Working Paper

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Eastern and Central Africa

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Abstract

Mt. Kenya lies at the origin of a wide variety of agro-ecological zones in Kenya, and the zones surrounding Mt. Kenya itself comprise Kenya's eastern and central provinces. The purpose of this survey is to establish the current vegetation status of both indigenous and exotic tree species in this wide range of agro-ecological zones of eastern and central Kenya, in terms of species composition and structure type. It also aims to determine how the tree vegetation is categorized as to type of species richness and tree abundance, as well as species composition, using some environmental variables. In this study, a farmer survey and a nursery survey were conducted with the vegetation survey. The purpose of the farmer survey was to know the present status of trees in order to improve their productivity under the agroforestry systems. We collected information, such as constraints of tree farming and agroforestry and what tree species the farmers want to plant most in their farms. A nursery survey also collected information, such as the type of tree species they have, how they raise tree seedlings, and seedling supply systems, in order to know the present situation of private nurseries, family nurseries, and group nurseries.

The survey team found 459 species in 87 families at 265 plots in the target areas surrounding Mt. Kenya. The average number of trees and shrubs per plot (1/2ha) is 204.5 and the number of species per plot is 17.6. More than 70% of all species are indigenous tree species, and such trees are more than 50% of all trees. Almost all zones have a higher number of exotic trees than indigenous trees, especially in the tea-dairy, coffee-tea, and main coffee zones. The lower locations, however, have more indigenous trees than exotic trees. A rank-abundance curve also shows that few species dominate the landscape. Ten species, out of 459 species, represent 43.5% of all trees. Most of them are exotic species such as *Grevillea robusta*, *Musa sapientum* and *Cupressus lusitanica*.

Through regression analysis we found that Embu District has a significantly greater number of trees than the other districts, and the inner lowland zone has fewer. The ordination diagram provides further evidence for compositional differences among districts. Species composition is especially varied between Embu and the other four districts. Meru and Kirinyaga districts are similar in species composition, as are Nyeri and Laikipia districts. The limited abundance of many indigenous tree species indicates that genetic diversity and population sizes could be too low to sustain several indigenous tree species within the agro-ecosystem unless their abundance is increased. We need to give more attention to the direct influential mechanisms and consider the root causes. Our survey team emphasizes 'Conserving biodiversity, while promoting agriculture production through agroforestry'.

Keywords: Mt. Kenya agro-ecological zones, vegetation survey, indigenous species, exotic species, Agroforestry

Contents

Part I
Results of a vegetation survey in five districts surrounding Mt. Kenya

1. Introduction

Mt. Kenya, a prominent mountain located at the equator, causes a wide variety of agro-ecological zones in Kenya. An agro-ecological zone is defined by its relevant agro-climatic factors and differentiated by soil pattern. The aim of such zone classification is to provide a framework for the ecological (natural) land-use potential. General agro-ecological zones were established by FAO (1978). The target districts we surveyed comprise Kenya's eastern and central provinces, surrounding Mt. Kenya. No previous comprehensive survey has covered all of these agro-ecological zones. As a world heritage site, Mt. Kenya forest is always the target of appeals to save natural vegetation, and therefore Kenya Wildlife Service has several times carried out vegetation surveys, using satellite images, aerial pictures and ground level surveys (Gathara, 1999; Vanleeuwe *et al.* 2003). The vegetation status of agricultural fields surrounding the mountain, however, was always dismissed and neglected by the researchers and government officials. The World Agroforestry Centre (ICRAF) has carried out several surveys about agroforestry potential, including fodder tree species trials, in recent decades (Hoekstra 1988; Thijssen *et al.* 1993; Roothaert *et al.* 1997). Without an initial understanding of the real situation of vegetation and people in the target area, ideas and plans might not be born. The agro-ecological zone category is attached as Appendix 1.

The present survey intended to begin by establishing the current vegetation status of both indigenous and exotic tree species in a wide range of agro-ecological zones of eastern and central Kenya. A random vegetation survey within the target zones would assess species inventory, which is then used to identify useful tree species for the production of timber, fuel, fruit, fertilizer and fodder around Mt. Kenya. Diversification of species composition can lead to enhancements of stability and productivity of ecosystems (Cottingham *et al.* 2001). Such diversification of tree species on farms is one of the objectives of the World Agroforestry Centre (ICRAF 2000). This survey also forms the basis of a vegetation map, which when combined with satellite image analyses can be used to assess future vegetation changes caused by such phenomena as global warming. We analyzed statistically how tree vegetation is categorized, in terms of species richness, tree abundance, and species composition,

corresponding to environmental valuables - including altitude, soil chemical and physical conditions - in the target area. Community ecology analysis was introduced to identify the significance of species richness and composition when affected by these variables.

A farmer survey was also undertaken with the vegetation survey. The purpose of the farmer survey was to establish more details about individual tree species on farm, and discover how farmers benefit from these species. We collected information such as constraints on tree farming and agroforestry, and what tree species farmers most want to plant in their farms. Such information is useful in recommending tree species to farmers and helping them understand how best to enhance productivity in agroforestry systems.

A nursery survey was also undertaken, to collect information on the type of tree species available in nurseries and how nurseries raise tree seedlings. We assessed private, cooperative, and group nurseries to understand how practices could be improved in the near future and how farmers can be provided with good seedlings and information. Results of the farmer and nursery surveys are studied in relationship to the vegetation survey result.

2. Background

In eastern and central Africa, land for agricultural production can be divided into two major ecological areas, the extensive arid or semi-arid lands and the humid lands. The humid lands, found mainly in the cool tropical highlands that range in altitude from 1200 to 3300 m, are favourable for farming. Their agricultural potential is high (Imbernon 1997; Ondieki 1999). These humid lands are also centres of high population density and high population growth. As they cover only a small part of the overall region, however, the lower lands (610-1200 m) are an important outlet for their populations, and there are strong links between the two ecological zones. Land-use practices and land-use dynamics are very different in the two ecological areas. By examining differences, we can gain an understanding of the constraints to future agricultural development or, conversely, its thresholds (Imbernon 1997). Table 1 shows the percentage of land categories for each of the districts around Mt. Kenya.

Table 1. Land category in each district surrounding Mt. Kenya

District	Arid (%)	Semi-arid (%)	Semi-arid to Semi-Humid (%)	Semi-humid (%)	Sub-humid (%)	Humid (%)	Total area (km^2)
Meru*	11.0	17.7	20.9	11.2	15.7	23.5	9922
Embu*	0.0	27.1	19.0	16.2	9.1	28.6	2818
Kirinyaga	0.0	2.9	17.1	31.0	12.0	37.1	1478
Nyeri	0.0	0.0	20.1	22.7	23.3	33.8	3356
Laikipia	13.1	30.1	14.4	4.8	37.2	0.3	9229

*Meru includes itself as well as Meru Central, Meru North, Meru South, Tharaka, and Nyambene districts, which were subdivided from the original Meru district. Embu consists of Embu and Mbeere districts. (Source: Jaetzold and Schmidt, 1983)

Source: Census report from the Kenya Central Bureau of Statistics, January 2001

3. Profiles of survey districts, population and land use systems

The nine districts include Meru Central, Meru North, Meru South, Tharaka, Embu, Mbeere (Eastern Province), Kirinyaga, Nyeri and Laikipia (Central Province). Until recently Meru Central, Meru North, Meru South, and Tharaka districts were under Meru District in the eastern side of Mt Kenya, whereas Embu and Mbeere districts were under Embu District in the southeastern side. Kirinyaga District is located in the southern, Nyeri District in the southwestern, and Laikipia District in the western side of the Mountain (Figure 1). In this report we employed the old classification, the five districts of Meru, Embu, Kirinyaga, Nyeri and Laikipia, to avoid confusion.

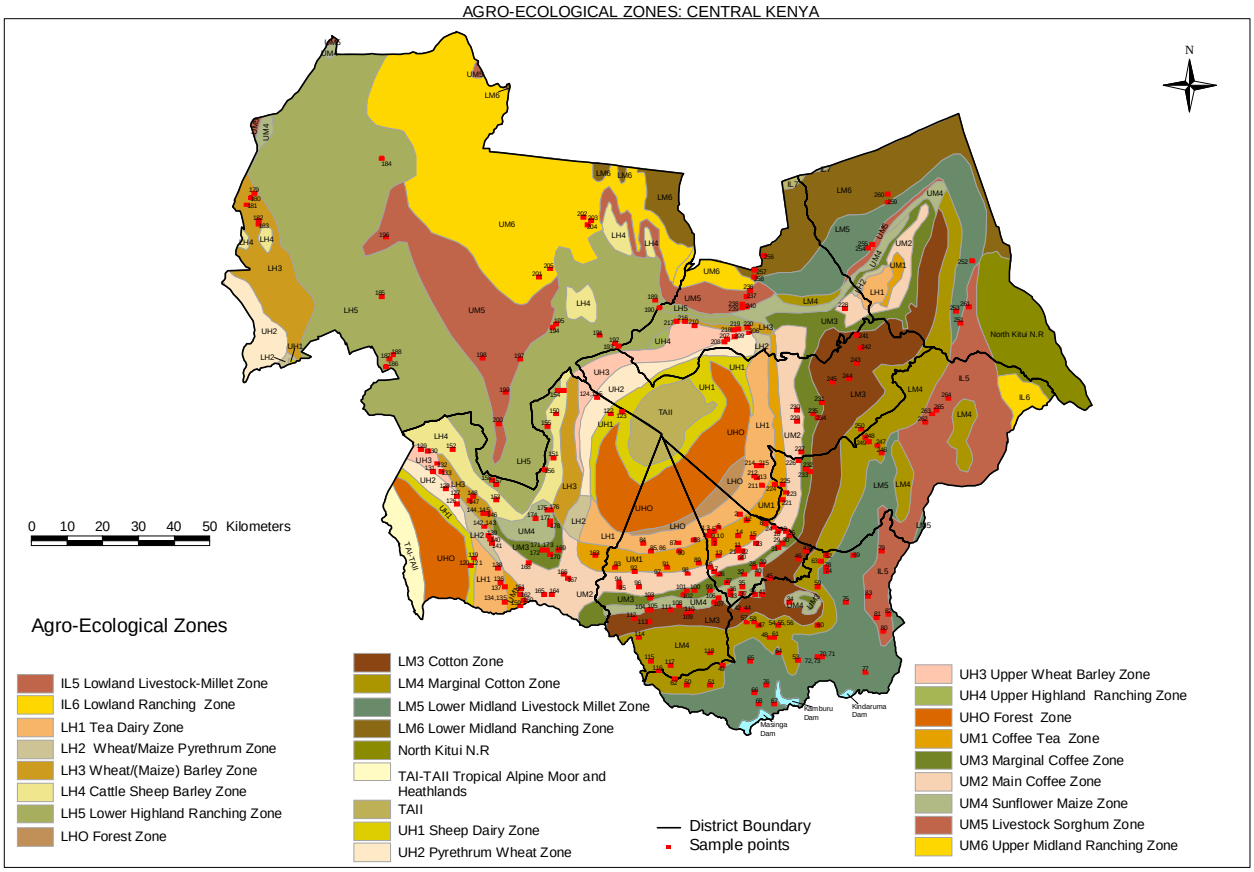

Figure 1. Agro-ecological zones in the surroundings of Mt. Kenya with the plots surveyed

Meru District: This contains Meru Central, Meru North, Meru South, and Tharaka districts. The District is located from the north to southeastern slopes of Mt. Kenya in the Eastern Province of Kenya. Meru District encompasses in total 9922 km^2 (Central Bureau of Statistics of Kenya 2001). The highest point within the district is the top of Mt. Kenya (5199 m), and the lowest is in the Meru National Park (610 m). Annual rainfall ranges between 2600 and 500 mm. This district shows the typical agro-ecological profile of the windward side of Mt. Kenya, from the cold and wet upper zones to the hot and dry lower zones in the Meru National Park. Of the 23 agro-ecological zones defined in Meru District, 21 are recognized as having agricultural potential, including the sheep and dairy zone (UH1) and lowland ranching zone (IL6) (Figure 1).

On the north side of Mt. Kenya are typical wheat and barley zones (UH3, LH3). Rainfall is scattered, due to the rain shadow of the Mountain and the effects of the western Kenya rainfall pattern, and therefore the area is hazardous for growing maize and other typical crops. On the southeastern slope of Mt. Kenya, the main agro-ecological zones have a typical pattern from the Embu district to the Meru South district. However, the sub-zones and diagrams show that the contrast between wet and dry seasons becomes more accentuated, making survival for permanent crops like coffee more difficult. The result is that a higher rainfall, and careful water and soil conservation, is necessary to overcome the intervening drought periods between seasons for tea, coffee, bananas, cotton and other crops that require more than one season for full growth (Jaetzold and Schmidt 1983).

Embu District: This district is located on the southeast slope of Mt. Kenya in Eastern Province. Embu District encompasses in total 2818 km^2 (Central Bureau of Statistics of Kenya, 2001). The highest point within the district is the top of Mt. Kenya (5199 m, shared with Meru and other districts), and the lowest is in the Tana River basin (700 m). Annual rainfall ranges between 2000 and 640 mm. This district shows the typical agro-ecological profile of the windward side of Mt. Kenya, from the cold and wet upper zones to the hot and dry lower zones in the Tana River basin. Variation is mainly due to altitude but also to the water recycling effect of the forests. Of the fourteen agro-ecological zones defined in Embu District, nine are recognized as having agricultural potential. The upper highlands are so wet and steep that forest is the best land use in the lower highland zones (UH0). Even in the tea-dairy zone (LH1), precipitation is still 1800 mm per year on average. The livestock-millet zone (LM5), with 650-800 mm rainfall, has less than a tenth of the climatic potential, and if the poor soils are considered, this is further reduced (Jaetzold and Schmidt 1983).

Kirinyaga District: Located on the southern slope of Mt. Kenya in Central Province, Kirinyaga District encompasses in total 1478 km^2 (Central Bureau of Statistics of Kenya 2001). The highest point within the district is the top of Mt. Kenya (5199 m), and the lowest is in Mwea (1090 m). Annual rainfall ranges between 2150 and 800 mm. The district has an agro-ecological profile similar to that of Embu District above the lower midland zones of Mt. Kenya, from cold and wet upper zones to the hot and dry lower zones in the Thiba River basin. Of twelve agro-ecological zones defined in Kirinyaga District, six are recognized as having agricultural potential. In the tea-dairy zone (LH1), precipitation is above 1925 mm per year on average, compared to the marginal cotton zone (LM4) with 800-950 mm. The lower highlands are so wet and steep that forest is the best land use in forest reserve. The typical agro-ecological pattern of the southeastern slopes of the Nyandarua Range is continued on the southern and eastern slopes of Mt. Kenya, due to the effects of the southeast trade wind that brings rainfall of as much as a 2500 mm annual average. Higher up, the rainfall decreases due to the lower moisture content of the trade wind inversion, but the higher altitudes are still so wet and steep that forest or conservation is the best land use. The lower, herbaceous parts of tropical alpine zones may be opened eventually for seasonal grazing of livestock by farmers living below the forests, due to the demands of increasing land pressure (Jaetzold and Schmidt 1983).

Nyeri District: Nyeri District is located on the western slope of Mt. Kenya in Central Province, in total 3356 km^2 (Central Bureau of Statistics of Kenya, 2001). This district encompasses the most western part of the moist windward side of Mt. Kenya, the drier western leeward side of this giant extinct volcano, the borders of the semi-arid Laikipia Plateau, and the moist windward eastern slope of the Nyandarua Range. The highest point within the district is the top of Mt. Kenya (5199 m), and the lowest is in Mukuruweini Division (about 1000 m) in the valley between Mt. Kenya and Aberdare National Park. Of fifteen agro-ecological zones defined in Nyeri District, twelve zones are recognized as having agricultural potential. The average annual rainfall ranges from 2200 mm on the most easterly edge of the Nyandarua Range to 700 mm on the Laikipia Plateau. In the wet districts, the southeasterly trade winds are forced up by the Mountains, causing frequent mists and sometimes drizzle above 1500 m during the months of June-September (part of the so-called long dry season at lower altitudes). In the second dry season, January-February, a dry wind blows from the northwest, from the Somali deserts. Towards the Laikipia Plateau, the lower highland zones become drier, with a wheat-maize-pyrethrum zone (LH2) and a cattle-sheep-barley zone (LH4), both relatively small strips. The rainfall pattern becomes trimodal here,

with middle rains in June-August intruding from the west. This is good for ranching in the lower highland ranching zone (LH5) but the rains are normally not heavy enough and too short for cultivation purposes (Jaetzold and Schmidt 1983).

Laikipia District: This district extends from the northeastern foot of the Aberdares to the western foot of Mt. Kenya in Central Province, in total 9229 km^2 (Central Bureau of Statistics of Kenya 2001). It consists mainly of an elevated plateau covered by volcanic ashes. This plain, situated at an altitude of 1800-2000 m, is the Laikipia Plateau, semi-arid grassland, formally inhabited by a Maasai sub-tribe. Even before the Maasai came, the plateau was not cultivated because of unfavourable rainfall. The lower highland ranching zone (LH5) and the upper midland ranching zone (UM6) are dominant. The annual average rainfall is fairly high at about 1200 to 400 mm, but it is unreliable and scattered through the year. This district does not typically have enough rainfall for crops, but districts with good potential for that are marked as the cattle-sheep-barley zone (LH4) and the lower highland ranching zone (LH5). In the upper midland livestock-sorghum zone (UM5), the use of water conservation techniques would increase opportunities for cropping. The population needs some cultivation options now, as many people have moved in recently, buying ranches cooperatively or just as squatters. In the high-altitude areas (cold-tolerant), planting sorghum is one possibility. It could be extended to the lower highland ranching zone (LH5) because altitudinal boundaries are not pronounced in this district. There is only one better area for cultivation (apart from a small strip uphill beyond Nanyuki), and that is the top of the Laikipia Escarpment, which borders the Rift Valley north of Nyandarua. In this complex of ridges at an altitude of 2000 to 2600 m, wheat and malt barley cultivation are possible, and to a certain extent maize. For coffee, it is either too cold or too dry (in the lower areas), although planted coffee trees may survive and yield low amounts. The same situation applies to tea production (Jaetzold and Schmidt 1983).

The climate details in the agro-ecological zones of target districts investigated are attached as Appendix 2. The productivity and characteristics of each zone on Mt. Kenya is given in Appendix 3.

According to the Census Report (Government of Kenya & U.S. Census Bureau 1999; Central Bureau of Statistics of Kenya 2001), the population densities of the five districts vary greatly, with a high of 309 people per km^2 in Kirinyaga District and a low of 34 people per km^2 in Laikipia District.

Table 2. Land and people in five districts surrounding Mt. Kenya

	Meru*	Embu*	Kirinyaga	Nyeri	Laikipia	Total/Average
Total land (km^2)	9583	2822	1476	3341	9479	26 701
Population	1 409 373	449 149	457 105	661 156	322 187	3 298 970
Population density (persons/ km^2)	141	159	309	198	34	124
Agricultural land (km^2)	5699.4	2299.4	1099.8	1873.7	2535.0	13507.3
Percentage agricultural land of total land	59.5	81.5	74.5	56.1	26.7	51
Households	307 152	101 929	114 439	168 786	78 175	770 481
Average number of ha/household	1.86	2.26	0.96	1.11	3.24	1.89

*Meru includes itself as well as Meru Central, Meru North, Meru South, Tharaka and Nyambene Districts, which were subdivided from the original Meru District. Embu consists of Embu and Mbeere Districts. (Source: Jaetzold and Schmidt 1983)
Source: Census report from the Kenya Central Bureau of Statistics, January 2001.

Within districts, higher-altitude land holds higher-density populations. Farm hectarage per household inversely follows the population density and is highest at 3.24 ha/household in Laikipia and lowest at 0.96 ha/household in Kirinyaga.

In general, the land-use system in the higher lands of any of the Mt. Kenya districts can be described as highly intensive mixed farming. Most of the farms engage in crop, livestock, and tree production, in part for income generation (coffee, tea, horticulture, and dairy production) and in part for self-sufficiency in food and firewood. Ondieki (1999) and Wangila *et al.* (1999) add that in these districts the crops such as tea, coffee, and maize are most often cultivated with *Macadamia* spp., *Pennisetum purpureum* Schum. (Napia grass), *Grevillea robusta* A. Cunn., *Calliandra calothyrsus* Meissner (CAm.), and other species under an agroforestry system. Livestock production is an important economic activity in lower areas, but availability of livestock feed is a major constraint. Given the small landholdings, many farms find this requirement difficult (Ondieki 1999; Wangila *et al.* 1999).

In contrast, the lower lands in any of the districts of Mt. Kenya have much less potential than the upper cultivated areas. The land of the lower districts was quickly occupied, especially in Meru, Embu and Kirinyaga districts, and a large part of the bush and scrub was replaced by food crops. Despite the reduced potential, people are settling day by day into these semi-arid areas, for food security and cash income from livestock and charcoal (Imbernon 1997).

4. Methods and Materials

4.1 Vegetation Survey

The vegetation survey was carried out between 1999 and 2004 for a number of plots (0.5 ha) in each agro-ecological zone of the target area. We used the agro-ecological map in Kenya (Kenya Soil Survey 1982 and digitalized at ICRAF) and a GPS locator to identify the exact location and boundaries of plots at the ground level. An agro-ecological zone is defined by its relevant agro-climatic factors and differentiated by soil pattern, to provide a framework for the ecological land use potential (Jaetzold & Schmidt 1983). Meru District consists of 19 major zones with different climatic conditions; Embu District, 9; Kirinyaga, 7; and Laikipia, 12.

Appendix 1 gives a summary of the climates of more than 20 agro-ecological zones in districts of the target area. The zone groups, such as the lower highlands (LH) and the upper midlands (UM), are temperature belts defined according to the maximum temperature limits within which the main crops can flourish; for example, *Coffea arabica* L. for the upper midlands (UM1 to 4). In addition, the zones are based on the probability of meeting the temperature and water requirements of their main leading crops (Kenya Soil Survey 1982). The names of the zones therefore refer to potentially leading crops, many of which might be grown in other zones with less profit. Livestock production is also possible in any zone, but possible stocking rates decrease from the tea-dairy zone downwards (Jaetzold & Schmidt 1983). Our survey was conducted along a transaction that cuts across ecological zones and varying altitudes.

The survey procedure was as follows:

- locations (longitude, latitude and altitude) were recorded with a Magellan GPS satellite navigator (Magellan Systems Corporation, 960 Overland Court, San Dimas, CA 91773, USA, 1996);
- plots of 50m x 100m were marked;
- for each village, the name, landscape, soil colour, inclination, percentage of natural grass, and cultivated ratio in plot were recorded;
- records were taken of all species within the plot as well as a count of the occurrence of all tree and shrub species and an estimation of average heights and diameters;
- responses to questions about the usage of each species were recorded;

- soil samples from four different points inside the plot, lying on a diagonal across it, were taken;
- any unidentifiable plant specimens were collected.

A final comparative analysis of data from different ecological zones of the survey areas produced the following results:

- plot location dataset
- tree and shrub species inventories by plot, agro-ecological zone, and district, surrounding the Mountain
- biomass datasets estimated from the above individual datasets
- ecological analyses for the above datasets

4.2 Soil analysis

Soil samples were collected at each plot during the survey. Each sample was a bulk gathered from four points within each plot. Samples were taken to the laboratories at ICRAF headquarters for analysis. Analyzed items were pH, exchange calcium (EXCA), exchange magnesium (EXMG), exchange potassium (EXK), exchange phosphate (EXP), soil organic carbon, and physical structure (ratio of clay, sand and silt).

4.3 Farmers survey and nursery survey

The farmer survey used a questionnaire to document further information on tree species on farms, including uses by individuals. Interviews were carried out with randomly selected households within different agro-ecological zones. The questionnaire used open-ended questions so that respondents could give spontaneous replies. The nursery survey used a questionnaire to collect information on the type of tree species available in nurseries, how tree seedlings were raised, the number and value of seedlings, and potting substrates. The survey team sampled nurseries at random throughout the survey area. Both questionnaires are attached as Appendix 12 & 16, and their results follow this vegetation survey report.

4.4 Data analysis methodology

Total and average tree species richness and tree abundance were calculated. Species accumulation curves were determined using an exact method for calculating the average number of accumulated taxa when sites and individual species are accumulated in a random pattern (Kindt 2002; Kindt and Coe in press; Kindt *et al.* in press). Diversity (which is determined by the number of species and the evenness in abundance of each species) was analyzed by rank-abundance curves and Renyi diversity profiles. Rank-abundance curves list species in decreasing order of abundance.

Renyi diversity profiles allow for partial ranking of ecological communities by diversity: a community of higher diversity will have a diversity profile that is everywhere above the profile of a second community. The diversity profiles provide more information than standard diversity indices, which are not able to delineate such interactions.

The potential influence of explanatory factors for individual farms on species richness and abundance was analyzed by regression. We fitted Generalized Linear Models (GLM) with a log link to the observed number of species and number of individuals (Hastie and Pregion 1993; Jongman *et al.* 1995). The log link ensures that predicted values will always be positive, which is a desirable property for count data (Kindt and Coe in press). We fitted GLM using a negative binomial variance function that has been recommended for the analysis of datasets with over-dispersion or clumped distributions. The contribution of each explanatory variable to deviance was tested by type-II ANOVA, removing each variable from a model that included all variables.

Differences in species composition were analyzed using the Bray-Curtis distance measure. This distance coefficient is one of the ecological distance measures that are best suited for analyzing differences in species composition (Jongman *et al.* 1995; Legendre and Legendre 1998; Quinn and Keough 2002; Kindt and Coe in press).

Distance-based Redundancy Analysis (db-RD) (Legendre and Anderson 1999) was used to estimate the significance of location differences on species composition. Constrained Analysis of Principal Coordinates (CAP) was used to provide ordination diagrams (Anderson and Willis 2003).

All these analyses were made with the *Biodiversity-R* software developed by Roeland Kindt (Kindt and Coe in press), building on the free *R.2.1.0* statistical programme and its contributing packages such as the vegan community ecology package (Oksanen *et al.* 2005; R Development Core Team 2005).

Table 3. Number of surveyed farms in agro-ecological zones in five districts surrounding Mt. Kenya

Zone Name	Meru	Embu	Kirinyaga	Nyeri	Laikipia	Total
UH(Upper Highland)1: Sheep and Dairy	_	_	_	5	_	5
UH(Upper Highland)2: Pyrethrum-Wheat	5	_	_	5	_	10
UH(Upper Highland)3: Upper Wheat-Barley		_	_	5	_	5
UH(Upper Highland)4: Upper Highland Ranching		_	_	_	_	<2>
LH(Lower Highland)1: Tea-Dairy	5	6	5	5	_	21
LH(Lower Highland)2: Wheat/Maize-Pyrethrum	5	_	_	5	_	10
LH(Lower Highland)3: Wheat/(Maize)-Barley		_	_	5	5	10
LH(Lower Highland)4: Cattle-Sheep-Barley		_	_	5	_	5
LH(Lower Highland)5: Lower Highland Ranching		_	_	5	12	17
UM(Upper Midland)1: Coffee-Tea	5	9	5	5	_	24
UM(Upper Midland)2: Main Coffee	5	9	5	5	_	24
UM(Upper Midland)3: Marginal Coffee	5	8	5	5	_	23
UM(Upper Midland)4: Sunflower-Maize	5	9	5	5	_	24
UM(Upper Midland)5: Livestock-Sorghum		_	_	_	5	5
UM(Upper Midland)6: Upper Midland Ranching		_	_	_	5	5
LM (Lower Midland)3: Cotton	5	5	5	_	_	15
LM(Lower Midland)4: Marginal Cotton	5	17	5	_	_	27
LM(Lower Midland)5: Lower Midland Livestock Millet	5	15	_	_	_	20
LM(Lower Midland)6: Lower Midland Ranching	5	_	_	_		5
IL(Inner Lowland)5: Lowland Livestock Millet	5	5	_	_	_	10
Total (20 zones)	60	83	35	60	27	265

5. Results of survey

In total, the survey investigated 265 plots of 0.5 ha each (Table 3). The location data of each plot is shown in Appendix 4.

5.1 Landscapes and vegetation types in different agro-ecological zones.

Although landscapes are different for each sampled plot, similar patterns are observed in each of the 20 individual zones tested in terms of exotic tree species and indigenous vegetation patterns. Here we show three typical landscapes and vegetation patterns derived from the survey results. There are of course more tree and shrub species than the 10 specified (see Table 4), but these species are representative of landscape in each zone. (In the following analysis, tea and coffee are excluded due to being main cash crops, and *Musa sapientum* is included because it is categorized as a fruit tree and occupies a similar niche to tree species).

5.1.1 Tea-Dairy Zone

Table 4. List of first ten tree species with average number per plot (tea-dairy zone)

Species name °=exotic species	Family	Total number of trees/plot
1. *Musa sapientum°*	Musaceae	115
2. *Cupressus lusitanica°*	Cupressaceae	39
3. *Grevillea robusta°*	Proteaceae	34
4. *Eucalyptus saligna°*	Myrtaceae	29
5. *Lantana camara°*	Verbenaceae	20
6. *Commiphora eminii*	Burseraceae	18
7. *Croton megalocarpus*	Euphorbiaceae	15
8. *Persea americana°*	Lauraceae	7
9. *Prunus domestica°*	Rosaceae	7
10. *Macadamia tetraphylla°*	Proteaceae	4

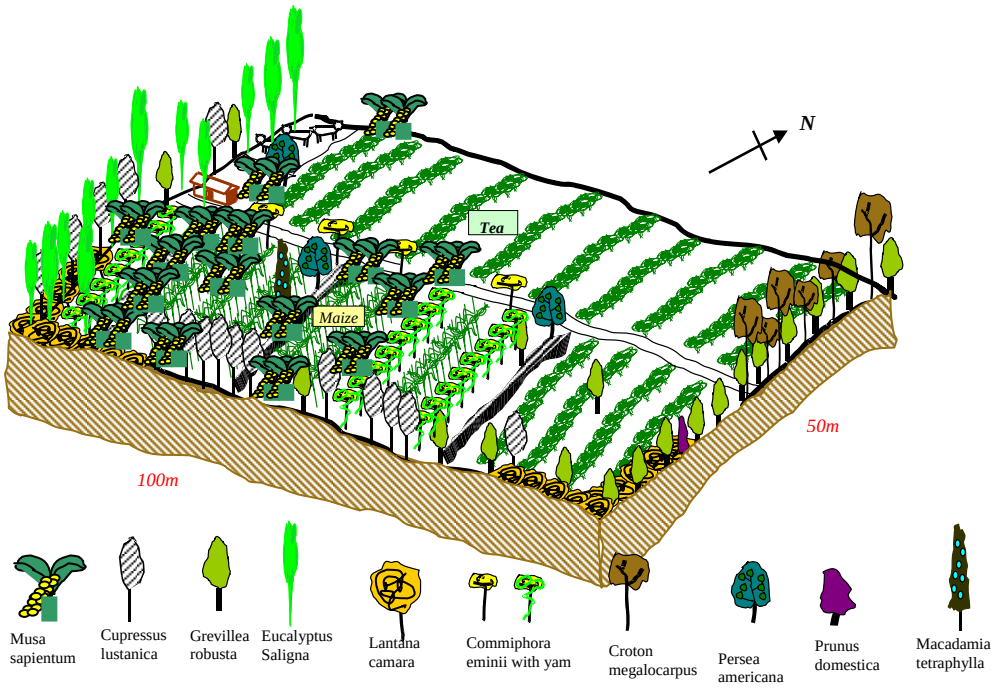

Figure 2. Typical landscape of tea-dairy zone

Notes

1) The altitude of the tea-dairy zone is between 1770 and 1590 m, the annual rainfall is between 2000 and 1750 mm, and the temperature is between 17.7 and 15.8 ºC. The main cash crops are tea and dairy milk.
2) Banana (*Musa sapientum)* is one of the major fruits on farms in this high cultivation zone.
3) *Grevillea robusta* has the highest number of trees per plot (not according to the table above). Ondieki (1999) observes that *Grevillea robusta* is grown on 96% of all farms in Embu District, and he adds that it is planted mostly along the external boundary to provide firewood and timber.
4) *Cupressus lusitanica* and *Eucalyptus saligna* followed *Grevillea robusta* in average abundance. *Cupressus lusitanica* is planted for timber, as an ornamental, and for windbreaks. *Eucalyptus saligna* is used for poles, timber, and firewood (Maundu and Tengnus 2005).
5) Other species with significant numbers of trees per plot are *Croton megalocarpus*, and *Persea americana.* Wood from *Croton megalocarpus* is used in house building and as firewood and the species is also used as a hedge plant. *Persea americana*, as Purser (1996) points out, is one of the most popular fruit trees propagated locally in Embu.
6) *Commiphora eminii* is often used as a support for yam and sometimes as a hedge plant (Beentje, 1994). *Eriobotrya japonica*, according to Maundu and Tengnus (2005), has various uses such as fruit, shade, poles, firewood and as a windbreak. *Bridelia micrantha* is useful for firewood, timber, fruit, medicine and fodder (Maundu and Tengnus, 2005). The wood is also used for building poles and is termite-resistant. A bark decoction is employed by the Maasai against dysentery in children (Beentje, 1994).

5.1.2 Sunflower-Maize Zone

Table 5. List of first ten tree species with average number per plot (sunflower-maize zone)

Species name °=exotic species	Family	Total number of trees
1. *Musa sapientum°*	Musaceae	53
2. *Grevillea robusta°*	Proteaceae	44
3. *Catha edulis*	Celastraceae	40
4. *Cupressus lusitanica°*	Cupressaceae	39
5. *Bougainvillea spectabilis°*	Nyctaginaceae	30
6. *Solanum incanum°*	Solanaceae	25
7. *Lantana camara°*	Verbenaceae	22
8. *Kigelia africana*	Bignoniaceae	20
9. *Tithonia diversifolia°*	Compositae	17
10. *Combretum collinum*	Combretaceae	12

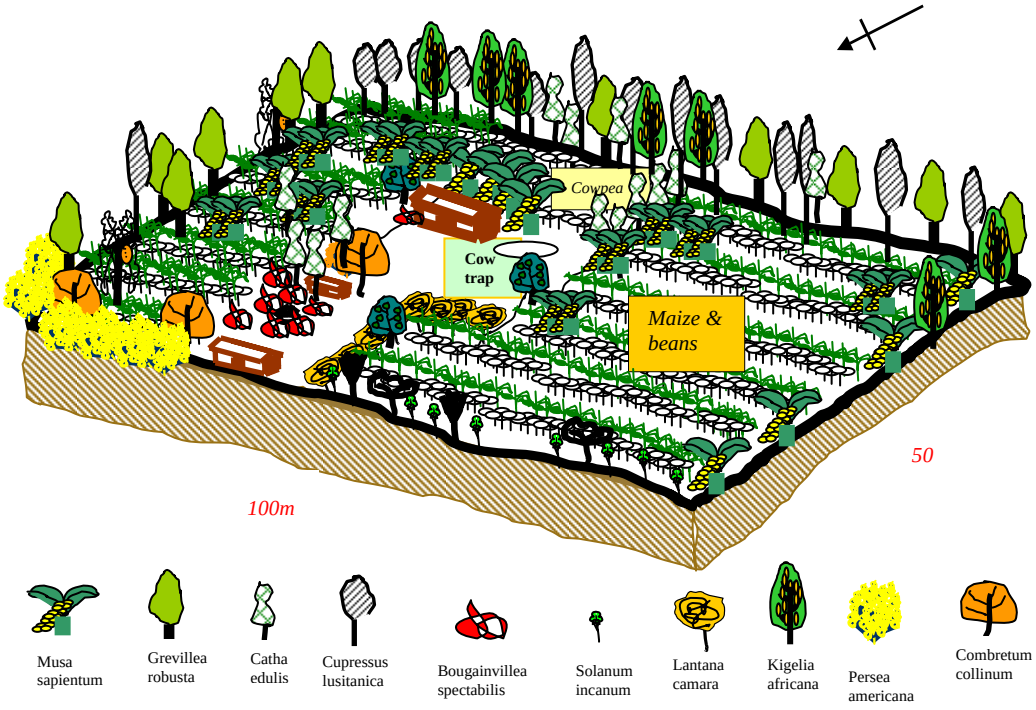

Figure 3. Landscape of sunflower-maize zone

Notes

1) The altitude of the sunflower-maize zone is between 1280 and 1070 m, annual rainfall is between 1100 and 980 mm, and temperature is between 20.7 and 20.0 °C. The main food crop is maize, intercropped with beans.
2) Banana (*Musa sapientum)* is one of the major fruit trees in the farms in this zone.
3) *Grevillea robusta* and *Cupressus lusitanica* are mostly planted as an external boundary marker as mentioned earlier.
4) *Catha edulis*, known locally as 'miraa' is used as a stimulant (Bennun *et al.* 1992). It is also grown in evergreen forests, riverine forests, or thickets in *Combretum* wooded grassland. Wood is hard and strong, used for building and furniture.
5) *Bougainvillea spectabilis* is an ornamental planted in gardens.
6) *Solanum incanum* and *Lantana camara* are invasives that escape from garden areas.
7) *Combretum* collinum, which grows naturally in wooded grassland, produces good charcoal (Beentje 1994).

5.1.3 Lowland Livestock Millet Zone

Table 6. List of first ten tree species with average number per plot (lowland livestock millet zone)

Species name	Family	Total number of trees
1. *Melia volkensii*	Meliaceae	29
2. *Commiphora habessinica*	Burseraceae	15
3. *Acacia ataxacantha*	Fabaceae	11
4. *Acacia senegal*	Fabaceae	10
5. *Commiphora africana*	Burseraceae	10
6. *Grewia bicolor*	Tiliaceae	10
7. *Hibiscus* spp.	Malvaceae	10
8. *Solanum incanum*	Solanaceae	10
9. *Grewia villosa*	Tiliaceae	8
10. *Berchemia discolor*	Rhamnacea	7

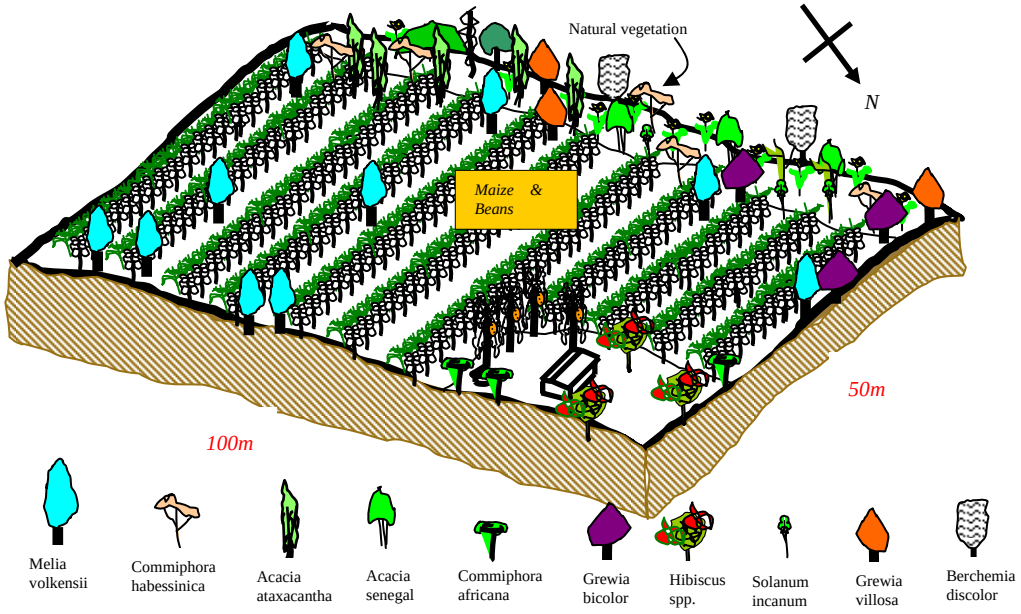

Figure 4. Landscape in the lowland livestock millet zone

Notes

1) The altitude of the lowland livestock millet zone is between 830 and 760 m, annual rainfall is between 780 and 640 mm, and temperature is between 23.9 and 23.5 ºC. Farmers traditionally grew millet or sorghum, though nowadays people prefer planting maize. Livestock is important because the area is very dry and hot.
2) *Melia volkensii* is planted because of its strong and durable timber, which is highly valued locally.
3) *Commiphora habessinica* is common in bushed grassland or upper parts of *Acacia-Commiphora* bushland, especially in rocky places (Beentje 1994; Dharani 2002).
4) *Commiphora africana* is distributed across Kenya and grows in bushed grassland and *Acacia-Commiphora* bushland. This species has many medicinal properties, especially its resin, bark, and fruit. Leaves contain bitter tannins, and bark from stem and roots helps with fevers and colds. A decoction of boiled roots is taken for swollen testicles and stomach disorders.
5) *Acacia ataxacantha* grows in dry (*Acacia-Commiphora*) bushland, often on rocks or near rivers. *Acacia senegal* is also known as 'Sudan Gum Arabic' and grows in *Acacia* or *Acacia-Commiphora* bushland or woodland. Maasai people use a bark infusion for diarrhoea or malaria (Beentje 1994).
6) *Grewia bicolor* grows mostly in dry Acacia bushland. Wood is used for house building and to make bows, arrows, spearshafts, and rungus. Fruit is edible.
7) *Berchemia discolor* also grows in dry bushland, often in riverine areas. Fruit is edible, while wood is resinous, hard, and used for tools and small implements. Bark infusion is used against liver ailments by the Turkana (Beentje 1994).

