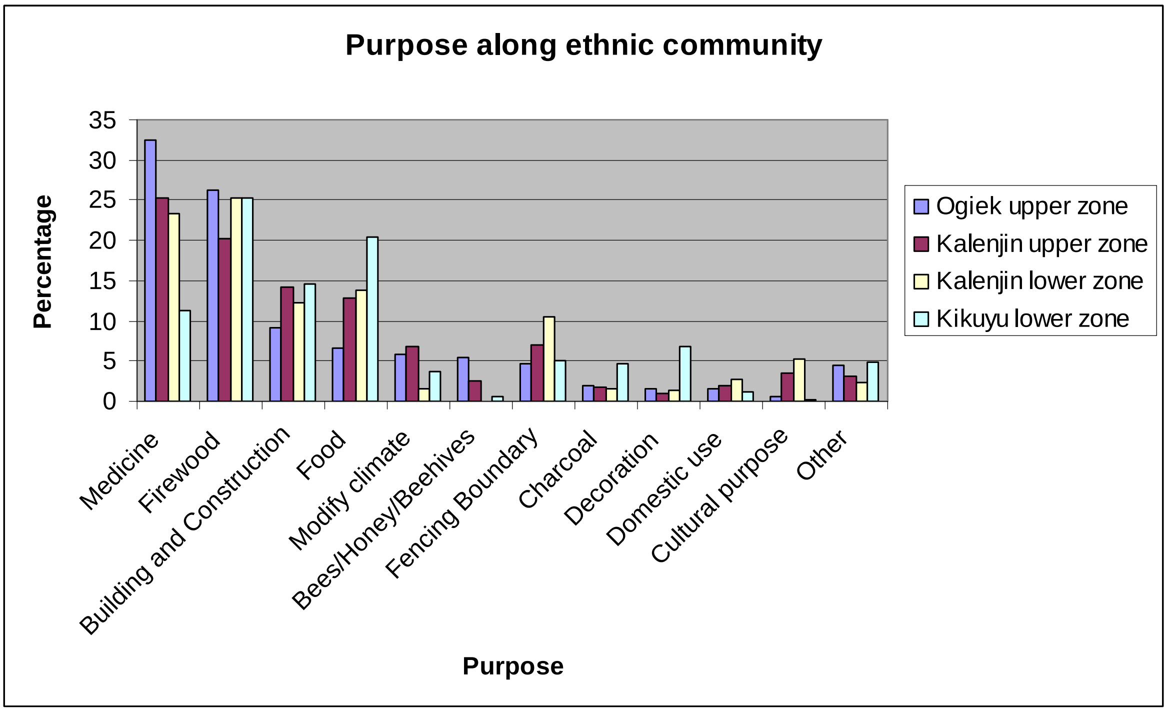

Figure 13: Purpose of plants along ethnic community **Source: Own data**

Kalenjin farmers situated in the upper zone designated numerous species for building and construction. The issue of modifying the climate seemed to be a central concern of this community especially in the upper zone. Plants were prevalently mentioned for fencing, boundary and cultural purposes among Kalenjin farmers in both zones. As mentioned above many species were used for specific cultural purposes like the preparation of ñMursikò. Fencing was an important topic in the lower zone, because farms were situated very close to each other. In the upper zone it was more the problem to evidence property rights.

Kikuyu farmers who were traditional vegetable farmers grew many food/fruit plants, whereof some were sold on the local markets. A remarkable number of plants were grown for decoration, which could be observed, when entering the farms. Many flowers were grown on Kikuyu farms for beautification around the homestead and along the boundary.

5.3 Field Walk ï Plant Identification

This subchapter presents the results of the botanical inventory. As mentioned above the recorded plants were selected by the farmers themselves and include trees, shrubs and herbaceous plants which were relevant for the farmers. It was identified how many different valuable species farmers maintain on their farms and how they obtain their seedlings/seeds. The most frequently mentioned plant species are shortly described, what they were used for and it is discussed why these species were relevant in the specific agro-ecological zone or for the particular ethnic group.

For some specific analysis (see *Table 5.2 Number of plant/tree species per household along ethnic group and agro-ecological zone*) only data on tree species was taken into account. The farmers identified nearly all plants bigger than knee-height (around 50 cm) as valuable except a minority which was declared as weed or not ñrelevantò for any purpose on the farm.

Pictures were taken during the identification by the farmers or specimens were collected. Following, the identification was done in assistance with Dr.S.T,Kariuki from Egerton University. The inventoried plant species were compared along two agro-ecological zones and the ethnical groups (see Demographic analysis *5.2 oben*). It has to be considered that the focus of the research was on the farmersô emic view and therefore on plants, farmers identified themselves as valuable and useful. Thereby the data allowed drawing conclusions on the respondentsô interests and preferences.

5.3.1 Plant Species per Household

In summary the farmers identified 1068 plants as valuable on their farms, whereof 54,4%, in number 563 plants, were tree species. The majority of 62,5%, in numbers 667 plants, of all mentioned plants were indigenous ones. 194 different species where identified as a result of plant identification at Egerton University, done by picture and/or specimen analysis, whereof 68 (35,1%) are tree species (*Table 11.2 Plant list - Tree species* and *Table 11.3 Plant list - No tree species*). 71,6% of all different species, in numbers 139 species, were indigenous ones.

Table 5.2 Number of plant/tree species per household along ethnic group and agro-ecological zone displays the mean number of species per household and separate the number of tree species along the agro-ecological zone and the ethnic group. Further the number of interviews, standard deviation, minimum and maximum number of species per household are presented.

On average each respondent mentioned 18±6 plant species (ranging between 8 and 31 species) which are used on the farm, whereof 9±4 were tree species (minimum and maximum per household are 2 and 21 species). Considering the agro-ecological zones only a minor difference could be observed, slightly more plant species were mentioned by the farmers in the Upper Zone. The number of tree species was for both zones the same. It is necessary to consider the ethnic groups for this analysis:

In view of the **ethnic group** it could be observed that most tree species were mentioned by Kikuyu farmers (12±4 tree species on average) and the least number of tree species by Kalenjin farmers (7±2 tree species on average). Both groups of farms were situated in the lower zone. A reason for this distribution might be land tenure, which was quite different between the two zones (see *oben*)

Furthermore Kikuyu farmers were traditional vegetable farmers and skilled with comprehensive knowledge on growing plants. It was conspicuous that many Kikuyu farmers (8 farmers / 50%) possess their own seedbeds and therefore receive seedlings from their own nursery on their farms. This gives a reason why Kikuyu farmers grew relatively more trees on their farms. All other farmers bought their seedlings from tree nurseries, if they donꞌt obtain them from neighbours or from the forest.

Kalenjin farmers were traditionally pastoralist and therefore a major part of their farm was pasture land. Trees played a minor role and were mainly grown at the boundary and around the homestead area. This explains why these farmers grew fewer trees.

Opposite, Kalenjin farmers situated in the upper zone grew relatively many tree species 11±3, compared to farmers of the same ethnic group in the lower zone. This might originated from a diffuse and insecure land tenure system in the upper zone. Growing trees was considered to strengthen the claim for property rights (Krupnik *et al.* 2006). Therefore many trees were grown at the boundary to clarify borders of the own property. Kalenjin farmers had to supply all their needs of tree products on their own farm, because they didnꞌt have a right to extract plants from the forest.

The Ogiek farmers, in comparison, had a right to extract plants from the forest as it was their ancestral land. Ogiek farmers grew only 7±2 trees on their farm. They maintained many other plant species on their farm, but few tree species. They possessed major knowledge on plants for medicinal purposes, but minor knowledge on planting trees and raising seedlings. The forest was there ever since and it was entrenched in their culture as environmentalists and caretaker of the forest to extract products from the forest without harming the environment. In former times it was not necessary to plant and cultivate trees, as a healthy forest ecosystem is self-supporting and trees grow by themselves.

As a conclusion it can be argued that the period, farmers have cultivated their farms didn't influence the number of plant species or tree species they grow on their farms. It is much more influenced by their cultural background, the political situation and the land tenure system.

In comparison of all groups, Kalenjin farmers from the lower zone own their farms for the longest period, but they grow the lowest number of tree species on their farm. The main reason is their cultural background of being pastoralist. They don't grow many trees, because a big share of their farm consists of open pasture land for their livestock.

5.3.2 Indigenous/Exotic Species

Indigenous Plants

The farmers mentioned 62,5%, in numbers 667, indigenous plants of 139 species. Of all 194 identified species it cover a portion of 71,6%. Indigenous plants are mainly obtained for free (94,7%). They are found or actively planted with a similar share of 41,7%. Only 16,8% are retained.

Seedlings of indigenous plants originated from the own seed bed, neighbour or the forest in similar portions of 27,1%, 26,3% and 26,0% respectively. Indigenous plants were cultivated by Kalenjin from upper zone(35,1%), Ogiek (28,5%). Kikuyu and Kalenjin from the lower zone cultivated fewer indigenous species on their farms (18,3% and 18,1% respectively). Most indigenous plants (63,6%) were maintained in the upper zone. This could be observed also in *Table 5.3* which displays tree species along agro-ecological zone and whether they were indigenous or exotic species. Indigenous species were mainly used for medicine (32,7%), firewood (34,8%), fencing and boundary (7,8%). Further for food (6,5%), building and construction (6,1%) and to modify the climate (4,5%). Compared to exotic species, a predictable higher portion was used for medicine and only indigenous plants are used for honey production and cultural purposes (see *Figure 14*).

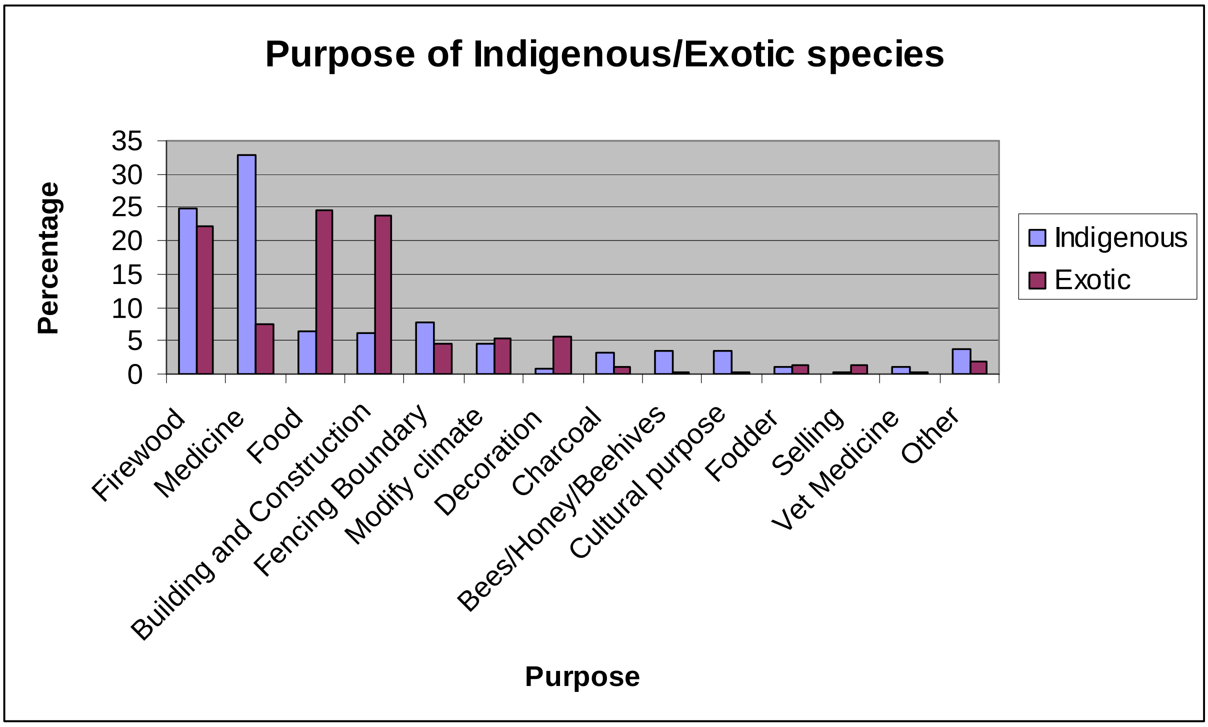

Figure 14: Purpose of indigenous and exotic species **Source: Own data**

Exotic Plants

Exotic species were more often bought (37,9%) than indigenous ones. In most cases (89,3%) exotic species were actively planted, rarely found (7,6%) or retained (3,1%). They originated mainly from the nurseries (45%) or own seedbeds (30,2%) or neighbours (15,7%). Mainly cultivated by Kikuyu farmers (40,6%) Kalenjin upper zone (27,4%), Kalenjin lower zone (20,2%) and least by Ogiek (11,7%). The majority of exotic trees (60,8%) was grown in the lower agro-ecological zone. This also shows *Table 5.3*.