5.2 Species richness

5.2.1 Encountered trees and shrubs

The survey team found 459 species and 87 families at the 265 surveyed plots. Appendix 4 provides a list of all trees and shrubs, including scientific name, local name, family name, status, plant type, uses, total number of plants, places found in all and average number per plot, and location on farm. The average total number of trees and shrubs per 0.5 ha plot is 204.5, with an average of 17.6 species per plot. The inventory is attached as Appendix 5.

The highest number of trees for any one family was for the Proteaceae (6719 trees), which include the important species *Grevillea robusta* and *Macadamia* spp. Next came the Euphorbiaceae (4827 trees), which includes as major species *Croton megalocarpus* and *Euphorbia tirucalli*. In third and fourth place respectively came the Verbenaceae (2675 trees, mostly *Lantana camara* and *Lippia javanica*) and the Cupressaceae (2639 trees, mostly *Cupressus lusitanica* and *Juniperus procera*). The detailed family list with total number of trees is shown in Appendix 6.

Table 7. First 15 families in the target area surrounding of Mt. Kenya

Family Name	Total No. trees	No. of species	Major species (1st)	Major species (2nd)
Proteaceae	6719	4	*Grevillea robusta* R.BR.	*Macadamia* spp. F.MUELL.
Euphorbiaceae	4827	33	*Croton megalocarpus* HUTCH.	*Euphorbia tirucalli* L.
Verbenaceae	2675	13	*Lantana camara* L.	*Lippia javanica* (BURM.F.) SPRENG.
Cupressaceae	2639	4	*Cupressus lusitanica* MILLER	*Juniperus procera* ENDL.
Musaceae	2636	2	*Musa sapientum* L.	
Fabaceae(m)	2322	29	*Acacia mearnsii* DE WILD.	*Acacia drepanolobium* HARMS EX SJOSTEDT
Ebenaceae	2259	3	*Euclea divinorum* HIERN	*Eucalyptus sp.* L'H'ERIT.
Compositae	2081	17	*Tithonia diversifolia* (HEMSL.) A.GRAY	*Gamolepsis chrysanthemoides* LESS.
Burseraceae	1892	7	*Commiphora eminii* spp. *zimmermanni* (ENGL.) GILLETT	*Commiphora africana* (A.RICH.) ENGL.
Solanaceae	1582	15	*Solanum incanum* L.	*Cyphomandra betacea* SENDTN.
Labiatae	1537	14	*Plectranthus barbatus* ANDR.	*Tetradenia riparia* (HOSHST.) CODD
Fabaceae(c)	1375	22	*Caesalpinia decapetala* (ROTH) ALSTON	*Cassia siamea* L.
Myrtaceae	1374	9	*Eucalyptus saligna* SM.	*Psidium guajava* L.
Celastraceae	1339	8	*Catha edulis* (VAHL) ENDL.	*Maytenus heterophylla* (ECKL. & ZEYH.) N.ROBSON
Anacardiaceae	1235	15	*Mangifera indica* L.	*Rhus natalensis* KRAUSS

The top 15 families are shown in Table 7 and further details are given in Appendix 5. Seven of these top 15 families consist predominantly of exotic tree species. The family order by individual districts is attached as Appendix 6. The highest total trees number across all districts was *Grevillea robusta* (6313, occurring on 192 of 265 plots), Proteaceae family, followed by *Musa sapientum, Cupressus lusitanica, Croton megalocarpus, Lantana camara,*

Euclea divinorum, Commiphora eminii spp. *zimmermanni* and *Catha edulis*, all of which were represented by more than 1000 individuals.

5.2.2 Average number of trees and species per plot in five districts and across main agro-ecological zones

The average number of species per plot was highest in Embu District (15.9) and lowest in Kirinyaga District (9.1). Other districts showed only slightly higher values than Kirinyaga (Figure 5). The total number of trees per plot was highest in Laikipia District (241.0) and lowest in Meru District (152.3), meaning high intensive farming lands have fewer trees than the less intensive areas.

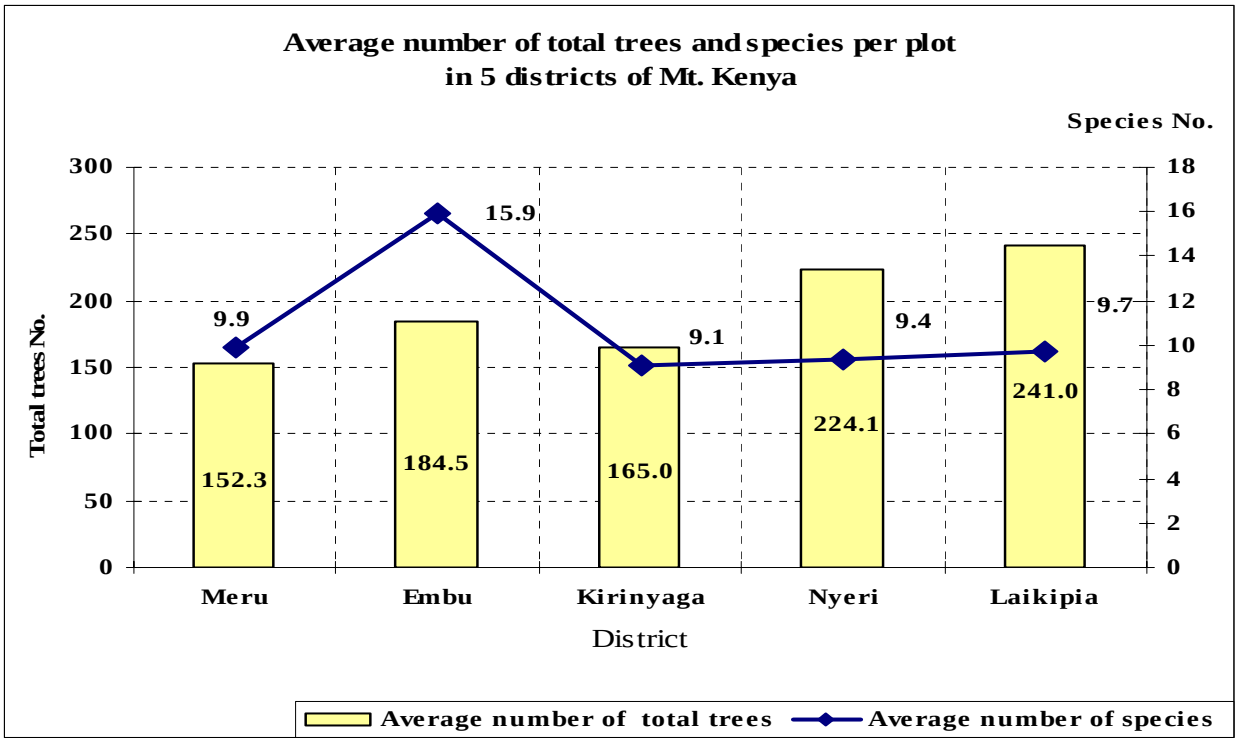

Figure 5. Average total species and trees numbers per plot in 5 districts of Mt. Kenya

For the 10 main agro-ecological zones, the average number of species varied between 15.0 and 19.7 per plot and the total number of trees varied between 89.1 and 258.5. Overall, the more intensive cultivation zones had more species per plot than the less intensive cultivation zones. The lowest total tree number per plot was in the lowest zone (lowland livestock millet zone) and the highest number was in the main coffee zone.

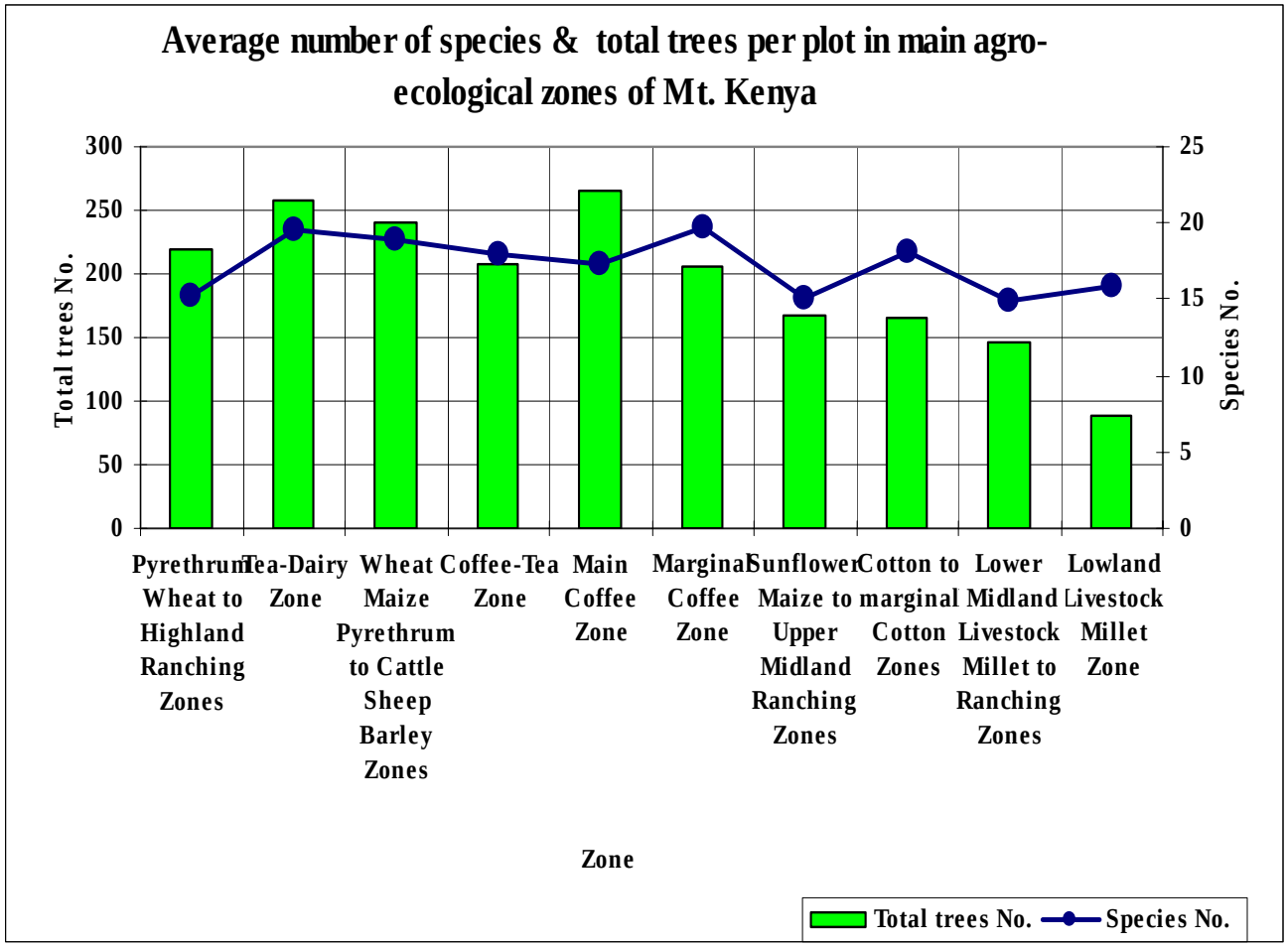

Figure 6. Average number of species and total trees per plot in main agro-ecological zones of Mt. Kenya

5.2.3 Comparison between indigenous and exotic tree species in total number of species and trees

More than 70% of all species identified were indigenous, and the total trees of indigenous species were 54% of all trees (Figure 7). Exotic trees therefore on average contributed significantly more in individuals per species than indigenous taxa. The lists of both indigenous and exotic species are attached (Appendix 7).

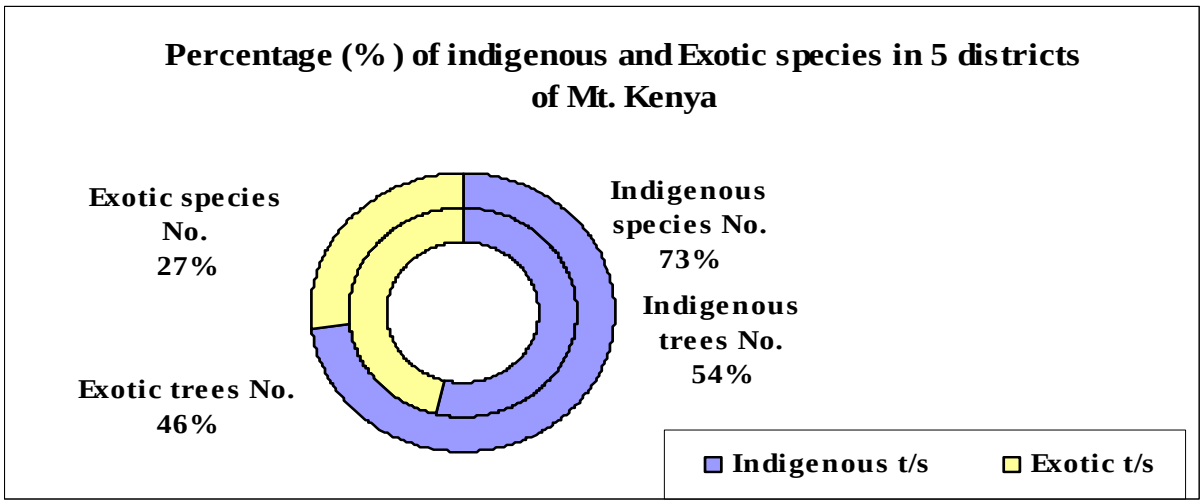

Figure 7. Percentage of indigenous and exotic species in 5 districts surrounding Mt. Kenya

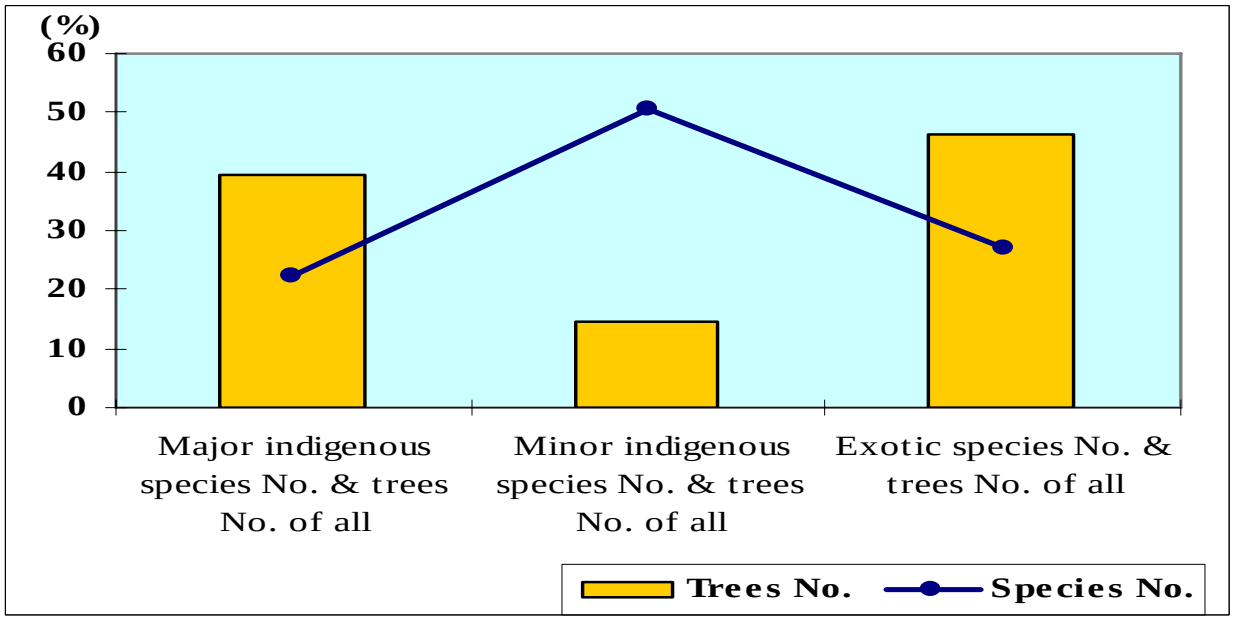

Figure 8. Percentage of major indigenous, minor indigenous, and exotic species in species number and total trees number in 5 districts of Mt. Kenya

Splitting indigenous trees into minor and major species (less than, or more than, an average of 10 plants per plot) revealed that although minor species contributed 51% of all species, that same category contributed only 15% of all trees. When we examine those species individually, most of these minor indigenous species are very useful for human body and life as shown of some species in Appendix 8.

5.2.4 Comparison of species number and total trees number for indigenous and exotic species, across districts

Considering the number of species identified by district, Meru had the highest proportion of indigenous species (73%) and Kirinyaga the lowest (52%). Considering total tree numbers by district, Laikipia had the highest proportion of indigenous trees (80%) and Kirinyaga the lowest (28%). Overall, there is a good correlation between the proportion of indigenous species in a region and the proportion of total number of indigenous trees on farm (districts with a higher proportion of indigenous species have a greater proportion by total tree number of these species on farm).

On the other hand, in the number of species identified by district, Kirinyaga had the highest proportion of exotic species (48%) and Meru the lowest (27%). In total tree numbers by district, Kirinyaga had the highest proportion of exotic trees (73%) and Laikipia the lowest (20%). Higher cultivation areas have a higher number of exotic species and total trees across districts.

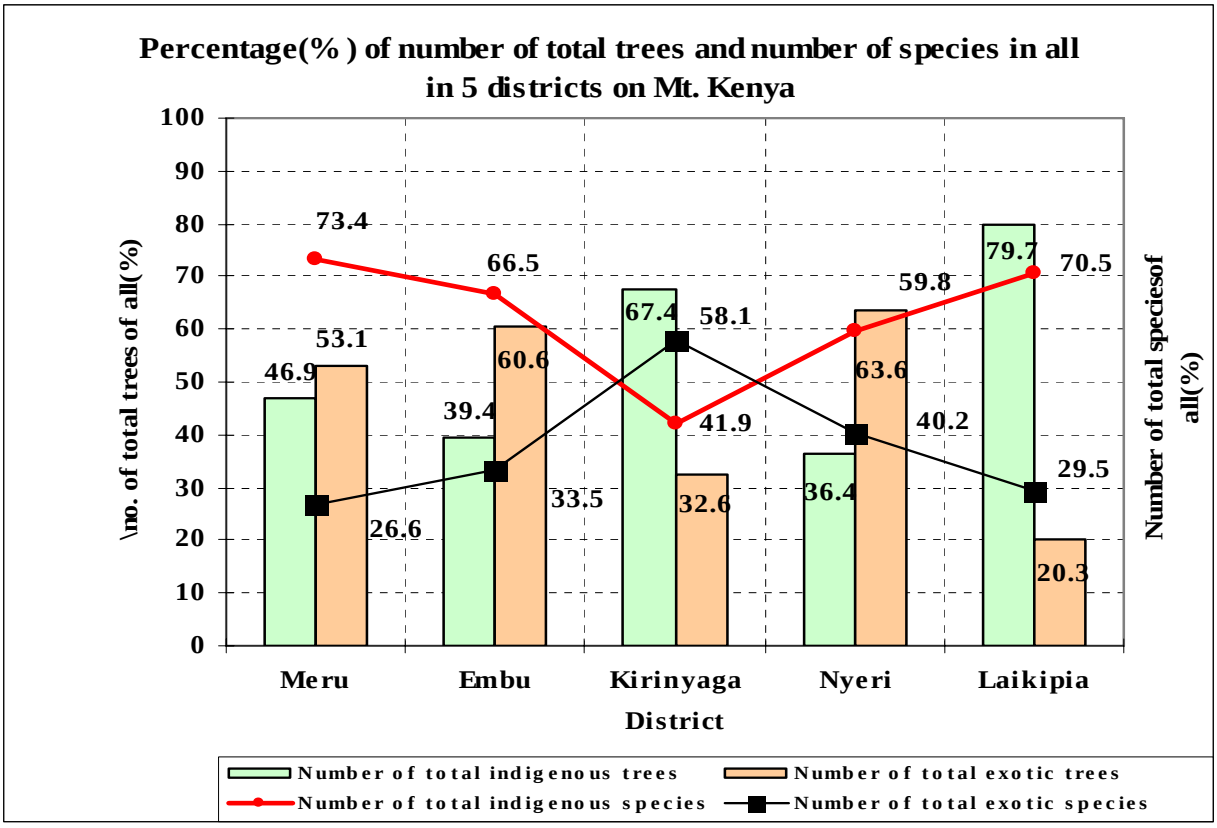

Figure 9. Comparison of percentage of indigenous and exotic species in each district of Mt. Kenya

Similar numbers are found for indigenous and exotic tree species (species richness) from a sheep-dairy zone to an upper midland ranching zone. In contrast, from a sunflower-maize (upper midland) zone to the lowland livestock millet zone the numbers change greatly, indigenous tree species increasing as the exotic ones decrease. In addition, the number of exotic trees in most zones is higher than the number of indigenous trees, especially in the tea-dairy, coffee-tea, and main coffee zones. The lower areas, however, have a greater number of indigenous trees than exotic trees (Figure 10).

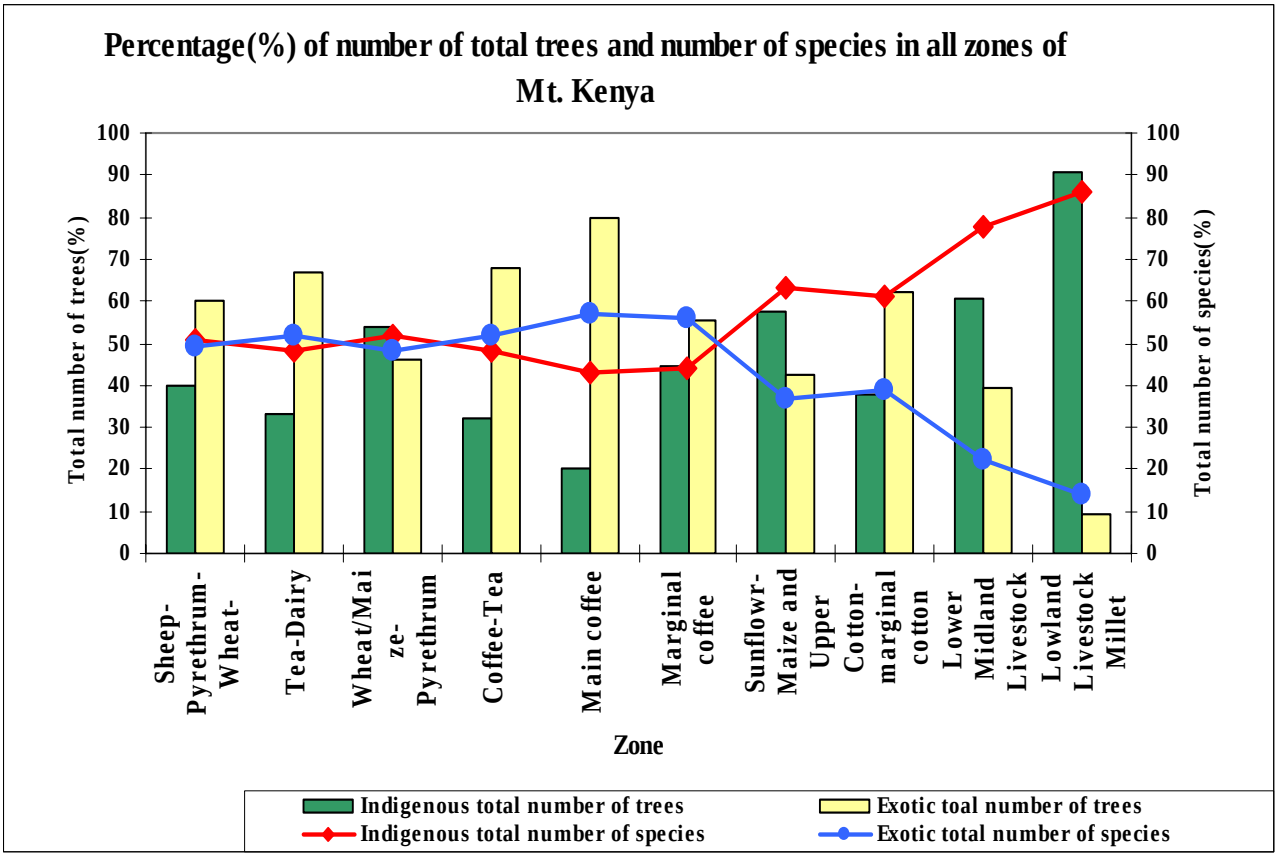

Figure 10. Comparison of percentage of indigenous and exotic species % total trees No. in zones surrounding of Mt. Kenya

Considering the number of species identified by agro-ecological zone, the lower livestock millet zone had the highest proportion of indigenous species (87%) and the main coffee zone the lowest (43%). In total tree numbers, the lower livestock millet zone had the highest proportion of indigenous (90%) and the main coffee zone the lowest (20%). As for the exotic species and their total tree numbers, the main coffee zone had the highest proportion of exotic species (58%) and the lowland livestock millet zone the lowest (14%); meanwhile, the main coffee zone had the highest proportion of exotic species trees (80%) and the lowland

livestock millet zone the lowest (10%). Overall, there is a clear indication that the number of species tends to change drastically from the sunflower-maize zone toward the lower zones, indigenous tree species increasing while exotic species decrease toward the lower zones. A similar tendency was shown in total tree numbers. Although the species numbers of both types are almost equal, the total tree numbers of exotic species are higher from the higher zones to the marginal coffee zone, and exotic species trees are more numerous than indigenous ones. The comparison of ratio of indigenous and exotic tree species in number of species and trees in each zone in each district is attached as Appendix 9.

5.2.5 Vegetation map for agro-ecological zones surrounding Mt. Kenya produced from the survey data

The vegetation map application was developed from the dataset, using MICROSOFT Access and Esri (Environmental Services Research Institute) Map Objects LT. This programme is used to query the underlying data and represent them spatially. The differences in vegetation for zone and district levels surrounding Mt. Kenya show clearly on this map. It can be used to determine tree species population density individually, and to judge the potential of planting a specific species in a target area and under similar climate conditions in any country. The map shows the current status of both indigenous and exotic tree species visually, and thus we can use it for future planning of tree production, tree propagation, and natural resources management. Anyone wanting to create a biodiversity conservation programme in the agro-ecological zones will find such a vegetation map useful. After ten years we will be able to assess the vegetation change using the current survey as a benchmark. One sample from this map is shown in Figure 11, below. The application is downloadable from the CD that with this working paper.

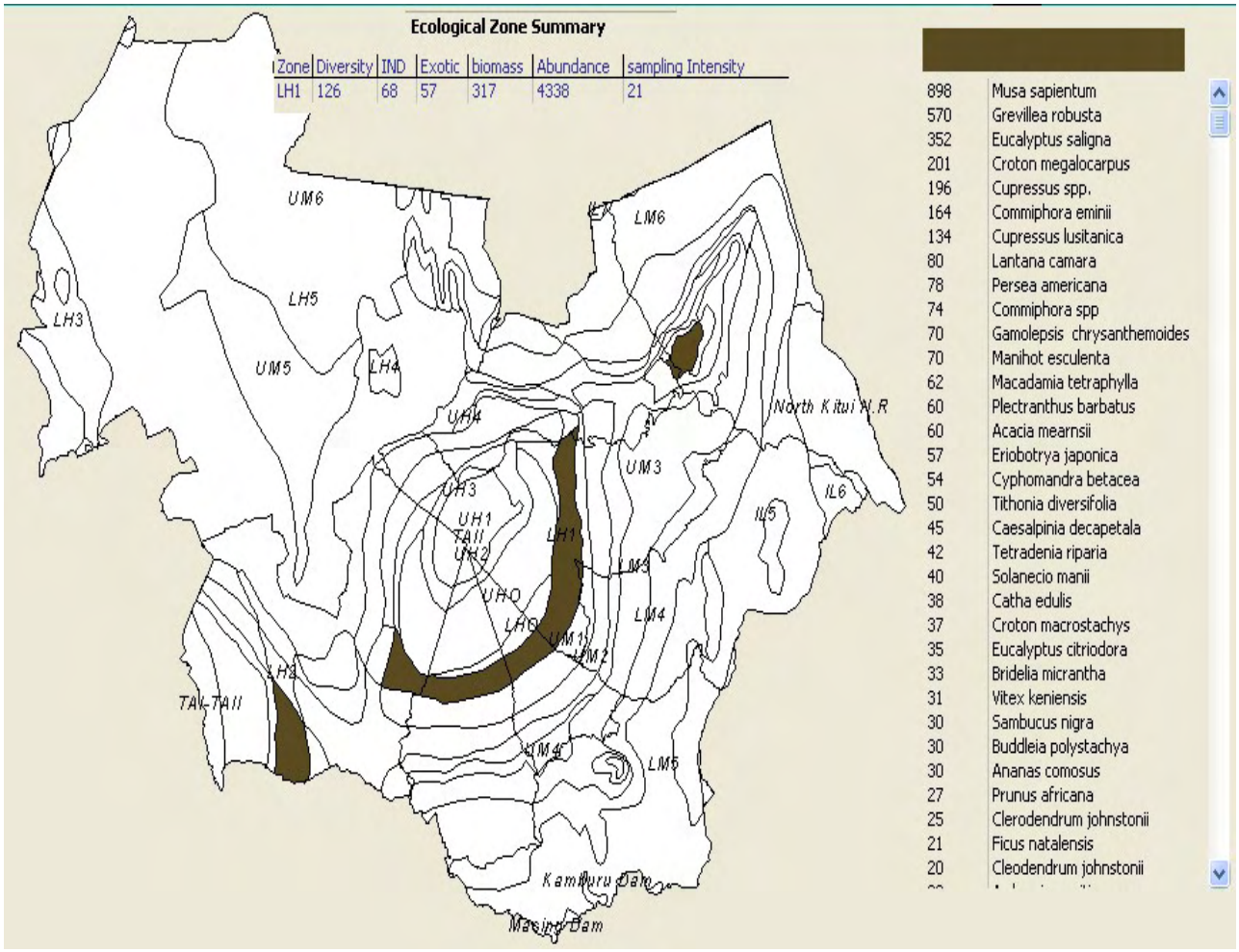

Figure 11. Sample of vegetation map, showing species name and number of trees in a zone

5.3 Statistical Analyses

5.3.1 Summary statistics

Table 8 gives an overview of the changes in species richness, abundance, and biomass within the districts and main agro-ecological zones.

Table 8. Species richness in the main agro-ecological zones and in districts

		IL	LM	UM	LH	UH	(all)
Number of farms	Embu	5	37	35	6	0	83
	Nyeri	0	0	20	25	15	60
	Kirinyaga	0	10	20	5	0	35
	Laikipia	0	0	10	17	0	27
	Meru	5	20	20	10	5	60
	(all)	10	67	105	63	20	265
Total richness	Embu	52	192	140	32	NA	261
	Nyeri	NA	NA	104	131	117	215
	Kirinyaga	NA	54	97	71	NA	136
	Laikipia	NA	NA	76	118	NA	144
	Meru	53	111	116	92	34	229
	(all)	88	243	278	232	129	492
Mean richness	Embu	17.0	18.1	15.8	13.0	NA	16.7
	Nyeri	NA	NA	17.2	17.4	16.1	17.0
	Kirinyaga	NA	14.8	15.9	23.6	NA	16.7
	Laikipia	NA	NA	14.2	19.7	NA	17.7
	Meru	14.6	15.3	21.3	19.1	11.2	17.5
	(all)	15.8	16.8	17.0	18.4	14.9	17.1
Mean abundance	Embu	81.0	163.9	205.8	262.0	NA	183.7
	Nyeri	NA	NA	223.7	182.8	219.2	205.6
	Kirinyaga	NA	106.1	122.5	191.0	NA	127.6
	Laikipia	NA	NA	150.6	213.2	NA	190.0
	Meru	68.2	116.5	134.2	140.8	88.8	120.1
	(all)	74.6	141.1	174.4	192.6	186.6	167.5
Mean biomass	Embu	4.0	8.7	14.0	23.6	NA	11.7
	Nyeri	NA	NA	9.5	9.3	13.3	10.4
	Kirinyaga	NA	8.5	9.2	12.3	NA	9.5
	Laikipia	NA	NA	7.7	10.9	NA	9.7
	Meru	3.0	8.4	11.9	9.9	8.3	9.3
	(all)	3.5	8.6	11.2	11.4	12.1	10.4

Total species richness shows the highest richness by district being Embu and the lowest Kirinyaga and Laikipia, while the highest mean richness is Laikipia and the lowest is Embu. The highest mean biomass is Embu, and Meru is the lowest. The highest mean abundance is in upper highland zones, the lowest in inner lowland zones. High cultivation districts and zones have high species richness, abundance, and biomass, whereas low cultivation districts and zones are the reverse.

5.3.2 Species accumulation curves

5.3.2.1 Species accumulation curves in all

Species accumulation curves show how species richness increases when all tree species that occur on all farms are counted (Figure 12). The curve shows that farms differ in species composition: not every farm has the same species. Many more species are encountered at large scale in the landscape. The more areas surveyed, the more number of species increases.

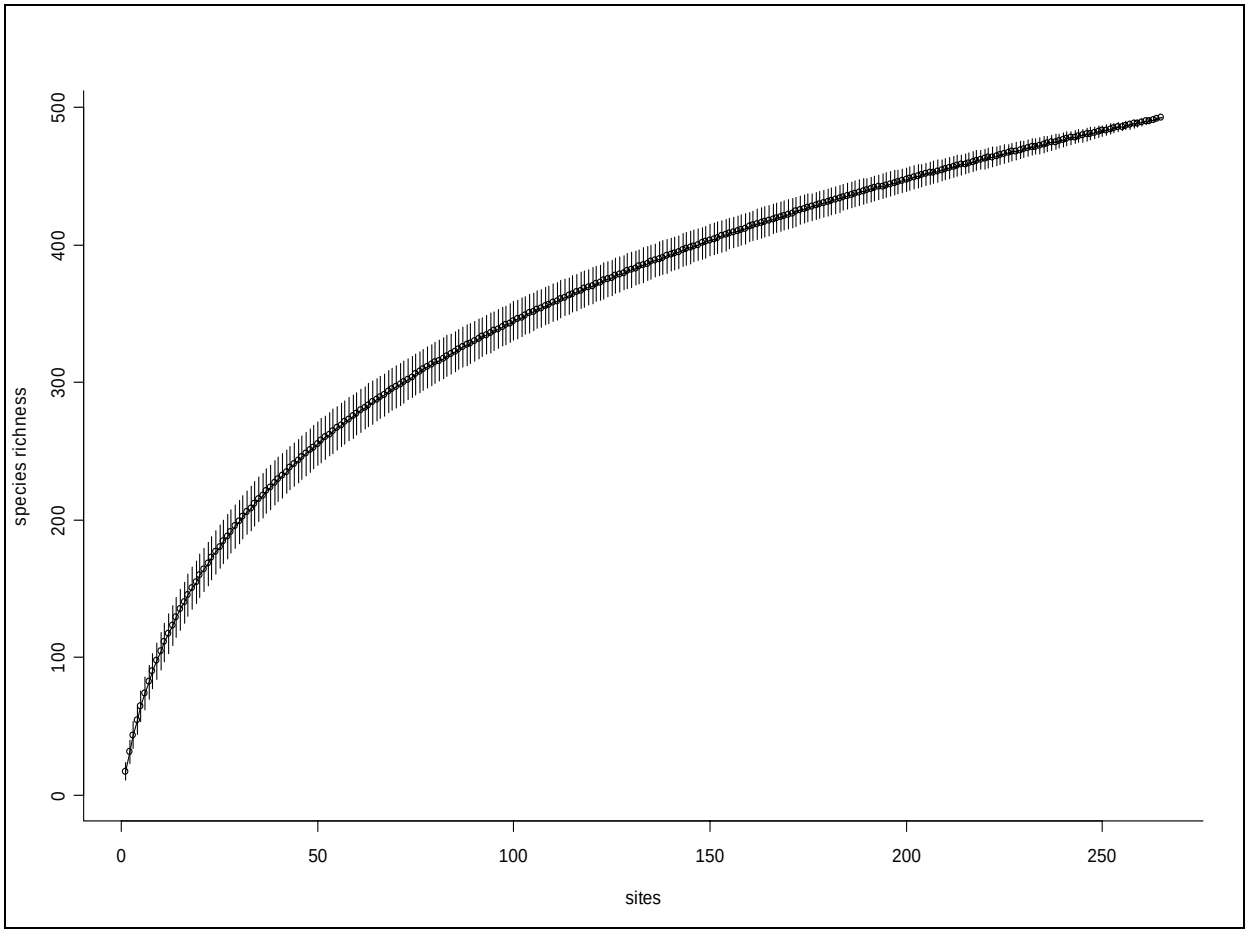

Figure 12. Overall species accumulation curves for all districts. Vertical bars indicate 1 standard deviation.

5.3.2.2 Species accumulation curves for five districts

The same methodology of species accumulation curves was used to compare species richness among five districts (Figure 13). Species richness is greatest in Embu and Meru districts, followed by Nyeri and Laikipia districts, and lowest in Kirinyaga. Embu and Meru districts have very similar curves, as do Nyeri and Laikipia.