Exotic plants were mainly used for food (24,6%), building and construction (23,7%) and firewood (22%). Further for medicine (7,4%), decoration (5,6%) and to modify the climate (5,4%).

In the upper zone much more indigenous plants (73,0%) were grown in contrast to only 49,9% in the lower zone. The highest number of indigenous plants was found within the Ogiek community, 80,2% of their plants were indigenous. For the other groups the fraction of indigenous plant species ranged from 68,0% for Kalenjin farmers (upper zone) to 57,2% for Kikuyu farmers (59,9% for Kalenjin farmers from the lower zone).

This might be a result of the economic infrastructure, which was much better in the lower zone where the villages were connected to a main road. While farms in the upper zone were located quite remotely and people living a more traditional life, where indigenous plants still had a higher value, or more reasonable exotic plants simply could not be afforded, as farmers in the upper regions were relatively poorer (Krupnik 2006; own observations). This showed also why 86,7% of all mentioned plant species were obtained for free in the upper zone, compared to only 77,8% in the lower zone. In the upper zone only 39,6% of all plants grown on the farm were actively planted, while 48,8% were found and 11,6% were retained. The high portion of found and retained (together 60,4%) plants in the upper zone could be traced back to the fact that the area was forested only a decade before and this was a result of natural rejuvenation of the area, as seeds from the former forest were left in the soil. Another reason was the close distance to the remaining forest and plants disperse naturally.

5.3.3 Plant Species and Purpose

Like pointed out above different species were valued by the farmers for various purposes. Farmers specified 1665 purposes for 1068 mentioned plants. These purposes were: firewood, medicine, food, building and construction, fencing/boundary, modify climate, decoration, charcoal, bees/honey/beehives, cultural purpose, domestic use, fodder, veterinary medicine, selling, support crops, soil conservation, beverages, attract birds, weed, experiment, landscaping and harvest seeds (see *Purpose of Plants unterhalb*).

Plant Species

Table 5.3 illustrated an extract of the 12 most commonly mentioned tree species also showing the frequencies, how many farmers mentioned the particular species during the field walk. The list of all tree species is found in the appendix (see *Table 11.2 Plant list - Tree species*). *Table 5.3* displays that much more indigenous tree species were maintained in the upper zone. The analysis was done by the agro-ecological zone, because for analysis by ethnic communities the results would loose their expressiveness.

In the following the ten most frequently mentioned plant species, covering 31,9% of all inventoried plants, were chosen for discussion. The full list of identified species is found in the appendix (see *Table 11.4 Plant list sorted alphabetically incl. frequency*). The number in the brakes next to the scientific name displays the frequency, how many farmers out of 60 identified this species on their farm.

All of this species were mentioned by at least 25 farmers out of 60. The single plant species were analysed by the source of the tree (planted, found or retained), if it was obtained for free (bought), the origin of the seedlings (tree nursery, own seedbed, neighbour or forest). Further it was discussed in which zone the plants were inventoried, and which ethnic community the farmers belong, who considered the species as valuable.

Table 5.3 Tree species identified by farmers along Agro-ecological Zones

Upper Zone			**Lower Zone**		
Indigenous	*Dombeya torrida*	30	**Indigenous**	*Croton megalocarpus*	25
	Olea europaea ssp. africana	21		*Dombeya torrida*	11
	Acacia mearnsii	11		*Acacia mearnsii*	9
	Nuxia congesta	11		*Acacia xanthophloea*	9
	Juniperus procera	9		**Total**	**111**
	Maytenus senegalensis	9	**Exotic**	*Cupressus lusitanica*	25
	Polyscias fulva	9		*Persea americana*	24
	Total	**168**		*Eucalyptus camaldulensis*	22
Exotic	*Cupressus lusitanica*	25		*Grevillea robusta*	22
	Grevillea robusta	18		*Pinus patula*	15
	Pinus patula	13		*Citrus sinensis*	11
	Eucalyptus camaldulensis	11		*Eriobotrya japonica*	9
	Persea Americana	10		*Callistemon sp.*	8
	Total	**111**		**Total**	**173**

Source: Own data - Extract of 12 most frequently mentioned tree species

Cupressus lusitanica (50)

óCypressô or óCheparusô was in 56% bought, and actively planted 98%. The seedlings originated mainly from the tree nurseries, infrequently from the own seedbed or the forest (64%, 18% and 10% resp.). This exotic species was the most frequently mentioned plant growing on 50 farms. It was used by all ethnic groups and in both zones with a similar frequency for building and construction and for firewood.

Dombeya torrida (41)

óSilibwetô is an indigenous species and therefore mainly obtained for free (90%). It was actively planted in 60% of the cases and in 12,5% retained. The seedlings originated mostly from the forest or from the tree nurseries (47,6% and 23,8% respectively). For 41 farmers *Dombeya torrida* was an important source of firewood and construction material in both zones, in the upper zone it was also used for honey production and medicine. All 30 farmers located in the upper zone identified this species on their farm. The tree is an important species for bee forage, construction or placing of bee hives and therefore it was mainly grown in the upper zone. Ogiek people are famous for honey production, which is linked with their culture, and it was generally very common in the upper Mau Catchment and the area around Nessuit

Grevillea robusta (40)

This exotic species was always actively planted, seeds were obtained from the nursery (64,1%), seldom from the own seed bed (17,9%) or neighbours (10%). Mainly Kikuyu farmers (37,5%) and Kalenjin farmers from the upper zone (27,5%) cultivated it. Only half of the Ogiek and Kalenjin farmers from the lower zone grew óGrevilleaô. It was highly promoted as suitable for agroforestry. Grevillea was commonly used for building and construction, firewood and to modify the climate in the upper zone.

Persea americana (34)

Avocados were mainly obtained for free (81,8%) from the own seed bed or neighbours. In 97% of the cases the plant was actively planted. All Kikuyu farmers grew avocado and half of the Kalenjin farmers (in both zones) maintained it as well on their farm. Only three Ogiek farmers grew avocado. 70% of the inventoried avocados were grown in the lower zone. This might be due to the good connection to markets, where avocados were sold.

Eucalyptus camaldulensis (33)

Half of the seedlings were obtained for free (50%) and all were actively planted (96,9%). The seedlings originated from the tree nurseries (51,6%) or from the own seed bed (24,2%). Eucalyptus produces many seeds and is a fast growing species. It was mainly cultivated in the lower zone (66,7%), farmers in the upper zone complained several times about the nutrient and water uptake of the plant. Eucalyptus was grown to produce wood for building and construction and firewood. Some farmers used it for fencing and to sell poles. Several farmers mentioned the negative effect on their farm. ñYou canôt grow maize within 10m around this treeò. The ñDaily Nationò (February 12th 2009) wrote about a project, where eucalyptus at a riparian area was cut down and replaced by mountain bamboo. After 6 months the effect of a higher water table was visible, because of the high water consumption of eucalyptus. Bamboo is growing as fast as eucalyptus and even easier to process. It would be better for the environment, because it doesnôt need this tremendous amount of water.

Ricinus communis (32)

óImaniatô, óMbolegitô, óMwarekiô or óCastor oilô were common names for this indigenous species, which was obtained for free (100%) and mainly (81,3%) actively planted. The seedlings were produced in the own seedbed (54,2%) or obtained from neighbours (33,3%) or the forest (8,3%). It was more often grown in the lower zone (62,5%) than in the upper zone (37,5%). Only 15,6% were grown by Ogiek farmers, while 34,4% were grown by Kikuyu farmers. This species was in both zones an important medicinal plant and used for firewood. In the lower zone some farmer mentioned its purpose for domestic use.

Croton megalocarpus (30)

This indigenous plant was mainly obtained for free (86,7%) and actively planted (90%) on the farm. The seedlings originated from the own seedbeds (71,4%), rarely from tree nurseries (17,9%) or the forest (10,7%). It was mainly cultivated in the lower zone (83,3%) by Kikuyu and Kalenjin farmers with the same share, to supply firewood, charcoal and medicine. Farms in the lower zone were far away from the forest and it was important to supply firewood on the own farm. In the upper zone it was only inventoried at two Ogiek and three Kalenjin farms, where it served to modify the climate.

Pinus patula (28)

In 63% of the cases the seedlings were bought and mainly actively planted (84,6%). The seedlings were obtained from the nursery (78,3%) or from the own seedbed (13,0%). The species was more or less evenly distributed within the ethnic groups and agro-ecological zone. In both zones it was used for building and construction and to produce firewood on the farm.

Senna didymobotrya (28)

óSenetwetô was an indigenous species and therefore obtained for free (100%). It was actively planted and found (35,7% each) or retained (28,6%) on the farm. It was mainly cultivated by Kalenjin farmers from the lower (46,4%) and upper zone (28,6%). By Ogiek 14,3% were planted and only 10,7% by Kikuyu farmers. óSenetwetô was an important plant within the Kalenjin community for cultural purposes. As medicinal plant it was used by all ethnic groups.

Olea europaea ssp. africana (25)

óYemditô, óEmitiotô or óMutamaiyuô was an indigenous species and mainly obtained for free (92%). Only in 40% of the cases it was planted, while it was found (44%) or retained (16%) in the other cases. The seedlings originate from the forest (50%) or seedbeds (20%) on the farm. It was mainly cultivated by Ogiek (48%) and Kalenjin (upper zone) (36%) farmers. In the lower zone it was only mentioned in 16% of the cases. Within the Ogiek community it was an important medicinal plant and used for particular cultural occasions. Further it was used for firewood and to modify the climate.

Table 5.4 Motivation for/against planting tree

	Kalenjin	**Kikuyu**	**Ogiek**
Motivation for planting trees	• Cultural purpose • Self-sufficiency • A prosperous farm need trees	• Many fruits - varieties • Trees for fencing/ security reason • Comprehensive knowledge on planting trees ï seedbeds	• Dry climate • Know how to live on the forest without harming • Respect of the forest and a healthy environment • Health issue • Trees/Forest are the basis of the traditional existence
Motivation against planting trees	• Extract products from the forest to meet their needs • Only option to earn money is connected with logging • Land in the upper zone is not suitable for pasture	• Knowledge on planting trees doesnât infiltrate in other communities	• Extract products from the forest to meet their needs • Only option to earn money is connected with logging • Lack of knowledge on planting trees

Source: Own data

Purpose of Plants

Especially within the Ogiek community, the farmers knew a lot about the specific use and preparation of plants and parts of plants as medicine. But they often lacked of knowledge about seed collection and maintaining of seedlings. Within the Kikuyu community knowledge on tree nursery and maintaining of seedlings was very common and widespread.

The species were analysed by the purpose they fulfil on the farm. For the farmers it was possible to mention as many purposes as they would like to. Altogether, farmers mentioned 1665 purposes for 1068 plants. These purposes were: firewood, medicine, food, building and construction, fencing/boundary, modify climate, decoration, charcoal, bees/honey/beehives, cultural purpose, domestic use, fodder, veterinary medicine, selling, support crops, soil conservation, beverages, attract birds, weed, experiment, landscaping and harvest seeds.

In most cases (for 1062 plants) farmers mentioned only one purpose, for 478 species they offered two functions, for 105 species three purposes and for only 17 species they found four options how they are used on the farm. For three species farmers mentioned even five purposes, these plants fulfil on their farms. For 6 species farmers didnôt mention a specific purpose.

All mentioned purposes were coded for SPSS 15.0 and sometimes combined to one group of answers. ñModify climateò for example includes answers like ñshadeò, ñattract rainò, ñwindbreakò or ñnice climateò.

ñSoil conservationò includes ñsoil structureò, ñprevent drying up soilsò, ñsoil fertilityò and ñprevent soil erosionò (see *appendix coding book 11.3*).

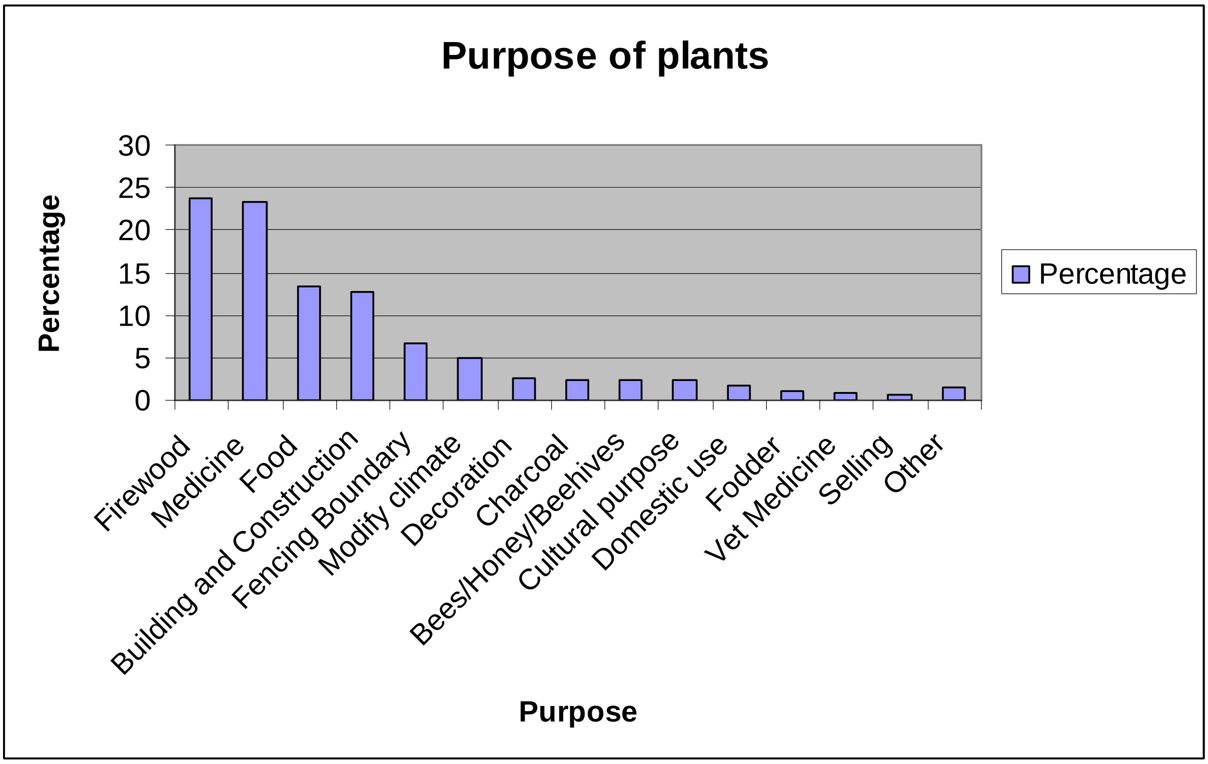

Figure 15: Purpose of plants - "What do you use this plant for?"   Source: Own data

Figure 15 shows how these purposes were distributed. ñOthersò include all values, which were named less than 10 times, which were support crops, soil conservation, beverages, attract birds, weed, experiment, landscaping and harvest seeds. In the following four purposes with the highest frequency were chosen for discussion and three which showed relevant differences within the ethnic groups, agro-ecological zones or gender. This was an outcome of comparing the following figures: *Figure 8 Purpose of plants by agro-ecological zone*, *Figure 13 Purpose of plants by ethnic community, Figure 13: Purpose of plants along ethnic community* and *Figure 5 Purpose of plants along gender of respondent*

Firewood

For firewood mainly (65,2%) indigenous species were used. It was clear that most of them are tree species. Numerous different species were declared as being maintained to supply the farm with firewood. The most important species, mentioned more than 19 times were *Cupressus lusitanica, Grevillea robusta, Dombeya torrida, Eucalyptus camaldulensis, Croton megalocarpus*, *Pinus patula* and *Olea europaea ssp.africana*.

Medicine

Most medicinal species were indigenous (88,1%). Only one third were trees and most of these species which were used for medicinal purposes were grown in the upper zone (69,8%). Next to firewood, the most different species were mentioned as useful for medicinal purposes, although many species are mentioned only by one respondent. The most frequently revealed species were Ricinus communis, *Senna didymobotrya, Vernonia auriculifera, Olea eurpaea ssp. africana, Dovyalis caffra* and *Plectranthus barbatus.* All mentioned more than 14 times.

Food

Most plants which were grown for food are exotic (69,4%) species. Half of the species were shrubs or herbaceous species. *Persea americana* was the most important species which is grown to harvest fruits. Further *Musa sp. Eriobotrya japonica, Citrus sinensis, Urtica massaica* and *Cyphomandra betacea* were maintained for food.

Building and Construction

The portion of exotic species grown for building and construction was quite high at 70,1%.

Trees were grown for this purpose in both zones. Timber and wood for construction was always needed on the farms. 70,1% of them were exotic species. The most frequently mentioned species were *Cupressus lusticana, Grevillea robusta, Eucalyptus camaldulensis, Pinus patula* and *Dombeya torrida*.

Modify climate

Indigenous and exotic species were mentioned with a similar portion for this purpose. Modifying the climate seems to be much more of an issue in the upper zone, where 75,3% plants, which were grown for this purpose, were located. Plants which were grown to modify the climate were mainly trees. Reasonable high portions (42%) were exotic species. *Croton megalocarpus, Cupressus lusitanica, Grevillea robusta and Olea eurpaea ssp. africana* were the most frequently mentioned species for modifying the climate.

Bees/Honey/Beehives

Species which were relevant for honey production were indigenous tree species. All together 15 different species were mentioned by men and women with a same portion. The most frequently species which are used for honey production in the way of bee forage or for constructing bee hives were *Dombeya torrida* and *Polyscias fulva*..

Cultural purpose

Species which were cultivated for their cultural use were relatively evenly distributed within the agro-ecological zones. Especially within the Kalenjin community independent of the zone many plants were used for cultural usage. This purpose mentioned 35 times within Kalenjin, only 2 and 1 time within Ogiek and Kikuyu communities respectively. Species which were used for cultural occasions are mainly indigenous species. *Senna didymobotrya*, *Olea eurpaea ssp. africana* and *Acacia mearnsii* were the most relevant species for cultural purposes.

5.4 FarmersôConstraints, Knowledge and Perceptions

The last section of the structured interview with open-ended questions deals with the farmersô constraints concerning planting more trees on their farm, the knowledge they possess concerning harvesting of seeds, maintenance of seedlings and growing trees and their future perception on farming and the conservation of the Mau Catchments (see *Appendix 11.2.2 Farmers**ô** view*).

The answers were entered in SPSS 15.0, but due to the various answers with specific nuances the answers are discussed and displayed as citations rather than figures. The focus in this chapter is on the farmersô view, how they see their situation. This is sometimes admirable reflected in a particular statement of single respondents.

Some questions concerning future perception needed further explanations in the field. Especially how farmersô see their own trees on their farm related to the entire Mau Catchment. Statements concerning the importance of various species maintained on the farm are construed as the importance of biodiversity.

5.4.1 FarmersôConstraints

Overall it can be announced that farmers are in general quite motivated to use their own farm to restore the Water Catchment Area by planting more trees. They have different motives why they want to grow more trees and why they want to maintain different species on their farm. Still they are facing numerous constraints, which they see themselves, detaining them from planting more trees.

Motivation

There was enough space on most of the farms (observation and farmersô answers) to plant more trees and many of the farmers wanted to have more trees on their farm. Only 11,7% of all Farmers (7 farmers out of 60) saw an adequate amount of trees on their farm, as their farm was too small to grow more trees. The other 53 farmers wanted to grow more trees on their farm for different reasons. They most frequent argument was that trees ñattract the rainò, ñmake a beautiful climate and a cool environmentò, ñimprove agricultural production on the farmò and conserve resource for ñfuture generationsò. Other motivations to grow more trees was the provision with products (see purpose of plants oben) from the own farm, to ñavoid going to the forestò and commercial reasons to improve the household income by ñselling seedlings or timberò.

Figure 16 shows the species farmer are already growing on their farm, but they wanted to have more. Different preferences were visible along the agro-ecological zone. In the upper zone farmer would like to grow more of *Olea europaea ssp. Africana, Fraxinus pennsylvinica, Polyscias fulva. Buddleia polystachya* and *Cyphomandra betacea*. These species were not mentioned in the lower zone, where farmers would like to grow more of *Croton megalocarpus, Mangifera indica, Senna didymobotrya, Melia azedarach, Acacia xanthophloea, Celtis sp., Vitis sp.* And *Psidium guajava*. Again these species were characteristic for the agro-ecological zone, like discussed earlier (see 5.3.3)

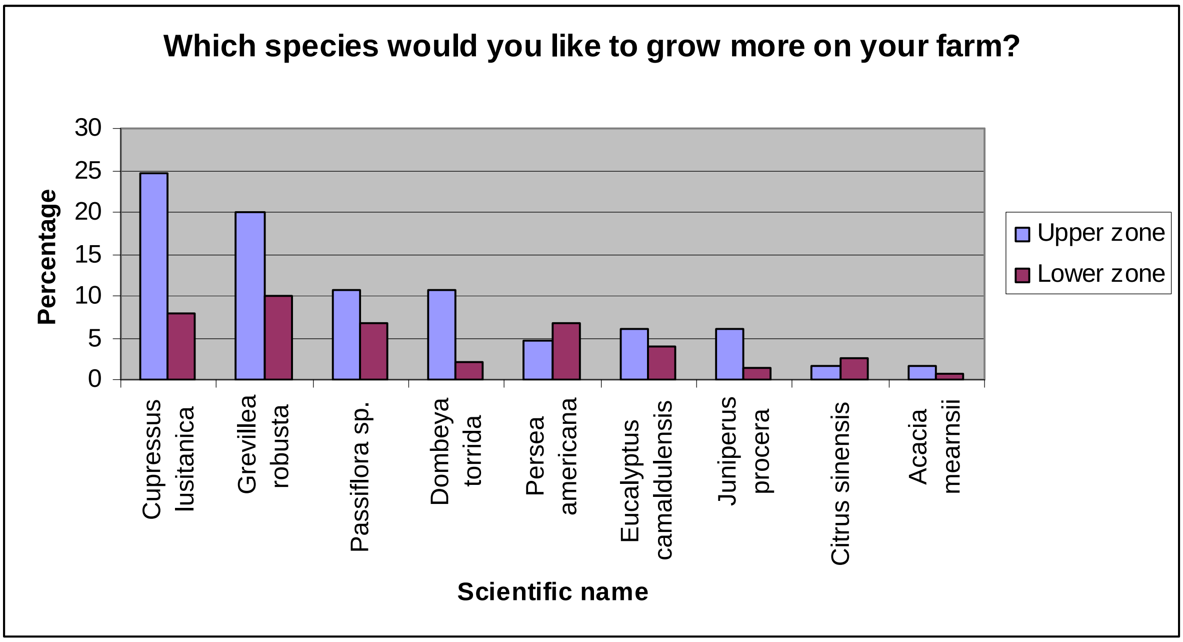

Figure 16: Species of which farmers want to grow more on their farm. Source: Own data

Generally this figure shows that farmers in the upper zone wanted to grow more species which were used for building and construction and firewood. In the lower zone farmers often argued that they canôt maintain more trees because need the space on the farm to meet their needs concerning vegetable and crops.

Biodiversity

A high diversity of tree species was important to all 60 farmers. For numerous respondents the driving force to maintain a high diversity of tree species on their farm was ñto be self-sufficientò (39 farmers) by the provision of products and purposes like food, medicine, firewood, timber, etc. (see *purposes 5.3.3 oben*) and to reduce the families expenses (18 farmers). Other motivations were to ñsave the environmentò, ñto help in the futureò and a variety of trees was necessary for bee keeping. Some farmers were convinced that the Mau forest ñcould be restored, if everybody grows more trees and uses agroforestryò. Another farmer argued that numerous species were important ñto control soil erosion and diseases on the farmò

When farmers were asked for their preference concerning introducing new species to their farm, they mentioned 40 different species they would like to grow on their farms. Remarkably often farmers mentioned fruit trees like *citrus sp.*, *persea americana* or *passiflora sp.* It was very difficult to obtain seeds for fruit trees in the upper zone (see *farmers training 6.3*). Although in the upper zone members of the community group, who were running the tree nursery in Nessuit, were maintaining an orchard for breeding purposes. They tried to grow different fruit trees to supply the surrounding farmers. This experiment just started one year ago, when the tree nursery was established.