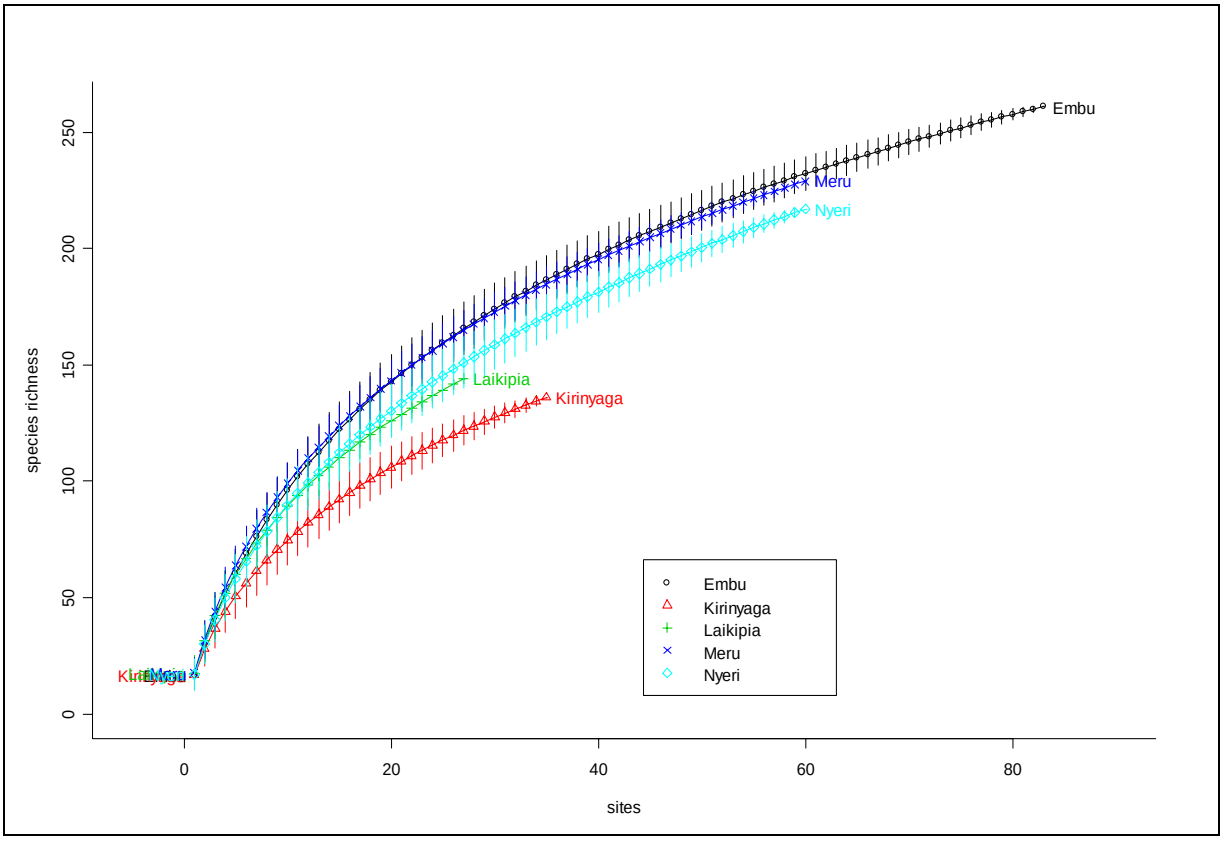

Figure 13. Species accumulation curves for 5 districts

5.3.2.3 Species accumulation curves for the major agro-ecological zones

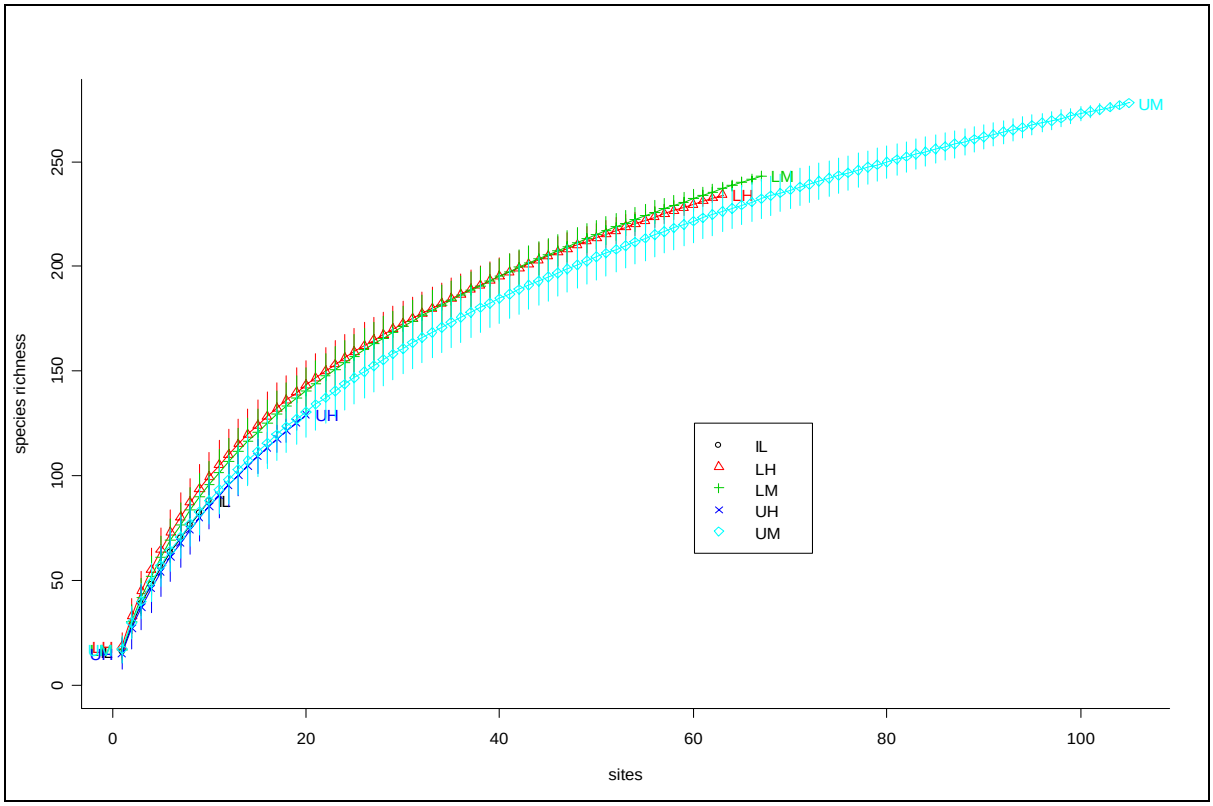

Figure 14. Species accumulation curve for the major agro-ecological zones

The same methodology of species accumulation curves was used to compare species richness among agro-ecological zones (Figure 14). Species richness among agro-ecological zones is greatest in the lower midland zones (comprised by the zones of cotton, marginal cotton, lower midland livestock millet and lower midland ranching). The inner lowland (lowland livestock millet zone) has the lowest species richness, although of a similar pattern. A ranking of zones would be lower midland > lower highland > upper midland > upper highland > inner lowland. The list of the top ten dominant species for the five districts is attached as Appendix 10.

5.3.2.4 Diversity

A rank-abundance curve is based on the total number of trees for every species, ranked in descending order. Few species dominate the landscape (Figure 15), with ten out of 459 species containing 43.5% of all trees. Four of these top 10 are exotic species, especially *Grevillea robusta*, which is present as 13.4 % of all trees (Table 9). This dominant species is planted everywhere in the agro-ecological zones of Mt. Kenya.

Table 9. Abundances (number of trees) for the first 10 most dominant species

Species Name	Rank	Abundance	% of all	In total
Grevillea robusta (Proteaceae F.)	1	6313	13.4	13.4
Musa sapientum (Musaceae F.)	2	2632	5.6	19.0
Cupressus lusitanica (Cupressaceae F.)	3	2331	5.0	24.0
Croton megalocarpus (Euphorbiaceae F.)	4	1835	3.9	27.9
Lantana camara (Verbenaceae F.)	5	1652	3.5	31.4
Euclea divinorum (Ebenaceae F.)	6	1625	3.5	34.9
Commiphora eminii ssp.zimmermannii (Burseraceae F.)	7	1121	2.4	37.2
Catha edulis (Celastraceae F.)	8	1111	2.4	39.6
Euphorbia tirucalli (Euphorbiaceae F.)	9	957	2.0	41.7
Tithonia diversifolia (Compositae F.)	10	870	1.9	43.5
Total		46,948		

The top three dominant species are *Grevillea robusta*, *Musa sapientum*, and *Cupressus lusitanica.* Together they are one-fourth of all trees. *Grevillea robusta*, especially, is planted all over the target area. Banana (*Musa sapientum*) is also widely planted in farms. This fruit is planted wherever people farm, although the higher the altitude the more trees are planted.

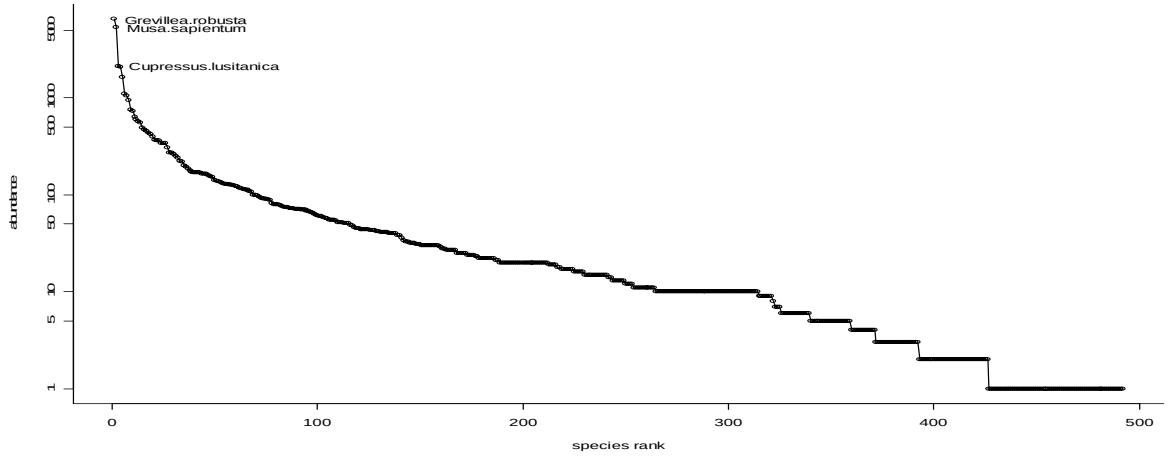

Figure 15. Rank-abundance curves for overall survey

Table 10. Rank abundance percentage of total tree numbers in 5 districts

District	Species No.1	Species No.2	Species No.3	Total %
Meru	*Grevillea robusta*	*Ricinus communis*	*Commiphora eminii*	25.9
Embu	*Musa sapientum*	*Grevillea robusta*	*Catha edulis*	41.4
Kirinyaga	*Grevillea robusta*	*Lantana camara*	*Euphorbia tirucalli*	43.1
Nyeri	*Musa sapientum*	*Grevillea robusta*	*Cupressus lusitanica*	41.9
Laikipia	*Euclea divinorum*	*Croton megalocarpus*	*Grevillea robusta*	41.9

Table 10 shows that in total trees number, the major species such as *Grevillea robusta, Musa sapientum, Croton megalocarpus, Lantana camara*, *Cupressus lusitanica, Persea americana, Commiphora eminii, Carica papaya, Mangifera indica, Euphorbia tirucalli,* and *Euclea divinorum* dominate with one-third of all trees. Three major tree species occupied from 25 to 43% of the total tree number in five districts. Kirinyaga had the highest rank with the first three species among five districts, and Meru had the lowest among all.

Table 11. Rank abundance percentage of total number of trees in each major zone

Agro-ecological zone	Species No.1	Species No.2	Species No.3	Total %
Upper Highland	*Cupressus lusitanica*	*Euclea divinorum*	*Grevillea robusta*	50.8
Lower Highland	*Grevillea robusta*	*Croton megalocarpus*	*Musa sapientum*	32.1
Upper Midland	*Musa sapientum*	*Grevillea robusta*	*Croton megalocarpus*	42.7
Lower Midland	*Grevillea robusta*	*Catha edulis*	*Lantana camara*	29.5
Inner Lowland	*Melia volkensii*	*Acacia ataxacantha*	*Acacia tortilis*	18.6

It can be seen in Table 11 that in the upper highland zones three major species, *Cupressus lusitanica, Grevillea robusta,* and *Euclea divinorum* account for 51% of that zone's tree count, and that the upper midland zones at 42.7% have a similar rate. In the inner lowland, the top three species, *Melia volkensii, Acacia ataxacantha,* and *Acacia tortilis*, were all indigenous species and accounted for almost 19%.

5.3.2.5 Regression analysis

We fitted a regression model to explain differences in species richness among the districts and major agro-ecological zones. There is no significant evidence for a clumped distribution (theta=12.0) among the districts, except for Embu District (significant >0.001). Diagnostic analysis of regression results indicated that more reliable results were obtained with a GLM with a negative binominal variance distribution. This result explains that Embu District has substantially more species, either planted or through natural propagation, than the other districts. The major agro-ecological zones show no statistical evidence of significant differences, which indicates no clear difference among zones in species richness (Table 12).

Table 12. Results of regression in species richness among districts and major agro-ecological zones

Variable	Coefficients	Significance
(Intercept)	2.7378	<2e-16 ***
District Kirinyaga	-0.0186	0.8100
District Laikipia 3	-0.0044	0.9630
District Meru	0.0466	0.4740
District Nyeri	0.0127	0.8690
Zone main LH	0.1641	0.2310
Zone main LM	0.0708	0.5870
Zone main UH	-0.0564	0.7210
Zone main UM	0.0855	0.5080

In analogy to the investigations for species richness, we fitted a regression model to explain differences in tree abundance among five districts and major zones (Table 13). There is significant evidence for the districts of Embu, Kirinyaga, and Meru, and for the major zones. The dispersion parameter for a negative binominal was fitted with theta estimated as 2.80. The model explained about 50% of deviance, reporting at a high level of significance that Embu District had more trees than any other districts, and also that the inner lowland zone had fewer trees than other zones.

Table 13. Results of regression in tree abundance among districts and major agro-ecological zones

Variable	Coefficients	Significance
(Intercept)	4.5272	<2e-16 ***
District Kirinyaga	-0.4345	0.0004 ***
District Laikipia 3	-0.1280	0.3899
District Meru	-0.4237	4.9e-05 ***
District Nyeri	-0.0178	0.8847
Zone main LH	0.8742	6.4e-05 ***
Zone main LM	0.5972	0.0040 **
Zone main UH	0.7780	0.0018 **
Zone main UM	0.7878	0.0001 ***

5.3.2.6 Differences in species composition

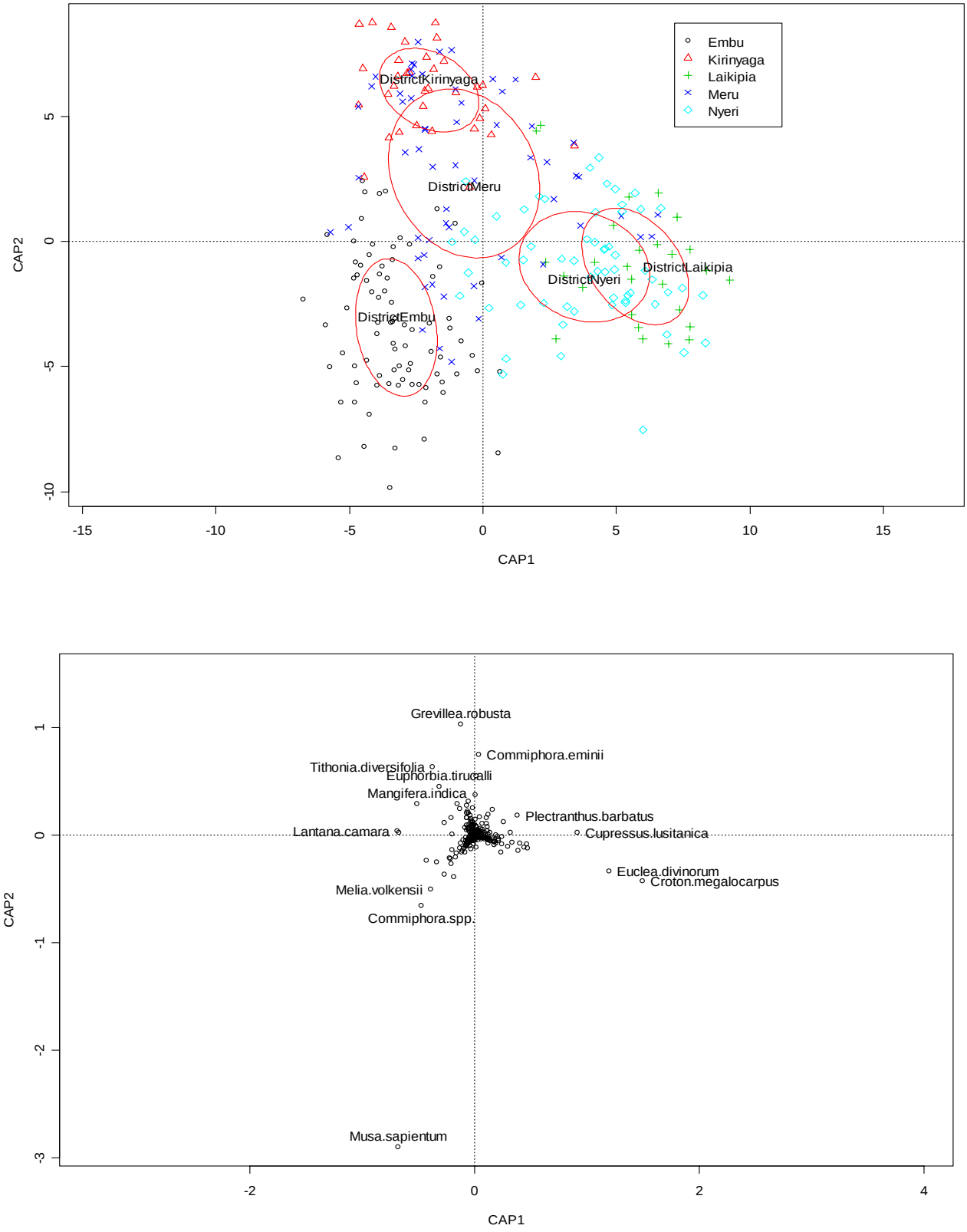

Figure 16. CAP ordination for districts. (Top part: ellipses indicate districts. Bottom part: Species indicate where they are dominant)

Differences in species composition were investigated by ordination models that investigated whether districts and agro-ecological zones explained differences in species composition. The ordination model for five districts explained 10.6% of the squared Bray-Curtis distance, with 8.0% shown on the first two axes. Randomization tests provided evidence for the influence of environmental variables on differences in species composition ($P<0.01$). The ordination diagram provides further evidence for compositional differences among districts (Figure 16 top). The symbols in the graph correspond to the survey plots in five districts. Survey plots, more similar in composition, are closer together on the graph. The ellipses indicate where 90% of plots of a district are expected to be on the graph. The ellipses do not overlap much, providing additional evidence of composition differences. Species composition is especially different for Embu compared to the other four districts. Meru and Kirinyaga districts have similar species composition, and so do Nyeri and Laikipia districts. The direction of districts and species position (Figure 16 bottom) indicates where the districts are located that are expected to contain more trees of specific species or, in the opposite direction, are not expected to see those specific species. For example, in Embu District *Melia volkensii* and *Commiphora* spp. are frequent, but *Plectranthus barbatus*, *Cupressus lusitanica* and other species appear less often here. In Meru and Kirinyaga districts Grevillea *robusta, Tithonia diversifolia, Euphorbia tirucalli* and *Mangifera indica* are often presented, but *Croton megalocarpus, Cupressus lusitanica* and *Plectranthus barbatus* are less common in these two districts.

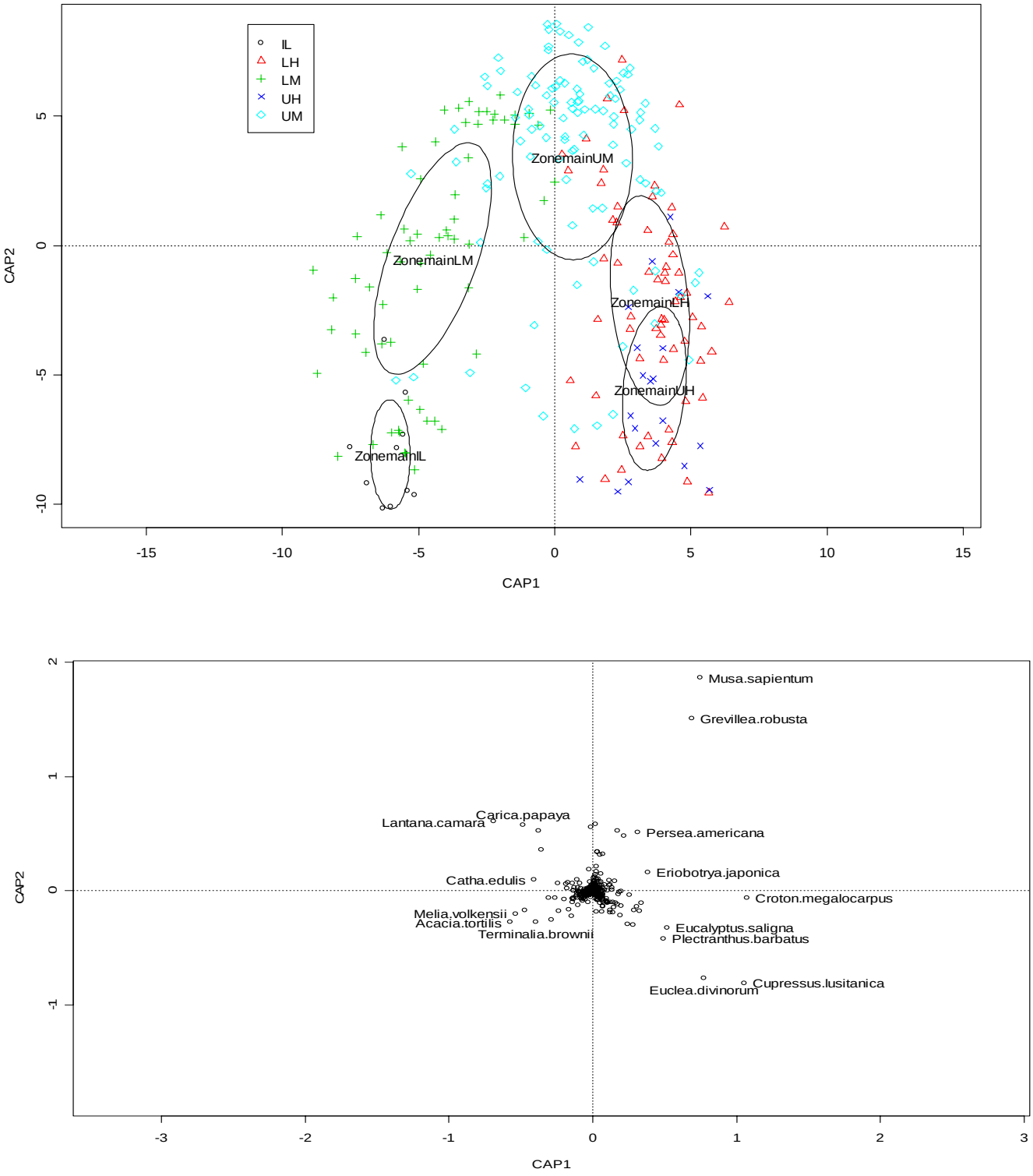

Figure 17. CAP ordination for districts (Top part: ellipses indicate agro-ecological zones. Bottom part: Species indicate where they are dominant.)

The ordination model for five agro-ecological zones explained 10.2% of the squared Bray-Curtis distance, with 87% shown on the first two axes. Randomization tests provided

evidence for the influence of environmental variables on differences in species composition ($P < 0.01$). The ordination diagram provides further evidence for compositional differences among major agro-ecological zones (Figure 17 top). The symbols in the graph correspond to the major zones in the survey areas. The ellipses indicate where 90% of plots of a major zone are expected to be placed on the graph. Since the ellipses, like the district graph, do not overlap much, we have evidence of composition differences. Species composition is quite different among zones, especially the inner lowland zones, the lower midland zones and the upper midland zones. There is a similar species composition between the upper highland and the lower highland zones.

The direction of agro-ecological zones and species position (Figure 17 bottom) indicates the location of districts expected to contain more trees of specific species and, in the opposite direction, districts not expected to see those specific species. For example, in the zones of the inner lowland *Melia volkensii, Acacia tortilis* and *Terminalia brownii* are frequently presented, but *Musa sapientum* and *Grevillea robusta* are not. The upper and lower highland zones have a similar species composition. *Eriobotrya japonica, Croton megalocarpus, Eucalyptus saligna and Plectranthus barbatus* are often presented, but *Lantana camara* and *Carica papaya* are less likely to be found in those zones.

5.3.2.7 Soil analysis

Table 14. Soil analysis data from 5 districts of Mt. Kenya

District	Sample No.	Alt	pH in water	Carbon (%)	EXCA	EXMG	EXK	EXP	Clay (%)	Sand (%)	Silt (%)
Meru	**60**	**1424**	**6.0**	**2.48**	**10.0**	**3.3**	**1.19**	**51.3**	**37.0**	**32.8**	**30.3**
Embu	**83**	**1304**	**6.4**	**1.74**	**8.1**	**2.7**	**0.82**	**25.4**	**34.9**	**38.6**	**26.5**
Kirinyaga	**35**	**1409**	**5.7**	**2.53**	**5.7**	**2.5**	**0.73**	**71.4**	**34.8**	**32.7**	**32.5**
Nyeri	**60**	**1997**	**5.9**	**3.39**	**14.1**	**3.2**	**1.46**	**21.4**	**9.0**	**57.3**	**33.8**
Laikipia	**23**	**1927**	**6.4**	**2.46**	**13.9**	**4.1**	**1.84**	**57.7**	**9.9**	**54.1**	**36.0**

The average data of soil analysis shows that Embu and Laikipia Districts have high pH values, and others have pH values lower than those two Districts. Nyeri District is the highest district in carbon contents (%), compared to the other districts. Nyeri and Laikipia districts have higher exchange calcium and potassium than other eastern parts of Mt. Kenya. Higher places seem to have higher calcium content in their soil.

There is little difference among the five districts in exchange magnesium, although Laikipia shows higher values than the others do. Meru, Kirinyaga and Laikipia have a higher amount of exchange phosphate than Embu and Nyeri districts.

The most prominent difference in soil composition among the districts is the percentage of clay soil in Nyeri and Laikipia districts, much lower than the other districts. This requires multivariate analysis with every individual datum. There is no significant evidence of a relationship between soil data and species richness, abundance, or species composition, as demonstrated by the results of statistical analyses done with other variables. The result of analysis is shown in Appendix 11.

6. Discussion

6.1 Biodiversity pattern on a district and agro-ecological level

6.1.1 Landscapes and vegetation types

There is a certain pattern of landscape and vegetation in a zone level. In the tea zones (tea-dairy zone and coffee-tea zone in the lower highland) tea plants occupy lots of space on farm and other trees cannot grow inside a tea farm, therefore trees such as *Eucalyptus* spp. and *Grevillea robusta* are planted mostly on the boundary and some fruit trees such as *Musa sapientum, Persea americana, Prunus domestica* and *Macadamia* spp. are planted in the spare space. In the sunflower-maize and sorghum zones (in the upper midlands) many trees are planted, though species number is not so high. In the lowland livestock millet zone (in the inner lowland) mostly indigenous tree species such as *Melia volkensii, Acacia* spp. and *Commiphora* spp. remain under natural vegetation without disturbance, though they will be disappearing sooner or later due to land clearance for farming. Generally in the higher altitude agro-ecological zones we can find mainly exotic species, while in the lower altitude agro-ecological zones we can find more indigenous tree species. It is indicated that more cultivation draws more exotic tree species to be planted by farmers for boundary, fruit and timber production. Often the presence of the invasive shrub *Lantana camara* is noted. This shrub grows like a weed on farm in every empty space under the sun.

We can question why the tree species *Grevillea robusta* has been planted so widely. The main reason is that this species can grow very fast from seed, thrives best in deep soil with good rainfall but also tolerates poorer soils. At the same time it is useful for timber, firewood and also for acting as a windbreak (Noad and Birnie 1989; Ondieki 1999). Banana, *Musa sapientum,* is planted on all farms. Especially intensive farming systems in the higher agro-

ecological zones seem to require these fruit trees as a complementary food source and sometimes as a cash crop. *Cupressus lusitanica* can be mostly seen above 1500 m with good soil and fair rainfall, and coppicing well, making a good hedge (Noad and Birnie 1989).

Two districts, Nyeri and Laikipia on the west side slope of Mt. Kenya have a higher number of trees per plot than on the eastern slope of the Mountain. This could be due to lesser cultivation, as there are many livestock rearing farms and less area under cultivation. More cultivation introduces more trees than less cultivation. Further investigation is necessary to find out why Embu District has much more species than other districts. A possible reason could be the effect of local government, local NGOs and World Agroforestry Centre's long-term programmes to encourage farmers to plant different varieties in the district. The total number of trees diminishes with decreasing altitude. It seems that farmers' motivation for planting trees in the higher zones is much greater than for people in the lower zones. Necessity pushes people towards planting trees. People also have an advantage to get seedlings from a nursery in the high-intensity cultivation zones.

The total number of exotic tree species is small, but the total number of trees is large. This indicates that many farmers have been getting a few common exotic tree species (e.g. *Grevillea robusta* and *Cupressus lusitanica*) in large numbers. This was confirmed in both the farmer and the nursery surveys. Four districts, Meru, Embu, Kirinyaga, and Nyeri have similar vegetation patterns, and therefore the composition of indigenous and exotic tree species should be similar. However, in Kirinyaga District, the total number of indigenous tree species is declining drastically and many indigenous trees have been replaced by trees of exotic species. This finding suggests that Kirinyaga District has been more intensively cultivated than other districts and is therefore losing many indigenous tree species. Laikipia District is the only place in this survey where many indigenous tree species can still be found. However, it is suspected that the same fate will befall this area, if agricultural cultivation also spreads more widely into this region.

Species accumulation curves indicate that when more extensive surveys are carried out, more species can be found, especially in Embu, Meru and Nyeri districts, as well as in the upper/lower midland and upper/lower highland. The results of species richness in regression analysis show that there is no statistical evidence for differences in biodiversity among districts except for Embu District. This is also proven by species accumulation curves. These results show that Embu District has both a higher species richness and higher total tree

abundance than the other districts. Some districts like Nyeri and Laikipia have low species richness and tree abundance. Also, some zones like the lower highland and the upper midland zones have a much higher number of trees than the inner lowland, lower midland and the upper highland zones.

Not all patterns observed in the regression analysis could be observed in the ordination diagram. This is not surprising, for the objectives of these two types of analysis are not exactly the same. The ordination diagram shows the results for differences in species composition for all species in both districts and agro-ecological zones, but only for 10.6% for district level and 10.2% for agro-ecological level of total squared Bray-Curtis distance. Moreover, the regression was based on a GLM with log link and negative binomial or quasi-Poisson variance functions, whereas the underlying regression steps of the ordination method were a linear regression. Since different patterns were analyzed, not all results will necessarily point in the same direction. The results, however, show that some similar patterns were observed in the regression. Agro-ecological zones with similar elevation show a high correspondence between the regression and ordination results, indicating that the effect of agro-ecological zone was as likely to be similar on individual species as on differences in species composition. In these analyses we did not separate the dataset into indigenous and exotic tree species due to limited paper length and time. It is definitely necessary to break down the dataset into these two categories, indigenous and exotic tree species, to obtain more exact data on species richness, tree abundance and species composition both in district level and agro-ecological zone level.

6.2 Biodiversity conservation through agroforestry

6.2.1 What is the meaning of minor species?

Comparing the number of species and trees between indigenous and exotic species, we observe that the indigenous species stand out in the number of species present, while the total number of trees is clearly dominated by exotic tree species. Considering the indigenous tree species, half of all species are minor species but the total number of trees is quite low. These scant numbers indicate that genetic diversity and population sizes could become too low to sustain such minor indigenous tree species within the agro-ecosystem unless their abundance is increased (O'Neill *et al.* 2001; Atta-Krah *et al.* 2004). This is regrettable as those minor species carry a lot of potential and could have various useful applications, but unfortunately

they are neglected even by those farmers that do have them on their farm. Farmers show little concern for sustainability and resilience in relation to the exploitation of natural resources, as they have little inherited knowledge on these aspects and because of the economical pressures they are facing daily. We urgently need to make them aware of the direct influential mechanisms such as habit loss and fragmentation, physical alteration, over-exploitation, pollution, the effects of introduction exotic species and global climate change. At the same time it should be realized that the root causes that drive these proximate threats lie in the high rate of human population growth, the unsustainable use of natural resources, the reigning economic policies that fail to value the environment and its resources, the lack of sufficient scientific knowledge, and in the weak legal and institutional systems (Bennun *et al.* 1992).

The present situation in the lower zones - from the cotton zone to the lowland livestock millet zone - indicates that indigenous trees are retained as natural vegetation and kept at a minimum level. Because of the severe hot and dry conditions in this region, farming activities have long been relatively limited, thus allowing the survival of some indigenous species, though many new settlers into this area are now starting with cultivation of maize, sorghum and millet. In fact during the period of our survey we saw many people starting to clear the bush and burning it for farming. They do not consider the importance of these indigenous trees in their daily life and neglect how useful they may be for the next generations.

6.2.2 Biodiversity conservation needed

Today about 1.4 million animals and plants are known to exist and have so far been inventoried on our planet. The real number of species on the Earth, however, is thought to be much higher, with estimates reaching as much as about 50 million, based on the survey of tropical forests (Wilson 1992). Probably, only 2.8% of all species have been named so far, in which the botany of those species is too limited to understand. It is feared that within a couple of decades a great number of natural resources will have been destroyed and as such biodiversity will be drastically diminished. Every year at least 4000 to 6000 species are disappearing. This sad development has unfortunately already started to affect the surveyed area surrounding Mt. Kenya. At an ecological level the situation is mainly seen as a degradation of forests in vast areas in the world, and is threatening our existence with global warming, disruption of the ozone layer, and soil degradation (Inoue 2001). We urgently need more investigation of this natural vegetation of the forest and the adjacent agro-ecological zones to know more about the biodiversity and to preserve its nature. From this survey we

learned that the present situation is such that we need to take action soon in order to save the biodiversity in the area, and to preserve it at least from human invasive activities.

In their book 'Ecoagriculture' McNeely and Scherr (2002) quote the words of Norman Myers: "It is in the common interest of both agriculture and the natural world that a mutually supportive relationship be developed between them. Production of food need not destroy the wild ecosystems of the world and their wealth of biological diversity. And preservation of wild ecosystems does not pose a threat to humanity feeding itself. In fact, just the opposite is true. Sensible use of nature, which includes substantially increased nature conservation efforts, is essential to feed the planet… Nature equals food. Without wild places, we can not hope to have food on our tables".

In their book, there are several examples of innovative landscape management strategies that successfully combined both objectives by applying eco-agriculture strategies. As much as 90% of biodiversity resources in the tropics are located in human-dominated landscapes. Agroforestry can reduce the exploitation of protected areas, increase biodiversity within working landscapes, and/or the diversity of trees in farming systems (Garrity 2004). Diversification of agroforestry systems results in improved biodiversity conservation, although the links between development and conservation goals need to be explored carefully since community involvement is not a sufficient requirement for biodiversity conservation (Salafsky *et al.* 1993; Attwell and Cotterill 2000; Adams *et al.* 2004).

Part II

Results from the farmer survey and nursery survey in 5 districts surrounding Mt. Kenya

Farmer survey

Abstract

In the agro-ecological zones in Meru, Embu, Kirinyaga, Nyeri and Laikipia districts surrounding Mt. Kenya, the farmer survey covered 225 farmers between April 2003 and May 2004. Data was analyzed by using SPSS. The study found 70 species; the average number of trees per farm was 225 and average farm size, 5.2 acres. The survey result shows that farmers are maintaining a diversity of tree species, either exotic or indigenous, on farm. At present exotic species are easily introduced because they have high value and are well known for uses such as timber, fruit, or food and medicine. Farmers can easily get seeds and seedlings, propagation is easy, and so is information from commercial sectors. From the higher to the lower zones, however, exotic species decrease and indigenous species increase. Many farmers plant a lot of Grevillea robusta as a multipurpose tree in the tree farming and agroforestry systems. Germplasm availability and distribution in the area has had a direct influence on species diversity. This report discusses the tree species encountered on farm, their local uses and services, germplasm sources for tree species, and related information. It aims to provide some baseline data for understanding selection of tree propagation for improved productivity in the systems of tree farming and agroforestry. The result suggests that farmers need to increase accessibility to germplasm to diversify trees in terms of species richness as well as farm productivity.

Keywords: Mt. Kenya, agro-ecological zones, farmer survey, exotic species, indigenous species, species diversity, germplasm

1. Introduction

Farmers plant trees largely in pursuit of their livelihood goals of income generation, risk management, household food security, and optimum use of available land, labor and capital. Farmers use and conserve species to obtain products such as food, wood, medicine and fodder, as well as numerous services. A tree plays a crucial role in the cultural life of people. Many products and services cannot be delivered by a few species only, and therefore farmers have a wide variety of tree species on farm. Farmers benefit from using tree species and thereby conserve biological diversity on farm. This conservation through improved

domestication of priority species is increasingly important because the natural forests are rapidly disappearing (Simons *et al.* 2000 and Vanleeuwe *et al.* 2003).

A greater emphasis on tree diversity not only increases productivity but also conserves biological diversity on farm. Farmers need biodiversity, including intraspecific diversity, for the productivity and sustainability of the agroforestry ecosystem (SGRP 2000). A broad genetic base provides the species with an adaptive capacity to respond to environmental fluctuations and changing farmer practices and markets. It ensures the vitality and long-term survival of the species in question and can be important for the vitality of the entire agroforestry ecosystem (Lengkeek *et al.* 2005a&b).

A farmer survey was conducted in the target area to focus on the knowledge, technology and productivity required for tree farming and agroforestry systems. It was anticipated that valuable information for incorporation into ICRAF's domestication strategies might be collected by interviewing farmers about their knowledge as to selection of tree species for improved productivity. At the same time the investigation of local knowledge for tree improvement would reveal the possibility for on-farm domestication when germplasm is handed over to other farmers. Information could also be gathered on local uses and services of tree species, and possibly incorporated into the multipurpose trees (MPTs) database at ICRAF.

Previous surveys in different regions and with different foci have demonstrated that much information can be collected through contacts with farmers. Often local people have built up a tremendous amount of knowledge on the diversity, potential, and problems of their environments. Knowledge of tree growing is transmitted from one generation to the next. New ideas and skills are added in every generation. It is therefore likely that farmers have developed a knowledge system on tree domestication.

Research in domestication on-farm will show the plant characteristics with high importance to farmers, as these are likely to be addressed in the farmers' own selection activities. Because the domestication of tree species is relatively new in comparison with the improvement of traditional forestry species (and certainly of the common agricultural crops), a lot of knowledge is still to be gathered. Research on farmer selection of tree ideotypes and integration of the ideas of breeders to improve tree species is still at an early stage of development. Learning from farmers could prevent domestication time losses caused by

having to re-discover facts already known by farmers. There are many examples of new interventions being developed by local communities (Kindt 1997). Knowing how farmers presently select their trees provides a prediction about future domestication. Farmers do not alter their methods when germplasm is handed over. Dangers of current practices can be addressed at that time so that the success of germplasm transfer is guaranteed.
The specific objectives of the survey were to gather information in the agro-ecological zones in Meru, Embu, Kirinyaga, Nyeri and Laikipia districts surrounding Mt. Kenya as to:

1 Practical knowledge and technology on selection, propagation and usage for improvement of tree species
2 Local uses, services and production of tree species for incorporation into the ICRAF MPTs Database.

2. Methods and materials

2.1 Selection of survey area and of informants

2.1.1 Selection of survey area

The region of Mt. Kenya was one of the target areas for ICRAF mainly because of its increasing population and intensive farming zones. The target area calls for measures for sustainable livelihoods through agroforestry. In addition, not much information on local perception on tree propagation and domestication from this area had been gathered for the MPTs Database. The research data could also build on previous investigations done by the Embu KEFRI/KARI/ICRAF Agroforestry Research project (Hoekstra 1988; Thijssen *et al*. 1993; Roothaert *et al.* 1997).

2.1.2 Selection of informants

Random selection was made of farmers who had propagated trees on their farms. This approach was expected to yield a lot of information, due to the farmers' experience and interest of propagation. A local person from each district was contracted to help identify suitable interviewees based on their experience in the area. Involvement of these local people helped in getting introduced and achieving the cooperation of informants. These people were

provided with information about the characteristics of target farmers and asked to ensure random sampling of farms and nurseries.

2.2 Interview

The interview had a semi-formal character: a questionnaire was used, some open-ended questions were asked, and the questioning was not limited to the recorded questions. A draft questionnaire was developed in collaboration with several ICRAF scientists. (This questionnaire is attached in Appendix 12.) This basic, precise and comprehensive interviewing tool was used to document information from individual tree farmers. Local contact persons assisted with translations in the local languages and in the identification of species.

This interview was done in the agro-ecological zones of five districts surrounding Mt. Kenya, between April 2003 and May 2004, compiling in all districts (number of farmer interviews in Meru, 65; Embu, 36; Kirinyaga, 35; Nyeri, 45 and Laikipia, 44). We used the zone map done by Kenya Soil Survey (Kenya Soil Survey 1982), and a Magellan GPS satellite as the vegetation survey did. The table below (Table 15) gives a summary of climate in the major agro-ecological zones. This activity was at the same period as the vegetation and nursery surveys, but with different locations and farmers.

Table 15. Climate details in the agro-ecological zones

Zone Name	Altitude in m	Annual mean temperature in ^{o}C	Annual average rainfall in mm	Initial leading crop
UH (Upper highland)1: Sheep-Dairy	**2070-2400**	**15.0-12.8**	**1080-2000**	**sheep, dairy farming**
LH(Lower Highland)1: Tea-dairy	**1770-2070**	**17.7-15.8**	**1750-2000**	**tea, dairy farming**
UM(Upper Midland)1: Coffee-tea	**1590-1830**	**18.9-17.5**	**1400-1800**	**coffee, tea**
UM(Upper Midland)2: Main coffee	**1400-1590**	**20.1-18.9**	**1200-1500**	**coffee**
UM(Upper Midland)3: Marginal coffee	**1280-1460**	**20.7-19.6**	**1000-1250**	**coffee, maize**
UM(Upper Midland)4: Sunflower-maize	**1280-1400**	**20.7-20.0**	**980-1100**	**sunflower, maize**
LM (Lower Midland)3: Cotton	**1070-1280**	**22.0-20.7**	**900-1100**	**cotton**
LM(Lower Midland)4: Marginal cotton	**980-1220**	**22.5-21.0**	**780-900**	**cotton**
LM(Lower Midland)5: Lower midland livestock millet	**830-1130**	**23.5-21.7**	**700-900**	**millet, livestock**
IL(Inner Lowland)5: Lowland livestock millet	**760-830**	**23.9-23.5**	**640-780**	**millet, livestock**

Source: Jaetzold & Schmidt. Farm management handbook of Kenya, Ministry of Agriculture, Kenya 1983.

Table 16 gives the categories of agro-ecological zones where the farmer survey was done.

Table 16. Categories of agro-ecological zones where the farmers survey was done

Zone name	No. of farms surveyed	Percentage
Upper highland (UH1-3)	**25**	**11**
Lower highland (LH1-5)	**63**	**28**
Upper midland (UM1-6)	**90**	**40**
Lower midland (LM3-6)	**37**	**16**
Lowland (IL5)	**10**	**5**
Total	**225**	**100**

2.3 Data entry and analysis

All data were entered into an SPSS (Statistical Programme for Social Science) for Windows Release 11.5 packages (© SPSS Inc.). A spreadsheet was developed to ensure that all bits of information could be entered. Interview responses on open-ended questions were post-coded for this purpose. Each question that had more than one answer was allotted as many variables as necessary in the spreadsheet to ensure that relevant information was not omitted. Answers to questions with more than one variable were not recorded in order of preference but in the order that the respondent replied. Upon completion of all the questionnaires and data entry, the entire spreadsheet was rechecked, to ensure that all of the data variables were correctly coded and entered. A further spot check of 10% of the questionnaires was carried out to ensure a high level of accuracy in data entry. Analysis of selected data and production of results was carried out using SPSS and many of its statistical options, including Frequency tables, Cross tabulations, and multi-variant frequency plus cross tabulations. Excel spreadsheet was also used for other complementary analysis.

3. Result

The average farm size was 5.2 acres, of which a cash crop occupied 0.9 acres, on average, and food crops 2.6 acres. The average family size per household was 7 people and average dependants per household were 5 people. More than 80% of all interviewees were farmers. Cattle were kept by 78.2% of households, and 50.7% and 40.1% respectively kept goats and sheep.

3.1 Encountered tree species on farms

3.1.1 Encountered tree species

The survey team found 70 species in 225 farms in the area. The average number of trees per farm was 225. Table 17 provides a list of the first 20 out of 70 species that were identified during the survey. The species are ranked by numbers of occurrences on farms. The full list is attached as Appendix 13.

Table 17. Encountered species with number of occurrences and average total trees on farm

Scientific name	Places where species was encountered & Average number of trees on farm per species			
	Places out of 1382	%	Rank	Average number of trees per species
Grevillea robusta	**183**	**13.2**	**1**	**70**
Persea americana	**105**	**7.6**	**2**	**8**
Musa sapientum	**103**	**7.5**	**3**	**110**
Eucalyptus saligna	**100**	**7.2**	**4**	**56**
Cupressus lusitanica	**89**	**6.4**	**5**	**30**
Mangifera indica	**82**	**5.9**	**6**	**10**
Croton megalocarpus	**74**	**5.4**	**7**	**31**
Carica papaya	**57**	**4.1**	**8**	**53**
Citrus sinensis	**37**	**2.7**	**9**	**18**
Eriobotrya japonica	**36**	**2.6**	**10**	**9**
Macadamia tetraphylla	**35**	**2.5**	**11**	**12**
Citrus limon	**27**	**2.0**	**12**	**3**
Commiphora eminii	**27**	**2.0**	**12**	**45**
Cordia africana	**27**	**2.0**	**12**	**9**
Jacaranda mimosifolia	**27**	**2.0**	**12**	**13**
Psidium guajava	**27**	**2.0**	**12**	**7**
Schinus molle	**24**	**1.7**	**17**	**9**
Acacia mearnsii	**19**	**1.4**	**18**	**89**
Croton macrostachyus	**18**	**1.3**	**19**	**13**
Senna siamea	**16**	**1.2**	**20**	**88**
Vitex keniensis	**16**	**1.2**	**20**	**13**

Grevillea robusta is very popular and ranked highest. Farmers prefer this species because of its multi-purpose usage as timber, fuelwood and fodder. *Eucalyptus saligna* and *Cupressus lusitanica* also are high-ranking species which are grown for timber and often find a niche as boundary markers. Fruit tree species such as *Persea americana, Musa sapientum, Mangifera indica, Eriobotrya japonica* and others, also ranked high.

3.1.2 Average number of trees per farm and per species in 5 districts

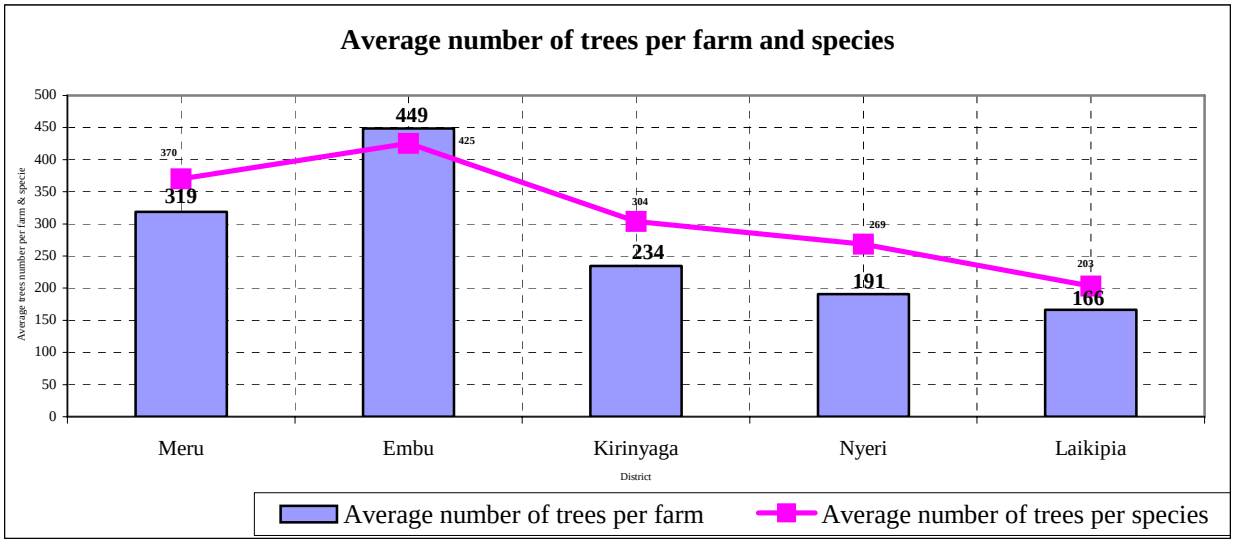

Figure 18. Average number of trees per farm and per species in 5 districts

The highest average number of trees per farm, 449, was found in Embu, followed by Meru (Figure 18). The lowest number was 166 in Laikipia District. The district with the highest tree numbers per farm had more than two times as many trees as the district with the lowest one. Similarly, Embu had the highest average number of trees, 425 per species, again followed by Meru.

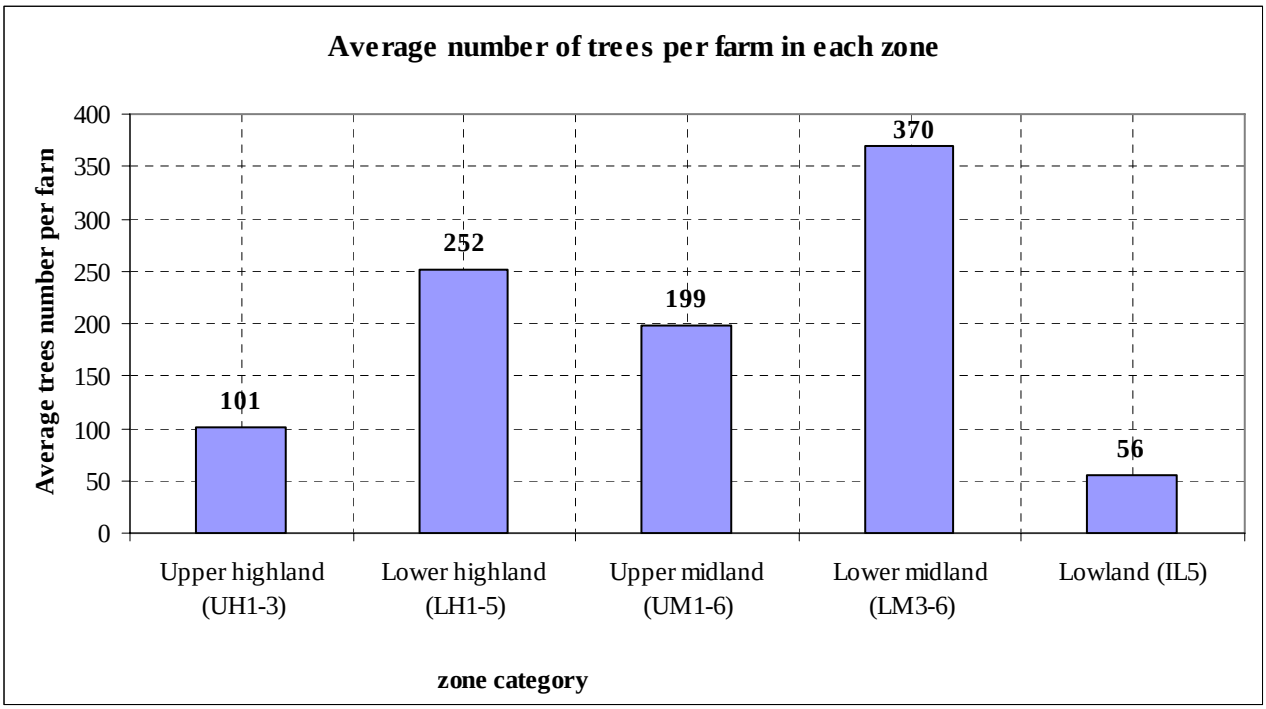

Figure 19. Average number of high value trees per each zone category

3.1.3 Average number of trees per farm per zone

The highest numbers of trees per farm were recorded in the lower midland zone, followed by the lower highland (Figure 19). The lowland zone, showing the lowest numbers, had an average of 56 trees per farm. In general, many farmers in all zone categories had a significant number of trees on their farms.

Table 18 gives a list of the most common tree species in each district, with percentage of occurrence. Full lists of all species per district are attached at the end of this report as Appendix 14.

Table 18. Ranking of most common tree species on farms by percent in each district

Meru	%	Embu	%	Kirinyaga	%
Grevillea robusta	12.7	*Grevillea robusta*	10.3	*Grevillea robusta*	17.1
Persea americana	7.7	*Musa sapientum*	8.0	*Musa sapientum*	14.0
Mangifera indica	7.5	*Persea americana*	7.6	*Mangifera indica*	12.4
Musa sapientum	7.5	*Mangifera indica*	7.6	*Persea americana*	9.3
Eucalyptus saligna	6.1	*Eucalyptus saligna*	6.8	*Eucalyptus saligna*	8.8

Nyeri	%	Laikipia	%
Grevillea robusta	14.4	*Grevillea robusta*	13.3
Cupressus lusitanica	11.2	*Croton megalocarpus*	12.2
Eucalyptus saligna	10.9	*Cupressus lusitanica*	7.4
Croton megalocarpus	8.8	*Citrus sinensis*	7.4
Persea americana	8.4	*Eucalyptus saligna*	6.3

Grevillea robusta was the first ranked and most popular species. It topped in every district. Most farmers also said that they liked the species because it could be propagated anywhere on farm, including scattered in the crops, because it did not affect crop yields much. Other popular species are *Musa sapientum*, *Persea americana*, *Eucalyptus saligna*, *Mangifera indica* and *Cupressus lusitanica*. They are all exotic species for various purposes such as fruit, timber and fuelwood.

Table 19 gives a list of the first five high value trees in each zone category against the percentage of occurrence. Full lists of all species per zone category are attached at the end of the report as Appendix 15.

Table 19. List of the first five high value trees in each zone category against the percentage

Upper highland	%	Lower highland	%	Upper midland	%
Grevillea robusta	17.2	*Grevillea robusta*	14.7	*Grevillea robusta*	12.8
Cupressus lusitanica	15.5	*Cupressus lusitanica*	9.2	*Musa sapientum*	9.1
Eucalyptus saligna	13.8	*Eucalyptus saligna*	9.0	*Persea americana*	8.3
Persea americana	9.5	*Croton megalocarpus*	8.5	*Mangifera indica*	7.5
Croton megalocarpus	7.8	*Persea americana*	7.7	*Eucalyptus saligna*	6.8

Lower midland	%	Lowland	%
Mangifera indica	12.4	*Terminalia brownii*	24.2
Grevillea robusta	11.5	*Acacia tortilis*	18.2
Carica papaya	10.1	*Melia volkensii*	15.2
Musa sapientum	7.8	*Tamarindus indica*	9.1
Senna siamea	6.5	*Commiphora africana*	6.1

Grevillea robusta was seen everywhere, but planted mostly in higher zones. *Cupressus lusitanica* and *Eucalyptus saligna* were found in the higher zones. In the lowland zones we found mostly indigenous tree species, such as *Terminalia brownii*, *Acacia tortilis*, *Melia volkensii* and *Tamarindus indica*. Generally, the number of exotic species decreased from higher to lower zones, while the number of the indigenous species increased.

3.1.4 Information on uses and services of tree species on farms

Table 20 gives information on uses and services of tree species in 5 districts, by percentage.

Table 20: Uses of trees on farm in 5 districts

Tree use	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Fruit or food	38.7	38.9	51.8	33.0	33.9
Timber	21.5	33.1	14.5	45.2	36.5
Fuelwood	18.5	11.3	28.5	14.0	14.0
Poles	7.2	4.7	2.6	0.4	0.4
Stakes	1.4	4.7		2.1	
Fodder	7.1	3.6	0.6	0.4	1.1
Shade	3.6	1.8	1.0	3.4	7.7
Fence	0.6	1.1		0.4	1.1
Medicine	1.1	0.8	1.0	1.1	4.8
Soil fertility	0.3				0.5

In all districts the main three uses of trees were for fruit or food, timber, and fuelwood, as shown in Table 20. In Kirinyaga these main three uses represented 94.8% of all applications, in Nyeri 92.2%, in Laikipia 84.4%, in Embu 83.3% and in Meru 78.7%. The use of trees for poles was high in Meru, fodder was also high in Meru, and medicine was high in Laikipia. Different places clearly put different values on the use of individual tree species.

Table 21 shows the summary of uses per zone, by percentage.

Table 21: Uses of trees on farms in each zone category

Tree use	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
Fruit or food	25.9	36.6	41.5	49.3	27.3
Timber	51.7	41.8	26.2	17.5	18.2
Fuelwood	13.8	10.5	17.2	16.6	3.0
Poles	0.9	1.6	2.3	8.3	21.2
Stakes	0.9	3.4	2.5		
Fodder	0.9	1.3	3.7	3.7	12.1
Shade	6.0	3.4	3.5	2.3	15.2
Fence		0.5	1.0		3.0
Medicine		1.8	2.0	2.3	
Soil fertility		0.3	0.2		

In zone level, the three main uses of trees for fruit or food, timber, and fuelwood were common in all zones except in the lowland zone, as shown. The total representation of these three main uses in the upper highland was 91.4%, in the lower highland 88.9%, in the upper midland 84.9%, in the lower midland 83.4% and in the lowland 48.5%. The higher zones had a higher rate of these three major uses. The lowland zone showed a different using system: 21.2%for poles, 12.1% for fodder and 15.2% for shade.

3.1.5 Methods of tree establishment

The method of tree establishment is especially important, as it determines the species diversity. Farmers have a control for tree diversity on farm if they establish trees by planting as compared to other methods of tree establishment. Table 22 shows the methods of tree establishment on farm in each district and zone category in percent.

Table 22 Tree establishment methods on farms in each district

Establishment methods	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Planted	80.4	85.1	92.2	96.5	97.0
Existed before current owner	13.0	8.4	4.7	2.4	3.0
Natural regeneration	6.6	6.5	3.1	1.1	

Given that almost 90% of all tree species found on farm were established through planting, it appears that almost all the farmers in the 5 districts recognized the importance of trees on farm. No significant change of method of establishment was noted within the districts. Table 23 shows establishment methods by zone categories.

Table 23. Tree establishment methods on farms in each zone category

Establishment methods	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
Planted	95.7	95.7	90.9	80.1	30.3
Existed before current owner	2.6	3.4	4.3	7.4	33.3
Natural regeneration	1.7	1.0	4.8	12.5	36.4

It is interesting to note that, from the upper highlands down to the lowlands, the ratio of planting went down and changed gradually from planting to the other two methods. In the lowland zones, all three methods of tree establishment—planted, existing before, and natural regeneration—were used by farmers in almost equal proportion. In the lower altitude, then, the natural methods were more likely to play a part in tree establishment.

3.1.6 Information on species niche on farms

Species niche is expected to greatly affect diversity, as farmers are keen to plant trees that have no negative effects on crop production. Table 24 and 25 compare the species niches in the districts and in the five zone categories, by percentage.

Table 24. Comparison of species niches in the five districts

Species niche	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Scattered on farms	72.4	46.2	66.7	59.6	56.5
External boundary	18.2	31.7	28.0	27.4	14.0
Home garden	3.6	14.7	2.1	3.5	7.4
Internal boundary	1.7	2.8		6.0	21.4
Woodland	4.1	2.8	3.6	3.5	0.4
Contour		1.8			0.4

Most trees in the districts were found scattered on farms. Farmers in Meru most often integrated crops with trees, and overall 60% of the species were scattered in crops. Approximately 30% were in either an external or an internal boundary. *Grevillea robusta* was mentioned by farmers as one of the best species that interacted well with crops without any effect, a factor that contributed significantly to its high ranking in terms of numbers and frequency in the districts. *Cordia africana* and *Bridelia micrantha* were also found in crops, but not as often. Trees principally grown in cropland were *Calliandra calothyrsus, Leucaena leucocephala*, and *Markhamia lutea*.

Table 25. Comparison of species niches in the five zones category

Species niche	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
Scattered on farms	53.4	54.7	65.5	80.6	87.9
External boundary	32.8	27.8	20.2	16.6	6.1
Home garden	4.3	3.8	4.1	0.9	
Internal boundary	6.9	9.6	6.8		6.1
Woodland	1.7	4.1	3.3	1.8	
Contour	0.9				

Two major species niches are ‘scattered on farms’ and ‘external boundary’ at 82.5% in the lower highland and 97.2% in the lower midland. Planting trees scattered in the crops increased from the highlands downwards, while the opposite was true for planting trees on the external boundary (Table 25). Woodlot was not common in the lower zones mainly because of the high cost of tree farming due to dry conditions and low crop productivity. The home garden was mainly preferred for fruit trees.

3.2 Tree species preferred for various uses and services

It is important to note that the farmers had the choice to mention any species they prefer for specific purposes regardless of whether they propagated a species or not.

3.2.1 Preferred timber tree species

Table 26 gives details of the preferred timber species per district, ranked by percentage.

Table 26. Preferred timber tree species in all districts

Species name	Meru	Embu	Kirinyaga	Nyeri	Laikipia
*Grevillea robusta**	17.9	22.4	9.9	20.8	17.8
*Cupressus lusitanica**	10.3	9.1	9.2	25.6	23.0
Cordia africana	15.5	13.3	22.1	14.3	11.5
*Eucalyptus saligna**	15.1	17.5	14.5	13.7	13.2
Vitex keniensis	6.3	16.8	6.1	2.4	4.0
Ocotea usambarensis	5.2	0.7	10.7	2.4	7.5
Prunus africana	1.1		8.4	6.4	5.7
Podocarpus falcatus	2.0	5.6	4.6	4.2	4.6
Juniperus procera	2.3	3.4	1.5	2.4	5.2
*Pinus patula**	4.3		1.5	5.4	2.3
Others	20.0	11.2	11.5	2.4	5.2

*: exotic species

Grevillea robusta ranked as the most preferred timber. This species can grow in a wide range of climatic conditions and does not affect the crops so much. Although it was multipurpose, its primary use was to provide timber to the farmers. The two species most preferred, *Grevillea robusta* and *Cupressus lusitanica* were both exotic species. *Cordia africana* was the most preferred species in Kirinyaga. Of the first ten species mentioned by the interviewees as preferred timber species, four were exotic and six were indigenous. Furthermore, the indigenous species appeared more frequently in the list than the exotic ones. Most of the timber species preferred by the farmers in the highlands were exotic species, but this changed gradually to indigenous species from highland downward to lowland zones. The farmers in midland zones, as the transition point from exotic to indigenous, had a wide variety of timber species; hence the zone probably had both of them in significant numbers.

Table 27 gives a list of the first five high value trees preferred for timber in each zone category, by the percentage of occurrence.

Table 27. List of the first five high value timber trees preferred in each zone category

Upper highland	%	Lower highland	%	Upper midland	%
*Cupressus lusitanica**	24.2	*Cupressus lusitanica**	20.5	*Cordia Africana*	17.8
*Grevillea robusta**	19.8	*Grevillea robusta**	19.7	*Grevillea robusta**	16.7
Cordia Africana	12.1	*Eucalyptus saligna**	16.0	*Eucalyptus saligna**	15.3
*Eucalyptus saligna**	12.1	*Cordia Africana*	10.2	*Cupressus lusitanica**	14.1
*Pinus patula**	8.8	*Podocarpus falcatus*	6.1	*Ocotea usambarensis*	8.2
Others (7 species)	23.1	Others (10 species)	27.5	Others (22 species)	28.0

Lower midland	%	Lowland	%
Cordia Africana	19.3	*Melia volkensii*	25.6
*Grevillea robusta**	17.9	*Grevillea robusta**	15.4
*Eucalyptus saligna**	13.6	*Cordia Africana*	12.8
Melia volkensii	8.6	*Eucalyptus saligna**	12.8
*Cupressus lusitanica**	7.1	*Vitex keniensis*	7.7
Others (18 species)	33.6	Others (7 species)	25.6

Three exotic tree species, *Cupressus lusitanica*, *Grevillea robusta* and *Eucalyptus saligna* were the major preferred species and the percentage was higher in the upper highland zones (56%) than in the lowland zones (28%).

3.2.2 Preferred fruit or food tree species

Tables 28 and 29 give details of the preferred fruit or food species in 5 districts and per zone category in the region of Mt. Kenya, ranked in percentage.

Table 28. Preferred fruit or food tree species in all districts

Species Name	Meru	Embu	Kirinyaga	Nyeri	Laikipia
*Persea americana**	18.7	19.9	21.7	29.3	23.3
*Citrus sinensis**	21.5	7.4	17.1	27.8	26.7
*Mangifera indica**	20.3	25.7	21.7	14.3	14.0
*Carica papaya**	15.1	20.6	15.5	7.5	8.0
*Citrus limon**	5.2	1.5	6.2	8.3	9.3
*Musa sapientum**	7.2	8.1	7.8	3.0	0.7
*Psidium guajava**	4.4		2.3	3.0	12.7
*Macadamia tetraphylla**	2.0	14.7	3.1	2.3	0.7
*Eriobotrya japonica**	0.4	2.2	3.9	3.0	1.3
*Annona cherimola**	2.0		0.8	1.5	3.3
Berchemia discolor	1.2				
Tamarindus indica	0.8				
Balanites aegyptiaca	0.8				
Ficus sycomorus	0.4				

Persea americana, *Mangifera indica* and *Citrus sinensis* were the most preferred fruit species. While *Mangifera indica* and *Citrus sinensis* topped in two districts each in terms of preference, *Persea americana* was first and second in preference in Nyeri, Kirinyaga and Laikipia districts. The first five major preferred species were all exotic species. In more than

75% of the responses they were selected by the farmers as a preferred species for production of fruit or food. Of the 14 species mentioned as preferred for fruit or food, only four (*Berchemia discolor, Tamarindus indica, Balanites aegyptiaca* and *Ficus sycomorus*) were indigenous, and those were only mentioned in Meru, with a low percentage of preference.

Table 29 shows preferred fruit or food species in zones, by percentage.

Table 29. Preferred fruit or food tree species in zone categories

Species name	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
*Persea Americana**	29.7	25.0	22.5	14.6	13.9
*Citrus sinensis**	27.0	22.6	18.0	20.8	13.9
*Mangifera indica**	12.2	17.0	19.5	24.3	25.0
*Carica papaya**	10.8	9.0	13.8	18.8	22.2
*Citrus limon**	9.5	6.1	6.0	4.2	5.6
*Musa sapientum**	4.1	4.7	5.7	6.9	5.6
*Psidium guajava**	4.1	4.7	5.4	3.5	2.8
*Macadamia tetraphylla**		5.7	5.7	1.4	
*Eriobotrya japonica**	1.4	2.8	2.4		
*Annona cherimola**	1.4	2.4	0.9	2.1	2.8
Berchemia discolor				1.4	2.8
Tamarindus indica				0.7	2.8
Balanites aegyptiaca				1.4	
Ficus sycomorus					2.8

The result shows that exotic species dominate as fruit trees in the area, with *Persea americana, Mangifera indica* and *Citrus sinensis* being the most popular ones. The popularity of the first two species (*Persea americana* and *Citrus sinensis*) seems to decrease from the highland to the lowland zones, while the opposite is true for the two next-listed popular species (*Mangifera indica* and *Carica Papaya*). The former does well in cool areas whereas the latter can survive the dry and hot climate, hence their popularity.

3.2.3 Preferred species for medicinal purposes

Table 30 gives details of the first ten species preferred for medicinal purposes, per district, ranked by percentage.

Table 30. Preferred medicinal species in all districts

Species name	Meru	Embu	Kirinyaga	Nyeri	Laikipia
*Azadirachta indica**	28.3	34.8	29.2	57.1	31.1
Croton macrostachyus		15.2	6.9		4.1
*Mangifera indica**	4.7	6.1	5.6		
Erythrina abyssinica		6.1	4.2		
*Citrus limon**		4.5	4.2		
Croton megalocarpus		4.5	5.6	9.5	20.3
Terminalia brownii	5.5	4.5			
Prunus africana			4.2	11.9	5.4
Schinus molle				4.8	
*Persea Americana**				4.8	
Others	61.5	24.3	40.1	11.9	39.1

The result shows that *Azadirachta indica* (Neem) comes first in the ranking of medicinal tree species preferred by the farmers of the survey area. This species scored very high, especially in Nyeri district, with a 57.1% preference. Globally, the species has established a reputation as a useful cure for various ailments, in the form of such products as malaria medicine, a powerful insect antifeedant and soap (Maundu & Tengnas, 2005). Other notable medicinal species were *Croton megalocarpus*, *C. macrostachyus*, *Terminalia brownii* and *Prunus africana.* These species are used mainly for curing fever, wounds, general stomach problems, and other ills. *Prunus africana* is well known globally for controlling prostrate problems.

Table 31 gives the first five medicinal species preferred in each zone, ranked by percentage.

Table 31. Preferred medicinal tree species per zone category

Upper highland	%	Lower highland	%	Upper midland	%
Azadirachta indica	40.0	*Azadirachta indica*	38.4	*Azadirachta indica*	30.7
Croton megalocarpus	12.0	*Croton megalocarpus*	9.6	*Croton megalocarpus*	8.5
Citrus limon	4.0	*Prunus Africana*	8.2	*Croton macrostachyus*	6.9
Croton macrostachyus	4.0	*Citrus limon*	6.8	*Erythrina abyssinica*	4.2
Eucalyptus saligna	4.0	*Croton macrostachyus*	6.8	*Eucalyptus saligna*	3.7
Others (5 species)	36.0	Others (15 species)	30.1	Others (35 species)	46.0

Lower midland	%	Lowland	%
Azadirachta indica	31.6	*Azadirachta indica*	38.9
Mangifera indica	6.6	*Terminalia brownii*	16.7
Carica papaya	5.3	Acacia tortilis	11.1
Piliostigma thonningii	5.3	*Melia volkensii*	11.1
Terminalia brownii	5.3	*Commiphora eminii*	5.6
Others (22 species)	46.1	Others (3 species)	16.7

Azadirachta indica (Neem) was the medicinal tree species most preferred, with 30 to 40% of all. Use of indigenous species for medicinal purposes increased from the highlands to the lowlands, largely because of their higher species diversity and high demand in these areas. The other important medicinal species were *Croton megalocarpus*, *C. Macrostachyus*, and *Prunus africana.* These species are used for curing different ailments, as previously mentioned.

3.3 Criteria used in species selection

Table 32 and 33 show the details of the diverse criteria used to decide which species to plant on farms per district and zone, by percentage.

Table 32. Criteria used by farmers to make decision of which species to plant on their farms per district

Criteria used	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Use of the species (i.e. multipurpose)	31.1	32.5	39.7	8.1	2.9
Suitability of tree to crop farming	26.1	13.0	38.4	29.3	22.3
Rate of growth	12.6	20.7	5.5	36.4	25.2
Suitability of tree to that area	25.2	19.5	13.7	7.1	22.3
Seed availability	2.5	1.3		15.1	27.3
Planting space	1.7	11.7	2.7	3.0	
Disease resistance				1.0	
Experience/knowledge of the tree	0.8				
Water availability		1.3			

Multipurpose use, suitability of tree to crop farming, and species rate of growth were among the main factors considered by the farmers in selecting species for propagation in each district. Lack of planting space was not a significant factor in Laikipia District because of the comparatively large farm sizes in this district. Lack of seed was a major factor, however, due to comparatively few nursery operations in the area.

Table 33. Criteria used by farmers to make decision of which species to plant on their farms per zone

Criteria used	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
Use of the species (i.e. multipurpose)	20.0	12.9	24.9	27.3	31.6
Suitability of tree to crop farming	28.0	25.8	26.9	24.7	10.5
Rate of growth	32.0	31.8	14.0	13.0	10.5
Suitability of tree to that area	12.0	14.4	17.1	26.0	36.8
Seed availability	2.0	13.6	13.0	2.6	5.3
Planting space	6.0	0.8	3.6	5.2	5.3
Disease resistance		0.8			
Experience/knowledge of the tree			0.5		
Water availability				1.3	

Because farmers in the highland zones did intensive farming, they were keen to plant species that would not affect crop yield, but this factor was not much considered in the lower zones where less farming is done. Multipurpose use of tree was considered in all zones, especially in the lower zones where farmers expect to obtain several products or uses from a single species because of the limited resources in those zones. Rate of growth was an important factor, especially in highlands where the climate was conducive for tree growing and trees were expected to grow faster and start sooner to be useful to farmers. Suitability of tree to the area was important to farmers in the lower zones as not all trees could survive under the hot conditions prevalent in that area. This explains why consideration for this factor increases from the highlands downward to the lowlands.

3.4 Sources of knowledge on tree propagation

Tables 34 and 35 give the sources of knowledge in the districts and the zones, by percentage.

Table 34. Sources of knowledge on tree propagation in each district, by percentage

Channel	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Own experience/did not learn anywhere	64.6	63.9	74.3	91.1	95.5
Ministry of Agriculture	13.8	22.1	14.3	4.4	
Through NGOs	10.8			4.5	2.2
Forest Department	3.1	5.6	11.4		2.3
Through seminars, conferences, chiefs barazas	7.7				
Neighbour's influence		5.6			
Taught by elder men		2.8			

Most informants had learned about the many aspects of tree propagation through diverse channels of knowledge transfer. Among these, their own experimentation was most important, scoring more than 60% in every district. This learning channel was mentioned by many informants, and scored especially high in Nyeri and Laikipia districts. Younger people had learned about tree propagation in school. Other major channels of knowledge, especially in the districts of Meru and Embu, were the Ministry of Agriculture, non-governmental organizations (NGOs), and the Forest Department.

Table 35. Sources of knowledge on tree propagation in each zone category, by percentage

Channel	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
Own experience/did not learn anywhere	88.0	73.0	77.8	73.0	90.0
Ministry of Agriculture	4.0	11.1	13.3	8.1	10.0
Through NGOs	4.0	1.6	6.7	5.4	
Forest Department	4.0	6.3	2.2	5.4	
Through seminars, conferences, chiefs barazas		3.2		8.1	
Neighbour's influence		3.2			
Taught by elder men		1.6			

In any zone, their own experimentation was the most important way by which farmers accumulated knowledge. This channel scored more than 70% in all zone categories. The upper highland and the lowland zones named ‘own experience’ more often than the other zones. In general, the Ministry of Agriculture, non-governmental organizations (NGOs), and the Forest Department were also important channels of learning tree propagation in a zone level.

3.5 Constraints to tree farming

Tables 36 and 37 provide a list of constraints to tree farming in each district and zone category in terms of percentages.

Table 36. Constraints to tree farming in each district, by percentage

Constraint	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Lack of seeds/seedlings	9.6	31.9	8.8	32.7	38.5
Lack of water	25.6	22.3	14.7	28.6	24.0
Lack of planting space	7.2	25.5	25.0	20.4	1.9
Diseases infestation	22.4	5.3	20.6	2.0	1.9
Harsh climate	11.2	7.4	7.4	7.2	6.7
Lack of information on tree management	0.8		1.5	1.0	15.4
Others	23.2	7.6	22.0	8.1	11.6

Lack of seeds/seedlings, water, planting space, diseases, and harsh climate were the major constraints among all. Embu and Nyeri districts cited the above five constraints in more than 90% of the responses, and other districts in more than 70%. Of all these, the lack of seeds/seedlings, water and planting space were clearly the most important constraints to tree propagation in all districts. Lack of seeds/seedlings was a major constraint in Embu and Nyeri districts, while lack of seeds/seedlings and water were major constraints in Laikipia district. Surprisingly, disease infestation was one of the big problems among farmers in Meru and Kirinyaga. Laikipia farmers also mentioned lack of information on tree management, more often than any other district.

Table 37. Constraints to tree farming in each zone category, by percentage

Constraint	Upper highland	Lower highland	Upper midland	Lower midland	Lowland
Lack of seeds/seedlings	29.8	27.7	27.0	14.3	20.0
Lack of water	19.1	24.8	21.1	28.6	32.0
Lack of planting space	14.9	14.6	20.0	8.8	
Diseases infestation	8.5	4.4	10.3	19.8	16.0
Harsh climate	10.6	6.6	4.9	13.2	20.0
Lack of information on tree management	4.3	6.6	3.8	1.1	
Others	12.8	15.3	13.0	14.3	12.0

These results show that lack of seeds/seedlings, water, planting space, diseases and harsh climate were the major constraints, a total percentage of more than 78% for all zones. Lack of seeds/seedling was one of the major constraints for tree propagation in all zones. Lack of water as a constraint gradually increased from the highland to the lowland zones. Lack of

planting space was not a constraint in the lowlands, but harsh conditions did hamper tree farming in this area.

4. Discussion

4.1 Diversity

The farmer survey results show that farmers are maintaining a diversity of tree species, both exotic and indigenous, on farm. At present exotic species are easily introduced by the farmers because of their high value and their well-known uses for timber, fruit or food, and medicine. For exotic species, farmers can easily get seeds and seedlings, easy propagation, and information from commercial sectors. Exotic tree species are therefore most often dominant compared to indigenous ones. This result supports previous findings (Oginosako *et al.* 2002). Rank-abundance of the first five species, *Grevillea robusta, Persea americana, Musa sapientum, Eucalyptus saligna* and *Cupressus lusitanica*, shares in majority among all. It shows similar ranking with the vegetation survey in the first chapter, especially that *Grevillea robusta* is widely recognized among the farmers. This species is popular among farmers as one of the multipurpose tree species, which can grow fast from seed, thrives best in deep soil with good rainfall but tolerates poor soils as well, and is useful for timber, firewood and also windbreak (Noad and Birnie 1989; Ondieki 1999).

Some farmers explained that they are interested in propagating every species that occurs in their surroundings, although it is likely that species preference is confounded with availability of propagation materials. The high diversity could also be explained by seed and seedling availability and distribution. Many farmers mention that most seeds are taken from trees grown directly in their homestead or neighbouring farms. Lack of germplasm reduces the motivation to grow new and useful species. A better germplasm distribution could result in a decrease or increase of on-farm tree species diversity, depending on differences in species. Strong demand calls for a greater supply of germplasm, and farmers are likely to buy preferred species to plant on their farms. Tree species diversity is likely to increase if farmers became interested in a greater number of species. Germplasm distribution for species diversity should therefore be based on information about species preferences and the interest of farmers in on-farm species diversity.

In the vegetation survey we found that many farmers have a few common exotic species in high numbers. It seems that market movement and information from the local community and commercial sectors have a substantial influence on the farmers.

Although we cannot present a complete conclusion until more research is done, the information gathered suggests that most of the preferred species in the survey area are popular and available in any market in the region.

4.2 Uses of trees

Farmers are eager to plant species that satisfy their needs. They are usually knowledgeable about the uses and services of the tree species on their farms. This knowledge may have accumulated from the propagation of many of these species and assimilated through the experiences of many generations. A variety of high-value tree species depends on availability of tree resources. Trees in the higher zones have three main uses—fruit or food, timber, and fuelwood—but the lower zones have more varied uses, such as poles, stakes, fodder, and shade. This suggests that the higher zones have a much higher potential in fruit, timber and fuelwood, but the lower zones have low productivity and need a variety of uses from different species for their life and farming system.

4.3 Species niche

Farmers had very clear ideas about the best niches for tree planting. Most trees are found scattered on farm. Trees on a boundary act as markers, which is why these types of niches are preferred when planting tall, straight trees like *Eucalyptus* spp. and *Cupressus lusitanica*. Some farmers also tried new niches, new planting schemes, or new species, such as planting *Leucaena leucocephala* in hedges in cropland. From the highlands to the lowlands, farm sizes are likely to increase due to a lower population density, and tree establishment may gradually change from the now-dominant planting method to the natural regeneration and existence of trees before the beginning of farming. To keep a well-managed cultivation, more useful species niches for individual tree species should be studied, as well as crop and tree production. Further careful study might be needed for indigenous tree species due to the difficulty of increasing them and a lack of study results on such rare species.

4.4 Most preferred species

Most timber species preferred by farmers in the highlands are exotic, including *Grevillea robusta* and *Cupressus lusitanica*, but this preference changes gradually to indigenous toward the lower areas. A majority of fruit or food species preferred by the farmers are exotic ones. They dominate as fruit or food trees in the area: the presence of *Persea americana* and *Citrus sinensis* is decreasing from the highland zones to the lower zones and in contrast the presence of *Mangifera indica* (and *Carica Papaya*) is increasing from the higher altitude to the lower altitude. This occurs because the former two do well in cool areas whereas the latter two can survive the dry and hot climate (Maundu & Tengnas, 2005). There is a high demand, however, to promote indigenous species as sources of food, fruit and income in especially dry areas where high tree diversity exists. In the drylands of Africa, incorporating farming with fruit trees such as mango trees for an alternative source of food and nutritional security is becoming increasingly crucial (Griesbach 2003). Where commercial exploitation of indigenous fruits occurs (for example, in western and southern African regions), indigenous fruits show great potential, as much as exotic fruits, for providing food security, vitamins, and income generation. In contrast, indigenous fruits have not been commercially exploited in East and Central Africa (ECA) even though a diversity of valuable fruit species might exist (Jama *et al.* 2005). Farmers and rural communities in the region have a considerable wealth of indigenous knowledge about the value and uses of these fruit tree species. There is, however, little domestication. Most fruits are collected from the wild, and communities living in these areas often rely on nature to supply indigenous fruit tree products (Muok *et al.* 2000). Unfortunately, each year more and more of these wild trees in the semi-arid areas are being destroyed through charcoal production and expansion of agriculture because they simply do not hold their own in commercial terms—even though this means losing favoured food items and a source of insurance against critical scarcity during drought (Jama et al 2005). National tree seed centres do not stock many indigenous species because there is little demand for them, compared to the exotic species. In addition, no extension materials have been developed from the few studies on the indigenous fruit species conducted so far (Oginosako *et al.* 2005).

In the case of mango trees, most farmers plant unimproved local varieties that produce a few small fruits with many fibres and these are not easily marketable. Although there are many improved varieties within specific sites and localities in the region, such materials are beyond the reach and means of most farmers (Leakey and Simons 1998). As for the indigenous fruit

species such as *Sclerocarya birrea, Adansonia digitata, Tamarindus indica, Vitex doniana, Balanites aegyptiaca, Parinari curatellifolia* and *Zyziphus mauritiana*, their ecological niches and propagation techniques need to be determined so that farmers can be guided on how and where to domesticate and produce. How to supply these products to wider markets in and outside the region is a key challenge that needs considerable research and development efforts. In particular, selection for taste, semi-processing, value adding, marketing, and storage are the fields where these efforts are required (Gunasena and Hughes 2000; Sidibe and Williams 2002).