FarmersôConstraints

Although farmers wanted to have more trees on their farm, there are various constraints they are facing. It was notable that the issue of cost is not mentioned as the main constraint, when farmers wanted to plant trees. The main reason was the availability of seeds or seedlings. Often the next tree nursery was quite far away or doesnọt supply farmers with the preferred species.

Table 5.5 Farmers' constraints - 'Why don't you grow more trees?'

Constraints	Frequency	Per Cent
Seed(ling)s not available	42	43,8
Cost	15	15,6
Need many resources	14	14,6
Take long to mature	7	7,3
Climate too cold	6	6,3
No answer	3	3,1
Lack of information	2	2,1
Drought	2	2,1
Restriction by government - eucalyptus	2	2,1
Stayed away for long time	2	2,1
Shallow soil	1	1,0
Total	96	100,00

Source: Own data

The main constraints to grow more trees were the accessibility to seedlings/seeds, especially fruit trees and some indigenous varieties of cultural value were difficult to obtain (see *farmers training 6.3*). Seedlings of indigenous species were easily obtained from the forest but they often donọt survive the transplantation. Further farmers argued a general lack of knowledge on maintaining trees, constraints them to grow more trees. Most of the interviewees faced various constraints like recorded in *Table 5.5*. Three farmers didnọt answer the question ñWhy donọt you grow more trees on your farm?ò The availability of seedlings was the major constraint mentioned by more than 2/3 of all farmers (42 farmers out of 60). The issue of cost was ranked on the second position. Further farmers saw the resources, which were needed to grow trees as a hindrance to maintain more trees on their farm. It has to be considered that in most households the water needed to be carried for quite a distance, and especially young seedlings require irrigation and special maintenance.

5.4.2 FarmersôKnowledge

Above all framers were cultivating their land for some time and knew their property. But as mentioned in the introduction, their starting position was not a healthy ecosystem. It was of interest how farmers see their position and how they are aware of different techniques to plant and maintain trees on their farm. Additional it was discussed where farmers obtain their seeds from and which purposes trees are supposed to serve on their farm.

Maintenance

To discover the actions farmers took to retain trees on their farm, they were asked how they were maintaining young and old trees. More than one third of all farmers mentioned pruning, weeding, watering, fencing/protection and manuring as the main working steps for maintaining trees.

40 out of 60 farmers mentioned drought as a reason why seedlings do not survive (see *Table 5.7*). Other frequently mentioned reasons are disease/pest/fungus and destruction by people (children) or animals.

Table 5.6 Why do seedlings not survive?

	Why do seedlings not survive?	**Frequency**	**Valid Per cent**
Not influenceable	Drought	40	38,5
	Disease/Pest/Fungus	14	13,5
	Soil	5	4,8
	No answer	4	3,9
	Lack of water	4	3,9
	Climate	4	3,9
	Rocky ground	1	1,0
	Total	72	69,2
Influenceable	Destruction by people/animals	14	13,5
	Poor transplantation	7	6,7
	Immature seed(lings)	6	5,8
	Poor maintenance	5	4,8
	Total	32	30,8
Total		104	100,00

Source: Own data

Farmers knew about many techniques to maintain seed/seedlings on their farm although they didnữ seem to use them. Often trees were meant to grow by themselves, without any need of maintenance. For example fencing/protection was mentioned as an important measure for maintaining seedlings and trees, whereas destruction by animals and people was mentioned as a main reason why seedlings do not survive (see *Table 5.7*).

Some causes, why seedlings die off, like destruction, poor transplanting, immature seeds and decreased soil fertility could be improved by the farmers. These influence able effects could be avoided by improvement of techniques, gained knowledge on transplanting seedlings and harvesting or raising seeds in seedbeds. Knowledge on soil improvement by composting and green manure would also be a solution to avoid the dying of seedlings.

Reasons like drought, diseases, climate or rocky ground canot be influenced by the farmers. These were facts, farmers had to cope with. The improvement of the environment by planting trees and the maintenance of a healthy ecosystem would help to reduce the vulnerability of suffering from these influences. This will be of a major importance when taking climate changes and the absence of rain seasons into consideration.

Table 5.7 Techniques - 'How do you maintain young/old trees?'

Technique	Frequency	Percentage
Pruning	46	25,3
Weeding	44	24,2
Watering	28	15,4
Fencing/Protecting	27	14,9
Manuring	20	11,0
Training	4	2,2
Replace old trees	3	1,7
Apply chemicals/pesticides	3	1,7
Not cutting	2	1,1
Shading	2	1,1
Agroforestry	1	0,6
Pest control	1	0,6
Woodlot instead of scattering	1	0,6
Total	182	100,00

Source: Own data

Farmers mentioned 13 different techniques for maintaining trees. On average each farmer mentioned three opportunities how they cultivate trees on their farm. *Table* 5.7 shows that some techniques, like pruning, weeding, watering, fencing and protection, and manuring were mentioned frequently and seemed to be very common. Others techniques displayed a relative low frequency. The application of chemicals was not common in the research area, because it was too costly for most of the farmers. Krupnik *et al.* 2006 argued that chemicals were applied in a way with such small doses, that it couldnǿt be counted for any improvements of crops. Nevertheless farmers trusted methods of conventional agriculture more than methods attributed to organic farming like green manure or composting. Composting was only mentioned by one farmer, who declared that he is just starting this experiment, as he heard about composting at a farmersô training.

Origin and Source of Plants grown on the Farm

The seeds and seedlings originated either from the tree nursery, from the own farm, from neighbors or from the forest. In the upper zone some Kalenjin farmers obtained the seedlings also from the adjacent riverside. The source of the species describes whether they were actively planted, retained or found on the farm as a result of natural growth.

Table 5.8 displays the origin of seeds and seedlings of tree species along the agro-ecological zone. In comparison to *Figure 17* which includes all plants identified by the farmers during the field walk. The difference within these two data sets is negligible. Because farmers of the different ethnic groups mentioned various numbers of plants on their farms only percentages are displayed in *Figure 17* to demonstrate the relative portions for each ethnic group and to facilitate the comparability.

Most of the mentioned plant species originated from tree nurseries, from the own farm as seeds, from neighbours or from the forest (32,3%, 28,8%, 20,3% and 15,3% respectively). The origin of other species (2,8%) couldnǿt be specified while a minority of plants (0,3%) originate from the riverside.

Table 5.8 Origin of Seed/-lings of actively planted Tree Species

Upper Zone			**Lower Zone**		
Origin	**Frequency**	**Valid Percent**	**Origin**	**Frequency**	**Valid Percent**
Nursery seedlings	76	52,4	Own seeds	107	45,2
Forest	32	22,1	Nursery seedlings	90	38,0
Own seeds	22	15,2	Forest	26	11,0
Neighbour	14	9,7	Neighbour	14	5,9
Riverside	1	0,7	Total	237	100,0
Total	145	100,0			

Source: Own data

Table 5.8 shows that nearly half (45,2%) of the planted trees in the lower zone originated from the own farmǿs nursery or seedbed, and from the tree nursery (38,0%). Whereas in the upper zone most planted tree seeds/seedlings originated from the tree nursery (52,4%) or from the forest (22,1%), and only a minority of 15,2% originated from the own seedbed.

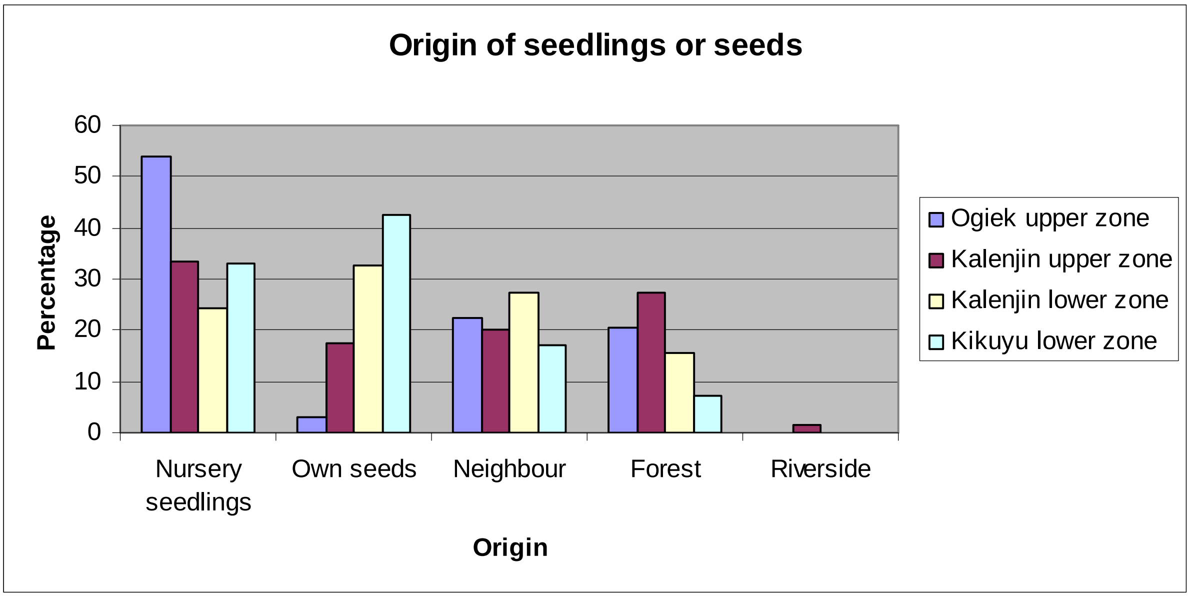

Figure 17: Origin of seedlings and seeds **Source: Own data**

It has to be considered that many plants were found on the farm as a result of natural rejuvenation. These plants were not counted in *Figure 17*.

It shows that Kikuyu farmers obtained most of the plants from the own farm (42,6%), from the nursery (33,0%) or from neighbours (17,0%). Similar numbers appeared for Kalenjin farmers from the lower zone. They obtained 32,7% of their plants from the own farm, 27,2% from neighbours and 24,5% from tree nurseries. In the upper zone only few plants originated from the own seedbeds, especially within the Ogiek community. Ogiek farmers obtained most of their plants from tree nurseries (54,0%), from neighbours (22,2%) and 20,6% from the forest. Only 3,1% were obtained from the own farm. Here *Figure 18* needs to be considered, which is explained below.

Kalenjin farmers in the upper zone also obtained the majority (33,6%) of their plants form tree nurseries, a high proportion originated from the forest (27,3%) and from neighbours(20,3%). A minority of 1,4% originated from the riverside.

It has to be considered that missing values were not counted in *Figure 17*. These missing values include also retained plants, as their origin canắt be defined because they have been already on the farm ever since. Especially in the upper zone for many plants the origin couldnắt be determined. On the one hand farmers didnôt remember and on the other hand it seemed they didnôt want to remember. While in the lower Zone only 21,8% were missing, there were 62,3% missing in the upper zone. The most missing values for the origin of the seeds or seedlings were counted within the Ogiek community (71,3%) and Kalenjin community of the upper zone (55,81%). This could be explained by the high amount of retained plants (see *Figure 18*). Within the Kalenjin farmers in the lower zone and Kikuyu farmers the origin of only 27,2% and 17,9% (respectively) of their plant species was unknown. Nevertheless *Figure 17* was useful, as the displayed values and the concluded information harmonized and matched up with information gathered from participatory observations during the interviews.

Figure 18 needs some further explanation. Plants were either actively planted or transplanted, found on the farm ï when plants sprout on the farm naturally or they were retained, when the plants were much older than the farm itself. Therefore plants were automatically obtained for free, if they were found or retained on the farm. If plants are bought or obtained for free is not correlated to the cultural background. Between 75,9% (Kikuyu) and 87,6% (Ogiek) of all species were obtained for free.