Azadirachta indica is a main medicinal tree species in the survey area. Recent medical and veterinary studies have proved the species has potential as a fungicide and as an antibacterial, antiviral agent. It is effective against dermatological insects, and it can also prevent and even treat dental diseases and control intestinal worms and intestinal nematodes. It has also been proved to cure malaria and to relieve pain and reduce fever (Noad and Birnie 1989; National Research Council 1992). Other notable medicinal species are *Croton megalocarpus, C. macrostachyus, Terminalia brownii* and *Prunus africana.* These species are used for curing fever and general stomach problems or for healing wounds. *Prunus africana* is globally known, especially for controlling prostrate problems (Beentje 1994 and Dharani 2002).

The indigenous medicinal species increase from the highlands to the lowlands, largely because of high species diversity in the lower areas. The farmers reported that they did not sell medicinal species to earn income for the household. Although farmers and rural communities in the region have a significant wealth of indigenous knowledge on the value and uses of the medicinal tree species, and even though some work has started on commercialization of traditional medicines in Kenya, much remains unknown, including production capacity and market potential in the rural areas with high quality and reasonable prices for consumers. Considerable research and development efforts are thus required for the sustainable production and utilization of such high value species.

4.5 Sources of knowledge

When informants were asked specifically about what was learned from previous generations concerning various aspects of tree propagation, they said that little knowledge had been inherited from their ancestors. One reason given was that the previous generations were only planting exotic tree species such as *Grevillea robusta, Eucalyptus* spp., and so forth, while

indigenous species were forgotten in forest and bush. Another reason was that given the smaller population pressure and greater amount of forest cover of the past, development of knowledge on the propagation of trees was not needed. Indeed, many interviewees seemed to be in a learning phase on tree propagation, discovering information related to propagation methods such as planting improved species, particularly indigenous ones. Most informants have learned about the many other aspects of tree propagation through diverse channels of knowledge transfer. Younger people explained that they had learned about tree propagation in school. Most interviewees expressed great interest in learning more about propagation and pre-planting selection. Teaching local propagators and experimenting with farmer-to-farmer transfer of information is therefore most necessary for a further development of knowledge. Experience will develop their skills and techniques further because farmers are keen to learn when they face a problem (Kindt 1997).

4.6 Constraints of tree farming

Farmers face many and varied constraints in their daily activities of tree propagation and growth, and these constraints need to be addressed for meaningful benefits to come from this activity. Lack of germplasm (seeds/seedlings), water, and planting space are the major constraints to tree propagation and growth. The quality of the germplasm was not often mentioned as a constraint, despite its importance in domestication. Appreciation of quality might be a key factor for successful introduction of domesticated materials in the near future. The findings on source selection indicate that to guarantee the success of germplasm introduction, farmers need to be made aware of the benefits of high quality materials. Otherwise they will probably continue to choose the cheapest sources of propagation materials, usually collecting from their own farm or neighbour’s fields, which might bring serious problems such as inbreeding. Guidelines for seed collection from a greater number of parent trees, with a wider geographical spread, should be given to the farmers. Mixing of seeds among different collectors should also be stimulated to avoid the danger of inbreeding within a small number of varieties. More study and research is needed in all aspects of tree farming and agroforestry for the farmers.

Part III
Nursery survey

Abstract

In the years 2003 and 2004, a survey of 100 nurseries investigated the mechanisms of the seedlings supply system within the Meru, Embu, Kirinyaga, Nyeri and Laikipia districts surrounding Mt. Kenya. The study found more than 1.5 million seedlings, 54 species in all. The result suggests that most high-ranking species found on nursery are the same as those found on farm. Thus, the lack of species diversity on nursery directly affects the species on farm, although some nursery operators did describe efforts to propagate any species they knew about. Due to lack of knowledge about alternative species within a farming community, a vicious circle has developed in which nurseries supply what farmers want. This prevents the farmers from trying out alternative and potentially more useful trees. One-third of the nurseries surveyed in the five districts usually suffer from drought. Nurseries need to have permanent water sources so that seedlings are ready for transplanting at the onset of the rains. The most frequent sources of plant materials are one's own or neighbouring farms, which indicates that farmers need to be made aware of the benefits of high quality materials to guarantee the success of germplasm introduction. Guidelines for seed collection should be given to farmers to avoid inbreeding. Information sharing and a communication network are required from now on.

Keywords: Mt. Kenya, agro-ecological zones, nursery survey, seedling, species, germplasm

1. Introduction

To alleviate many of the problems facing the rural population, such as a fuelwood shortage, soil erosion, and decreasing soil fertility, the agroforestry system must emphasize tree species that are useful and multipurpose. A lack of germplasm in sufficient quantities and quality at the small-scale level is one factor that limits agroforestry development. The ability to supply these trees is an important responsibility of the many small-scale nurseries in any given locality. Seedlings sourced through tree nurseries are expected to form an important component of future tree cover on farm. The genetic composition of nursery seedlings therefore affects the productivity and sustainability of agroforestry ecosystems. Surveying current practices of nursery operations in the five districts of Mt. Kenya helps quantify parameters associated with the collection, production, and distribution of tree germplasm in the area. Considerable variation is expected for seed-propagated nursery species (for example, the quantity of seedlings raised in nursery). Current seed collection practice is likely

to be the most obvious limiting bottleneck in delivering high levels of genetic diversity to farmers (Dawson *et al.* 2005).

A nursery survey was conducted in the Mt. Kenya region, with a focus on the knowledge of local tree nursery operators. It was anticipated that valuable information for enhancing production of nursery seedlings might be collected by interviewing farmers about their knowledge on the selection of tree species for improved productivity. The specific objectives of the survey were to gather information in the agro-ecological zones of Meru, Embu, Kirinyaga, Nyeri and Laikipia districts surrounding Mt. Kenya as to:

1 Indigenous knowledge on the selection of tree species for improvement
2 Quantifying tree nursery parameters associated with the collection, production, management, and distribution of tree germplasm in the area.

2. Methods and materials

2.1 Selection of survey area and of informants

2.1.1 Selection of survey area

The Mt. Kenya region was selected because it is one of the target areas for the World Agroforestry Centre (ICRAF), mainly because of an ever-increasing population that requires more alternatives for sustainable livelihoods. In addition, this area currently lacks information about tree nursery operations. The research could also build on previous investigations in the area by the Embu KEFRI – KARI – ICRAF Agroforestry Research Project (Hoekstra, 1988; Thijssen et al. 1993; Roothaert et al. 1997). All the districts surrounding Mt. Kenya were selected.

2.1.2 Selection of informants

Operating nurseries were selected at random, with the expectation that much could be learned by contacting local nursery operators. These criteria usually resulted in selection of nursery operators who were actively operating nurseries at the time of the interview. This approach seemed to yield considerable information, due to the operators' experience and interest. A local person from each district, with experience in the area, was contracted to help identify

suitable candidates for undergoing the interviews, supplemented by random sampling techniques.

2.2 Interviews

During the interview some open-ended questions were asked in combination with prepared questions from a questionnaire developed in collaboration with ICRAF scientists. This basic, precise, and comprehensive interviewing tool for documenting information from individual nursery operators was field tested during a pilot phase, and any necessary changes were made before the actual survey. (The questionnaire is attached at the end of report as Appendix 16.) Locally contracted persons assisted with translation into the local languages, plus identification of species on nurseries as needed.

The interviews took place between April 2003 and May 2004. In total 100 nursery operators of 20 nurseries in the five districts surrounding Mt. Kenya (Meru, Embu, Kirinyaga, Nyeri and Laikipia) were interviewed. Table 38 gives a breakdown of the agro-ecological zones surveyed.

Table 38. Categories of agro-ecological zones where the nurseries' survey was executed

Zone name	No. of nurseries surveyed
Upper highland (UH1-3)	11
Lower highland (LH1-5)	27
Upper midland (UM1-6)	53
Lower midland (LM3-6)	9
Total	100

Climate details for the agro-ecological zones are shown in Table 1 of the farmer survey report. The zone categories, such as lower highlands (LH) and upper midland (UM), are temperature belts defined according to the maximum temperature limits within which the main crops in the survey area can flourish, for example, *Coffea arabica* for the upper midlands (UM1 to 4).

2.3 Data entry and analysis

All data were entered into SPSS, as for the farmer survey. A spreadsheet was developed to ensure that all information could be entered. Upon completion of all questionnaires and data entry, the entire spreadsheet was rechecked to ensure that all data variables were correctly

coded and entered. A further spot check of 10% of the questionnaires ensured a high level of accuracy in data entry. Analysis of selected data and production of results was carried out using SPSS and Excel spreadsheets.

3. Result

3.1 Type of nurseries surveyed

A wide range of individuals and groups own and manage the nurseries. Tables 39 and 40 below show the details of nursery ownership in the district and zone categories, by percentage. The three main nursery types were group nurseries, private nurseries, and family nurseries; the latter account for most of the nurseries surveyed. The objective of the group nurseries, which work mostly at a community level, is to alleviate social and environmental problems. With this objective in mind and with the assistance from non-governmental organizations such as the Green Belt Movement, they sometimes give seedlings to the locality at no cost. The main advantage of group nurseries is that to alleviate social and environmental problems they are willing to diversify species, which they do by trying improved exotic and indigenous species. In contrast to this, the primary objective of private and family nurseries is the generation of a cash income.

Table 39. Type and number of nurseries in each district

Nursery type	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Group	35.0	35.0	45.0	40.0	45.0
Private	15.0	45.0	35.0	25.0	40.0
Family	40.0	10.0	5.0	20.0	15.0
Forest department	5.0	10.0	15.0		
Project				10.0	
Company	5.0				
Church				5.0	

Groups, private individuals, and family owned more than 85% of all nurseries surveyed in each district. Group nurseries were the most popular in each district representing at least 35% of all nurseries, followed by private nurseries with over 15% occurrence and then family nurseries with a presence of at least over 5%. Family nurseries were especially popular in Meru District, where they scored 40% of all nurseries surveyed.

Table 40. Type and number of nurseries in each zone

Nursery type	Upper highland	Lower highland	Upper midland	Lower midland
Group	45.5	40.7	39.6	33.3
Private	18.2	29.6	32.1	55.6
Family	18.2	18.5	20.8	
Forest department		7.4	7.5	
Project	18.2			
Company				11.1
Church		3.7		

Group, private, and family nurseries are the most popular nursery types in the survey area. Group nurseries decrease from the upper highland zones to the lower midland zones, whereas private nurseries increase. Family nurseries are not common in the lower midland zones.

3.2 Species produced in the nurseries

3.2.1 Species produced in the nurseries

The survey observed many species, recording over 1.5 million seedlings and 54 species at the 100 tree nurseries. Overall, the average number of seedlings per nursery was 15 054.

Table 41 is a list of the first 10 of the 54 identified species, ranked by number of occurrences on nurseries. The full list of species is attached as Appendix 17.

Table 41. Encountered species with number of occurrences and average total seedlings per nursery

Botanical name	Places where species was encountered & Average seedling number per nursery			
	# /100	%	rank	Average seedlings number per nursery
*Grevillea robusta**	81	12.5	1	7432
*Eucalyptus saligna**	49	7.6	2	2235
*Cupressus lusitanica**	43	6.6	3	3038
Casuarina cunninghamiana	32	4.9	4	7162
Prunus africana	31	4.8	5	1896
Markhamia lutea	27	4.2	6	1227
Cordia africana	26	4.0	7	561
*Carica papaya**	23	3.6	8	549
Vitex keniensis	23	3.6	8	1220
*Persea Americana**	20	3.1	10	160
Others		45.1		

Most of the high-ranking species encountered on the farm are the same as the high-ranking species on the nurseries such as *Grevillea robusta*. Among the other high-ranking indigenous

species were *Prunus africana*, *Markhamia lutea*, and *Cordia africana*. Cultural preferences, poles, fuelwood and timber production, good performance in crop mixtures, and good coppicing ability were given as explanations of species importance and thus for demand.
Fruit trees ranked high, and exotic fruits ranked highest. Papaya, avocado, and mango were ranked within the 15 most frequently occurring species.

3.2.2 Species raised in the nurseries in each district, ranked by percentage

Table 42 shows the top five species raised in each district, ranked by percentage. Lists of all the species raised in the nurseries in each district are given in Appendix 18.

Table 42. First five species on the nursery ranked, by percentage

Meru	%	Embu	%	Kirinyaga	%
Grevillea robusta	8.3	*Grevillea robusta*	11.5	*Grevillea robusta*	14.2
Markhamia lutea	7.6	*Carica papaya*	7.7	*Eucalyptus saligna*	10.2
Prunus africana	6.8	*Mangifera indica*	6.2	*Cupressus lusitanica*	7.1
Vitex keniensis	6.8	*Calliandra calothyrsus*	6.2	*Markhamia lutea*	5.5
Eucalyptus saligna	6.1	*Eucalyptus saligna*	5.4	*Bridelia micrantha*	4.7

Nyeri	%	Laikipia	%
Grevillea robusta	13.3	*Grevillea robusta*	15.4
Casuarina cunninghamiana	8.1	*Cupressus lusitanica*	12.2
Eucalyptus saligna	7.4	*Eucalyptus saligna*	8.9
Cupressus lusitanica	7.4	*Casuarina cunninghamiana*	8.1
Cordia africana	5.2	*Acacia mearnsii*	5.7

Grevillea robusta was highest in popularity in all districts. *Eucalyptus saligna* and *Cupressus lusitanica* also ranked high, just as is the case with tree species found on farm. The same species was also highest in total and average numbers in the districts.

3.2.3 Species raised in the nurseries, ranked by percentage in each zone category

Table 43 gives the top five species raised in each zone category, ranked by percent. Lists of all the species raised in the nurseries in each zone category are shown in Appendix 19.

Table 43. First five species on the nursery, ranked by percent

Upper highland	%	Lower highland	%	Upper midland	%
Cupressus lusitanica	14.1	*Grevillea robusta**	13.4	*Grevillea robusta**	10.8
*Grevillea robusta**	14.1	*Cupressus lusitanica**	11.0	*Eucalyptus saligna**	6.8
*Eucalyptus saligna**	9.4	*Eucalyptus saligna**	9.3	*Markhamia lutea*	5.6
Acacia mearnsii	6.3	*Casuarina cunninghamiana*	7.6	*Cordia Africana*	5.3
*Jacaranda mimosifolia**	6.3	*Podocarpus falcatus*	5.2	*Carica papaya**	5.0

Lower midland	%
*Grevillea robusta**	24.2
Mangifera indica	12.1
*Senna siamea**	12.1
*Carica papaya**	9.1
*Eucalyptus saligna**	9.1

Figure 20 shows comparison of the total number of seedlings and species in the nurseries per district.

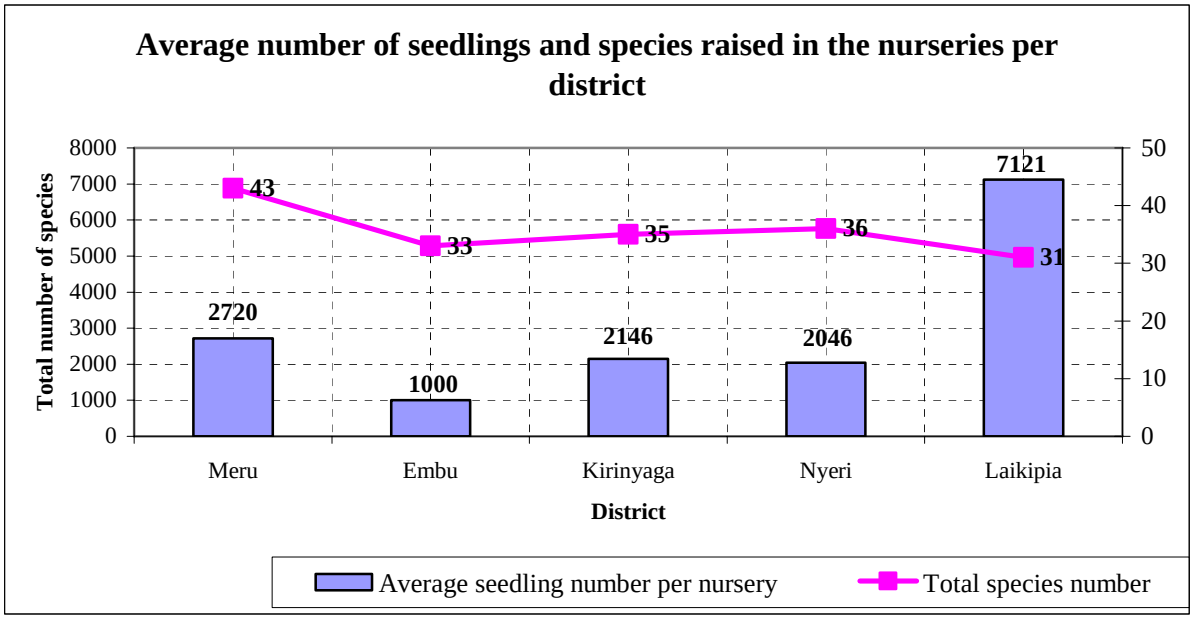

Figure 20. Average number of seedlings and species raised per district

The results demonstrate that a relatively high number of seedlings and species are present in the visited nurseries. Meru district had the highest total number of species found in the nursery, followed by Nyeri district. Laikipia district clearly had the highest average number of seedlings per nursery compared to other districts.

3.2.5 Average number of seedlings per nursery in each zone category

Figure 21 gives the average number of seedlings per nursery and total number of species per zone.

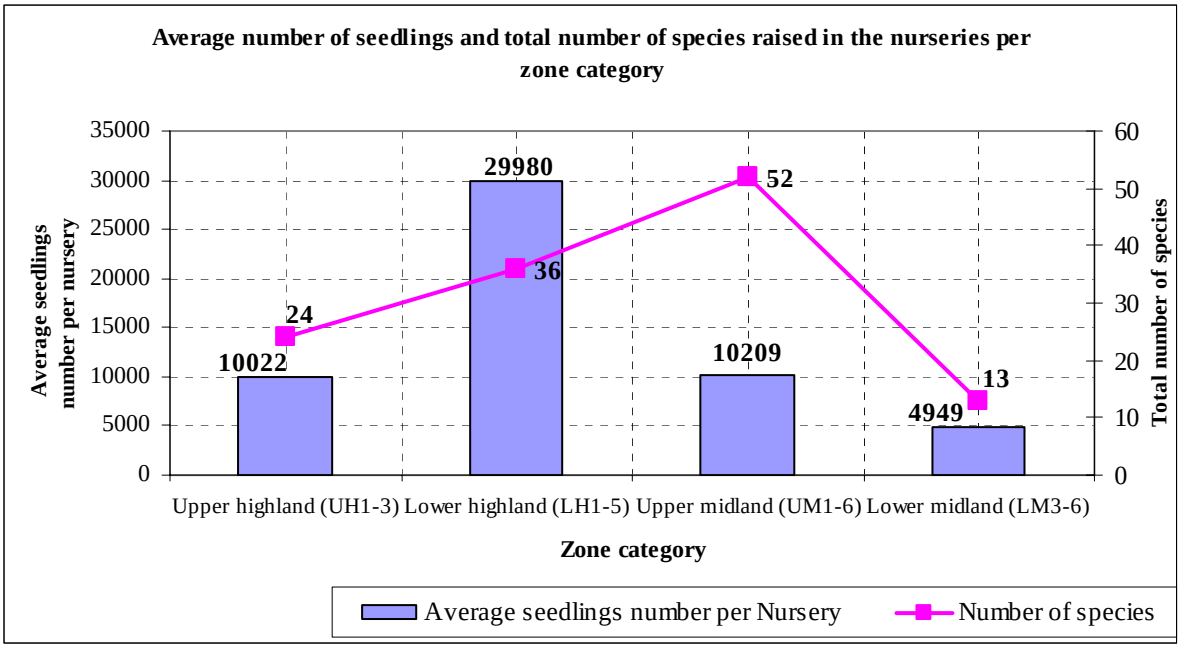

Figure 21. Average number of seedlings per nursery and total number of species per each zone category

The upper midland zones (including the zones of coffee-tea, main coffee, marginal coffee and sunflower-maize) had the highest number of species per nursery and the lower midland zones (including the zones of cotton, marginal cotton and lower midland livestock millet) had the lowest average. Also, the lower highland zones had the highest average number of seedlings and the lower midland had the lowest average. Some informants explained their efforts to propagate any species they detected with seeds, as long as there was a need. A significant number of informants mentioned that they are more and more aware of the need to start planting the diverse range of species, especially the indigenous species that in the past regenerated naturally in their environments. Some operators told about pioneer activities relating to on-farm planting and raising of species at a time when access to germplasm from communal areas deteriorated.

3.2.6 Means of production of seedlings

Table 44 and 45 show details of the means of production of seedlings by percentage per district and zone category.

Table 44. Means of production of seedlings on the nursery per district, by percentage

Means of production	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Polytubes	96.2	100.0	100.0	96.3	100.0
Direct sowing	3.8			3.7	

Table 45. Means of production of seedlings on the nursery per zone category, by percentage

Means of production	Upper highland	Lower highland	Upper midland	Lower midland
Polytubes	90.6	100.0	98.9	100.0
Direct sowing	9.4		1.1	

The two tables clearly show that the use of potting bags (polytubes) is the most common and popular type of seedling production method.

3.2.7 Seed propagation method

Table 46 and 47 show a summary of propagation techniques of seedlings per district and zone.

Table 46. Propagation techniques of seedlings on the nursery per district, by percentage

Propagation technique	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Seed	100	100	99.2	97.8	98.4
Grafting			0.8	0.7	1.6
Cuttings				1.5	

Table 47. Propagation techniques of seedlings on the nursery per zone category, by percentage

Propagation technique	Upper highland	Lower highland	Upper midland	Lower midland
Seed	98.4	98.3	99.5	100.0
Grafting	1.6	0.6	0.5	
Cuttings		1.2		

Throughout the survey, operators mentioned that almost 100% produced seedlings came from seeds, but sometimes nursery operators used grafting and cutting methods. These results were uniform among both districts and zones.

3.3 Species demand

Table 48 and 49 provide a list of the first five species with the highest demand in each district and zone category, in order of rank.

Table 48. First five species with highest demand in each district

Meru	Embu	Kirinyaga	Nyeri	Laikipia
Grevillea robusta	*Grevillea robusta*	*Grevillea robusta*	*Grevillea robusta*	*Grevillea robusta*
Vitex keniensis	*Eucalyptus saligna*	*Eucalyptus saligna*	*Cupressus lusitanica*	*Cupressus lusitanica*
Eucalyptus saligna	*Mangifera indica*	*Cupressus lusitanica*	*Eucalyptus saligna*	*Eucalyptus saligna*
Cordia Africana	*Dovyalis caffra*	*Dovyalis caffra*	*Eucalyptus grandis*	*Casuarina cunninghamiana*
Markhamia lutea	*Melia volkensii*	*Mangifera indica*	*Vitex keniensis*	*Eucalyptus grandis*

Table 49. First five species with highest demand in each zone category

Upper highland	Lower highland	Upper midland	Lower midland
Cupressus lusitanica	*Grevillea robusta*	*Grevillea robusta*	*Grevillea robusta*
Grevillea robusta	*Eucalyptus saligna*	*Eucalyptus saligna*	*Eucalyptus saligna*
Eucalyptus saligna	*Cupressus lusitanica*	*Vitex keniensis*	*Mangifera indica*
Eucalyptus grandis	*Casuarina cunninghamiana*	*Cordia africana*	*Senna siamea*
Juniperus procera	*Eucalyptus grandis*	*Cupressus lusitanica*	*Dovyalis caffra*

The results show that *Grevillea robusta*, *Eucalyptus saligna*, and *Cupressus lusitanica* are the most popular species by demand in the survey area. *Grevillea robusta* is the highest demanded species in all districts and topped the list in three out of the four zones, making it the most popular species in the survey area.

3.4 Source of water for the nursery

Table 50 shows the nursery water sources, by percentage, in both districts and zones. The availability of water is often the main factor that determines location of a nursery.

Table 50. Water sources for the nurseries per district, by percentage

Water source	Meru	Embu	Kirinyaga	Nyeri	Laikipia
River	35.0	50.0	40.0	70.0	45.0
Tap	55.0	45.0	50.0	15.0	10.0
Dam			5.0	10.0	20.0
Borehole	10.0	5.0	5.0		5.0
Well					20.0
Spring				5.0	

Although rivers usually account for water sources, nursery sources may vary considerably throughout the districts. The highest score for rivers as source of water is in Nyeri at 70% and the lowest in Meru at 35%. A water tap is next highest to rivers, with Meru the highest at 55% and Nyeri the lowest at 15%. The other significant water source is dams, especially in Laikipia district. These three sources combined account for more than 75% of the water sources for nurseries in the survey area.

Table 51. Water sources for the nurseries per zone category, by percentage

Water source	Upper highland	Lower highland	Upper midland	Lower midland
River	18.2	55.6	54.7	22.2
Tap	36.4	25.9	35.8	55.6
Dam	18.2	7.4	3.8	11.1
Borehole		3.7	5.7	11.1
Well	27.3	3.7		
Spring		3.7		

The source of water for nurseries varies considerably throughout the zones, with river, tap, and dam as the most used sources in any zone. Of the three, tap is used the most commonly of all in the lower midland zones. River accounts for over 50% of nursery water sources in each of two zone categories, lower highland and upper midland. Rivers and tap combined represent 75% of the water sources for nurseries.

3.5 Compost use in the nursery

Table 52 and 53 give information on compost use in the nurseries in the survey area.

Table 52. Compost use in the nursery in each district, by percentage

Compost use	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Use	5.0	10.0	30.0	15.0	15.0
Don't use	95.0	90.0	70.0	85.0	85.0

These results clearly show that over 70% of nursery operators in the districts don't use compost on their nurseries. This is critical, especially in Meru and Embu districts.

Table 53. Compost use in the nursery in each zone category, by percentage

Compost use	Upper highland	Lower highland	Upper midland	Lower midland
Use		24.0	15.0	25.0
Don't use	100.0	76.0	85.0	75.0

Just as is the case in districts, over 75% of nursery operators in all zones categories do not use compost. All nursery operators sampled in the upper highland zones do not use compost at all.

3.6 Sources of plant material

Table 54 and 55 provide a summary on the most important plant material sources per district and zone category, by percentage.

Table 54. Sources of plant material in five districts, by percentage

Plant material source	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Own farm	52.5	59.0	25.0	2.6	61.5
Neighbor's farm	7.5	2.6	55.0	69.2	5.1
Private dealer	12.5	2.6		12.8	25.6
Forest	12.5	7.7	17.5		
NGO/other agencies	2.5	15.4		7.7	2.6
KEFRI/FD	5.0	2.6	2.5	7.7	5.1
Other village	5.0	5.1			
Communal land	2.5	5.1			

Informants collected over 60% of the plant materials such as seeds and seedlings on neighbours' farms or their own farm. Use of a private dealer to provide plant material was significant in Laikipia, followed by Nyeri and Meru districts. Kirinyaga had 17.5% from the forest and Meru, 12.5%. NGOs and other agencies provide some plant materials, especially in Embu.

Table 55. Sources of plant material in the zone categories

Plant material source	Upper highland	Lower highland	Upper midland	Lower midland
Own farm	66.7	24.5	36.8	76.5
Neighbor's farm	9.5	17.0	37.7	23.5
Private dealer	9.5	28.3	3.8	
Forest		13.2	7.5	
NGO/other agencies		11.3	4.7	
KEFRI/FD	14.3	5.7	2.8	
Other village			3.8	
Communal land			2.8	

Just as is the case with districts, in the zones the most common sources from which informants collected plant materials were their own farms and the neighbours' farms. These two sources accounted for over 70% of plant material sources in three zone categories out of the four, but not in the lower highland zones. Surprisingly, the use of a private dealer as a source of plant material is common in the lower highland.

3.7 Sources of knowledge on nursery management

Table 56 and 57 show the nursery management learning channels in the zones and districts, by percentage.

Table 56. Sources of knowledge on nursery management in each district

Knowledge source	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Own experience	30.0	25.0	65.0	90.0	80.0
Ministry of Agriculture	25.0	40.0		5.0	
Forest Department	20.0	25.0	20.0		5.0
NGO	20.0	5.0	15.0	5.0	15.0
Private training	5.0	5.0			

A considerable number of nursery operators in the districts use only their own experience and knowledge for nursery management, and have not attended any training. From the result, this is especially critical in Nyeri and Laikipia districts, where up to 80% or more of the operators have not received any training. Kirinyaga also has many people who only rely on their own experience (65%), a higher percentage than Meru and Embu districts. A substantial number of nursery operators in Embu District have been trained. Overall about 60% of the nursery operators have never been trained on nursery management.

Table 57. Sources of knowledge on nursery management in each zone category

Knowledge source	Upper highland	Lower highland	Upper midland	Lower midland
Own experience	81.8	63.0	56.6	22.2
Ministry of Agriculture		11.1	15.1	33.3
Forest Department		11.1	15.1	33.3
NGO	9.1	14.8	11.3	11.1
Private training	9.1		1.9	

Again in the zones as well, a large number of nursery operators rely exclusively on their own experience because they have not attended any training. The results show this to be critical in the upper highlands, where over 80% of the operators have not received any training, but the proportion lessens towards the lower zones. In the lower midland zones the nursery operators depend mostly on the Ministry of Agriculture and the Forestry Department, while in the upper highland zones they depend on their own experience and knowledge.

3.8 Problems associated with the management of a nursery

Each nursery operator surveyed was asked to list the problems encountered in managing a nursery. All replies, by percent of response in each district and zone category, are shown in tables 58 and 59.

Table 58. Nursery constraints in the districts, by percentage

Constraint	Meru	Embu	Kirinyaga	Nyeri	Laikipia
Lack of tools	13.1	10.4	17.5	18.6	22.1
Lack of quality seed supply	4.9	24.6	8.8	17.1	18.2
Polytubes too costly	9.8	13.0	14.0	14.3	18.2
Lack of water	16.4	18.8	15.8		3.9
Marketing of seedlings	4.9	5.8	8.8	12.9	14.3
Labour cost	9.8	2.9	14.0	4.3	2.6
Availability of quality soil	8.2	1.4	5.3	4.3	7.8
Lack of capital	6.6	2.9		14.3	
Lack of management capabilities	4.9		1.8	7.1	7.8
Diseases	8.2	4.3	3.5		1.3
Others (12)	13.2	15.9	10.5	7.1	3.8

Lack of tools, lack of quality seed supply, and the cost of polyethylene tubes (polytubes) were mentioned as major constraints throughout the districts. Marketing of seedlings, labour cost and quality soils were also listed as nursery constraints in all districts. Other minor constraints mentioned were unavailability of fertilizer, pesticides, labour, and forest soil, as well as game damage and lack of space for nursery expansion among others.

Table 59. Nursery constraints in zone categories, by percentage

Constraint	Upper highland	Lower highland	Upper midland	Lower midland
Lack of tools	20.9	21.1	13.8	10.3
Lack of quality seed supply	16.3	16.8	13.8	17.2
Polytubes too costly	11.6	13.7	15.0	13.8
Lack of water	2.3	7.4	12.6	20.7
Marketing of seedlings	11.6	10.5	10.2	
Labour cost	4.7	2.1	7.2	17.2
Availability of quality soil	2.3	10.5	4.2	
Lack of capital	7.0	3.2	6.0	
Lack of management capabilities	11.6	5.3	2.4	3.4
Diseases		2.1	4.8	3.4
Others	11.7	7.4	10.2	13.8

Lack of tools, lack of quality seed supply, the cost of polyethylene tubes (polytubes), and lack of water were mentioned as major constraints throughout the zones. Other constraints mentioned were unavailability of fertilizer, pesticides, labour, and forest soil; as well as game damage and lack of space for nursery expansion among others.

The lack of tools, quality seed supply, and polytubes were major constraints throughout the zones. Also important is that lack of water and the high labour cost are constraints that increase in the lower midland.

4. Discussion

4.1 High demand makes good supply

The result demonstrates that a high number of species are present in the nurseries. Some informants explained their effort to propagate any species they detected with seeds, which indicates the interest local people have in propagating a diversity of species with germplasm availability. Also of importance is that most of the species that are ranking highly on farms do also in the nurseries. This means that species diversity on nursery directly affects the species on farm. It is important, however, to point out that the number of species and the variety of species can be improved, thus providing a wider range of benefits to the farmers. Throughout the survey, a high regard and demand for *Grevillea robusta* was observed.

Although this species fulfils many uses, this reliance on a single species might lead to irreparable damage if any pathogen broke out. All *Grevillea robusta* seeds are collected locally, as many other species are adopted. This method will lead to inbreeding as a gradual decrease in the genetic base results in any time. It has been suggested that over 35 mother trees should be left to grow to maturity in any one area, thus allowing enough trees to prevent inbreeding (Connor 1997). The mature trees will ensure establishment of greater seed banks, thus eliminating the general problems of an insufficient supply of good quality seeds throughout the country. The farmers, who are major recipients of nursery seeds, should be aware of genetic issues so that they can improve quality and raise healthy seedlings. Local demand is offered as the main reason for the decision process. Due to lack of knowledge about alternative species, especially within the farming community, a vicious circle has developed in which nurseries only supply what farmers want, and lack of knowledge prevents the farmers from trying out alternative and potentially more beneficial, useful, and multi-purpose trees. Guidelines should be given to farmers for seed collection from a greater number of parent trees that have a wider geographical spread; mixing of seeds among different collectors should also be stimulated, to avoid inbreeding. Information sharing and a communication network will help eliminate a lack of understanding. However, despite some constraints, nursery operators in all the districts and zones said they have a plan to raise more species, especially indigenous tree species because of an increasing demand.

4.2 Water source influences the fate of nursery?

The availability of water is often the main factor that determines the location of a nursery. On average, 80 litres of water is required for every 1000 seedlings per day (Connor 1997). If the water is carried every day, the distance from the water source has a practical limit; otherwise people get tired of carrying water and gradually reduce the amount of water seedlings receive. This can partly explain why nurseries are scarce in dry areas. One third of nurseries usually suffer from drought in any district and throughout the year, which indicates that many of the water sources, in particular the small streams and tap water systems, dry up in the dry season when the nursery most requires the water. This has a major effect on the production capacity and seedling survival rates in the nursery. To avoid this effect, future nurseries need to have permanent water sources so that seedlings are ready for transplanting at the onset of the rains.

4.3 Compost is necessary?

The use of compost in the nursery enhances the health of seedlings raised there. Analysis from both districts and zones revealed that almost all nursery operators in the survey area do not use compost for improving the health of the seedlings. Compost is made from locally available materials and hence an affordable way of improving the health of seedlings. Awareness on the importance of compost to grow seedlings is required for improving the quality of trees. This is likely to increase demand for compost when it is understood that the use of it increases the survival of the seedlings after transplanting.

4.4 Source of plant material

High quality viable seeds are necessary to ensure the production of vigorous seedlings on nursery. The source of plant material is therefore important, as it affects the survival of a seedling from its early stages to transplanting time. It was anticipated that preferences for a source could be influenced highly by availability of germplasm from the source. Availability of germplasm could vary over location and time, depending on species distribution, abundance, maturity, and seed setting (Kindt 1997). The most frequent sources of plant materials are one's own farm or neighbouring farms. A similar survey in Murang'a District of the Kenyan highlands indicated also that a majority of nursery operators rely on local collection as the source of seeds for their nurseries (Connor 1997). The reason given for preference of local collection is the cost factor, including purchasing and transport costs.

Though the quality of germplasm is not often mentioned as a selection criterion, appreciation of quality will be a key factor for successful introduction of domesticated materials. The findings on source selection indicate that farmers need to be made aware of the benefits of high quality materials to guarantee the success of germplasm introduction (Kindt 1997). Otherwise they will probably continue to opt for the cheapest sources of propagation material. It is necessary to note that a serious problem may arise as result of relying on local collections alone (Connor 1997). A seed database must be established showing all the cultural practices necessary from the time of seed collection, to sowing, pricking out, pruning, irrigation, and transplanting for each species in the region.

4.5 Source of knowledge and skills

Skills in the management of the nurseries are an essential component to the success of nursery farming. Therefore the channels through which the farmers learn the nursery management is important as this dictates the level of skills of nursery management. It is expected that with more management skills acquired, the nursery will be more likely to thrive. Knowledge and skills are important as it shows the level of training and the training channels available in the survey area. A considerable number of nursery operators in the survey area use their own experience for nursery management, for they have not attended any training. This is critical in some places where many operators have never been trained on nursery management and thus use their own experience in the work. The lower zones indicated more clearly the need for training than the higher zones, probably because the trees grown there are much more vulnerable under the harsh climate. A significant percentage of nursery operators obtained training either by the Ministry of Agriculture or by the Forest Department in the lower midland zones. It is necessary to step up hands-on training and capacity building efforts on nursery management to promote nursery farming in the districts (Muriuki 2005). A well-coordinated training is required to equip operators with skills of effective nursery management. Basic courses on seed management, nursery management, bookkeeping and marketing could be run, greatly increasing nursery operators' knowledge and expertise to succeed in their enterprises. It is important because operators need up-to-date information on technical and cultural practices involved in producing quality seedlings. This can be achieved by contact with external forces, whether through government agencies, such as the extension agents, non-governmental organizations or other national and international research centres.

4.6 Constraints for nursery management

Lack of water as one of the constraints becomes more and more common, from the highland zones down to the lowland, largely because of dryness in the latter zone. In a similar survey in Murang'a district, the same problem was mentioned in a significant percentage of all responses (Connor 1997). Also, one of the main prerequisites for increasing the use of high value tree species is the availability of a regular and good-quality seed supply. In the survey, a significant number of nursery operators found it difficult to obtain seeds. The issue of a seed supply system has to be addressed in order to offer a greater variety of species. This in turn will help alleviate the ever-increasing problems of soil erosion, fuelwood shortages, and

fodder unavailability. The lack of knowledge about nursery management has also been mentioned, and it includes a lack of knowledge about marketing of seedlings, good planting techniques, awareness of the existing problems in the communities, lack of species availability, and the general lack of knowledge of basic nursery management techniques. Many of the nurseries surveyed have such problems, and the building of training capacity will help them.

In synopsis, the survey identified a number of major economic and production constraints associated with tree nurseries, such as the lack of seeds and the water scarcity. Solutions are expected to be found that will ensure that nurseries will be considered one of the most important links in establishing a sustainable agroforestry, in terms of quality and variety of seedlings. The lack of seeds for exotic and indigenous tree species decreases the variety of species in many nurseries and hence makes difficult the use of different types of trees in the agroforestry system. An alternative would be for government agencies to establish a nation-wide certified seed centre, with the help of some government research centres like KEFRI. In this way nursery operators could readily purchase top quality seeds and pass on seedlings with better characteristics to the farmers.

4.7 Future developments for tree nurseries

One of the main observations was that private nurseries tend to produce few species. Only a few private nurseries are willing to take chances with alternative species when they know that the demand is for a certain species only. Commercial and private nurseries need to diversify species and to look more closely at the environmental issues that need to be tackled, rather than simply bowing to local demand and running their nursery businesses for profit only. Outside organizations should encourage local people to establish small co-operatives where the necessary tools, water storage tanks, and seeds for a nursery can be purchased. Communication links can be established between the co-operatives and extension agents, creating a flow of information for nursery management and development. Local manufacturers such as those of coffee and tea production should also be encouraged to establish co-operatives with their clients, as they have the resources to help nursery managers and farmers. Of importance to note from the survey is the lack of school nurseries. Such nurseries are important, as schools can use them to foster in students an awareness of environmental problems. These nurseries can, and should, place much emphasis on the useful trees. Establishment of simple trial plots, or of short classes that discuss useful trees,

environmental benefit potential, and management practices, could encourage the youth to utilize useful trees.

4.8 Conclusion and next step for natural resource management and agricultural development

From the results of three surveys (vegetation, farmer, and nursery), we can now clearly conclude that the farmers surrounding Mt. Kenya have preserved tree diversity, whether intentionally or not. Farmers in the upper zones have numerous exotic trees from a small number of species, whereas farmers in the lower zones have many indigenous tree species but only a small number of trees. The farmers are trying to expand biodiversity in their own ways, despite limitations in the germplasm supply from outside and in their own inherited knowledge and skills. Nursery people also want to diversify tree species, but they have no ideas or skills to develop diversification.

Exotic tree species are mostly dominant in the intensive farming systems, especially in the higher intensive farming areas as a high-value tree for timber, fruit or food, and medicine. It seems that exotic tree species have conquered the farm territory whereas indigenous species have lost theirs. Indigenous species have been surviving under the harsh condition, where it is difficult to grow annual crops, but day-by-day new settlers start land clearance and burn such original trees without realizing what the impact of their action is. As a consequence, indigenous trees are losing their niche and territory and indigenous knowledge is disappearing at the same time.

From a compensating stage at first, exotic tree species can be valuable for the farmers now. On the other hand indigenous trees species seems to be forgotten by them, despite the fact that most indigenous tree species have many unrealized values for their life and economy. The value of indigenous tree species must be revealed and be demonstrated for both commercial and natural conservation purposes. Indigenous tree species, especially, are not well taken over from the old generation. In the drylands some farmers, and even some children, demonstrated plenty of indigenous knowledge of how to use these trees on their farms. Unfortunately, however, such precious knowledge and skills will not be passed down to the next generation, due to the demand for cash income and the poor understanding of natural resources—issues often discussed under the names ‘old-fashioned style’ or ‘low-benefit business’. Eventually we will face the extinction of indigenous tree species unless we take immediate action, such as:

1) To help farmers understand, in a technical manner, how indigenous species are important and useful in their life and income
2) To encourage nursery people to open a new business opportunity with indigenous tree species, by supplying propagation technology
3) To show farmers how to utilize indigenous tree species for fruit production, processed goods, medicinal products, timber and fodder
4) To share and disseminate important information, knowledge, and skills related to indigenous tree species to local people
5) To reach out, telling international development agencies how important the materials of indigenous tree species are for the world's next generation

In order to promote the above tasks, we need more study on natural resources and ecology, and agricultural development in rural areas. Unless we work with local people and recognize the natural ecosystem, agricultural development, and social economy with natural resource management, our efforts will not achieve any fruitful result. A new type of agriculture is needed that leads to increased food security and conservation gains. Human population density and biodiversity are positively correlated in many areas (McNeely & Scherr 2002). The importance of agroforestry is therefore now realized from the viewpoints of ecology, agriculture, and economy, because agroforestry is the only way to promote agricultural production through the conservation of natural resources. We truly emphasize this slogan: 'Conserving biodiversity, while promoting agriculture production through agroforestry technology'

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Appendix 1

AGRO-ECOLOGICAL ZONES OF THE TROPICS [1)]

Main zones / Belts of Z.	0 (perhumid)	1 (humid)	2 (subhumid)	3 (semi-humid)	4 (transitional)	5 (semi-arid)	6 (arid)	7 (perarid)
TA Tropical Alpine zones Ann.mean 2-10ºC	Glacier / Mountain swamps	II. Sheep zone / 1.Cattle-sheep zone						High altitude deserts
UH Upper High-Land zones Ann.Mean 10-15ºC Seasonal night frosts	Zones	Sheep-Dairy Zone	Pyrethrum-Wheat zone	Wheat-Barley zone	U. Highland Ranching Zone	* U.H. Nomadism zone [4)]		
LH Lower Highl. Zones Ann. Mean 15-18ºC M. min. 8-11ºC Norm. no frost	Zones	***Tea-Diary zone***	Wheat/ Maize [2)] - Pyrethrum zone	Wheat/(m) [2)] - Barley zone	Cattle-Sheep-Barley zone	L. Highland Ranching zone	* L.H. Nomadism zone [4)]	
UM Upper Mid-land zones Ann. Mean 18-21ºC M. min. 11-14ºC	Zones	***Coffee-Tea zone***	***Main Coffee zone***	***Marginal Coffee zone***	***Sunflower-Maize [3)] zone***	Livestock-Sorghum zone	U. midland Ranching zone	U. Midland Nom.Zone [4)]
LM Lower Mid-Land zones Ann. Mean 21-24ºC M. min. >14 ºC	* Forests	L. Midl. Sugar-Cane zone	Marginal Sugarcane zone	***L. midland Cotton zone***	***Marginal Cotton Zone [6)]***	***L.Midland Livestock-Millet zone***	L. midland Ranching zone	L. midland Nom.zone [4)]
L Lowland zones **IL I**nner Lowland zones Ann. Mean>24ºC Mean max.>31ºC	* Forests	* Rice-Taro zone	* Lowland Sugarcane zone	* Lowland Cotton zone	* Groundnut zone	***Lowland Livestock-Millet zone***	Lowland Ranching zone	Lowland Nom.Zone [4)]
CLCoastal lowl.z [5)] Ann.mean>24 ºC Mean max.<31ºC	*	* Cocoa-Oilpalm zone	Lowland Sugarcane zone	Coconut-Cassava zone	Cashewnut-Cass.zone	Lowland Livestock Millet zone	Lowland Ranching zone	Lowland Nom.Zone [4)]

Source: Farm Management handbook of Kenya, Ministry of Agriculture, Kenya, 1983. **N/B * Not in Kenya**

1) Inner Tropics, different zonation towards the margins. The T for Tropical is left out in the thermal belts of zones (except at TA), because it is only necessary if other climates occur in the same country. The names of potentially leading crops were used to indicate the zones. Of course these crops can also be grown in some other zones, but they are then normally less profitable.
2) Wheat or maize depending on farm scale, topography, a.o 3) Maize is a good cash crop here, but maize also in LH 1, UM 1-3, LM and L 1-4;
4) Nomadism, semi-nomadism and other forms of shifting grazing 5) An exception because of the vicinity of cold currents are the tropical cold Coastal Lowlands cCL in Peru and Namibia. Ann. Mean there between 18 and 24ºC
6) In unimodal rainfall areas growing periods may be already too short for Cotton. Then the zone could be called Lower Midland Sunflower-Maize zone.

Appendix 2

Climate in the agro-ecological zones

	Zone Name	Altitude in m	Annual mean temperature in °C	Annual average rainfall in mm	Initial leading crop
Meru	UH(Upper Highland)1:Sheep-dairy	Forest Reserve, important as a catchment area			
	UH(Upper Highland)2:Pyrethrum-wheat	2440-2740	14.7-13.2	950-1200	pyrethrum, wheat
	UH(Upper Highland)3:Upper wheat-barley	2230-2900	14.7-14.3	900-1050	wheat, barley
	UH(Upper Highland)4:Upper highland ranching	Not suitable for rainfed agriculture			
	LH(Lower Highland)1: Tea-dairy	1830-2200	15.8-15.1	1200-2000	tea, dairy
	LH(Lower Highland)2: Wheat/maize-pyrethrum	1890-2130	16.6-14.5	900-1050	wheat, maize, pyrethrum
	LH(Lower Highland)3: Wheat/(maize)-barley	2070-2220	15.6-14.5	800-1000	wheat, maize, barley
	LH(Lower Highland)4: Cattle-sheep-barley	2070-2220	16.9-15.6	770-1000	cattle, sheep, barley
	LH(Lower Highland)5: Lower highland ranching	Not suitable for rainfed agriculture			
	UM(Upper Midland)1: Coffee-tea	1520-1800	17.8-17.5	1100-1600	coffee, tea
	UM(Upper Midland)2: Main coffee	1280-1680	19.3-17.8	950-1500	coffee
	UM(Upper Midland)3: Marginal coffee	1280-1520	20.8-17.5	870-1000	coffee, maize
	UM(Upper Midland)4: Sunflower-maize	1520-1770	18.6-17.5	800-900	sunflower, maize
	UM(Upper Midland)5: Livestock-sorghum	1520-1770			
	UM(Upper Midland)6: Upper midland ranching	Not suitable for rainfed agriculture			
	LM(Lower Midland)3: Cotton	910-1280			
	LM(Lower Midland)4: Marginal cotton	760-1220			
	LM(Lower Midland)5: Lower midland livestock-millet	700-910			
	LM(Lower Midland)6: Lower midland ranching	Not suitable for rainfed agriculture			
	IL(Inner Lowland)5: Lowland livestock millet	610-700	23.9-23.5	640-780	millet, livestock
	IL(Inner Lowland)6: Lowland ranching	Not suitable for rainfed agriculture			

Embu	LH(Lower Highland)1: Tea-dairy	1770-2070	17.7-15.8	1750-2000	tea, dairy farming
	UM(Upper Midland)1: Coffee-tea	1590-1830	18.9-17.5	1400-1800	coffee, tea
	UM(Upper Midland)2: Main coffee	1400-1590	20.1-18.9	1200-1500	coffee
	UM(Upper Midland)3: Marginal coffee	1280-1460	20.7-19.6	1000-1250	coffee, maize
	UM(Upper Midland)4: Sunflower-maize	1280-1400	20.7-20.0	980-1100	sunflower, maize
	LM (Lower Midland)3: Cotton	1070-1280	22.0-20.7	900-1100	cotton
	LM(Lower Midland)4: Marginal cotton	980-1220	22.5-21.0	780-900	cotton
	LM(Lower Midland)5: Lower midland livestock millet	830-1130	23.5-21.7	700-900	millet, livestock
	IL(Inner Lowland)5: Lowland livestock millet	760-830	23.9-23.5	640-780	millet, livestock
Kirinyaga	LH(Lower Highland)1: Tea-dairy	1760-2130	17.8-14.5	1700-2150	tea, dairy farming
	UM(Upper Midland)1: Coffee-tea	1520-1820	19.3-17.5	1400-1700	coffee, tea
	UM(Upper Midland)2: Main coffee	1400-1580	20.1-19.0	1200-1500	coffee
	UM(Upper Midland)3: Marginal coffee	1310-1400	20.6-20.1	1100-1250	coffee, maize
	UM(Upper Midland)4: Sunflower-maize	1280-1340	20.9-20.4	950-1200	sunflower, maize
	LM (Lower Midland)3: Cotton	1220-1280	21.2-20.9	900-1200	cotton
	LM(Lower Midland)4: Marginal cotton	1090-1220	22.0-21.2	800-950	cotton
	LM(Lower Midland)5: Lower midland livestock millet	Small transitional strip			
Nyeri	UH(Upper Highland)1:Sheep-dairy	2070-2400	15.0-12.8	1080-2000	sheep
	UH(Upper Highland)2:Pyrethrum-wheat	2130-2380	14.7-13.2	950-1200	pyrethrum, wheat
	UH(Upper Highland)3:Upper wheat-barley	2130-2200	14.7-14.3	900-1050	wheat, barley
	LH(Lower Highland)1: Tea-dairy	1950-2070	15.8-15.1	1200-2000	tea, dairy
	LH(Lower Highland)2: Wheat/maize-pyrethrum	1830-2100	16.6-14.5	900-1050	wheat, maize, pyrethrum
	LH(Lower Highland)3: Wheat/(maize)-barley	1980-2130	15.6-14.5	800-1000	wheat, maize, barley
	LH(Lower Highland)4: Cattle-sheep-barley	1800-1980	16.9-15.6	770-1000	cattle, sheep, barley

	LH(Lower Highland)5: Lower highland ranching	1890-1950	16.2-15.8	650-850	cattle sheep
	UM(Upper Midland)1: Coffee-tea	1710-1780	17.8-17.5	1100-1600	coffee, tea
	UM(Upper Midland)2: Main coffee	1460-1710	19.3-17.8	950-1500	coffee
	UM(Upper Midland)3: Marginal coffee	1220-1780	20.8-17.5	870-1000	coffee, maize
	UM(Upper Midland)4: Sunflower-maize	1580-1780	18.6-17.5	800-900	sunflower, maize
Laikipia	UH(Upper Highland)2:Pyrethrum-wheat	2280-2590	14.9-12.9	1000-1200	pyrethrum, wheat
	LH(Lower Highland)3: Wheat/(maize)-barley	2100-2350	16.1-14.9	850-1000	wheat, maize, barley
	LH(Lower Highland)4: Cattle-sheep-barley	1820-2280	17.7-16.5	730-900	cattle, sheep, barley
	LH(Lower Highland)5: Lower highland ranching	1800-2140	17.3-15.3	570-800	cattle, sheep
	UM(Upper Midland)5: Livestock-sorghum	1760-1830	17.9-17.5	590-700	sunflower, maize
	UM(Upper Midland)6: Upper midland ranching	1300-1800	20.9-17.8	380-620	cattle, goat
	LM(Lower Midland)6: Lower midland ranching	1200-1300	21.5-20.9	400-500	cattle, goat

Appendix 3

Productivity and characteristics of each zones in Mt. Kenya Regions

Zone Name	General Information	Climatic Characteristics
UH(Upper Highland)1: Sheep and Dairy	Climatic conditions not well suited for grain crops except oats, but favourable for artificial pastures, if not forest on slopes is ecologically more advisable.	Cool & humid; annual average precipitation more than 80% of the potential evaporation. Dry seasons negotiable.
UH(Upper Highland)2: Pyrethrum-Wheat	Climatic conditions good for pyrethrum and fair for wheat.	Cool & sub-humid; annual average precipitation 65- 80 % of the potential evaporation.
UH(Upper Highland)3: Upper Wheat-Barely	Climatic conditions good for wheat & barley, fair to poor for pyrethrum.	Cool & sub-humid; annual average precipitation 50-65% of the potential evaporation and growing periods must have at least 130 days in 6 out of 10 years.
UH(Upper Highland)4: Upper Highland Ranching	Only marginal or not suitable for rainfed crops or dairy. Natural pasture for upgraded cattle and sheep, low density grazing.	Cool & sub-humid; annual average precipitation 40-50% of the potential evaporation; 60% probability of growing periods less than 130 days.
LH(Lower Highland)1: Tea-dairy	Climatic conditions good for tea, dairy pastures, potatoes and vegetables, fair for maize.	Moderately cool & humid; annual average precipitation at least 80% of the potential evaporation.
LH(Lower Highland)2: Wheat/Maize-Pyrethrum	Climatic conditions fair-good for pyrethrum and wheat, fair for maize.	Moderately cool & sub-humid; annual average precipitation 65-80 % of the potential evaporation.
LH(Lower Highland)3: Wheat/(Maize)-Barely	Climatic conditions good for wheat and barley, fair-marginal for maize.	Moderately cool & sub-humid; annual average precipitation 50-65% of the potential evaporation and growing periods must be well developed and at least 115 days in 6 out of 10 years.
LH(Lower Highland)4: Cattle-Sheep-Barely	Climatic conditions fair for barley and wheat; natural pasture for medium density grazing.	Moderately cool & transitional; annual average precipitation 40-50% of the potential evaporation and growing periods must be at least 105 days in 6 out of 10 years.
LH(Lower Highland)5: Lower Highland Ranching	Except of very early maturing barely not suited for rainfed crops or dairy. Natural pasture for low density grazing	Moderately cool & semi-arid; annual average precipitation 25-40% of the potential evaporation and 60% probability of growing periods less than 105 days.
UM(Upper Midland)1: Coffee-Tea	Climatic conditions good to fair for Arabica coffee and tea, the same for maize.	Temperate & humid; annual average precipitation at least 80% of the potential evaporation.
UM(Upper Midland)2: Main Coffee	Climatic conditions good for Arabica coffee and maize.	Temperate & sub-humid; annual average precipitation65-80 % of the potential evaporation.
UM(Upper Midland)3: Marginal Coffee	Moisture conditions fair to poor for coffee, irrigation profitable, fair for maize.	Temperate & sub-humid; annual average precipitation 50-65% of the potential evaporation.
UM(Upper Midland)4: Sunflower-Maize	With unimodal rainfall good for sunflower and maize, with bimodal rainfall mainly fair, sisal good in large scale.	Temperate & sub-humid; annual average precipitation 40-50% of the potential evaporation.
UM(Upper Midland)5: Livestock-Sorghum	Climatic conditions fair for sorghum, poor for maize. Natural pasture for low density grazing. Sisal fair to poor.	Temperate & semi-arid; annual average precipitation 25-40% of the potential evaporation, growing periods must be at least 65 days in 6 out of 10 years.
UM(Upper Midland)6: Upper Midland Ranching	Only marginal or not suitable for rainfed crops or dairy. Natural pasture for low to very low density grazing.	Temperate & sub-humid; annual average precipitation 15-25% of the potential evaporation.
LM (Lower Midland)3: Cotton	Climatic conditions good to fair for cotton, fair for maize.	Warm & semi-humid; annual average precipitation 50-65% of the potential evaporation.

LM(Lower Midland)4: Marginal Cotton	**Climatic conditions fair to poor for cotton and maize, fair for pigeon peas, good for sisal.**	**Warm & transitional; annual average precipitation 40-50% of the potential evaporation.**
LM(Lower Midland)5: Lower Midland Livestock Millet	**Climatic conditions fair to poor for millets, cowpeas and green grams or sisal. Natural pasture for low density.**	**Warm & semi-arid; annual average precipitation 25-40% of the potential evaporation, or less or more because growing periods must be at least 45 days in 6 out of 10 years.**
LM(Lower Midland)6: Lower Midland Ranching	**Not suitable for rainfed crops. Natural pasture for low to very low density grazing.**	**Warm, semi-arid in areas with intermediate rainfall, arid in other areas.**
IL(Inner Lowland)5: Lowland Livestock Millet	**Climatic conditions fair to marginal for millets, cowpeas and green grams or sisal. Natural pasture for low density grazing.**	**Hot & semi-arid; annual average precipitation 25-40% of the potential evaporation, or less or more because growing periods must be at least 45 days in 6 out of 10 years.**

* Good= Average yield more than 60 % of the optimum on suitable soils.
* Fair= Average yield 40-60 % of the optimum on suitable soils.
* Poor= Average yield 20-40 % of the optimum on suitable soils.

Appendix 4

Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
1	E(37)-(25)-(00)	S(0)-(20)-(00)	1847	NA	LH1	Tea dairy zone	2559
2	E(37)-(26)-(40)	S(0)-(19)-(60)	1780	Munyutu	LH1	Tea dairy zone	2516
3	E(37)-(26)-(60)	S(0)-(19)-(00)	1785	Ndunduri	LH1	Tea dairy zone	2491
4	E(37)-(27)-(20)	S(0)-(19)-(30)	1746	Ndunduri	LH1	Tea dairy zone	2488
5	E(37)-(29)-(20)	S(0)-(18)-(00)	1775	Kiambogo	LH1	Tea dairy zone	2447
6	E(37)-(30)-(50)	S(0)-(17)-(40)	1785	Musege	LH1	Tea dairy zone	2446
7	E(37)-(27)-(00)	S(00)-(22)-(00)	1670	Kithiga	UM1	Coffee tea zone	2430
8	E(37)-(26)-(00)	S(0)-(21)-(20)	1595	Kiangungi	UM1	Coffee tea zone	2305
9	E(37)-(26)-(00)	S(0)-(20)-(60)	1748	Ndunduri	UM1	Coffee tea zone	2285
10	E(37)-(26)-(20)	S(0)-(20)-(00)	1730	Ndunduri	UM1	Coffee tea zone	2285
11	E(37)-(29)-(60)	S(0)-(21)-(80)	1635	Kianjuki	UM1	Coffee tea zone	2283
12	E(37)-(32)-(20)	S(0)-(20)-(00)	1780	Kebigwa soweto	UM1	Coffee tea zone	2265
13	E(37)-(30)-(00)	S(0)-(19)-(80)	1590	Mukago	UM1	Coffee tea zone	2244
14	E(37)-(31)-(20)	S(0)-(18)-(30)	1735	Kabotele	UM1	Coffee tea zone	2205
15	E(37)-(32)-(00)	S(0)-(17)-(60)	1690	Kubukubu	UM1	Coffee tea zone	2182
16	E(37)-(27)-(30)	S(0)-(23)-(00)	1497	Gatunduri	UM2	Main coffee zone	2166
17	E(37)-(26)-(40)	S(0)-(23)-(00)	1495	Dukere	UM2	Main coffee zone	2163
18	E(37)-(30)-(00)	S(0)-(23)-(40)	1520	Kathani	UM2	Main coffee zone	2159
19	E(37)-(30)-(60)	S(0)-(22)-(40)	1465	Kathani	UM2	Main coffee zone	2132
20	E(37)-(30)-(00)	S(0)-(22)-(00)	1600	Kianjuki	UM2	Main coffee zone	2131
21	E(37)-(32)-(20)	S(0)-(21)-(50)	1560	Kianjuki	UM2	Main coffee zone	2119
22	E(37)-(35)-(20)	S(0)-(21)-(60)	1580	Kianjuki	UM2	Main coffee zone	2108
23	E(37)-(34)-(50)	S(0)-(19)-(20)	1545	Kevote	UM2	Main coffee zone	2100
24	E(37)-(36)-(00)	S(0)-(19)-(30)	1485	Mufu	UM2	Main coffee zone	2095
25	E(37)-(28)-(40)	S(0)-(25)-(50)	1450	Kigumo	UM3	Marginal coffee zone	2087
26	E(37)-(27)-(60)	S(0)-(25)-(30)	1450	No name	UM3	Marginal coffee zone	2086
27	E(37)-(29)-(00)	S(0)-(24)-(50)	1325	Kamio	UM3	Marginal coffee zone	2078

Appendix 4

Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
28	E(37)-(30)-(40)	S(0)-(24)-(00)	1460	Rukiri	UM3	Marginal coffee zone	2062
29	E(37)-(32)-(50)	S(0)-(23)-(50)	1280	Ndagoma	UM3	Marginal coffee zone	2053
30	E(37)-(37)-(50)	S(0)-(21)-(50)	1290	Kathunguri	UM3	Marginal coffee zone	2050
31	E(37)-(38)-(00)	S(0)-(21)-(00)	1530	Muchonoke	UM3	Marginal coffee zone	2045
32	E(37)-(37)-(80)	S(0)-(20)-(20)	1455	Kangara	UM3	Marginal coffee zone	2044
33	E(37)-(30)-(00)	S(0)-(27)-(40)	1323	Itabua	UM4	Sunflower-maize zone	2037
34	E(37)-(29)-(40)	S(0)-(26)-(60)	1305	Siakago	UM4	Sunflower-maize zone	2034
35	E(37)-(29)-(20)	S(0)-(26)-(40)	1371	Kambo	UM4	Sunflower-maize zone	2029
36	E(37)-(29)-(60)	S(0)-(25)-(80)	1368	Muthatara	UM4	Sunflower-maize zone	2028
37	E(37)-(31)-(40)	S(0)-(25)-(50)	1253	Ndaguma	UM4	Sunflower-maize zone	2019
38	E(37)-(31)-(90)	S(0)-(24)-(40)	1258	Kandogo	UM4	Sunflower-maize zone	2018
39	E(37)-(33)-(50)	S(0)-(25)-(50)	1251	Kinyaro	UM4	Sunflower-maize zone	2017
40	E(37)-(33)-(70)	S(0)-(24)-(50)	1269	Gichugu	UM4	Sunflower-maize zone	2017
41	E(37)-(38)-(40)	S(0)-(28)-(00)	1269	Kadogo	UM4	Sunflower-maize zone	2015
42	E(37)-(30)-(50)	S(0)-(29)-(50)	1280	Dagoma	LM3	Cotton zone	2015
43	E(37)-(35)-(00)	S(0)-(29)-(00)	1265	Kariru	LM3	Cotton zone	2011
44	E(37)-(36)-(20)	S(0)-(25)-(50)	1215	Ndagoma	LM3	Cotton zone	2011
45	E(37)-(37)-(00)	S(0)-(23)-(30)	1250	Iyando	LM3	Cotton zone	2003
46	E(37)-(38)-(60)	S(0)-(21)-(90)	1158	Karurumo	LM3	Cotton zone	1996
47	E(37)-(17)-(50)	S(0)-(37)-(00)	1207	Mararu	LM4	Marginal cotton zone	1996
48	E(37)-(20)-(00)	S(0)-(38)-(00)	1200		LM4	Marginal cotton zone	1996
49	E(37)-(25)-(30)	S(0)-(39)-(00)	1104	Kiendo kakindu	LM4	Marginal cotton zone	1996
50	E(37)-(26)-(00)	S(0)-(36)-(00)	1171	Wamikuyu	LM4	Marginal cotton zone	1994
51	E(37)-(31)-(50)	S(0)-(31)-(30)	1114	Mbozuki	LM4	Marginal cotton zone	1990
52	E(37)-(32)-(30)	S(0)-(31)-(50)	1100	Kanyuambora	LM4	Marginal cotton zone	1989
53	E(37)-(32)-(50)	S(0)-(31)-(50)	1100	Kiamukuu	LM4	Marginal cotton zone	1989
54	E(37)-(35)-(00)	S(0)-(33)-(40)	1220	Kambita	LM4	Marginal cotton zone	1985

Appendix 4

Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
55	E(37)-(35)-(60)	S(0)-(33)-(40)	1236	Kambita	LM4	Marginal cotton zone	1980
56	E(37)-(36)-(60)	S(0)-(32)-(20)	1205	Kambita	LM4	Marginal cotton zone	1980
57	E(37)-(36)-(00)	S(0)-(32)-(00)	1110	Gachoka	LM4	Marginal cotton zone	1977
58	E(37)-(35)-(80)	S(0)-(31)-(40)	1165	Muraru	LM4	Marginal cotton zone	1970
59	E(37)-(35)-(20)	S(0)-(31)-(40)	1125	Kui	LM4	Marginal cotton zone	1968
60	E(37)-(42)-(50)	S(0)-(30)-(20)	1160	Ndutori	LM4	Marginal cotton zone	1955
61	E(37)-(42)-(00)	N(0)-(26)-(30)	1140	Kianguta	LM4	Marginal cotton zone	1949
62	E(37)-(42)-(20)	N(0)-(24)-(00)	1160	Ng'anga	LM4	Marginal cotton zone	1940
63	E(37)-(42)-(40)	N(0)-(22)-(50)	1170	Kiathenge	LM4	Marginal cotton zone	1932
64	E(37)-(33)-(00)	N(0)-(40)-(20)	1307	Kajaga	LM5	Lower midland livestock millet zone	1914
65	E(37)-(31)-(40)	N(0)-(41)-(40)	1025	Gachuriri	LM5	Lower midland livestock millet zone	1907
66	E(37)-(31)-(00)	N(0)-(40)-(50)	1117	Ndune	LM5	Lower midland livestock millet zone	1899
67	E(37)-(33)-(00)	N(0)-(37)-(00)	1110	Ndundani	LM5	Lower midland livestock millet zone	1896
68	E(37)-(32)-(00)	N(0)-(34)-(40)	1060	Kithechu	LM5	Lower midland livestock millet zone	1892
69	E(37)-(36)-(00)	N(0)-(34)-(50)	845	Kagandari	LM5	Lower midland livestock millet zone	1891
70	E(37)-(40)-(00)	N(0)-(35)-(00)	1133	Ivondo	LM5	Lower midland livestock millet zone	1865
71	E(37)-(42)-(20)	N(0)-(35)-(00)	1115	Ivondo	LM5	Lower midland livestock millet zone	1862
72	E(37)-(42)-(00)	N(0)-(35)-(00)	1132	Ivondo	LM5	Lower midland livestock millet zone	1859
73	E(37)-(43)-(00)	N(0)-(35)-(00)	1087	Ivondo	LM5	Lower midland livestock millet zone	1849
74	E(37)-(44)-(00)	N(0)-(35)-(80)	995	Karuruma	LM5	Lower midland livestock millet zone	1847
75	E(37)-(49)-(30)	N(0)-(39)-(90)	845	Nguthi	LM5	Lower midland livestock millet zone	1847
76	E(37)-(48)-(20)	N(0)-(36)-(00)	1080	Marurumo	LM5	Lower midland livestock millet zone	1847
77	E(37)-(48)-(00)	N(0)-(31)-(50)	870	Mboca	LM5	Lower midland livestock millet zone	1843
78	E(37)-(46)-(00)	N(0)-(23)-(00)	940	Karangiri	LM5	Lower midland livestock millet zone	1840
79	E(37)-(53)-(60)	N(0)-(29)-(20)	698	Ciangera	IL5	Lowland livestock millet zone	1834
80	E(37)-(50)-(30)	N(0)-(29)-(20)	700	Mugani	IL5	Lowland livestock millet zone	1830
81	E(37)-(50)-(20)	N(0)-(27)-(40)	658	Riacina	IL5	Lowland livestock millet zone	1821

Appendix 4

Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
82	E(37)-(50)-(00)	N(0)-(25)-(50)	700	Ngiiri	IL5	Lowland livestock millet zone	1821
83	E(37)-(53)-(00)	N(0)-(21)-(30)	730	Itambararia	IL5	Lowland livestock millet zone	1821
84	E(37)-(15)-(22)	S(0)-(24)-(93)	2011	Makedonia	LH1-1	Tea dairy zone	1821
85	E(37)-(16)-(32)	S(0)-(27)-(16)	1762	Gitumbi	LH1-2	Tea dairy zone	1814
86	E(37)-(17)-(02)	S(0)-(26)-(57)	1865	Ndunguri	LH1-3	Tea dairy zone	1814
87	E(37)-(21)-(07)	S(0)-(26)-(63)	1651	Kiagondi	LH1-4	Tea dairy zone	1806
88	E(37)-(23)-(40)	S(0)-(26)-(43)	1510	Karia	LH1-5	Tea dairy zone	1804
89	E(37)-(23)-(53)	S(0)-(28)-(56)	1593	Wakaburu	UM1-1	Coffee tea zone	1798
90	E(37)-(20)-(64)	S(0)-(27)-(0)	1661	Kiaruri	UM1-2	Coffee tea zone	1798
91	E(37)-(19)-(08)	S(0)-(29)-(15)	1556	Githaga	UM1-3	Coffee tea zone	1798
92	E(37)-(14)-(41)	S(0)-(29)-(49)	1656	Kamuiru	UM1-4	Coffee tea zone	1787
93	E(37)-(10)-(74)	S(0)-(29)-(11)	1726	Kiangai	UM1-5	Coffee tea zone	1785
94	E(37)-(11)-(58)	S(0)-(31)-(51)	1539	Njoga	UM2-1	Main coffee zone	1785
95	E(37)-(11)-(51)	S(0)-(32)-(08)	1502	Kiangoma	UM2-2	Main coffee zone	1780
96	E(37)-(14)-(65)	S(0)-(31)-(85)	1464	Mutitu	UM2-3	Main coffee zone	1780
97	E(37)-(18)-(01)	S(0)-(30)-(48)	1450	Githegi	UM2-4	Main coffee zone	1778
98	E(37)-(21)-(85)	S(0)-(30)-(17)	1431	Mutitu	UM2-5	Main coffee zone	1775
99	E(37)-(25)-(36)	S(0)-(33)-(17)	1290	Ichangi	UM3-1	Marginal coffee zone	1771
100	E(37)-(23)-(26)	S(0)-(33)-(17)	1380	Kagongo	UM3-2	Marginal coffee zone	1765
101	E(37)-(21)-(86)	S(0)-(33)-(04)	1280	Kabari	UM3-3	Marginal coffee zone	1762
102	E(37)-(20)-(82)	S(0)-(33)-(23)	1334	Rukenya	UM3-4	Marginal coffee zone	1753
103	E(37)-(16)-(58)	S(0)-(36)-(94)	1245	Ndaba	UM3-5	Marginal coffee zone	1748
104	E(37)-(15)-(63)	S(0)-(35)-(53)	1337	Kiaga	UM4-1	Sunflower-maize zone	1748
105	E(37)-(16)-(37)	S(0)-(35)-(60)	1267	Wangata	UM4-2	Sunflower-maize zone	1746
106	E(37)-(27)-(10)	S(0)-(34)-(16)	1226	Murinduku	UM4-3	Sunflower-maize zone	1745
107	E(37)-(26)-(41)	S(0)-(34)-(48)	1270	Murinduku	UM4-4	Sunflower-maize zone	1735
108	E(37)-(20)-(69)	S(0)-(34)-(92)	1305	Ndomba	UM4-5	Sunflower-maize zone	1730

Appendix 4

Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
109	E(37)-(21)-(71)	S(0)-(36)-(28)	1137	Nguraini	LM3-1	Cotton zone	1728
110	E(37)-(21)-(42)	S(0)-(35)-(17)	1275	Nyangati	LM3-2	Cotton zone	1726
111	E(37)-(19)-(62)	S(0)-(35)-(72)	1253	Riambui	LM3-3	Cotton zone	1723
112	E(37)-(14)-(16)	S(0)-(36)-(51)	1230	Kathumbu	LM3-4	Cotton zone	1713
113	E(37)-(16)-(31)	S(0)-(33)-(80)	1337	Kithungri	LM3-5	Cotton zone	1711
114	E(37)-(15)-(04)	S(0)-(40)-(14)	1547	Mombu	LM4-1	Marginal cotton zone	1708
115	E(37)-(16)-(33)	S(0)-(43)-(44)	1017	Rukanga	LM4-2	Marginal cotton zone	1706
116	E(37)-(18)-(01)	S(0)-(44)-(96)	1031	Kirwara	LM4-3	Marginal cotton zone	1690
117	E(37)-(20)-(02)	S(0)-(44)-(07)	1031	Mutitihi	LM4-4	Marginal cotton zone	1688
118	E(37)-(25)-(49)	S(0)-(42)-(41)	1137	Kiarukongo	LM4-5	Marginal cotton zone	1678
119	E(36)-(51)-(32.7)	S(0)-(27)-(42.5)	2285	Gatombiro	UH1-1	Sheep-dairy zone	1670
120	E(36)-(51)-(14.2)	S(0)-(28)-(39.1)	2283	Ihithe	UH1-2	Sheep-dairy zone	1661
121	E(36)-(51)-(15.6)	S(0)-(28)-(49.1)	2265	NA	UH1-3	Sheep-dairy zone	1656
122	E(37)-(6)-(10.3)	S(0)-(2)-(9.6)	2108	Kwamwea	UH1-4	Sheep-dairy zone	1651
123	E(37)-(05)-(55.5)	S(0)-(1)-(57)	2087	Hooko	UH1-5	Sheep-dairy zone	1635
124	E(37)-(5)-(58.9)	S(0)-(1)-(46)	2086	Kwamiwea	UH2-1	Pyrethrum wheat zone	1625
125	E(0)-(1)-(43.7)	S(37)-(5)-(59.3)	2095	Kwamwea	UH2-2	Pyrethrum wheat zone	1620
126	E(36)-(49)-(29)	S(0)-(18)-(24.7)	2305	Mitero	UH2-3	Pyrethrum wheat zone	1600
127	E(36)-(47)-(16.3)	S(0)-(18)-(29.9)	2430	Endarasha	UH2-4	Pyrethrum wheat zone	1595
128	E(36)-(46)-(6.6)	S(0)-(16)-(56.7)	2516	Watuka	UH2-5	Pyrethrum wheat zone	1593
129	E(0)-(11)-(18)	S(36)-(41)-(52)	2491	Maragi in Mugunda	UH3-1	Upper wheat barley zone	1590
130	E(0)-(9)-(11)	S(36)-(42)-(36)	2285	Nairutia	UH3-2	Upper wheat barley zone	1580
131	E(36)-(47)-(19)	S(0)-(12)-(57)	2205	Kabendera	UH3-3	Upper wheat barley zone	1572
132	E(36)-(48)-(06)	S(0)-(12)-(08)	2119	Kabendera	UH3-4	Upper wheat barley zone	1560

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Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
133	E(36)-(48)-(31)	S(0)-(13)-(26)	1994	Gachota	UH3-5	Upper wheat barley zone	1560
134	E(36)-(54)-(27)	S(0)-(34)-(42)	2131	Gachichi	LH1-1	Tea dairy zone	1560
135	E(36)-(54)-(39)	S(0)-(34)-(42)	1968	Gichu	LH1-2	Tea dairy zone	1556
136	E(36)-(53)-(46)	S(0)-(31)-(57)	2018	Muroha	LH1-3	Tea dairy zone	1554
137	E(36)-(54)-(33)	S(0)-(32)-(6)	1955	Gathumbi	LH1-4	Tea dairy zone	1550
138	E(36)-(54)-(45)	S(0)-(29)-(34)	2003	Karangia	LH1-5	Tea dairy zone	1547
139	E(36)-(54)-(12)	S(0)-(24)-(20)	1980	Ihororo	LH2-1	Wheat/maize pyrethrum zone	1545
140	E(36)-(53)-(28)	S(0)-(25)-(13)	1970	Rutura	LH2-2	Wheat/maize pyrethrum zone	1539
141	E(36)-(52)-(56)	S(0)-(25)-(47)	1932	Chania	LH2-3	Wheat/maize pyrethrum zone	1530
142	E(36)-(53)-(48)	S(0)-(23)-(02)	2015	Nyarugumo	LH2-4	Wheat/maize pyrethrum zone	1520
143	E(36)-(53)-(58)	S(0)-(22)-(54)	2015	Kihuyu	LH2-5	Wheat/maize pyrethrum zone	1510
144	E(36)-(53)-(6)	S(0)-(20)-(30)	2028	Amboni	LH3-1		1502
145	E(36)-(53)-(16)	S(0)-(20)-(24)	2045	Kanoo	LH3-2	Wheat/(maize) barley zone	1497
146	E(36)-(53)-(54)	S(0)-(20)-(21)	1996	Expage	LH3-3	Wheat/(maize) barley zone	1496
147	E(36)-(52)-(12)	S(0)-(17)-(43)	1996	Satima	LH3-4	Wheat/(maize) barley zone	1495
148	E(36)-(52)-(45)	S(0)-(17)-(32)	2053	Labula	LH3-5	Wheat/(maize) barley zone	1485
149	E(37)-(3)-(26.1)	S(0)-(02)-(21.3)	1977	Ragati	LH4-1	Cattle sheep barley zone	1466
150	E(37)-(2)-(26.3)	S(0)-(05)-(45.1)	1980	Buret	LH4-2	Cattle sheep barley zone	1465
151	E(37)-(0)-(57.3)	S(0)-(12)-(41.8)	2044	Aguthi	LH4-3	Cattle sheep barley zone	1464
152	E(36)-(46)-(52.6)	S(0)-(11)-(7.4)	2159	Birisha	LH4-4	Cattle sheep barley zone	1464
153	E(36)-(53)-(20.1)	S(0)-(19)-(27.1)	1989	Muiga settlement	LH4-5	Cattle sheep barley zone	1460
154	E(37)-(3)-(17.3)	S(0)-(02)-(20.3)	1989	Ngarariga	LH5-1	Lower highland ranching zone	1455
155	E(37)-(2)-(1.2)	S(0)-(07)-(40.5)	2034	Mureru	LH5-2	Lower highland ranching zone	1450
156	E(37)-(0)-(47.6)	S(0)-(14)-(23.4)	1985	Gatuamba	LH5-3	Lower highland ranching zone	1450
157	E(36)-(53)-(20)	S(0)-(16)-(38.9)	1996	Muthui-ine	LH5-4	Lower highland ranching zone	1450
158	E(36)-(52)-(58.6)	S(0)-(16)-(12.7)	2017	Muthui-ini	LH5-5	Lower highland ranching zone	1431
159	E(36)-(57)-(11)	S(0)-(35)-(11)	1862	Maruiri	UM1-1	Coffee tea zone	1411