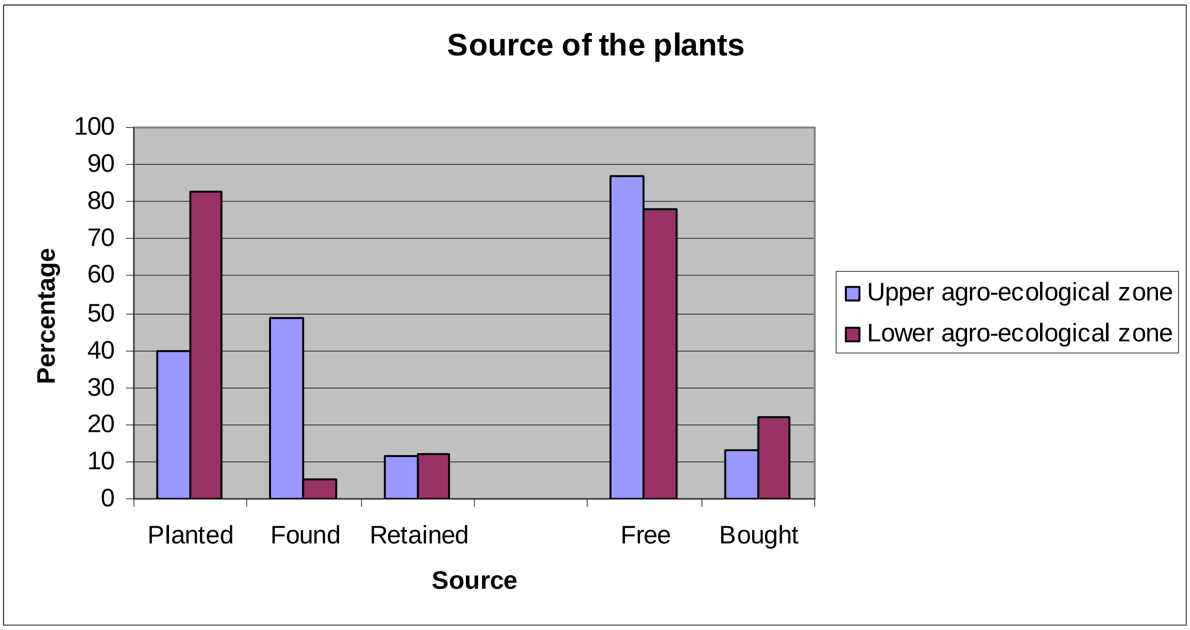

Figure 18: Source of the plants along agro-ecological zone **Source: Own data**

This figure discovers the source of the plants as another difference between the two agro-ecological zones. Capturing all plants, farmers in the lower zone were more likely to actively plant trees and shrubs, as plants didnât disperse from the forest and need to be actively planted. Actually 82,9% of the plants in the lower zone were actively planted compared to a much lower portion of 39,6% in the upper zone. All other plants were old trees, which were retained and have been on the farm ever since or the trees were found on the farm and grown naturally. The percentage of retained plants was in both zones similar and most of these species were indigenous (90,4%).

Seeds and Seedlings obtained for Free / Bought

Only 17,3% of all plant species were bought at tree nurseries or at neighboursâ. The majority of all plants (82,7%) was obtained for free, originating from the own farm, neighbours, forest or the riparian forest.

This was different for **actively planted** species, which were mainly exotic (55,8%) and tree (66,7%) species. More than half of all mentioned plants (59,2%) were actively planted, while others were found or retained on the farm (29,1% and 11,7% respectively). The majority (70,8%) of actively planted species were bought, while the rest was obtained for free. Actively planted species originated from tree nurseries (32,3%), from the own farm as seeds (29,0%), from neighbours (20%) or the forest (15,5).

Actively planted species were more likely to be exotic tree species, which were bought in tree nurseries.

5.4.3 Farmers Perception

The farmers, especially in the Upper Zone seemed very likely to adopt new farming systems and techniques if they were shown to them (see *Tree management training 6.3*). They were very keen to plant more trees on their farm, not only to support themselves with food, firewood, medicine, wood for building and construction, fodder, etc. but also to improve their environment and to reforest the area. Farmers mentioned the missing forest as the reason for the dry climate which causes major health problems in the upper zone. The forest modified the climate, it was ñnot that cold during the nights and during the day there was a cool breezeò and the children were not ñcoughing the whole year roundò.

Mau Relation

Most of the farmers saw a positive relation of the trees on their own farm to the Mau Escarpment.

Farmers were very strong aware of the negative effects of deforestation. They were influenced by the effects ten years after the forest was lost in a very direct way. 49 out of 60 farmers (table 3.6) mentioned that trees ñattract rainò which was essentially needed. Especially during the dry season the effects of drought and missing shading of the land, were tremendous. The farmers knew that trees would not only modify the climate on their own farm, but in the entire catchments area. They saw trees as a tool to retain soil moisture and conserve soil and the whole water catchments area. Only four farmers out of 60 did not see a positive relation or didnôt see their trees related to the water catchments area. One farmer saw a positive relation, but didnôt see enough effort by his neighbours, the government and other actors around the Mau Forest. His trees had the same effect like ña drop in the oceanò. This statement displays the often found helplessness farmers felt when talking about the shrinking forest.

Main constraints in the area were the social tensions within the different ethnical groups and therefore a lack of information flow between the different groups. This problem was also identified by the farmers themselves. (They viewed their neighbourôs trees, but donôt ask him how he managed to grow them so nicely.) Information flows were very strongly bordered within a cultural group. Only few groups were trying to break these borders. In the upper zone Kalenjin and Ogiek farmers were more likely to interact, at least on the weekly market and at the tree nursery. In the lower zone the two ethnical groups lived quite separated in two villages. Although members of the youth group, who were also running a tree nursery, explained that they were also working with youths from the neighbouring village.

Almost all farmers were aware of the importance of the trees to retain the soil moisture on their farms and to conserve the Mau Water Catchment as a whole. In the farmers point of view, the trees were strongly related to the climate in the area and therefore to the productivity of their fields and also to their health. Some argued that they get sick because of the dry climate and the absence of the forest.

Many people, especially in the upper zone (Ogiek community), remembered the conditions, when the area was still forested. They argued that the nights were not that cold and during daytime they were less exposed to the sun. The farmers were of the opinion that the forest needs to be restored. Other farmers were more pessimistic as they consider the trees on their farm as a ñdrop in the oceanò concerning the relation to the whole Mau Catchment. A high variety of trees was mostly important to become self sufficient with the products grown on their own farm (see Table 5.9).

Very frequently farmers mentioned that trees ñattract the rainò.

Table 5.9 ôHow are the trees on your farm related to the Mau Catchment?ô

Reason	Frequency	Valid Percent
Attracts rain	49	38,9
Soil conservation	28	22,2
Modify climate	22	17,5
Conserve watercatchment	11	8,7
Windbreak	7	5,6
No difference - trees on farm same value as forest	3	2,4
Beautiful environment	2	1,6
No relation	1	0,8
Shade	1	0,8
Drop in the ocean - no hope	1	0,8
Tourist attraction	1	0,8
Total	126	100,0

Source: Own data

This statement shows that farmers have a very different explanation of patterns compared to the scientific view, but nevertheless the outcome or the overall meaning is the same (Krupnik *et al.* 2006; Rist 2006). The motivation of the farmers is a very important when considering the implementation of an agroforestry or reforestation project.

Tree Nursery

Two interviews were conducted with operators of community tree nurseries in Sigotik and Nessuit. The Nurseries were in a very good shape, with fences, shadow and a water tank. Eight people were in charge of the nursery and looked after the plants for watering. One tree nursery even included an experimental orchard, to produce offshoots which could be sold as seedlings in the near future. Especially in the upper zone it was very difficult to obtain seedlings for fruit trees, because they were simply not sold in the local tree nurseries.

50 % of all plants received from a tree nursery belong to the following species: *Cupressus lusitanica, Grevillea robusta, Pinus patula, Eucalyptus camaldulensis* and *Persea americana.* 78,4% of all plants originating from tree nurseries were exotic species and most of them 86,6% were trees. The most frequently mentioned purpose of these plant species are building and construction, firewood and food.

This was in accordance to the results from the visits at two tree nurseries. They only supply farmers with very few species: *Cupressus lusitanica, Grevillea robusta, Pinus patula* and *Eucalyptus camaldulensis*. The assortment was small because the tree nurseries were just implemented a year ago within the SUMAWA-Project. Although the operators were trying to expand the assortment and offer also indigenous species as there was a ñconsiderable demandò. They had several problems with raising indigenous species, as they said they lack knowledge. Transplantations of seedlings from the forest often failed and they had difficulties to obtain seeds (*Farmers training 6.3*). The owner of the tree nursery argued that it was difficult to find skilled people for harvesting seeds of indigenous plants. Some inhabitants of the village possessed the required knowledge on harvesting mature seeds, but it was quite difficult and costly in terms of time.

6 Conclusion and Recommendations

This chapter summarizes results and main conclusions of the research. After the interviews were finished, a farmer training was organized in the upper zone, as a thank-you for the farmersô help. Further recommendations are formulated.

6.1 Conclusion

The destruction of the East Mau Catchment area is an issue of great importance as the deforestation and land degradation are obviously destroying the environment. Droughts during the dry season, floods in the rain season and lower water tables are the result of forest mismanagement and settlement in unsuitable areas. The goal of this study was to analyse the perceptions of the local communities, how they use and maintain the natural assets of trees and shrubs, and how they see the conservation of these resources and their relation to the entire Mau Catchment area.

A research matrix was developed and interviews with 60 small scale farmers, in two agro-ecological zones and three different ethnic groups, were conducted. Although the sample was too small to gain definitive results, they are in accordance with an on-going research carried out within the OAT project, where 292 interviews were conducted.

The surrounding situation in the Mau Catchment area, like political tensions and the situation in a rural area itself, influenced the way how interviews were conducted. The population in the research area is not homogenous. This was why a stratified sample was used for sample selection. A local guide for each ethnical group in the upper agro-ecological zone was necessary to identify the target group and for the orientation in the field. This led to the selection by the guide, which was avoidable. The farmers were not contacted before the interview and the interview situation was a casual situation on the farm.

The demographic analysis of the data showed, that although nearly all households were headed by man, mainly women responded to the questionnaire, as they were around on the farm. During a circuit walk on the farm, the interviewee identified the plant species and the purpose they fulfil on the farm. All farmers wanted to have more trees, as they value not only the economic advantages, but also environmental and cultural services of trees on their farm. A high biodiversity on the farm is endorsed mainly due to economic reasons, as it helps to be self-sufficient. Contrary these results, there are apparently very few trees (less than 20 trees per ha) in the whole research area, which is far away from any agroforestry approach.

Farmers face various constraints when planting trees. Surprisingly money is not the main constraint, but the accessibility of mature seeds and seedlings, especially for preferred indigenous species. A lack of knowledge on seed harvesting and maintenance of seedlings restrain farmers of planting trees. Some reasons why seedlings don't survive are not influenced by the farmer, such as drought, pest, diseases, fungus and poor soils. Other constraints, like destruction by children and cattle, poor transplantation or poor maintenance could be easily improved with enhanced farming systems and training. Although farmers know about various farming techniques, they seem not to use them. While protection of seedlings is mentioned frequently as a measure to maintain seedlings, destruction by children and animals is a major reason why seedlings don't survive.

Due to steep slopes the area is not suitable for agriculture, soil erosion is increasing and the water storage capacity declines. Sustainable farming systems are urgently needed. Most farmers lack knowledge on proper farming systems, including components of organic farming like composting, nutrient cycling and green manure, or agroforestry. Nevertheless they showed great interest, as they were concerned about the basis of their livelihoods. The motivation for planting trees were income and a better environment, but they didn't see many other benefits for their crops, such as increased soil fertility, controlled soil erosion and improved water household.

Different farming systems are in place, dependent on the cultural background. It has to be considered, that there is only minimal exchange of knowledge within different ethnic groups, although farms are neighbouring each other. To mention some examples: considering the origin of seeds and seedlings, it was notable that especially within the Kikuyu community many farmers possess their own seedbed. Opposing Ogiek farmers, who identified remarkably numerous species used for medicine. On Kalenjin farms fewer tree species were identified, because a big part of their farms was open pasture land without trees, as they are traditionally pastoralist. Therefore specific knowledge on farming system and trees is strongly dependent on the ethnical belonging, which is often ignored in researches in this area.

The identified species and their respective purposes were analysed by gender, agro-ecological zone (*Figure 8*) and ethnic group (*Figure 13*). These results showed that women identified more species which are important for firewood and medicine, as these were needed for women's tasks within the household like cooking and childcare. Men identified more species used for decoration and modifying the climate. Species which are used for food, construction and timber production were identified by both genders in a similar share.