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Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
160	E(36)-(58)-(45)	S(0)-(34)-(33)	1849	Githagara	UM1-2	Coffee tea zone	1406
161	E(36)-(57)-(44)	S(0)-(33)-(13)	1847	Gathundia	UM1-3	Coffee tea zone	1384
162	E(36)-(56)-(56)	S(0)-(33)-(36)	1896	Kianganda	UM1-4	Coffee tea zone	1380
163	E(37)-(8)-(39)	S(0)-(27)-(44)	1806	Kiarithaini	UM1-5	Coffee tea zone	1372
164	E(37)-(1)-(37)	S(0)-(33)-(26)	1748	Maganjo	UM2-1	Main coffee zone	1371
165	E(37)-(0)-(37)	S(0)-(33)-(27)	1821	Kagarii	UM2-2	Main coffee zone	1368
166	E(37)-(3)-(47)	S(0)-(30)-(49)	1708	Thaigaini	UM2-3	Main coffee zone	1364
167	E(37)-(4)-(24)	S(0)-(30)-(55)	1620	Mbaramui	UM2-4	Main coffee zone	1353
168	E(36)-(58)-(18)	S(0)-(29)-(04)	1798	Kiandu	UM2-5	Main coffee zone	1348
169	E(37)-(02)-(09)	S(0)-(24)-(04)	1728	Maganjo	UM3-1	Marginal coffee zone	1337
170	E(37)-(0)-(56)	S(0)-(24)-(27)	1778	Kanuna	UM3-2	Marginal coffee zone	1337
171	E(37)-(0)-(32)	S(0)-(24)-(10)	1753	Kanuna	UM3-3	Marginal coffee zone	1334
172	E(37)-(0)-(8)	S(0)-(24)-(5)	1711	Kiganjo	UM3-4	Marginal coffee zone	1325
173	E(37)-(0)-(39)	S(0)-(24)-(14)	1723	Kerichu	UM3-5	Marginal coffee zone	1323
174	E(37)-(02)-(26)	S(0)-(21)-(01)	1840	Mathina	UM4-1	Sunflower maize zone	1322
175	E(37)-(4)-(28)	S(0)-(20)-(1)	1899	Ndathi	UM4-2	Sunflower maize zone	1316
176	E(37)-(4)-(50)	S(0)-(19)-(50)	1940	Mbiriri	UM4-3	Sunflower maize zone	1307
177	E(37)-(4)-(42)	S(0)-(22)-(13)	1847	Iruri	UM4-4	Sunflower maize zone	1305
178	E(37)-(4)-(55)	S(0)-(22)-(42)	1830	Iruri	UM4-5	Sunflower maize zone	1305
179	E(36)-(19)-(52)	N(0)-(28)-(51)	1821	Eighteen	LH3-1	Wheat/(maize) barley zone	1305
180	E(36)-(19)-(23)	N(0)-(28)-(05)	1821	Ndindika	LH3-2	Wheat/(maize) barley zone	1301
181	E(36)-(18)-(50)	N(0)-(26)-(43)	1821	Boma	LH3-3	Wheat/(maize) barley zone	1290
182	E(36)-(20)-(35)	N(0)-(24)-(53)	2037	Njorua	LH3-4	Wheat/(maize) barley zone	1290
183	E(36)-(20)-(29)	N(0)-(23)-(54)	2019	Ndururu	LH3-5	Wheat/(maize) barley zone	1280
184	E(36)-(36)-(10)	N(0)-(33)-(12)	1914	Mutamaiyu	LH5-1	Lower highland ranching zone	1280
185	E(36)-(36)-(00)	N(0)-(11)-(50)	1891	Matigari	LH5-2	Lower highland ranching zone	1280
186	E(36)-(36)-(53)	N(0)-(01)-(26)	2050	Raya	LH5-3	Lower highland ranching zone	1275

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Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
187	E(36)-(37)-(10)	N(0)-(02)-(20)	2017	Kiamariga	LH5-4	Lower highland ranching zone	1272
188	E(36)-(37)-(49)	N(0)-(03)-(13)	2062	Kiamaringa	LH5-5	Lower highland ranching zone	1272
189	E(37)-(17)-(38)	N(0)-(11)-(25)	2166	Ithi	LH5-6	Lower highland ranching zone	1270
190	E(37)-(17)-(46)	N(0)-(10)-(09)	2163	Ethi	LH5-7	Lower highland ranching zone	1269
191	E(37)-(08)-(56)	N(0)-(06)-(07)	1990	Ndaiga	LH5-8	Lower highland ranching zone	1269
192	E(37)-(11)-(32)	N(0)-(04)-(32)	2132	Gitugi	LH5-9	Lower highland ranching zone	1267
193	E(37)-(12)-(16)	N(0)-(03)-(52)	2182	Genia	LH5-10	Lower highland ranching zone	1265
194	E(37)-(02)-(04)	N(0)-(08)-(02)	1798	Kariunga	LH5-11	Lower highland ranching zone	1259
195	E(37)-(02)-(09)	N(0)-(08)-(05)	1798	Kariunga	LH5-12	Lower highland ranching zone	1259
196	E(36)-(36)-(34)	N(0)-(20)-(42)	1892	Marura	UM5-1	Livestock sorghum zone	1258
197	E(36)-(57)-(10)	N(0)-(02)-(25)	1765	matanya	UM5-2	Livestock sorghum zone	1253
198	E(36)-(34)-(49)	S(0)-(00)-(59)	1804	Ngari nyiro	UM5-3	Livestock sorghum zone	1253
199	E(36)-(56)-(30)	S(0)-(04)-(40)	1859	Thomee	UM5-4	Livestock sorghum zone	1251
200	E(36)-(50)-(46)	S(0)-(07)-(07)	1949	Mugaita	UM5-5	Livestock sorghum zone	1250
201	E(37)-(00)-(48)	N(0)-(11)-(18)	1688	Kimungaudura	UM6-1	Upper midland ranching zone	1250
202	E(37)-(10)-(58)	N(0)-(24)-(00)	1814	Mukongo	UM6-2	Upper midland ranching zone	1245
203	E(37)-(11)-(44)	N(0)-(23)-(14)	1814	Bogishi	UM6-3	Upper midland ranching zone	1236
204	E(37)-(11)-(24)	N(0)-(22)-(50)	1771	Bogishi	UM6-4	Upper midland ranching zone	1230
205	E(37)-(01)-(21)	N(0)-(09)-(37)	1787	Rugutu	UM6-5	Upper midland ranching zone	1226
206	E(37)-(31)-(59.1)	N(0)-(0.6)-(59.1)	2244	Kamarai	UH2345-1	(Pyrethrum wheat-upper wheat barley-upper highland ranching) zones	1220
207	E(37)-(28)-(11.4)	N(0)-(5)-(30.7)	2488	Kiborione	UH2345-2	(Pyrethrum wheat-upper wheat barley-upper highland ranching) zones	1215
208	E(37)-(28)-(7.5)	N(0)-(4)-(59.6)	2559	Ntirimiti	UH2345-3	(Pyrethrum wheat-upper wheat barley-upper highland ranching) zones	1207
209	E(37)-(29)-(39.1)	N(0)-(5)-(33.6)	2447	Mugae	UH2345-4	(Pyrethrum wheat-upper wheat barley-upper highland ranching) zones	1205
210	E(37)-(23)-(40.8)	N(0)-(7)-(50.4)	2446	Kisima	UH2345-5	(Pyrethrum wheat-upper wheat barley-upper highland ranching) zones	1200

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Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
211	E(37)-(36)-(50)	S(0)-(17)-(23)	1560	Ngongu	LH1-1	Tea dairy zone	1178
212	E(37)-(35)-(40)	S(0)-(16)-(01)	1713	Kirigi	LH1-2	Tea dairy zone	1171
213	E(37)-(35)-(53)	S(0)-(15)-(54)	1706	Kirigi	LH1-3	Tea dairy zone	1170
214	E(37)-(35)-(42)	S(0)-(14)-(25)	1745	Gimbani	LH1-4	Tea dairy zone	1165
215	E(37)-(36)-(23)	S(0)-(14)-(32)	1678	Mutindwa	LH1-5	Tea dairy zone	1160
216	E(37)-(08)-(52 .5)	N(0)-(1)-(46.6)	2100	Ontiliili	LH234-1	(Wheat/maize pyrethrum-barley-cattle sheep barley) zones	1160
217	E(37)-(07)-(58.9)	N(0)-(2)-(01)	2029	Mau Mau	LH234-2	(Wheat/maize pyrethrum-barley-cattle sheep barley) zones	1158
218	E(37)-(28)-(56.7)	N(0)-(06)-(34.7)	2011	Gaterone	LH234-3	(Wheat/maize pyrethrum-barley-cattle sheep barley) zones	1140
219	E(37)-(30)-(2.2)	N(0)-(8)-(36.4)	1996	Manjarene	LH234-4	(Wheat/maize pyrethrum-barley-cattle sheep barley) zones	1137
220	E(37)-(31)-(15.9)	N(0)-(8)-(11.3)	2078	Ntugi	LH234-5	(Wheat/maize pyrethrum-barley-cattle sheep barley) zones	1137
221	E(37)-(36)-(34)	S(0)-(19)-(15)	1272	Kiagondu	UM1-1	Coffee tea zone	1133
222	E(37)-(36)-(52)	S(0)-(19)-(13)	1572	Kiagondu	UM1-2	Coffee tea zone	1132
223	E(37)-(37)-(20)	S(0)-(17)-(44)	1554	Kiabio	UM1-3	Coffee tea zone	1125
224	E(37)-(38)-(30)	S(0)-(17)-(28)	1560	Kiini	UM1-4	Coffee tea zone	1117
225	E(37)-(39)-(27)	S(0)-(17)-(41)	1496	Kenico	UM1-5	Coffee tea zone	1115
226	E(0)-(13)-(20)	S(37)-(39)-(24)	1384	Kagutani	UM2-1	Main coffee zone	1114
227	E(37)-(40)-(22)	S(0)-(11)-(59)	1259	Mbirone	UM2-2	Main coffee zone	1110
228	E(37)-(40)-(36)	N(0)-(09)-(45)	1364	Kachigu	UM2-3	Main coffee zone	1110
229	E(37)-(40)-(08)	S(0)-(07)-(17)	1411	Nkurune	UM2-4	Main coffee zone	1104
230	E(37)-(40)-(11)	S(0)-(05)-(26)	1464	Rambu	UM2-5	Main coffee zone	1103
231	E(37)-(42)-(25)	S(0)-(04)-(25)	1353	Mujwa	UM3-1	Marginal coffee zone	1100
232	E(37)-(41)-(13)	S(0)-(14)-(27)	1322	Kariakomo	UM3-2	Marginal coffee zone	1100
233	E(37)-(40)-(19)	S(0)-(14)-(21)	1259	Kariakomo	UM3-3	Marginal coffee zone	1087
234	E(37)-(41)-(48)	S(0)-(06)-(28)	1305	Gikingo	UM3-4	Marginal coffee zone	1080
235	E(37)-(41)-(24)	S(0)-(06)-(15)	1316	Mukouu	UM3-5	Marginal coffee zone	1060
236	E(37)-(31)-(54)	N(0)-(13)-(27)	1550	Kithima	UM456-1	(Sunflower maize-livestock sorghum-upper midland ranching) zones	1031

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Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
237	E(37)-(31)-(17)	N(0)-(11)-(59)	1625	Kamugeha	UM456-2	(Sunflower maize-livestock sorghum-upper midland ranching) zones	1031
238	E(37)-(30)-(21)	N(0)-(10)-(33)	1834	Ithira	UM456-3	(Sunflower maize-livestock sorghum-upper midland ranching) zones	1026
239	E(37)-(30)-(53)	N(0)-(10)-(27)	1843	Dnunbura	UM456-4	(Sunflower maize-livestock sorghum-upper midland ranching) zones	1025
240	E(37)-(31)-(01)	N(0)-(09)-(47)	1907	Thiira	UM456-5	(Sunflower maize-livestock sorghum-upper midland ranching) zones	1017
241	E(37)-(47)-(49)	N(0)-(05)-(59)	970	Matetu	LM3-1	Cotton zone	995
242	E(0)-(03)-(57)	N(37)-(48)-(45)	985	Kanywee	LM3-2	Cotton zone	985
243	E(37)-(48)-(10)	S(0)-(02)-(03)	1026	Kaare	LM3-3	Cotton zone	984
244	E(37)-(46)-(31)	S(0)-(00)-(48)	1103	Nguchia	LM3-4	Cotton zone	970
245	E(37)-(44)-(24)	S(0)-(01)-(11)	1178	Nkumbo	LM3-5	Cotton zone	940
246	E(37)-(51)-(30)	S(0)-(11)-(49)	812	Gitongo	LM4-1	Marginal cotton zone	915
247	E(37)-(51)-(06)	S(0)-(10)-(53)	856	Githongo	LM4-2	Marginal cotton zone	897
248	E(37)-(49)-(46)	S(0)-(10)-(21)	897	Tunyai	LM4-3	Marginal cotton zone	870
249	E(37)-(49)-(05)	S(0)-(09)-(36)	915	Kibuka	LM4-4	Marginal cotton zone	858
250	E(37)-(48)-(35)	S(0)-(08)-(21)	984	Kiriria	LM4-5	Marginal cotton zone	856
251	E(38)-(06)-(49.9)	N(0)-(6)-(49.9)	801	Kathithini	LM5-1	Lower midland livestock millet zone	854
252	E(38)-(05)-(32.5)	N(0)-(17)-(26.6)	858	Makutano	LM5-2	Lower midland livestock millet zone	845
253	E(38)-(6)-(6.7)	N(0)-(8)-(6.6)	854	Gatwe	LM5-3	Lower midland livestock millet zone	845
254	E(37)-(50)-(23.8)	N(0)-(19)-(16.1)	1372	Marioni	LM5-4	Lower midland livestock millet zone	812
255	E(37)-(51)-(00)	N(0)-(20)-(00)	1250	Eastleigh	LM5-5	Lower midland livestock millet zone	801
256	E(37)-(33)-(36.4)	N(0)-(17)-(42.5)	1272	Mali-tano	LM6-1	Lower midland ranching zone	730
257	E(37)-(32)-(35.7)	N(0)-(15)-(57.8)	1406	Kithima	LM6-2	Lower midland ranching zone	700
258	E(37)-(32)-(21.6)	N(0)-(15)-(16.5)	1466	Maili-nane	LM6-3	Lower midland ranching zone	700
259	E(37)-(53)-(05.9)	N(0)-(23)-(38.3)	1348	Jara	LM6-4	Lower midland ranching zone	698
260	E(37)-(52)-(45.4)	N(0)-(24)-(27)	1301	Mbututia	LM6-5	Lower midland ranching zone	689
261	E(37)-(59)-(22.5)	N(0)-(10)-(13.2)	603	Kamatungu	IL5-1	Lowland livestock millet zone	664

Appendix 4

Location data of all plots in the target areas

Total No.	Longitude	Latitude	Altitude(m)	Village name	Zones name	Agro-ecological zone name	Altitude
262	E(37)-(58)-(56.7)	S(0)-(7)-(28.7)	664	Karungaru	IL5-2	Lowland livestock millet zone	658
263	E(37)-(59)-(31)	S(0)-(5)-(47.5)	658	Tumanya	IL5-3	Lowland livestock millet zone	658
264	E(38)-(01)-(35.5)	S(0)-(3)-(31.6)	689	Kithima	IL5-4	Lowland livestock millet zone	611
265	E(38)-(0)-(12.8)	S(0)-(5)-(37.1)	611	Ntanderuni	IL5-5	Lowland livestock millet zone	603

Appendix 5

List of Trees & Shrubs in the 5 districts surrounding of Mt Kenya **(E:Embu/K:Kirinyaga/L:Laikipia/M:meru/N:Nyeri)**

No.	Scientific Name	Local Name	Family Name	Status	Plant type	Uses	Total No.	Places of 265 plots	Avg.no/plot	District
1	Abutilon longicuspe A.RICH	Muondoe/Mwondwe	Malvaceae	indigenous	shrub	fibre	120	5	24.0	L/N
2	Abutilon mauritianum (JACQ.) SWEET	Mukeu	Malvaceae	indigenous	shrub/herb	leaf infusion for dysentery	40	2	20.0	L/N
3	Acacia ataxacantha DC.	Murangari	Fabaceae(m)	indigenous	shrub/tree	craft/ building	131	12	10.9	E/M
4	Acacia brevispica HARMS.	Murangare	Fabaceae(m)	indigenous	shrub/tree	firewood/branches for hut's roof	26	11	2.4	E/M
5	Acacia drepanolobium HARMS EX SJOSTEDT	Muuga/Muruai/Ruai	Fabaceae(m)	indigenous	shrub/tree	firewood/charcoal/medicinal/branches for biomass/shade	374	11	34.0	E/L/M/N
6	Acacia gerrardii BENTH.	Etir/Muruai	Fabaceae(m)	indigenous	tree	firewood/soup/medicinal	16	3	5.3	L
7	Acacia hockii DE WILD.	Mugaa	Fabaceae(m)	indigenous	shrub/tree	firewood/pole/bark for making rope	142	11	12.9	E/L/M
8	Acacia kirkii BRENAN	Murera	Fabaceae(m)	indigenous	tree	firewood/pole	9	4	2.3	K/M/N
9	Acacia mearnsii DE WILD.	Muthanduku	Fabaceae(m)	introduced	tree	wattle bark/ firewood/charcoal/pole	471	25	18.8	E/K/L/M/N
10	Acacia melanoxylon R.BR.	Mwana rumu	Fabaceae(m)	introduced	tree	firewood/charcoal/pole	27	2	13.5	M/N
11	Acacia mellifera (BURCH.) BRENAN	Muthingira/Muikunya/Mukura	Fabaceae(m)	indigenous	shrub/tree	firewood/charcoal/bark for medicine	123	15	8.2	E/M
12	Acacia nilotica WILLD.EX DELILE	Musemai/Mugaa/Kirunti/Kiroriti/ Mukiroroti/Kiruai	Fabaceae(m)	indigenous	tree	medicinal/firewood	160	23	7.0	E/L/M
13	Acacia polyacantha WILLD	Mugaa/Muombo	Fabaceae(m)	indigenous	tree	charcoal/firewood/fodder/building material	78	13	6.0	E/M
14	Acacia robusta BURCH	Kithi	Fabaceae(m)	indigenous	tree	building materials/firewood	4	1	4.0	E
15	Acacia senegal WILD	Mgunga	Fabaceae(m)	indigenous	shrub/tree	gum arabic/bark infusion as medicinal	87	14	6.2	E/M
16	Acacia seyal var. fistla OLIV.	Murera	Fabaceae(m)	indigenous	shrub/tree	firewood/charcoal	2	1	2.0	M
17	Acacia seyal var. seyal DELILE	Mugemeri/Murema/Lerai	Fabaceae(m)	indigenous	shrub/tree	firewood/charcoal/bark for red dye/gum edible & tea	25	9	2.8	E/L/M
18	Acacia tortilis (FORSSK.) HAYNE	Mugunga/Mukiroroti/Mugaa	Fabaceae(m)	indigenous	tree	firewood/charcoal/fodder	272	37	7.4	E/K/M
19	Acacia xanthophloea BENTH.	Musewa/Murera/Lelai	Fabaceae(m)	indigenous	tree	firewood/fodder/charcoal/shade	38	9	4.2	L/M/N
20	Acalypha fruticosa FORSSK.	Mukukua	Euphorbiaceae	indigenous	shrub	wood ash for medicinal/toothbrush	3	1	3.0	E
21	Achyranthes aspera L.	**	Amaranthaceae	indigenous	shrub	fence	60	2	30.0	L
22	Acokanthera schimperi (A.DC) SCHWEINF.	Muricho/Murichu/Mururu/Omurijoi	Apocynaceae	indigenous	tree/shrub	**	48	10	4.8	L/M/N
23	Acrocarpus fraxinifolius ARN.	Mrekiaifoko	Fabaceae(c)	introduced	shrub/tree	timber for beehive/shade	23	8	2.9	E/K/M/N
24	Adansonia digitata L.	Muamba	Bombacaceae	indigenous	tree	fruits/ fibre/root for dye	7	5	1.4	E/M
25	Adenia globosa ENGL.	**	Passifloraceae	indigenous	shrub/climber	**	5	1	5.0	E
26	Agave sisalana(sisal) PERR. EX ENGELM	MakongoMakonge/Abukut	Agaveaceae	introduced	shrub	fence/demarcation/fibre for rope,bags etc..	192	13	14.8	E/L/M/N
27	Albizia amara (ROXB.) BOIVIN	Mukuruwe/Kiundwa	Fabaceae(m)	indigenous	tree	firewood/charcoal	11	2	5.5	E/N
28	Albizia anthelmintica BRONGN.	Mwarua/Muguta	Fabaceae(m)	indigenous	shrub	deworming	44	12	3.7	E/M
29	Albizia gummifera (J.F.GMEL.) C.A.SM	Mubariti/Mukuruwe/Mukurue	Fabaceae(m)	indigenous	tree	firewood/charcoal/timber/medicinal	13	7	1.9	K/M/N
30	Albizia schimperiana OLIV.	**	Fabaceae(m)	indigenous	tree	firewood/timber/charcoal/medicinal	4	4	1.0	E/N
31	Aleurites moluccana (L.) WILLD	Mukurue	Euphorbiaceae	introduced	tree	nut oil	1	1	1.0	L
32	Allophylus rubifolius (HOCHS.) ENGL.	Muthe	Sapindaceae	indigenous	shrub/tree	fruit	4	1	4.0	E
33	Aloe kedongensis REYNOLDS	**	Aloeaceae	indigenous	shrub	medicinal	20	1	20.0	N
34	Aloe latifolia (AITON) HAW.	Sukurui	Aloeaceae	introduced	shrub	medicinal/making tannin	10	1	10.0	L
35	Aloe nyeriensis CHRISTIAN	Muthikurui/Thukurui	Aloeaceae	indigenous	shrub	fence/medicinal	80	4	20.0	L/N
36	Aloe secundiflora ENGL.	kiruma	Aloeaceae	introduced	shrub	medicinal/alcohol material	50	3	16.7	L/N
37	Aloe sp. L.	**	Liliaceae	indigenous	shrub	medicinal	1	1	1.0	E
38	Ambrosia maritima L.	**	Compositae	introduced	shrub	medicinal/fence	40	2	20.0	K
39	Anacardium occidentale L.	Ngoroce	Anacardiaceae	introduced	tree	cashew nut	1	1	1.0	M
40	Annona cherimola(Custard apple) MILLER	Mutomoko	Annonaceae	introduced	fruit tree	edible pulp/fruit	50	25	2.0	E/K/L/M/N
41	Annona muricata L.	Mfenesi/Mutomoko	Annonaceae	introduced	fruit tree	fruit	8	3	2.7	K/M
42	Annona senegalensis PERS.	Makulo	Annonaceae	indigenous	shrub/tree	fruit edible/bark for dye	1	1	1.0	E
43	Anthocleista grandifolia GILG	**	Loganiaceae	indigenous	tree	**	1	1	1.0	N
44	Antidesma venosum TUL.	Munyoronyoro	Euphorbiaceae	indigenous	shrub/tree	**	3	1	3.0	M
45	Araucaria columnaris(Pine) JUSS.	**	Araucariaceae	introduced	tree	timber/firewood	3	1	3.0	N
46	Araucaria heterophylla (SALISB.)	**	Araucariaceae	introduced	tree	**	2	2	1.0	K

No.	Scientific Name	Local Name	Family Name	Status	Plant type	Uses	Total No.	Places of 265 plots	Avg.no/plot	District
47	Artocarpus heterophyllus(Jackfruit) LAM.	**	Moraceae	indigenous	fruit tree	fruit	1	1	1.0	M
48	Arundinaria alpina(Mountain Bamboo) K.SCHUM.	Murangi	Gramineae	indigenous	tree/shrub	fence/chair making	10	1	10.0	E
49	Asparagus africanus LAM.	**	Asparagaceae	indigenous	shrub	fence/medicinal	66	6	11.0	E/L/N
50	Asparagus buchanani BAKER	Murura	Asparagaceae	indigenous	shrub	medicinal	40	3	13.3	L/N
51	Asparagus racemosus WILLD.	**	Asparagaceae	introduced	shrub	fence	2	1	2.0	N
52	Asparagus sp. L.	**	Asparagaceae	indigenous	shrub	**	10	1	10.0	L
53	Aspilia pluriseta SCHWEINF.EX ENGL.	**	Asteraceae	indigenous	shrub	ornamental	100	5	20.0	M
54	Asteranthe asterias (S.MOORE) ENGL. & DIELS	Muturethiga	Annonaceae	indigenous	shrub/tree	building pole	10	1	10.0	E
55	Azadirachta indica(Neem tree) A.JUSS	Murubaine/Mwarumbaine/Mkilifi	Meliaceae	introduced	tree	fuel/timber/shade/curving/medicinal	12	6	2.0	E/K/M/N
56	Azanza garckeana (F.HOFFM.) EXCELL & HILLC.	Mutoo	Malvaceae	indigenous	tree/shrub	fruit exudates edible/firewood/pole	45	29	1.6	E/K/M/N
57	Balanites aegyptiaca (L.) DELILE	Nguswa/ Muchurubu/Mububua	Balanitaceae	indigenous	tree	firewood/charcoal/fruit/ fodder/medicinal	97	14	6.9	E/L/M
58	Balanites sp. DEL.	Muvuvua	Balanitaceae	indigenous	shrub/tree	fruit/wood for building	13	3	4.3	E
59	Bambusa vulgaris SCHRADER EX WENDL.	**	Gramineae	introduced	shrub	fence/pole/furniture	1	1	1.0	L
60	Barleria eranthemoides R.BR.	**	Acanthaceae	indigenous	shrub	**	10	1	10.0	E
61	Barleria sp. L.	**	Acanthaceae	indigenous	shrub	**	10	1	10.0	E
62	Bauhinia tometosa L.	**	Caesalpiniaceae	indigenous	tree	fence	2	1	2.0	N
63	Berchemia discolor (KLOTZSCH) HEMSL.	Muthuana	Rhamnaceae	indigenous	tree/shrub	fruit edible/wood for stools	38	9	4.2	E/M
64	Bersama abyssinica FRESEN.	Murumiando	Melianthaceae	indigenous	shrub/tree	leaves poisonous to stock/wood for spoons	2	2	1.0	E/N
65	Boscia angustifolia A.RICH	Kiare/Lorien	Capparaceae	indigenous	shrub/tree	firewood	20	6	3.3	E/L
66	Boscia coriacea PAX	Muthiu	Capparaceae	indigenous	shrub/tree	wood for building/fruit edible	139	3	46.3	E
67	Bougainvillea sp. COMM.EX JUSS.	Mahua/Boganveria	Nyctaginaceae	introduced	shrub	ornamental/fence/garden/roadside decorating	182	25	7.3	E/K/L/M/N
68	Bourreria nemoralis (GURKE) THULIN	**	Boraginaceae	indigenous	shrub/tree	**	6	1	6.0	M
69	Bourreria teitensis (GURKE) THULIN	**	Boraginaceae	indigenous	shrub	**	5	1	5.0	M
70	Brachychiton acerifolium F.MUELL.	**	Sterculiaceae	introduced	tree	ornamental	1	1	1.0	E
71	Brachylaena huillensis O.HOFFM.	Muhogo	Compositae	indigenous	tree	timber/wood carving/firewood	2	2	1.0	N
72	Bridelia micrantha (HOCHST.)BAILL.	Mukoigo/Mukwego	Euphorbiaceae	indigenous	tree	fodder/firewood/building material/pole	194	50	3.9	E/K/M/N
73	Bridelia taitensis VATKE & PAX	Muandi/Mukwego	Euphorbiaceae	indigenous	shrub/tree	medicine/fruit edible	27	7	3.9	E/M
74	Brucea antidysenterica LAM.	Mukuriahungu	Simaroubaceae	indigenous	tree/shrub	shade/ornamental	1	1	1.0	N
75	Buddleia madagascariensis L.	**	Loganiaceae	introduced	shrub/tree	fence	40	2	20.0	K/N
76	Buddleia polystachya FRESEN.	**	Loganiaceae	indigenous	shrub	fence	162	10	16.2	L/N
77	Buddleia salviifolia (L.) LAM	**	Loganiaceae	introduced	shrub/tree	fence/ornamental	20	1	20.0	N
78	Cadaba farinosa FORSSK.	**	Capparaceae	indigenous	shrub/tree	roots for STD, chest cold	22	3	7.3	E
79	Caesalpinia decapetala (ROTH) ALSTON	Majana/Mubage	Fabaceae(c)	indigenous	shrub	hedge plant/live fence	211	18	11.7	E/K/M/N
80	Caesalpinia spinosa (MOLINA) KUNTZE	**	Fabaceae(c)	introduced	tree	**	3	1	3.0	M
81	Caesalpinia volkensii HARMS	Mubuthi/Muchuthi	Fabaceae(c)	indigenous	shrub	firewood/malaria medicine	5	3	1.7	E/L/M
82	Calliandra calothyrsus MEISSNER (C AM.)	Cariandra	Fabaceae(m)	introduced	tree	fodder/firewood/fence	101	7	14.4	K/M/N
83	Calliandra haematocephala BENTH	**	Fabaceae(m)	introduced	shrub	**	1	1	1.0	K
84	Callistemon citrinus(Bottole brush) R.BR.	Bottle brush	Myrtaceae	introduced	tree	ornamental/firewood/fence/windbreak	128	41	3.1	E/L/M/N
85	Callistemon spectabilis R.BR.	**	Myrtaceae	introduced	shrub/tree	ornamental	9	1	9.0	N
86	Calodendrum capense (L.F) THUNB.	Muraracii/Muhachi	Rutaceae	indigenous	tree	firewood/ornamental/wood for furniture	6	4	1.5	E/M/N
87	Calotropis procera (AITON) W.T.AITON	**	Asclepiadaceae	indigenous	shrub	**	5	1	5.0	M
88	Calpurnea aurea (AITON) BENTH.	Muchingiri	Fabaceae(p)	indigenous	tree/shrub	**	6	2	3.0	N
89	Canavalia sp. DC.	Muthandambogo	Capparaceae	indigenous	shrub	root for medicine	1	1	1.0	E
90	Canthium soligocarpam LAM.	Mubiru	Rubiaceae	introduced	shrub/tree	**	20	1	20.0	K
91	Capparis tomentosa LAM.	Kitandamboo(Kamba)	Capparaceae	indigenous	shrub/climber	root infusion is emetic & purgative	50	5	10.0	E
92	Carica papaya(Papaya) L.	Mbabai/Mababai	Caricaceae	introduced	fruit tree	fruit	566	91	6.2	E/K/L/M/N
93	Carrisa edulis (FORSSK.) VAHL	Mukawa	Apocynaceae	indigenous	shrub/scrambling	fruit/medicinal/firewood/fodder	109	15	7.3	L/M/N
94	Casaeria battiscombei R.E.FR.	**	Flacourtiaceae	indigenous	tree	firewood	3	2	1.5	M
95	Casimiroa edulis(White sapote) LLAVE & LEX.	Mtimoko/Kaba ngoho	Rutaceae	introduced	fruit tree	fruit	6	6	1.0	K/L/M/N

No.	Scientific Name	Local Name	Family Name	Status	Plant type	Uses	Total No.	Places of 265 plots	Avg.no/plot	District
96	Cassia abbreviata OLIV.	**	Fabaceae(c)	indigenous	tree	**	1	1	1.0	K
97	Cassia floribunda CAV.	Mucingiri	Fabaceae(c)	indigenous	tree	ornamental	1	1	1.0	N
98	Senna longiracemosa (VATKE) LOCK	Mwenu	Fabaceae(c)	indigenous	shrub/tree	remedy for malaria	2	1	2.0	E
99	Cassia occidentalis L.	**	Fabaceae(c)	introduced	tree	**	5	1	5.0	K
100	Cassia siamea L.	**	Fabaceae(c)	introduced	tree	street tree	185	17	10.9	E/M
101	Cassia spectabilis L.	Muangwa/Mwenu	Fabaceae(c)	introduced	tree	firewood/ornamental/boundary/street tree	153	32	4.8	E/K/L/M/N
102	Cassia tomentosa L.	Mucingiri	Fabaceae(c)	introduced	tree	fence/fruit/ornamental/windbreak	83	6	13.8	L/N
103	Cassipourea malosana (BAKER) ALSTON	Muthaithi	Rhizophoraceae	indigenous	tree	firewood/pole/handles	3	2	1.5	E/N
104	Casuarina cunninghamiana MIQ.	Muchababunduki/Muchinda nugu	Casuarinaceae	introduced	tree	hedge plant/timber/firewood	92	26	3.5	E/K/L/M/N
105	Catha edulis (VAHL) ENDL.	Miraa/Muirungi	Celastraceae	indigenous	tree	chewing as a stimulant/cash crop/wood for building	1111	25	44.4	E/K/M
106	Celtis africana BURM.F.	Murundu	Ulmaceae	indigenous	tree	timber/firewood	1	1	1.0	N
107	Cestrum aurantiacum LINDL.	**	Solanaceae	introduced	shrub	**	25	2	12.5	K
108	Cestrum elegans SCHLTDL.	**	Solanaceae	introduced	shrub	fence/ornamental	20	1	20.0	K
109	Cestrum nocturnum L.	**	Solanaceae	introduced	shrub	ornamental/mosquito repellent	101	6	16.8	M/N
110	Chorisia speciosa GIBBS & SEMIR	**	Bombacaceae	introduced	tree	ornamental	2	2	1.0	N
111	Citrus aurantium L.	**	Rutaceae	introduced	fruit tree	fruit	2	2	1.0	K/N
112	Citrus limon(Lemon) (L.) BURM.F.	Murimau/Marimau	Rutaceae	introduced	fruit tree	fruit	81	32	2.5	E/K/M/N
113	Citrus sinensis(Orange) (L.) OSBECK	Mucungwa/Muchungwa	Rutaceae	introduced	fruit tree	fruit/firewood/medicinal	161	45	3.6	E/K/L/M/N
114	Clausena anisata (WILLD.) BENTH.	Mutathi	Rutaceae	indigenous	shrub/tree	root decoction as medicine	52	6	8.7	E/K/N
115	Clerodendron eriophyllum GURKE	**	Verbenaceae	indigenous	tree	**	1	1	1.0	K
116	Clerodendrum johnstonii OLIV.	Murigono	Verbenaceae	indigenous	shrub	ornamental/fence/firewood/root for medicine	182	15	12.1	E/K/M/N
117	Clerodendrum myricoides (HOCHST.) VATKE	Munjuga-iria/Mugutugutu	Verbenaceae	indigenous	shrub/climber	root for medicine/wood for arrows	106	7	15.1	E/K/L/M
118	Clerodendrum spp. L.	**	Verbenaceae	indigenous	shrub	ornamental/fence	10	1	10.0	N
119	Clutia abyssinica JAUB.& SPACH	Muthimamburi	Euphorbiaceae	indigenous	shrub	root for liver pain	20	1	20.0	N
120	Combretum aculeatum VENT.	Mutithi(Kamba)	Combretaceae	indigenous	shrub	rafter	48	12	4.0	E/M
121	Combretum adenogonium(fragrans) LOEFL.	Mutithi/Muthigora	Combretaceae	indigenous	tree	rafter/twig fibres for basketry	5	1	5.0	M
122	Combretum collinum FRESEN.	Muraba/Mutithi	Combretaceae	indigenous	tree	charcoal	187	20	9.4	E/M
123	Combretum fragrans(adenogonium) F.HOFFM.	Muthithi	Combretaceae	indigenous	shrub	**	4	1	4.0	K
124	Combretum molle G.DON	Murama/Muraba	Combretaceae	indigenous	tree	fodder/pole/charcoal/firewood/medicinal	154	28	5.5	E/K/L/M
125	Combretum sp. LOEFL.	Murama	Combretaceae	indigenous	tree	**	5	1	5.0	K
126	Combretum zeyheri SOND.	Muthithi	Combretaceae	indigenous	tree	building/ firewood	48	7	6.9	E
127	Commiphora africana (A.RICH.) ENGL.	Mutunguru	Burseraceae	indigenous	tree	resin, bark and fruit for medicinal/live fence/pole	491	18	27.3	E/K/M
128	Commiphora chimperi CHIOV.	Mutungugu/Mutungu/Mukungugu	Burseraceae	indigenous	shrub/tree	fence	20	1	20.0	M
129	Commiphora edulis (KLOTZSCH) ENGL.	**	Burseraceae	indigenous	shrub	fence/firewood	6	2	3.0	M
130	Commiphora eminii ssp.zimmermannii (ENGL.) GILLETT	Mukungugu/Mutungugu	Burseraceae	indigenous	tree	support for yams/fence/pole/firewood	1121	73	15.4	E/K/L/M/N
131	Commiphora habessinica (O.BERG) ENGL.	Mutungu	Burseraceae	indigenous	shrub/tree	fence	21	6	3.5	E
132	Commiphora samharensis SCHWEINF.	Mutunaurea	Burseraceae	indigenous	shrub/tree	support for yams/fence/pole/firewood	49	6	8.2	E/M
133	Commiphora sp. JACQ.	**	Burseraceae	indigenous	tree	wood carving	184	19	9.7	E
134	Cordia africana LAM.	Muringa	Boraginaceae	indigenous	tree	timber/firewood/fibre/fodder/ beehive hanging/pole	201	59	3.4	E/K/L/M/N
135	Cordia monoica ROXB.	Muthigi/Mucici/Seki	Boraginaceae	indigenous	tree	fruit/leaves as sandpaper/firewood/medicinal	14	8	1.8	E/K/L/M
136	Cordia myxa L.	**	Boraginaceae	introduced	tree	medicinal/cabinet material	2	2	1.0	K
137	Cordia sinensis LAM.	Muthea	Boraginaceae	indigenous	tree	fruit edible	2	2	1.0	E
138	Cotyledon barbeyi BAKER	Ol masiligi	Crassulaceae	indigenous	herb	fence	20	1	20.0	L
139	Crotalaria agatiflora SCHWEINF.	muchingiri	Fabaceae(p)	indigenous	herb	ornamental	20	1	20.0	N
140	Crotalaria axillaris AITON	**	Fabaceae(p)	indigenous	shrub/herb	leaf for sore eyes	20	1	20.0	N
141	Crotalaria spp. L.	Mocingiri	Fabaceae(p)	indigenous	tree/shrub	fibre/green manure/ornamental	7	2	3.5	E/N
142	Croton dichogamus PAX	Kererwa	Euphorbiaceae	indigenous	shrub/tree	medicinal/firewood	23	2	11.5	L
143	Croton macrostachyus DELILE	Mutuntu/Mutundu	Euphorbiaceae	indigenous	tree	fodder/timber/firewood/axe handle/root for remedy/building/hedge plant	356	81	4.4	E/K/L/M/N