Differences could be observed within the agro-ecological zones. Regarding the most frequently mentioned tree species in the upper zone, which was situated quite remote at the edge of the forest, more indigenous species were identified. This was due to the close distance to the forest, which led to natural rejuvenation on the farm and it was easier for farmers to transplant seedlings from the forest on their farm. Another reason was the accessibility, because farmers simply had no access to exotic species from tree nurseries. The lower zone was characterized by a better infrastructure and farmers had access to seedlings of exotic species and a bigger local market.

Within the different ethnic groups various preferences could be observed. For example in both zones the same percentage of plants was identified for their value intended for *cultural purpose*. When considering the ethnic community it was observed that *cultural purpose* was of major importance for the Kalenjin community, who were interviewed in both zones, as they used many plants for the production of mursik, a traditional milk drink. Another example was species, which were mainly grown for honey production, which was mainly done by the Ogiek community in the upper zone. In the lower zone honey production was neglected.

Nevertheless, too few trees were grown in the area to avoid further environmental degradation, and often the only way to produce cash income was to work for logging companies. But the farmers are forced to meet the needs for their families facing lower yields on their fields. There was an awareness of the importance of a healthy ecosystem to improve the agricultural production. Farmers valued trees as they ñattract rainò, ñconserve resources for future generationò and ñmake a beautiful climateò. In the upper zone modifying the climate was a prevailing issue. Farmers argued that they faced fewer illnesses when they lived in forested area. There was a collective memory of the forest which was cleared just a decade ago, which motivated farmers to improve their environment. However, farmers appeared quite desperate, hopeless and powerless against their diminishing natural assets. They want and need to learn how to increase their yields by sustainable farming measures.

6.2 Recommendations

For restoring the environment in the Mau Catchment area the help of the local population is necessary. For the implementation of projects, stakeholders need to participate and it is envisaged that this is not a difficult process if they identify the positive outcomes themselves. Compared to other areas, like the Kakamega forest reserves, where the forest is sneaking away over decades, stakeholders donøt see the negative effects of land degradation as it appears only slowly. In the Mau Forest, the deforestation appeared within a very short time span and the generations living in the area do remember the situation before. The farmers in the research area relate their environmental problems directly to absence of the trees, which is a very good starting point for further extension work in this area. Unfortunately, the government offers other ósolutionsô to recover the Mau Forest. Ejecting people from the area can't be considered as a solution and it will lead to violence. Compensation payments are costly, difficult to organize, as many people have difficulties to provide evidence of their claim to properties and there is no other place for these people to go. The money from these compensation payments would be better invested in projects, which include the local population, to raise the awareness of the importance of a healthy environment and to facilitate farmerøs conversion to agroforestry farming systems. Agroforestry areas canøt be considered as forest, but it would prevent farmers from destroying the remaining forest and riparian areas, if they could meet the demand for forest products by supplies on their own farms.

Nevertheless it is necessary to protect the water catchment area. It is useful to implement a riparian conservation zone along the rivers in the Mau water catchment area, as the area is big enough to host many people, if they get the chance to restore the environment and learn how to manage their land in a proper and sustainable way.

A study on medicinal plant would be necessary especially in the upper zone, as traditional knowledge on specific uses in human and veterinary medicine was explained. This knowledge is traditionally passed to the following generation. The fact that most of the formerly forested areas were cleared and a change of the peopleøs way of living gave reason for concern about this knowledge being lost in the near future.

6.3 Tree Management Training

During the research, it was recognized that most farmers in the upper zone of the research area, possessed comprehensive knowledge on commercial, ecological and medicinal usage of plants. At the same time, many farmers lacked knowledge on planting trees, maintaining seeds and seedling, as the forest was there ever since and planting trees became important just in recent years. All thirty interviewed farmers (Kalenjin and Ogiek farmers from the upper zone) were invited for a one day ñtree management trainingò held by Mr. Shadrack Inoti (Egerton University) at the local tree nursery in Nessuit. 20 men and six women participated at this training. For their participation the farmers received five tree seedlings from the local tree nursery.

Many interviewees mentioned earlier that seeds, for favored indigenous, and often culturally important tree species, were not available and seed collection was difficult for some species. Therefore, the tree nurseries in Nessuit, Sigotik, which were run by community groups, and another tree nursery in Kamwaura, which is run by a youth group, were supported with seeds from the Kenyan Forestry Research Institute (KEFRI). Unfortunately, it is necessary to mention that many of the high demanded seeds were ñout of stockò or ñnot availableò.

The Farmers appreciated the training and showed serious interest on planting trees. Most farmers were aware of the ecological problems caused by the absence of the forest and wanted to contribute by planting trees on their own farms.

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óZwei Dinge sollen Kinder von ihren Eltern bekommen: Wurzeln und Flügel ó
(Johann Wolfgang von Goethe)

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Tables and Figures

8.1 Tables

8.2 Figures

9 Abstract

Many forest ecosystems of high global value are often located in areas with high population densities, widespread poverty, and intensive agricultural land use. Rapid population growth in the East Mau Catchment, has led to expansion of cultivation. Deforestation and intensified cultivation of steep slopes without adequate soil conservation measures results in soil impoverishment through soil erosion. Degraded soil condition leads to lower yields, and in turn localised hunger and poverty. Therefore there is an urgent need to develop alternative strategies to mitigate these problems.

Agroforestry has a high potential to prevent soil degradation, is increasingly becoming an essential tool for achieving the goal of biodiversity conservation, and improving sustainable livelihoods. Understanding farmersô strategies of managing on-farm tree diversity is important for successful implementation of agroforestry programs.

In the East Mau Catchment five ethnic groups live as small scale farmers with diverse cultural backgrounds, farming systems and knowledge of plants. A survey was carried out by conducting 60 standardized questionnaires with closed- and open-ended questions, amongst farmers of three ethnical groups, situated in two agro-ecological zones. The aim of this study was to record the different preferences in tree and shrub species. Information was gathered on purposes of tree and shrub species, farmersô knowledge on maintenance and cultivation of this natural asset, and their perceptions concerning the conservation of their environment.

The farmers, who identified 194 valuable species (68 tree species) on their farms, are aware of the environmental, economic and cultural services of the forest. The major constraints for on-farm reforestation are lack of knowledge and accessibility of seeds and seedlings.

10 Zusammenfassung

Viele Waldökosysteme von globalem Wert befinden sich in Gebieten mit hohen Populationsdichten, weitverbreiteter Armut und intensiver Landnutzung. Rasches Populationswachstum im östlichen Mau Gebiet (Nakuru, Kenia) führt zur Ausweitung des landwirtschaftlich genutzten Gebietes. Abholzung und intensivierte Kultivierung steiler Hänge ohne adäquate Bodenkonservierungsmaßnahmen führt zu Bodenverarmung durch Bodenerosion. Degenerierte Bodenbeschaffenheit führt zu geringerem Ertrag und dadurch lokalisiert zu Hunger und Armut. Aus diesem Grund ist es notwendig mit alternativen landwirtschaftlichen Strategien dieser Entwicklung entgegen zu wirken.

Forstlandwirtschaft verfügt über großes Potential, Bodendegradation zu verhindern und wird immer mehr zum Instrument, um Biodiversität zu schützen und zu erhalten, und gleichzeitig Lebensgrundlagen nachhaltig zu verbessern. Um Agroforstwirtschaft zu implementieren, ist es notwendig die gängigen lokalen Landnutzungssysteme und den Umgang und Wertschätzung der lokalen Bevölkerung in Bezug auf Artenvielfalt zu verstehen. Im östlichen Mau Gebiet leben fünf ethnische Gruppen als Kleinbauern mit sehr unterschiedlichen kulturellen Hintergründen, landwirtschaftlichen Systemen und Pflanzenwissen.

Standardisierte Interviews mit offenen und geschlossenen Fragen wurden mit 60 Kleinbauern aus zwei agro-ökologischen Zonen durchgeführt, die drei unterschiedlichen Kulturgruppen angehörten. Das Ziel dieser Arbeit war es, unterschiedliche Präferenzen dieser Gruppen bezüglich Baum- und Straucharten aufzuzeigen. Die gesammelten Informationen beziehen sich auf die Verwendung der einzelnen Baum- und Straucharten, das lokale Wissen der Bauern bezüglich Erhaltung und Kultivierung des natürlichen Kapitals, und die lokale Wahrnehmung und Wertschätzung von Artenvielfalt und Umweltschutz.

Die befragten Personen, welche insgesamt 194 aus ihrer Sicht wertvolle Arten (davon 68 Baumarten) auf ihrem Besitz identifizierten, schätzen den Wald nicht nur aufgrund seines ökonomischen, sondern auch durch dessen ökologischen und kulturellen Wertes. Das größte Hindernis für vermehrte Aufforstung stellen fehlendes Knowhow und Verfügbarkeit von Samen und Setzlingen dar.

11 Appendix

11.1 Research Matrix

Differences of tree and shrub species among small holder farms in the East Mau Catchment - considering agro-ecological zone and ethnicity

Objectives

The broad objective of this study is to determine differences in tree and shrub species diversity among farmers of three different ethnicities and located in three different agro-ecological zones in the East Mau Catchment. The specific objectives include:

1. To identify tree and shrub species on small holder farms and how farmers use them for medicine, food, fodder, domestic purpose, firewood, timber, etc.
2. To identify farmersô knowledge on maintenance of trees and shrubs.
3. To identify farmersô perceptions concerning biodiversity conservation and the relation of the trees on their farm and the Mau Water Catchment Area

Research Question

Use of Tree and Shrub species

- Which tree and shrub species are grown on small holder farms for which purposes?
- To what extent does the cultural background/agro-ecological zone affect usage or preference of different species?
- Is the farmerøs production adequate for their use? (self-sufficiency)

Farmersô knowledge

- How do farmers grow and maintain their seed/seedling of tree and shrub species?
- Is the biodiversity of tree and shrub species a result of planting activities or a by-product of general land cultivation respectively fallow situations (gender aspect)
- Do farmers have access to seeds/seedlings in the community? (Tree Nursery)

Farmersô perception:

- Which further species would farmers prefer on their farm?
- What are the constraints/preferences for more trees and shrubs?
- Do farmers consider tree and shrub biodiversity as important concerning the conservation of the Mau Water Catchments Area?

Table 11.1 Research Matrix

Objective	Research Question(s)	Required data	Question(s)	Indicator(s)	Method(s)
Identify used woody plant species on the farm	Which tree and shrub species are grown on the farm for which purposes?	Purposes of woody plant species Woody plant species on the farm	Which plants do you use for this Purpose? (Food, medicine, fuel, fodder, ornamental, shade, timber, boundary, soil fertility, charcoal, fruit, pest control, dyes, construction, beverages, é) Which woody plants (trees and shrubs) grow on your farm?	Purposes of woody plants List of plants found on the field	Questionnaire Plant survey ï go in the field
identify the occurrence of woody species in the different agro-ecological zones and ethnic groups of the East Mau Catchment	To what extent does the cultural background/agro-ecological zone affect usage or preference of different species?	Geographic/ Demographic data	location, ethnicity, age, gender, household size/income, farm size, duration of stay on the farm	Differences in identified plants and purposes, considering location and cultural background	Questionnaire Ericôs database ï secondary data
Identify farmerôs knowledge on tree and shrub species and where these are cultivated within the farm or outside	How/where do farmers maintain/grow the identified species on their farm Are the identified species planted by the farmer (male, female, old, youth) or grown naturally?	Maintenance of the identified used plants Location of the identified woody species ï identify biotopes (hedge, field, edge of forest/ pondé)	Where is this tree located on your farm? How many do you have of this species? Why? Who planted this tree? How do you maintain this tree/shrub?	Biotopes Location of plants Knowledge on ecology of species Gendered knowledge	Questionnaire Field survey ï walk around on the farm

Identify how the cultivation of these plants can be promoted.	What techniques and strategies do farmers use to maintain a number of species on their farms?	Most important woody plant species ï (with most important purpose ï farmers view)	Why did you grow this tree, not another one? Which one is the most important? Where do you get your seeds/ seedling from?	Farmers value of a species Farmers access to resource	Questionnaire ï open ended question Visit local tree nursery in each agro-ecological zone
Identify farmersô perceptions concerning biodiversity conservation of trees and shrubs related to the Mau Catchment as a whole.	Which further species would farmers prefer on their farm? What are the constraints/preferences for more trees and shrubs?	Farmers view/ values	Which other trees would you like to grow on your farm? Would you like to have more of x? Why donôt you grow more of x?	Farmerôs goal/wish Constraints farmers cope with	Questionnaire ï open ended question

11.2 Questionnaire

11.2.1 Research Manual

This research manual displays the information which is meant to be recorded with the Questionnaire 11.2.2. Further it describes how the information is gathered and how the interview takes place.

Section 1: Interview identification
location, farm, household, interviewee, interview number, responsible person,

Section 2: Purpose of Trees and Shrubs
Walk around on the Farm; ask for the trees and shrubs.
Farmers should not see the questionnaire during the interview to avoid bias

- Point to a certain species growing in the farm - record name
- Ask farmer about the age or planting date of this tree
- Ask whether more of the same species were planted at the same time in the niche
- Indicate the number of trees under No
- Record all information on establishment and origin of the trees and shrubs and mode of acquisition
- Record all information on the purpose on the farm
- Try to record info in a systematic way ï niche by niche, species by species

Questions answered by table for Section 2

- Which woody plants (trees and shrubs) grow on your farm?
- How many do you have of this Indigenous/exotic species (No)?
- Where is this tree located on your farm (Niches)?
- Who planted this tree (Establishment)?
- Where do you get your seeds/ seedling from (Origin)?
- Buying or for free? Mode of acquisition
- What is the purpose of this plant on your farm?

Section 3: Farmers view

- Farmerôs preferred trees and shrub species
- Farmerôs perception and view on number of planted trees
- Constraints to Biodiversity of Trees and Shrubs
- Importance of Biodiversity

Section 4: Tree Nursery

- Location of the Tree Nursery and Interviewee identification
- Offered species
- Size/dimension of tree nursery
- Knowledge on farmers preferences

11.2.2 Questionnaire

Questionnaire

Differences of tree and shrub species among farmers in the East Mau Catchment considering different agro-ecological zone and ethnicity

The aim of this study is to record the differences of preferred tree and shrub species among farmers of three different agro-ecological zones and with diverse cultural backgrounds, settled in the East Mau Catchment.

1 Interview identification

Interview number / date	
1. Name of interviewer Ethnic community	
2. Village	
3. Since when did your family live here?	_______Years
4. Name/Age household head Gender(circle)	________________________________ Male Female Age_____
5. Name of respondent	
6. Gender of respondent (circle)	Male Female
7. Respondent is (circle)	Husband Wife Child(ren)
8. GPS position	_ _° _ _ô_ _ N; _ _° _ _ô_ _ E;
9. Altitude	_ _ _ _ masl
10. Nearest tree nursery	Distance (km) Name:
11. Who is responsible for planting for buying the seeds for maintaining the seedlings for harvesting?	

2 Trees on the farm and purpose

Questionnaire - Table - plant list

3 Farmers view

1. Which species is the most important?
2. Which purpose has this species on your farm?
3. Why is it important to you?

Rank	**1. Most important species**	**3. Reason for ranking**

Trees and Shrubs Biodiversity Conservation

4. How do you maintain Young / Old trees?		
5. Why do seedlings not survive?		
6. Which other trees would you like to grow on your farm? Would you like to have more of a certain species?		
7. Why donȇt you grow more of x (**constraints**)?		
8. Do you see an adequate amount of different trees and shrubs on your farm? Why/why not? 9. Do you consider a high number of different trees as important? Why/why not? (**Biodiversity**) 10. How are the trees on your farm related to the whole Mau Catchment?		

11.2.3 Questionnaire - Table - plant list

Questionnaire ï Section 2 ï Table					
No	**1.Plant name(s)**	**2.Niches (circle)**	**3.Establishment**	**4.Origin**	**5. Purpose**
		HomeS Ornamental Hedge Other: ScatT __________ Boundary Woodlot	Planted Who: Year: Retained Found	Nursery Neighbour Forest Seed Seedlings Free / buying	
		HomeS Ornamental Hedge Other: ScatT __________ Boundary Woodlot	Planted Who: Year: Retained Found	Nursery Neighbour Forest Seed Seedlings Free / buying	
		HomeS Ornamental Hedge Other: ScatT __________ Boundary Woodlot	Planted Who: Year: Retained Found	Nursery Neighbour Forest Seed Seedlings Free / buying	
		HomeS Ornamental Hedge Other: ScatT __________ Boundary Woodlot	Planted Who: Year: Retained Found	Nursery Neighbour Forest Seed Seedlings Free / buying	

11.3 Coding book for SPSS 15.0

This code-book includes answers mentioned by the respondents. The arrow indicates recoded values. Similar answers are put together under one value, for example ñChildrenò includes ñson/daughterò and ñgrandchildrenò. The number in front of the question indicates the question number of the questionnaire (see 11.2.2 Questionnaire)

Missing values:
-1 ódata not collectedô
-2 ónot applicableô
-3 ôno otherô

1.2) Ethnic group:
1 'Kalenjin'
2 'Ogiek'
3 'Kikuyu'
4 ôKalenjin Upper Zoneô

1.11) Who is responsible for Planting, buying, maintaining, and harvesting?

1'Wife'
2 'Husband'
3 'Wife and children'
4 'Wife and husband'
5 'All family members'
6 'Son/daughter' -> Children = 11
7 'Husband and Children'
8 'Grandchild' -> Children = 11
9 'Grandparents' -> Other relatives = 12
10 'Brother/Sister' -> Other relatives = 12
11 óChildrenô
12 óOther relativesô

2.4) Origin of plants

1 'Nursery seedlings'
2 'Neighbour'
3 'Forest'
4 'Own farm seeds' -> Seeds = 8
5 'Own farm seedlings' -> Seeds = 8
6 óForest and Neighboursô
7 óForest and Nurseryô
8 óSeedsô
9 'Riverside'

2.5) Purpose of specific species:

1 'Bees/Honey/Beehives'
2 'Building and Construction'
3 'Beverages'
4 'Charcoal'
5 'Medicine'
6 'Vet Medicine'
7 'Fencing Boundary'
8 'Firewood'
9 'Food'
10 'Fodder'
11 'Fruit' -> Food = 9
12 'Decoration'
13 'Pest control'
14 'Prevent Soil Erosion'->Soil conservation=42
15 'Shade' -> Modify climate = 44
16 'Soil Fertility' -> Soil conservation = 42
17 'Drying up soil' -> Soil conservation = 42
18 'Selling'
19 'Timber' -> Building and Construction = 2
20 'Easy to maintain'
21 'Weed'
22 'Soap' -> Domestic use = 43
23 'Toothbrush' -> Domestic use = 43
24 'Washing utensil' -> Domestic use = 43
25 'Broom' -> Domestic use = 43
26 'Attract rain' -> Modify climate = 44
27 'Poison' -> Medicine = 5
28 'Cultural purpose'
29 'Soil structure' -> Soil conservation = 42
30 'Rope' -> Domestic use = 43
31 'Windbreak' -> Modify climate = 44
32 'Glue' -> Domestic use = 43
33 'Oil' -> Domestic use = 43
34 'Support crops'

35 'Experiment'
36 'Nice climate' -> Modify climate = 44
37 'Grow fast'
38 'Attract birds'
39 'Landscaping'
40 'Harvest seed'
41 'Cigarettes' -> Domestic use = 43
42 óSoil conservationô
43 óDomestic useô
44 óModify climateô

3.4) How do you maintain Young/Old Trees?

1 'Pruning'
2 'Weeding'
3 'Watering'
4 'Manuring'
5 'Fencing/Protecting'
6 'Irrigation' -> Watering = 3
7 'Not cutting'
8 'Agroforestry'
9 'Pest control'
10 'Cutting old trees' -> Replace old trees=11
11 'Replace old trees'
12 'Training'
13 'Soil dipping' -> Manuring = 4
14 'Apply chemicals/pesticides'
15 'Shading'
16 óWoodlotô(instead of scattering)

3.7) Why donôt you grow more trees? (Constraints)

1 'Cost'
2 'Seed(ling)s not available'
3 'No nursery' -> Seed(lings) not available = 2
4 'Lack of information'
5 'Difficult maintenance' -> Many Resources needed = 16
6 'Drought'
7 'Shallow soil'
8 'Farm size' -> Many Resources needed = 16
9 'Immature seed'-> Seed(lings) not available = 2
10 'Climate too cold'
11 'Take long to mature'
12 'Destroy farm - need lot of water' -> Many Resources needed = 16
13 'Lack of information exchange between farmers' -> Lack of information' = 4
14 'Restriction by government - eucalyptus'
15 ãôStayed away for long timeô
16 óMany Resources neededô

3.10) How are the trees on your farm related to the whole Mau Catchment?

0 'No relation'
1 'Attracts rain'
2 'Soil conservation'
3 'Retain soil moisture' -> Soil conservation = 2
4 'Keep water table high' -> Conserve Watercatchment = 13
5 'Shade river' -> Conserve Watercatchment = 13
6 'Make streams flowing' -> Conserve Watercatchment = 13
7 'Fresh air' -> Modify climate = 10
8 'Prevent desertification' -> Soil conservation = 2
9 'Windbreak'
10 'Modify climate'
11 'Beautiful environment'
12 'Shade'
13 'Conserve watercatchment'
14 'No difference - trees on farm, in the forest' -> Others = 17
15 'Drop in the ocean - no hope' -> Others = 17
16 'Tourist attraction' -> Others = 17
17 óOthersô

11.4 List of identified species

Table 11.2 Plant list - Tree species

No.	Scientific name	indigenous/ exotic
1	Acacia abyssinica	Indigenous
2	Acacia mearnsii	Indigenous
3	Acacia xanthophloea	Indigenous
4	Achyranthes aspera	Indigenous
5	Annona squamosa	Indigenous
6	Bersama abyssinica	Indigenous
7	Callistemon sp.	Exotic
8	Celtis sp.	Indigenous
9	Citrus lemon	Exotic
10	Citrus sinensis	Exotic
11	Commiphora eminii	Indigenous
12	Croton macrostachyus	Indigenous
13	Croton megalocarpus	Indigenous
14	Cupressus lusitanica	Exotic
15	Cupressus mediteranneae	Exotic
16	Cussonia holstii	Indigenous
17	Cussonia spicata	Indigenous
18	Diospyrus abyssinica	Indigenous
19	Dombeya rotundifolia	Indigenous
20	Dombeya torrida	Indigenous
21	Ekerbergia capensis	Indigenous
22	Eriobotrya japonica	Exotic
23	Erythrina melanacantha	Indigenous
24	Eucalyptus camaldulensis	Exotic
25	Eucalyptus melanoxyllum	Exotic
26	Eucalyptus saligna	Exotic
27	Euclea divinorum	Indigenous
28	Ficus thonningii	Indigenous
29	Fraxinus pennsylvinica	Exotic
30	Giripanyat	Indigenous
31	Grevillea robusta	Exotic
32	Hevea brasiliensis	Exotic
33	Jacaranda mimosifolia	Exotic
34	Juniperus procera	Indigenous
35	Loledongenyet	Indigenous
36	Maerua triphylla	Indigenous
37	Malus domestica	Indigenous
38	Mangifera indica	Exotic
39	Markhamia lutea	Indigenous
40	Maytenus ovatus	Indigenous
41	Maytenus senegalensis	Indigenous
42	Melia azedarach	Exotic
43	Morus alba	Exotic
44	Nuxia congesta	Indigenous
45	Olea capensis	Indigenous
46	Olea europaea ssp. africana	Indigenous
47	Pentaclethra macrophylla	Indigenous
48	Persea americana	Exotic
49	Pinus patula	Exotic
50	Podocarpus latifolius	Indigenous
51	Polyscias fulva	Indigenous
52	Polyscias kikuyuensis	Indigenous
53	Prunus africana	Indigenous
54	Prunus sp.	Exotic
55	Psidium guajava	Exotic
56	Pyrus sp.	Exotic
57	Rapanea melanophloeos	Indigenous
58	Solanecio mannii	Indigenous
59	Spathodea nilotica	Indigenous
60	Synadenium compactum	Indigenous
61	Tarchonanthus camphorates	Indigenous
62	Teclea nobilis	Indigenous
63	Terminalia sp.	Exotic
64	Vangueria acutiloba	Indigenous
65	Warburgia ugandensis	Indigenous
66	Zanthoxylum usambarense	Indigenous

Table 11.3 Plant list - No tree species

No.	Scientific name	Indigenous/ exotic
67	Aloe vera	Exotic
68	Amaranthus hybrida	Exotic
69	Ananas comosus	Exotic
70	Artemesia vulgaris	Exotic
71	Arundinaria alpine	Indigenous
72	Asparagus africana	Indigenous
73	Basella alba	Indigenous
74	Bidens pilosa	Indigenous
75	Bougeumvela spectabilis	Exotic
76	Bracken fern	Indigenous
77	Buddleia polystachya	Indigenous
78	Buserwet	Indigenous
79	Caesalpina spinosa	Indigenous
80	Caesalpinia decapetala	Exotic
81	Camellia sinensis	Exotic
82	Carduus keniensis	Indigenous
83	Carica papaya	Exotic
84	Chepchai	Indigenous
85	Clerodendrum myricoides	Indigenous
86	Clutia abyssinica	Indigenous
87	Crassocephalum manii	Indigenous
88	Crassocephalum montiosum	Indigenous
89	Crotalaria agatiflora	Indigenous
90	Crotalaria brevidens	Indigenous
91	Cucurbita pepo	Exotic
92	Cyphomandra betacea	Exotic
93	Cyphomandra fragrans	Indigenous
94	Cyphomandra fragrans	Indigenous
95	Cyphostema bambuseti	Indigenous
96	Datura stramonium	Indigenous
97	Dobera glabra	Indigenous
98	Dovyalis abyssinica	Indigenous
99	Dovyalis caffra	Exotic
100	Duranta sp.	Exotic
101	Elephatia	Indigenous
102	Ensete ventricosum	Indigenous
103	Epiphillum oxypetalum	Exotic
104	Geranum maculate	Exotic
105	Gomphorcapus physocarpus	Indigenous
106	Gomphorcapus selunatus	Indigenous
107	Gontorbruit	Indigenous
108	Grewia forbesii	Indigenous
109	Grewia similis	Indigenous
110	Grewia tembensis	Indigenous
111	Helichryssum montuosum	Indigenous
112	Hibiscus cannabinus	Exotic
113	Hibiscus rosa-sinensis	Exotic
114	Hypoestis verticillaris	Indigenous
115	Ilimosekwet	Indigenous
116	Indigoferra arrecta	Indigenous
117	Ipomoea spathulata	Indigenous
118	Kalanchoe densiflora	Indigenous
119	Kibuimetiet	Indigenous
120	Lagenaria siceraria	Exotic
121	Lagenera allata	Exotic
122	Lantana camara	Exotic
123	Lantana trifolia	Indigenous
124	Leonotis mollisma	Indigenous
125	Lumeito	Indigenous
126	Malva verticillata	Exotic
127	Manihot esculenta	Exotic
128	Maronget	Indigenous
129	Mijawet	Indigenous
130	Mirabilis jalapa	Exotic
131	Momordica foetida	Indigenous
132	Mukige	Indigenous
133	Mukungeet	Indigenous
134	Musa sp.	Exotic
135	Mutumiat	Indigenous
136	Nicotiana glauca	Exotic
137	Nicotiana tabacum	Exotic
138	Nyagiliet	Indigenous
139	Oswet	Indigenous
140	Passiflora sp.	Exotic
141	Patkawet	Indigenous
142	Pavetta gardeniifolia	Indigenous
143	Pavonia urens	Indigenous
144	Physalis peruviana	Indigenous
145	Phytolacca dadecandra	Indigenous
146	Piraswet	Indigenous
147	Pistacia aethiopica	Indigenous
148	Plectranthus barbatus	Indigenous
149	Polygonum pulchrum	Indigenous
150	Puny'ta	Indigenous
151	Rhamnus prinoides	Indigenous
152	Rhamnus staddo	Indigenous
153	Rhus natalensis	Indigenous
154	Rhus vulgaris	Indigenous
155	Ricinus communis	Indigenous
156	Rosa odorata	Exotic
157	Rosmarinus officinalis	Exotic
158	Rubus pinnatus	Indigenous

159	Rubus sp.	Indigenous
160	Rubus steudneri	Indigenous
161	Rubus volkensii	Indigenous
162	Rumex acetosella	Indigenous
163	Saiya	Indigenous
164	Salvia coccinea	Exotic
165	Sambacus sp.	Exotic
166	Satureia bifolia	Indigenous
167	Scutia myrtina	Indigenous
168	Senecio palittianus	Indigenous
169	Senecio sp.	Indigenous
170	Senecio sylingiflora	Indigenous
171	Senna didymobotrya	Indigenous
172	Senna occidentalis	Indigenous
173	Senna tomentosa	Indigenous
174	Sesbania sesban	Indigenous
175	Sigorowet	Indigenous
176	Sinendet	Indigenous
177	Solanum aculeastrum	Indigenous
178	Solanum incarnum	Indigenous
179	Solanum sissillersitinum	Indigenous
180	Steabane sp.	Indigenous
181	Strelitzia sp.	Indigenous
182	Subeywet	Indigenous
183	Tabarariet	Indigenous
184	Tagetes americanum	Exotic
185	Tagetes minuta	Indigenous
186	Tiepkirpo	Indigenous
187	Tinet	Indigenous
188	Tithonia diversifolia	Indigenous
189	Unknown local name	Indigenous
190	Urtica massaica	Indigenous
191	Vernonia auriculifera	Indigenous
192	Vernonia lasiopus	Indigenous
193	Vitis sp.	Exotic
194	Yucca oleifolia	Exotic

Table 11.4 Plant list sorted alphabetically incl. frequency

Scientific name	**Frequency**
Acacia abyssinica	9
Acacia mearnsii	20
Acacia xanthophloea	9
Achyranthes aspera	3
Aloe vera	1
Amaranthus hybrida	1
Ananas comosus	1
Annona squamosa	2
Artemesia vulgaris	5
Arundinaria alpine	6
Asparagus africana	1
Basella alba	8
Bersama abyssinica	4
Bidens pilosa	2
Bougeumvela spectabilis	2
Bracken fern	1
Buddleia polystachya	10
Buserwet	1
Caesalpina spinosa	1
Caesalpinia decapetala	8
Callistemon sp.	13
Camellia sinensis	1
Carduus keniensis	3
Carica papaya	5
Celtis sp.	3
Chepchai	1
Citrus lemon	6
Citrus sinensis	14
Clerodendrum myricoides	1
Clutia abyssinica	1
Commiphora eminii	2
Crassocephalum manii	1
Crassocephalum montiosum	1
Crotalaria agatiflora	3
Crotalaria brevidens	2
Croton macrostachyus	1
Croton megalocarpus	30
Cucurbita pepo	1
Cupressus lusitanica	50
Cupressus mediteranneae	1
Cussonia holstii	4
Cussonia spicata	2
Cyphomandra betacea	10
Cyphomandra fragrans	3
Cyphomandra fragrans	3
Cyphostema bambuseti	1
Datura stramonium	4
Diospyrus abyssinica	8
Dobera glabra	1
Dombeya rotundifolia	2
Dombeya torrida	41
Dovyalis abyssinica	1
Dovyalis caffra	21
Duranta sp.	4
Ekerbergia capensis	3
Elephatia	1
Ensete ventricosum	2
Epiphillum oxypetalum	1
Eriobotrya japonica	16
Erythrina melanacantha	1
Eucalyptus camaldulensis	33
Eucalyptus melanoxyllum	2
Eucalyptus saligna	1
Euclea divinorum	6
Ficus thonningii	5
Fraxinus pennsylvinica	11
Geranum maculate	1
Giripanyat	1
Gomphorcapus physocarpus	4
Gomphorcapus selunatus	1
Gontorbruit	1
Grevillea robusta	40
Grewia forbesii	1
Grewia similis	2
Grewia tembensis	1
Helichryssum montuosum	1

Hevea brasiliensis	1
Hibiscus cannabinus	2
Hibiscus rosa-sinensis	1
Hypoestis verticillaris	1
Ilimosekwet	1
Indigoferra arrecta	1
Ipomoea spathulata	2
Jacaranda mimosifolia	2
Juniperus procera	14
Kalanchoe densiflora	4
Kibuimetiet	1
Lagenaria siceraria	1
Lagenera allata	2
Lantana camara	7
Lantana trifolia	2
Leonotis mollisma	6
Loledongenyet	1
Lumeito	1
Maerua triphylla	1
Malus domestica	2
Malva verticillata	1
Mangifera indica	7
Manihot esculenta	3
Markhamia lutea	3
Maronget	3
Maytenus ovatus	3
Maytenus senegalensis	10
Melia azedarach	4
Mijawet	2
Mirabilis jalapa	1
Momordica foetida	4
Morus alba	4
Mukige	1
Mukungeet	1
Musa sp.	18
Mutumiat	2
Nicotiana glauca	1
Nicotiana tabacum	1
Nuxia congesta	12
Nyagiliet	1
Olea capensis	6
Olea europaea ssp.	25

africana	
Oswet	1
Passiflora sp.	7
Patkawet	1
Pavetta gardeniifolia	12
Pavonia urens	8
Pentaclethra macrophylla	1
Persea americana	34
Physalis peruviana	1
Phytolacca dadecandra	1
Pinus patula	28
Piraswet	1
Pistacia aethiopica	1
Plectranthus barbatus	19
Podocarpus latifolius	4
Polygonum pulchrum	6
Polyscias fulva	9
Polyscias kikuyuensis	1
Prunus africana	9
Prunus sp.	5
Psidium guajava	9
Puny'ta	1
Pyrus sp.	1
Rapanea melanophloeos	6
Rhamnus prinoides	1
Rhamnus staddo	5
Rhus natalensis	19
Rhus vulgaris	1
Ricinus communis	32
Rosa odorata	2
Rosmarinus officinalis	3
Rubus pinnatus	8
Rubus sp.	4
Rubus steudneri	18
Rubus volkensii	1
Rumex acetosella	1
Saiya	1
Salvia coccinea	1
Sambacus sp.	1
Satureia bifolia	2

Scutia myrtina	3
Senecio palittianus	4
Senecio sp.	1
Senecio sylingiflora	1
Senna didymobotrya	28
Senna occidentalis	1
Senna tomentosa	1
Sesbania sesban	2
Sigorowet	1
Sinendet	1
Solanecio mannii	2
Solanum aculeastrum	13
Solanum incarnum	12
Solanum sissillersitinum	11
Spathodea nilotica	1
Steabane sp.	1
Strelitzia sp.	1
Subeywet	1
Synadenium compactum	1
Tabarariet	1
Tagetes americanum	1
Tagetes minuta	11
Tarchonanthus camphorates	5
Teclea nobilis	1
Terminalia sp.	2
Tiepkirpo	1
Tinet	1
Tithonia diversifolia	9
Unknown local	1
Urtica massaica	10
Vangueria acutiloba	1
Vernonia auriculifera	19
Vernonia lasiopus	7
Vitis sp.	1
Warburgia ugandensis	1
Yucca oleifolia	1
Zanthoxylum usambarense	2
Total	1068

11.5 Work Plan

Table 11.5 Work Plan

TOPIC ï ACTIVITY		**DATE**
Literature review		Mid November
	Arrive in Kenya	21^{st} Nov
Proposal		Until 28^{th} Nov
Meeting with Eric Bett, Rhoda Birech, S.T.Kariuki and Shadrack Inoti	- Translator and Botanic student - Transport? - Local contact person	28^{th} Nov
Prepare questionnaire	With Daniel and Eric ï valid for SPSS	Until 2^{nd} Dec
Pre-testing of the questionnaire	Outside Research Area - Egerton	3^{rd} -5^{th} Dec
Interviews with farmers - 15 per week Zone 1	30 Interviews in Nessuit and Sigotik 15 Ogiek 15 Kalenjin	8^{th}-21^{st} Dec
Entering data of the first 30 interviews		21^{st} Dec ï 5^{th} Jan Over x-mas
30 Interviews with farmers - 15 per week Zone 3	30 Interviews in Sosiot and Kamwaura 15 Kikuyu 15 Kalenjin	5^{th} ï 30^{th} Jan
Data entering and analyzing of the interviews		5^{th} Jan ï 15^{th} Feb
Farmers Training		16^{th} Feb
Finish Master Thesis	Analyzing, Results, Discussion, Layouté	1^{st} Apr - October