No.	Scientific Name	Local Name	Family Name	Status	Plant type	Uses	Total No.	Places of 265 plots	Avg.no/plot	District
144	Croton megalocarpus HUTCH.	Mukinduri	Euphorbiaceae	indigenous	tree	firewood/charcoal/fence/shade/medicinal/pole/hedge plant	1835	108	17.0	E/K/L/M/N
145	Cupressus lustianica MILLER	Mutarakwe/Muthithinda	Cupressaceae	introduced	tree	timber/firewood/rafter/medicinal	2331	72	32.4	E/K/L/M/N
146	Cupressus sempervirens L.	Muthithinda	Cupressaceae	introduced	tree	ornamental	1	1	1.0	N
147	Cupressus sp. L.	**	Cupressaceae	introduced	tree	timber/live fence	148	9	16.4	E
148	Cussonia arborea A.RICH.	Malendi	Araliaceae	indigenous	tree	wood for mole trap	1	1	1.0	E
149	Cussonia holstii ENGL.	Mukurukuru/Mwenjera/Murogorogo/Murob a/Lourulu	Araliaceae	indigenous	tree	timber/root for medicine/beehive/fodder	23	12	1.9	E/L/M/N
150	Cussonia spicata THUNB.	Muroha	Araliaceae	indigenous	tree	firewood	1	1	1.0	L
151	Cyathula polycephala BAKER	Mutegenye	Amaranthaceae	indigenous	shrub/climber	**	25	2	12.5	K
152	Cyphomandra betacea(Tree tomato) SENDTN.	Matunda ma thakame	Solanaceae	introduced	shrub/tree	vegetable/fruit	244	31	7.9	E/K/M/N
153	Dalbergia melanoxylon GUILL.& PERR.	Mvingo	Fabaceae(p)	indigenous	tree	wood carving	6	2	3.0	E
154	Datura stramonium L.	**	Solanaceae	introduced	shrub/herb	medicine for asthma	53	4	13.3	E/N
155	Datura suaveolens(Angel's trumpet) HUMB. & BONPL. EX WI	Kihua	Solanaceae	introduced	shrub	ornamental/fence/fodder	52	6	8.7	K/N
156	Delonix elata (L.) GAMBLE	Mwarange	Fabaceae(c)	indigenous	tree	wood for utensils/firewood	9	4	2.3	E
157	Delonix regia (HOOK.)	Mwarange	Fabaceae(c)	introduced	tree	shade/firewood/stools/walking sticks	40	3	13.3	E/M
158	Dichrostachys cinerea (L.) WIGHT & ARN.	Muchanachana	Fabaceae(m)	indigenous	shrub/tree	making cattle bomas	26	11	2.4	E/K/M
159	Diospyros abyssinica (HIERN) F.WHITE	Muiruthi	Ebenaceae	indigenous	tree	timber/axe handle, furniture	1	1	1.0	N
160	Dodonaea angustifolia L.F.	Muremamuthua	Sapindaceae	indigenous	shrub/tree	timber/firewood	147	7	21.0	L/M
161	Dombeya burgessiae GERR. EX HARV. & SOND.	Mukeu	Sterculiaceae	indigenous	shrub	fibre	20	1	20.0	M
162	Dombeya rotundifolia PLANCH.	Mutoo	Sterculiaceae	indigenous	tree	bark for fibre	10	2	5.0	E
163	Dovyalis abyssinica (A.RICH.) WARB.	Mukambura	Flacourtiaceae	indigenous	shrub/tree	firewood/fruit/medicinal/soap material	5	4	1.3	E/L/N
164	Dovyalis caffra(Kei-apple) (HOOK.F. & HARVEY)	Kaiyaba	Flacourtiaceae	introduced	shrub	fence/fruit	714	35	20.4	E/K/L/M/N
165	Dracaena afromontana MILDBR.	**	Dracaenaceae	indigenous	tree	**	2	1	2.0	K
166	Dracaena ellenbeckiana ENGL.	Muthare	Dracaenaceae	indigenous	tree	fodder	1	1	1.0	M
167	Dracaena steudneri ENGL.	Muthare/Murigurigu	Dracaenaceae	indigenous	shrub/tree	fodder	22	3	7.3	E/M
168	Duosperma kilimandscharica (LINDAU) DAYTON	Muthuti	Acanthaceae	indigenous	shrub	fence/vegetable	25	2	12.5	M
169	Dyschoriste thunbergiiflora (S.MOORE) LINDAU	Muage	Acanthaceae	indigenous	shrub	**	17	3	5.7	E/K/M
170	Ehretia cymosa THONN.	Murembu	Boraginaceae	indigenous	tree	tool/root for diarrhoea/hedge/firewood/handle	22	12	1.8	E/M/N
171	Ekebergia capensis SPARRM.	Mununga	Rosaceae	indigenous	tree	firewood/medicinal/stool /beehive	14	8	1.8	E/K/M/N
172	Elaeodendron buchananii (LOES.) LOES.	Murogi/Mutanga	Celastraceae	indigenous	tree	hard and fairly durable wood/firewood	7	3	2.3	L/N
173	Embelia schimperi VATKE	Matindia ariithi	Myrsinaceae	indigenous	shrub/climber	medicinal	1	1	1.0	N
174	Ensete ventricosum (WELW.) CHEESMAN	Iuindu	Musaceae	indigenous	tree	ornamental	4	2	2.0	K/N
175	Entada abyssinica STEUD.EX A.RICH.	**	Fabaceae(m)	indigenous	tree	**	1	1	1.0	M
176	Eriobotrya japonica (THUNB.)	Muharu/Mabera	Fabaceae(p)	introduced	fruit tree	fruit/firewood	262	85	3.1	E/K/L/M/N
177	Erythrina abyssinica DC.	Muhuti/Mubuti/Muuti/Murukati	Fabaceae(p)	indigenous	tree	fruit/firewood/medicinal/wood for stool & beehive	75	36	2.1	E/K/L/M/N
178	Erythrina lysistemon HUTCH	**	Fabaceae(p)	introduced	tree	shade/timber/firewood/ornamental	10	2	5.0	L/M
179	Erythrina melanacantha HARMS	Mukunguu(Embu)	Fabaceae(p)	indigenous	tree	firewood/beehive/wood for headrest	4	3	1.3	E
180	Erythrococca bongensis PAX	Muharangare	Euphorbiaceae	indigenous	tree/shrub	medicinal/branches for arrow shafts	20	1	20.0	N
181	Eucalyptus citriodora HOOK.	**	Myrtaceae	introduced	tree	**	68	5	13.6	K
182	Eucalyptus globulus LABILL.	Munyuamai/Mubau	Myrtaceae	introduced	tree	timber/firewood/pole/medicinal	122	13	9.4	L/M/N
183	Eucalyptus paniculata SM.	**	Myrtaceae	introduced	tree	woodfuel/timber	100	1	100.0	N
184	Eucalyptus saligna SM.	Mibau/Mubau/Munyuamai	Myrtaceae	introduced	tree	firewood/timber/pole	757	48	15.8	E/K/L/M/N
185	Eucalyptus sp. L'H'ERIT.	**	Ebenaceae	introduced	tree	firewood/pole	633	16	39.6	E/N
186	Euclea divinorum HIERN	Mukinyai/Mukinyei/Ol kingei	Ebenaceae	indigenous	shrub/tree	root for yellow dye& toothache/pole/toothbrush/firewood	1625	33	49.2	E/L/M/N
187	Euphobia cryptospinosa P.R.O.BALLY	**	Euphorbiaceae	indigenous	shrub	ornamental	1	1	1.0	N
188	Euphorbia candelabrum KOTSCHY	Mububungu/Kibubungi	Euphorbiaceae	indigenous	tree	boundary/fence/bark decoction for childbirth	17	5	3.4	E/N/M
189	Euphorbia cotinifolia(Red euphorbia) L.	**	Euphorbiaceae	introduced	shrub/tree	dye/fence	27	4	6.8	K/M/N
190	Euphorbia friesiorum (HASSL.) S.CARTER	Kithuri	Euphorbiaceae	indigenous	shrub/tree	latex causes blindness	11	1	11.0	E
191	Euphorbia heterochroma PAX	**	Euphorbiaceae	indigenous	shrub	**	1	1	1.0	N

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192	Euphorbia matabelensis PAX	**	Euphorbiaceae	indigenous	shrub/tree	fence /ornamental	1	1	1.0	E
193	Euphorbia pulcherrima(Poinsettia) WILLD.EX KLOTZSCH	**	Euphorbiaceae	introduced	shrub	ornamental	15	8	1.9	E/M/N
194	Euphorbia sp. L.	**	Euphorbiaceae	introduced	tree	fence etc.	89	8	11.1	E
195	Euphorbia tirucalli L.	Kariaria/Muthuri	Euphorbiaceae	indigenous	shrub/tree	fence	957	55	17.4	E/K/L/M
196	Fagaropsis hildebrandtii (ENGL.) MILNE-REDH.	Mubundibindi	Rutaceae	indigenous	shrub/tree	wood for furniture	2	1	2.0	E
197	Faurea saligna HARV.	Mutorothua	Proteaceae	indigenous	tree	timber for furniture	15	4	3.8	E
198	Ficus benjamina L.	**	Moraceae	introduced	tree	shade/street tree	8	6	1.3	E/M
199	Ficus capreifolia DELILE	Mugumo	Moraceae	indigenous	tree	beehive hanging/shade	1	1	1.0	M
200	Ficus elastica L.	**	Moraceae	introduced	tree	ornamental & street tree	2	2	1.0	E/N
201	Ficus lutea VAHL	Mumbu	Moraceae	indigenous	tree	**	3	3	1.0	E/K
202	Ficus natalensis HOCHST.	Mugumo	Moraceae	indigenous	tree	fodder/firewood/shade/barkcloth	81	18	4.5	E/M/N
203	Ficus sp. L.	**	Moraceae	indigenous	tree	boundary/pole etc	2	2	1.0	E
204	Ficus sur FORSSK.	Mukuyu	Moraceae	indigenous	tree	fruit edible/wood for stools/fiber/timber/beehive hanging	20	11	1.8	E/M
205	Ficus sycomorus L.	Mukuyu	Moraceae	indigenous	tree	sacred tree/firewood	27	5	5.4	E/M
206	Ficus thonningii BLUME	Mugumo	Moraceae	indigenous	tree	fruit edible/bark for string/fodder/firewood	19	15	1.3	E/K/L/M/N
207	Ficus vasta FORSSK.	Mugomo	Moraceae	indigenous	tree	trapping gum for birds	1	1	1.0	M
208	Filicium decipiens (WRIGHT & ARN.) THWAITES	**	Sapindaceae	indigenous	tree	**	1	1	1.0	K
209	Flueggea virosa (WILLD.) VOIGT	Mukuluu	Euphorbiaceae	indigenous	shrub	fruit /charcoal/root for chest pain	74	7	10.6	E/M
210	Fraxinus pennsylvanica MARSHALL	Mugaita	Oleaceae	introduced	tree	timber/firewood/shade/ornamental	22	5	4.4	K/M/N
211	Fuchsia arborescens SIMS	**	Onagraceae	introduced	shrub	shade	1	1	1.0	K
212	Fuchsia magellanica DC (MEX.)	**	Onagraceae	introduced	shrub/tree	ornamental	20	1	20.0	N
213	Galiniera saxifraga (HOSHST.) BRIDSON	Muthigitha	Rubiaceae	indigenous	tree/shrub	walking stick	1	1	1.0	N
214	Gamolepsis chrysanthemoides LESS.	Ihua ria muhangi	Compositae	introduced	shrub	fence/ornamental	320	16	20.0	K/L/M/N
215	Garcinia livingstonei T.ANDERSON	Murera/Muthuthuri	Guttiferae	indigenous	tree	fruit/firewood	23	3	7.7	E/M
216	Gardenia fiorii CHIOV.	**	Rubiaceae	indigenous	shrub	**	1	1	1.0	M
217	Gardenia ternifolia SCHUMACH. & THONN.	**	Rubiaceae	indigenous	shrub	**	3	2	1.5	K/M
218	Gloriosa simplex L.	**	Liliaceae	introduced	shrub	**	20	1	20.0	K
219	Gnidia latifolia (OLIV.) GILG	Musunziili	Thymeleaceae	indigenous	shrub/tree	bark for rope/leaves are poisonous	22	5	4.4	E
220	Gnidia subcordata MEISN.	Muchingiri	Thymeleaceae	indigenous	shrub	bark fibre for rope	1	1	1.0	L
221	Grewia fallax K.SCHUM.	**	Tiliaceae	indigenous	shrub/tree	**	8	4	2.0	K
222	Grevillea robusta R.BR.	Mukima	Proteaceae	introduced	tree	timber/firewood/fodder/pole/windbreak	6313	192	32.9	E/K/L/M/N
223	Grewia bicolor JUSS.	Murigi/Mulawa	Tiliaceae	indigenous	shrub/tree	fruit/fibre/pole	102	14	7.3	E/L/M
224	Grewia forbesii HARV. EX MAST.	**	Tiliaceae	indigenous	shrub/tree	**	1	1	1.0	M
225	Grewia similis K.SCHUM	Mutheregendu/Mutherigendi	Tiliaceae	indigenous	shrub	fruit/fodder/firewood/fence/pole	33	9	3.7	L/M/N
226	Grewia sp. L.	**	Tiliaceae	indigenous	shrub/tree	firewood/timber	20	5	4.0	E
227	Grewia tembensis FRESEN.	Mutuva/Muthegendi	Tiliaceae	indigenous	shrub	root for cough/fruit/firewood	10	5	2.0	E/L/M
228	Grewia villosa WILLD.	Mulawa	Tiliaceae	indigenous	tree	fruit edible/wood for building	80	5	16.0	E/M
229	Gutenbergia cordifolia BENTH. EX OLIV.	**	Compositae	indigenous	shrub	live fence	20	1	20.0	K
230	Hagenia abyssinica (BRUCE) J.F.GMEL.	Mumondo	Rosaceae	indigenous	tree	bark for anthelmintic/wood for carpentry/deworming	2	2	1.0	N
231	Hakea saligna SCHRADER.	Muburanyota	Proteaceae	introduced	tree	shade	28	3	9.3	M/N
232	Harrisonia abyssinica OLIV.	Mutagataga/Mutandangubo	Simaroubaceae	indigenous	shrub/tree	fodder/fruit/root for VD, diarrhoea	21	5	4.2	E/M
233	Harungana madagascariensis LAM. EX POIR.	Munyamwe	Guttiferae	indigenous	tree	leaf & bark for bloody diarrhoea/firewood	2	2	1.0	M
234	Hermannia uhligii ENGL.	**	Sterculiaceae	indigenous	shrub	**	1	1	1.0	E
235	Hevea brasiliensis (Rubber tree) (A.JUSS.) MULL.ARG.	**	Euphorbiaceae	introduced	tree	best natural rubber	1	1	1.0	E
236	Hibiscus spp. L.	Njurai	Malvaceae	introduced	shrub	fence/ornamental	301	27	11.1	E/K/L/N
237	Hoslundia opposita VAHL	Musovi	Labiatae	indigenous	shrub	fruit edible/leaves for tea	21	2	10.5	E/M
238	Hydrangea macrophylla (THUNB.) SER.	**	Hydrangeaceae	introduced	shrub	ornamental	1	1	1.0	M
239	Hymenodictylon parvifolium OLIV.	Mulinditi	Euphorbiaceae	indigenous	shrub/tree	medicine/ carving	1	1	1.0	E
240	Indigofera arrecta A.RICH.	Mucugucugu	Fabaceae(p)	indigenous	shrub	firewood/deworming	92	8	11.5	E/L/M

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241	Indigofera garckeana VATKE	Mucingiri	Fabaceae(p)	indigenous	shrub	firewood	20	1	20.0	L
242	Ipomoea hildebrandtii VATKE	**	Convolvulaceae	indigenous	shrub	ornamental	5	1	5.0	N
243	Ipomoea kituiensis VATKE	Kihua/Rugiteni/Lokiteng	Convolvulaceae	indigenous	shrub/climber	ornamental/fence/fodder/roots for stomach-ache	115	10	11.5	E/L/N
244	Ipomoea obscura (L.) KER GAWL.	**	Convolvulaceae	introduced	shrub	pot herb	15	2	7.5	E
245	Ipomoea sp. L.	**	Convolvulaceae	introduced	shrub	ornamental	10	1	10.0	L
246	Jacaranda mimosofolia D.DON	Muchakaranda/Mucakaranda	Bignoniaceae	introduced	tree	timber/wood carving/charcoal/banana support/shade/firewood	111	42	2.6	E/K/L/M/N
247	Jasminum sp. L.	**	Oleaceae	introduced	shrub	fence/ornamental	300	15	20.0	K/M/N
248	Jatropha curcas L.	**	Euphorbiaceae	indigenous	shrub/tree	fence/firewood/medicinal/oil seed	191	20	9.6	E/K/M/N
249	Juniperus procera ENDL.	Mutarakwa/Oltarakwe	Cupressaceae	indigenous	tree	timber/firewood/medicinal/pole	159	22	7.2	L/M/N
250	Justicia whytei S.MOORE	**	Acanthaceae	indigenous	shrub	**	20	1	20.0	L
251	Keetia gueinzii (SOND.) BRIDSON	Mogokoma	Rubiaceae	indigenous	climber/shrub	fruit edible	20	1	20.0	N
252	Kigelia africana(Sausage tree) (LAM.) BENTH.	Kiratina/Muratina	Bignoniaceae	indigenous	tree	firewood/brewing local beer	52	13	4.0	E/K/M
253	Lannea alata (ENGL.) ENGL.	Mutungu	Anacardiaceae	indigenous	shrub/tree	fruit edible	5	3	1.7	E/M
254	Lannea rivae (CHIOV.) SACLEUX	Mutharara/Mutherema/Atubunjungi	Anacardiaceae	indigenous	shrub/tree	fruit/bark for fibre/timber	20	9	2.2	E/L/M
255	Lannea schimperi (A.RICH.) ENGL.	Murasi	Anacardiaceae	indigenous	tree	fruit edible/bark for tea, rope and red-brown dye/bark decoction for headache and stomach-ache	3	2	1.5	E
256	Lannea schweinfurthii (ENGL.) ENGL.	Muraci	Anacardiaceae	indigenous	shrub/tree	fruit/firewood/bark for tea, rope, dye, medicine	7	6	1.2	E/M
257	Lannea sp. A.RICH.	**	Anacardiaceae	indigenous	shrub/tree	fruit edible/bark for medicine	16	4	4.0	E
258	Lannea triphylla (A.RICH.) ENGL.	Kitherema	Anacardiaceae	indigenous	shrub/tree	fruit, root edible/bark for rope	1	1	1.0	E
259	Lantana camara L.	Mukigi/Muchomoro	Verbenaceae	indigenous	shrub	fence/fodder	1652	89	18.6	E/K/M/N
260	Lantana trifolia L.	Mukenia	Verbenaceae	indigenous	shrub	firewood/medicinal(cold)/fence/fruit edible	120	7	17.1	L/M/N
261	Lecaniodiscus fraxinifolius BAKER	**	Sapindaceae	indigenous	fruit tree	**	1	1	1.0	K
262	Leonotis nepetifolia var. africana (P.BEAUV.) J.K.MORTON	**	Labiatae	indigenous	shrub	roots for stomach troubles	180	9	20.0	L/M/N
263	Leucaena luecocephala (LAM.) DE WIT	**	Fabaceae(m)	introduced	tree	fodder/ornamental/greemanure/agroforestry	125	27	4.6	E/K/L/M/N
264	Leucaena sp. BENTH.	**	Fabaceae(m)	introduced	tree	firewood/green manure	5	3	1.7	E
265	Leucas calostachys OLIV.	**	Labiatae	indigenous	shrub	**	20	1	20.0	L
266	Leucas grandis GURKE	Mucii	Labiatae	indigenous	shrub	**	20	1	20.0	N
267	Leucas martinicensis (JACQ.) R.BR.	Bebe	Labiatae	introduced	shrub	fence	40	2	20.0	L
268	Lippia javonica (BURM.F.) SPRENG.	Muthiriti/Mukenia	Verbenaceae	indigenous	shrub	firewood/fence/building material/store for maize	354	19	18.6	L/M/N
269	Lippia kituiensis VATKE	**	Verbenaceae	indigenous	shrub	fence	45	3	15.0	M
270	Lonchocarpus bussei HARMS	Muthigiri	Papilionaceae	indigenous	tree	medicine/wood for pestle	13	2	6.5	E
271	Lonchocarpus eriocalyx HARMS	Kinguuthe/Muthingiri	Fabaceae(p)	indigenous	shrub/tree	medicinal(asthma)/pole /firewood/wood for pestle/bark for stomach problems	56	16	3.5	E/K/M
272	Lycium europaeum L.	Lokii	Solanaceae	indigenous	shrub	fodder/medicinal/fence	47	3	15.7	L
273	Macadamia integrifolia Maiden & Betche	Mukandania	Proteaceae	introduced	fruit/tree	nut/oil/timber/firewood	60	8	7.5	E
274	Macadamia tetraphylla L. Johnson	Mukandania	Proteaceae	introduced	fruit/tree	nut/oil/timber/firewood	303	56	6.5	E/K/M/N
275	Markhamia lutea (BENTH.) K.SCHUM.	**	Bignoniaceae	indigenous	tree	stem for stool/ beehive/ boundary/pole/firewood/timber	102	31	3.3	E/K/L/M/N
276	Macaranga kilimandscharica PAX	Mukaragati/Muchami	Euphorbiaceae	indigenous	tree	nut/oil/timber/firewood	10	5	2.0	E/K/M/N
277	Maerua angolensis DC.	Mware/Kiare	Capparaceae	indigenous	shrub/tree	firewood/wood for boxes/medicinal-deworming	11	5	2.2	E/M
278	Maerua crassipes FORSSK.	Gitanangia	Capparaceae	indigenous	shrub/tree	wood for furniture	2	1	2.0	E
279	Maerua decumbens (BRONGN) DE WOLF	**	Capparaceae	indigenous	shrub	root for water purification/fruit edible	5	1	5.0	E
280	Maerua edulis (GILG-BEN. & BENEDICT) DEWOLF	Muburuburu	Capparaceae	indigenous	shrub	root for stomach-ache	5	1	5.0	E
281	Maerua kirkii (OLIV.) F. WHITE	Mabubu	Capparaceae	indigenous	shrub/tree	root for purifying water	11	2	5.5	E
282	Maerua triphylla A.RICH.	Mununga mai/Mulingula/Lotasha	Capparaceae	indigenous	shrub/tree	firewood/shade/fence/medicinal/leaves for yellow dye	54	9	6.0	E/L/M/N
283	Maesa lanceolata FORSSK.	Mundonge	Myrsinaceae	indigenous	tree	firewood/deworming	3	3	1.0	M/N
284	Malus domestica BORKH.	**	Rosaceae	introduced	fruit tree	fruit	22	2	11.0	K/M
285	Malus sylvestris(Apple) (L.) MILLER')	**	Rosaceae	introduced	fruit tree	fruit	2	2	1.0	N
286	Malva parviflora L.	**	Malvaceae	introduced	shrub	**	20	1	20.0	N
287	Mangifera indica(Mango) L.	Muembe/Mwembe	Anacardiaceae	introduced	fruit tree	fruit/timber/charcoal/firewood	441	111	4.0	E/K/L/M/N
288	Manihot glaziovii(Tree cassava) MULL.ARG.	Kimuanga	Euphorbiaceae	introduced	shrub/tree	ornamental/rubber/erosion protection/shade	7	6	1.2	E/K

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289	Margaritaria discoidea (BAILL.)	Mukarara	Euphorbiaceae	indigenous	shrub/tree	ornamental/shade/erosion control/fodder/timber/firewood	10	6	1.7	E/K/M
290	Maytenus arbutifolia (A.RICH.) WILCZEK	Muburu	Celastraceae	indigenous	shrub	stem for stool and beehive/boundary	21	2	10.5	E
291	Maytenus heterophylla (ECKL. & ZEYH.) N.ROBSON	Muthuthi	Celastraceae	indigenous	shrub/tree	firewood/medicinal/root as vegetable/fence	79	10	7.9	E/L/N
292	Maytenus putterlickioides (OLIV.) EXELL & MENDONCA	Murera	Celastraceae	indigenous	tree	firewood/medicinal	1	1	1.0	M
293	Maytenus senegalensis (LAM.) EXELL	Muthuthi	Celastraceae	indigenous	shrub	medicinal/root as vegetable	19	4	4.8	E/M
294	Maytenus sp. MOLINA.	Muthithi	Celastraceae	indigenous	shrub/tree	wood for furniture	31	1	31.0	N
295	Melaleuca armillaris SM.	**	Myrtaceae	introduced	shrub	ornamental	15	1	15.0	N
296	Melanthera scandens (SCHUMACH. & THONN.)	**	Compositae	introduced	shrub	**	20	1	20.0	M
297	Melia azedarach L.	Mwarubaine	Meliaceae	introduced	tree	firewood/ornamental/medicinal-malaria/wood for tool handles & sticks	56	17	3.3	E/K/L/M/N
298	Melia volkensii GURKE	Mukau	Meliaceae	indigenous	tree	timber/ornamental/firewood	342	28	12.2	E/M
299	Microglossa pyrifolia (LAM.) KUNTZE	**	Compositae	indigenous	shrub	**	20	1	20.0	K
300	Milicia excelsa(WELW.) C.C. BERG	Mururi	Moraceae	indigenous	tree	timber/fodder/firewood	1	1	1.0	M
301	Millettia dura DUNN	Muhatia	Fabaceae(p)	indigenous	tree	good timber-termite resistant/fodder/hoe/axe handle/fodder	41	15	2.7	E/M/N
302	Morus alba(Mulberry) L.	Mutaratare/Mutare/Ndare	Moraceae	introduced	fruit tree	fruit edible/leaves for silkworm/fodder/hoe/axe handle	139	36	3.9	E/K/L/M/N
303	Musa sapientum(Banana) L.	Marigu/Ndigu	Musaceae	introduced	shrub	fruit/fodder	2632	57	46.2	E/L/M/N
304	Myrianthus holstii ENGL.	Mutuya	Moraceae	indigenous	tree	fruit edible	1	1	1.0	M
305	Myrica salicifolia HOSCHST. EX. A. RICH	Muthogoya	Myricaceae	indigenous	tree	fruit edible	1	1	1.0	E
306	Mystroxylon aethiopicum (THUNB.) LOES.	Munyamate/Mukawa	Celastraceae	indigenous	shrub/tree	fruit edible/bark for tea and brown dye/firewood/medicinal	70	6	11.7	L/N
307	Neoboutonia macrocalyx PAX	Mutundu	Euphorbiaceae	indigenous	tree	firewood/wood for paper pulp	3	2	1.5	K/N
308	Newtonia buchananii (BAKER) G.C.C.GILBERT & BOUTIQUI	Mukui	Fabaceae(m)	indigenous	tree	timber/firewood	2	1	2.0	M
309	Newtonia hildebrandtii (VATKE) TORRE	Mutuntu	Fabaceae(m)	indigenous	tree	timber/fodder/medicinal/bark for intoxicating stuff	4	3	1.3	E/M
310	Ochna inermis (FORSSK.) SCHWEINF.	**	Ochnaceae	indigenous	shrub	**	1	1	1.0	M
311	Ochna insculpta SLEUMER	Mutebi	Ochnaceae	indigenous	shrub/tree	wood carving/timber	1	1	1.0	E
312	Ochna ovata O.HOFFM.	Kitandi	Ochnaceae	indigenous	shrub/tree	wood for building and walking sticks	5	1	5.0	E
313	Ocimum gratissimum SUAVE	Mukandu	Labiatae	indigenous	shrub	fence/firewood/medicinal(toothache/fever)	102	12	8.5	K/L/M/N
314	Ocimum suave L.	**	Labiatae	indigenous	shrub/herb	leaves for cough remedies	40	2	20.0	E
315	Ocotea usambarensis ENGL.	Muthaiti	Lauraceae	indigenous	tree	firewood/timber	2	1	2.0	M
316	Olea europaea ssp. Africana (MILL)	Sukuru/Mutamaiyu	Oleaceae	indigenous	shrub/tree	firewood/milk steriliser/medicinal/wood carving/charcoal/timber/fruit edible	70	30	2.3	E/K/L/M/N
317	Olea laurifolia L.	Sungurui	Oleaceae	indigenous	shrub/tree	brewing beer	3	3	1.0	L
318	Olinia rochetiana A.JUSS.	Muchui	Oliniaceae	indigenous	shrub/tree	medicine	4	2	2.0	L
319	Opuntia vulgaris MILL.	Matome/Mubetu	Cactaceae	indigenous	shrub	fence/fruit	120	6	20.0	L/M
320	Ormocarpum kirkii S.MOORE	Muthingii	Fabaceae(p)	indigenous	tree	timber/fruit edible/firewood	35	3	11.7	E/M
321	Oncoba spinosa FORSSK.	Kiage	Flacourtiaceae	indigenous	shrub/tree	fruit edible, wood for furniture	1	1	1.0	N
322	Osyris lanceolata HOCHST. & STEUDEL	Muthithioni	Santalaceae	indigenous	shrub/tree	medicinal/ fibre/fruit/bark for making tea	25	2	12.5	L
323	Ozoroa insignis DELILE	Mugadi	Anacardiaceae	indigenous	tree	medicinal	18	6	3.0	E/M
324	Pachystela brevipes (BAKER) ENGL.	Muthankumi/Muthethea	Sapotaceae	indigenous	tree	handle making/fodder/firewood	3	2	1.5	M
325	Pappea capensis ECKL. & ZEYH.	Mubaa/Muthingongi	Sapindaceae	indigenous	shrub/tree	fruit & seed edible/firewood/root,bark for kidney trouble	17	9	1.9	E/L/M/N
326	Parinari curatellifolia PLANCH. EX BENTH	Mura	Chrysobalanaceae	indigenous	tree	seed edible	3	2	1.5	E
327	Pavetta sp. L.	**	Rubiaceae	indigenous	shrub	**	20	1	20.0	M
328	Pavetta teitana K.SCHUM.	**	Rubiaceae	indigenous	shrub/tree	fence	25	2	12.5	K/L
329	Pentas parvifolia HIERM	Kirere	Rubiaceae	indigenous	shrub	fruit edible	10	1	10.0	E
330	Persea americana(Avocado) MILL.	Mukorobea/Makondobia/Mukondobia/Muabakado/Abakando	Laraceae	introduced	fruit tree	fruit/timber/firewood	553	127	4.4	E/K/L/M/N
331	Phiranthus sepians	Mukura	Euphorbiaceae	indigenous	shrub	**	1	1	1.0	K
332	Phoenix reclinata JACQ.	Mukindu	Palmae	indigenous	shrub	ornamental	26	4	6.5	N
333	Phoenix roebelenii O'BRIEN EX C.ROEBELEN	**	Palmae	introduced	palm	**	1	1	1.0	K
334	Phoenix sp. L.	Engol	Palmae	introduced	tree	ornamental	1	1	1.0	L
335	Phragmanthera rufescens (DC.) BALLE	**	Loranthaceae	introduced	shrub	**	20	1	20.0	L

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336	Phyllanthus sepialis MULL.ARG.	Mukura	Euphorbiaceae	indigenous	shrub	**	1	1	1.0	K
337	Phyllanthus sp. L.		Euphorbiaceae	indigenous	shrub/tree	**	40	5	8.0	E
338	Phytolacca dodecandra L'HER.	Muhoko	Phytolaccaceae	indigenous	shrub	fence/women's abortion	21	2	10.5	M/N
339	Piliostigma thonningii(Camel's foot) (SCHUMACH.) MILNE-R	Muukura/Mukolokoro	Fabaceae(c)	indigenous	tree	fodder/beehive hanging/fence/wood for bows/bark for red dye, cough/pods and seeds for blue dye	86	23	3.7	E/K/L/M/N
340	Pinus patula SCHLECT. & CHAM.	Muchabunduki/Muchinda nugu	Pinaceae	introduced	tree	timber/firewood/boxwood/wood pulp	27	8	3.4	L/M/N
341	Pinus sp. L.	Mucinda-ngugu	Pinaceae	introduced	tree	wood for bows/pods,seeds for blue dye	124	3	41.3	E
342	Pistacia aethiopica KOKWARO	Mugaita	Anacardiaceae	indigenous	shrub/tree	medicinal	2	1	2.0	N
343	Pisum sativum L.	**	Fabaceae(p)	introduced	fruit tree	fruit	3	2	1.5	M
344	Plectranthus barbatus ANDR.	Maigoya/Muigoya	Labiatae	indigenous	shrub	fence/medicinal/firewood	615	27	22.8	K/L/M/N
345	Podocarpus falcatus MIRB.	Muthengera	Podocarpaceae	indigenous	tree	timber/firewood	2	1	2.0	L
346	Polyscias kikuyuensis SUMMERH.	Mutati	Araliaceae	indigenous	tree	firewood/rat trap	2	1	2.0	N
347	Portulacaria afra L.	Muthithinda	Portulacaceae	introduced	shrub	fence	20	1	20.0	L
348	Premna resinosa (HOCHST.) SCHAUER	Mukaaka	Verbenaceae	indigenous	shrub	timber/paper material	17	3	5.7	E
349	Plumeria rubra L.	**	Apocynaceae	introduced	tree	**	1	1	1.0	K
350	Prunus africana (HOOK.F.) KALKMAN	Mwiria/Muiri	Rosaceae	indigenous	tree	timber/firewood/medicinal	64	27	2.4	E/K/M/N
351	Prunus domestica(plum) L.	Ndarathini	Rosaceae	introduced	tree	fruit/firewood/timber/medicinal	55	19	2.9	E/L/M/N
352	Prunus persica (L) BATSCH	Muchemu	Rosaceae	introduced	tree	fruit	5	1	5.0	N
353	Prunus sp. L.	**	Rosaceae	introduced	shrub/tree	**	1	1	1.0	N
354	Psiadia punctulata (DC.) VATKE	Mwendanguiko/Rombai/Muriae/Siapei	Compositae	indigenous	shrub	firewood/medicinal	276	24	11.5	L/M/N
355	Psidium guajava(Guava) L.	Mubera	Myrtaceae	introduced	fruit tree	fruit/firewood/animal fodder	173	67	2.6	E/K/L/M/N
356	Psydrax schimperiana (A.RICH.) BRIDSON	Ruathe	Rubiaceae	indigenous	shrub/tree	timber/firewood	21	2	10.5	L/N
357	Pterolobium stellatum (FORSSK.) BRENAN	Mutangaruri	Fabaceae(c)	indigenous	shrub	root for stomach-ache	40	2	20.0	N
358	Punica granatum L.	Mukungumanga	Punicaceae	introduced	tree	fruit/medicinal	1	1	1.0	N
359	Pycnostachys umbrosa (VATKE) PERKINS	Muhoro	Labiatae	indigenous	shrub	fence/medicinal	80	4	20.0	K/L/M/N
360	Pyrus communis(Pear) L.	Munjamu	Rosaceae	introduced	fruit tree	fruit	43	4	10.8	N
361	Rapanea melanophloeos (L.) MEZ	**	Myrsinaceae	indigenous	tree	**	2	2	1.0	M
362	Rauvolfia caffra SOND.	Mwerere/Mutuu	Apocynaceae	indigenous	shrub/tree	fruit/timber/firewood/cattle medicine	9	5	1.8	E/K/M
363	Rhamnus prinoides L'HER.	Mukarakinga	Rhamnaceae	indigenous	shrub/tree	medicinal	1	1	1.0	N
364	Rhamnus staddo A.RICH.	Mukuru/Bukura/Ngukura/Mbukura	Rhamnaceae	indigenous	shrub/tree	firewood/fence/soup/medicinal	98	12	8.2	L/M/N
365	Rhoicissus tridentata (L.F.) WILD & R.B.DRUMM.	Mugwaci	Vitaceae	indigenous	shrub	medicine for mothers after birth	20	1	20.0	L
366	Rhus natalensis KRAUSS	Muthithiu	Anacardiaceae	indigenous	shrub/tree	fruit/fence/firewood/fodder/root for medicine	249	30	8.3	E/L/M/N
367	Rhus tenuinervis ENGL.	Muthithiu	Anacardiaceae	indigenous	shrub	fruit/fodder	11	3	3.7	M
368	Rhus vulgaris MEIKLE	Muthigio/Kitheu	Anacardiaceae	indigenous	shrub/tree	firewood/fruit edible/fruit for diarrhoea/dye/toothbrush/fodder	199	7	28.4	E/L/N
369	Ricinus communis(Castor oil) L.	Mwariki	Euphorbiaceae	indigenous	tree	firewood/ornamental/windbreak/fruit/banana support/root for gonorrhoea/oil seed	827	61	13.6	E/K/L/M/N
370	Rosa vulgaris L.	**	Rosaceae	introduced	shrub/tree	fence	20	1	20.0	N
371	Rothmannia longiflora SALISB.	Mukomera	Rubiaceae	indigenous	tree	fodder/firewood	1	1	1.0	M
372	Rubus keniensis STANDL.	Mutare	Rosaceae	indigenous	shrub	fruit/fence	6	1	6.0	N
373	Rubus pinnatus WILLD.	Mutare	Rosaceae	indigenous	shrub	fruit/fence	45	3	15.0	L/N
374	Rubus scheffleri ENGL.	Mutare	Rosaceae	indigenous	shrub	fence	60	3	20.0	K
375	Rubus sp. L.	**	Rosaceae	indigenous	shrub	fence	20	1	20.0	N
376	Salvia merjamie FORSSK.	**	Labiatae	introduced	shrub	fence/ornamental	21	2	10.5	L/M
377	Salvia microphylla KUNTH	Ihua	Labiatae	introduced	shrub/tree	ornamental	60	3	20.0	M/N
378	Sambucus nigra L.	**	Caprifoliaceae	introduced	tree	fence/medicine for animals	50	4	12.5	K
379	Sapium ellipticum (KRAUSS) PAX	Muthatha/Muthathi	Euphorbiaceae	indigenous	tree	fodder/firewood/timber/oil/root for gonorrhoea	31	14	2.2	E/M
380	Schinus molle(Pepper tree) L.	Mugaita/Mutenderia/Musanduku	Anacardiaceae	indigenous	tree	firewood/timber/shade/windbreak	250	28	8.9	L/M/N
381	Schrebera alata (HOCHST.) WELW.	Mutuma	Oleaceae	indigenous	tree	firewood/medicinal	4	1	4.0	L
382	Sclerocarya birrea (A.RICH.) HOCHST.	Mukomothi	Anacardiaceae	indigenous	tree	fruit edible/wood for bowls/bark for dysentry,bad liver and rheumatism	12	6	2.0	E

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383	Scolopia zeyheri (NEES) HARV.	Mutanga/Kamuruai	Flacourtiaceae	indigenous	shrub/tree	fruit/bark for bowls/building wood	8	4	2.0	E/M/N
384	Scutia myrtina (BURM.F.) KURZ	Mulangari/Motangaruria/Muthana nguru/Sana nguru	Rhamnaceae	indigenous	shrub/scrambler	firewood/medicinal/fruit/wood for building	203	12	16.9	E/L/N
385	Senecio petitianus A.RICH.	**	Compositae	introduced	shub/tree	fodder	20	1	20.0	N
386	Senna didymobotrya (FRESEN.) IRWIN & BARNEBY	Mwinu/Mwenu/Oenetoi	Fabaceae(c)	indigenous	tree	firewood/leaves for fish poison & small pox/medicinal for stomach-ache	166	18	9.2	L/M/N
387	Senna longiracemosa (VATKE) LOCK	Mwenu	Fabaceae(c)	indigenous	shrub/tree	leaves for fish poison	2	1	2.0	E
388	Senna septemtrionalis (VIVIANI) IRWIN & BARNEBY	Muchingiri	Fabaceae(c)	indigenous	shrub	ornamental/fence	25	3	8.3	N/L
389	Senna siamea (LAM.) IRWIN & BARNEBY	Mukwe/Mukacia	Fabaceae(c)	introduced	tree	pole/timber/firewood/shade	90	9	10.0	K/M/N
390	Senna singueana (DEL.) LOCK	Mukengeka	Fabaceae(c)	indigenous	shrub/tree	firewood/roots for medicine	165	19	8.7	E/M
391	Senna sp. MILLER	**	Fabaceae(c)	indigenous	shrub/tree	medicinal etc.	54	5	10.8	E
392	Senna occisdentalis (L.) LINK	**	Fabaceae(c)	introduced	shrub	**	1	1	1.0	K
393	Sesbania sesban (L.) MERRILL	Musungiri/Muthethia	Fabaceae(p)	indigenous	shrub/tree	firewood/medicinal/fodder/shade/green manure	40	9	4.4	E/L/M/N
394	Solanecio mannii (HOOK.F.) C.JEFFREY	Mwathathi	Compositae	indigenous	shrub/tree	fence/firewood/medicinal/fodder/safari ants repellent/tick protection	148	10	14.8	E/K/L/M/N
395	Solanecio nandensis (S.MOORE) C.JEFFREY	**	Compositae	introduced	shrub	fence	20	1	20.0	N
396	Solanum aculeastrum DUNAL	Mutura/Gitra	Solanaceae	indigenous	shrub/tree	fruit/medicinal/fence	116	8	14.5	K/L/M/N
397	Solanum anguivi LAM.	Mutongu	Solanaceae	indigenous	shrub/herb	**	21	2	10.5	N
398	Solanum arundo MATTEI	Ntura	Solanaceae	indigenous	shrub	**	17	1	17.0	M
399	Solanum incanum L.	Mutongu/Ndongu	Solanaceae	indigenous	shrub	hedge plant/fruit pulp for wart, wound, toothache & cold	778	36	21.6	E/K/L/M/N
400	Solanum mauritianum SCOP.	**	Solanaceae	indigenous	shrub/tree	**	20	1	20.0	K
401	Solanum renschii VATKE	**	Solanaceae	indigenous	shrub	root for typhoid	1	1	1.0	E
402	Spathodea campanulata(Nandi frame) P.BEAUV.	Muchababinduki/Kibobakashi	Bignoniaceae	indigenous	tree	shade/fruit pulp for wart, wound & toothache/ark for liver complains/timber/firewood	31	20	1.6	E/K/M/N
403	Stachytarpheta jamaicensis (L.) VAHL	**	Verbenaceae	introduced	shrub	fence	40	2	20.0	K
404	Steganotaenia araliacea HOSCHST.	Muvuavui	Umbelliferae	indigenous	tree/shrub	bark for liver complaints	2	2	1.0	E
405	Sterculia africana (LOUR.) FIORI	Kiuria	Sterculiaceae	indigenous	shrub/tree	bark against fever/infusion is emetic	11	7	1.6	E
406	Strychnos henningsii GILG	Mubege	Loganiaceae	indigenous	shrub/tree	fruit edible	1	1	1.0	M
407	Strychnos madagascariensis POIR.	Mwage	Loganiaceae	indigenous	shrub/tree	timber, beehive hanging, bark for string	3	3	1.0	E/K
408	Strychnos usambarensis GILG	Mutikani	Loganiaceae	indigenous	shrub/tree	wood for building	9	3	3.0	E
409	Synadenium compactum N.E.BR.	Kyatha/Watha/Muthuri	Euphorbiaceae	indigenous	shrub/tree	ripen fruit edible/demarcation/poisonous/medicinal	29	7	4.1	E/K/L/M/N
410	Syzygium guineense (WILLD.) DC.	Mukui	Myrtaceae	indigenous	tree	firewood/fruit/timber	2	2	1.0	N
411	Tabernaemontana stapfiana BRITTEN	Mwerere	Apocynaceae	Indigenous	tree	medicinal/firewood/charcoal	5	5	1.0	M/N
412	Tabernaemontana ventricosa HOSCHST. EX A.DC.	Mwerere	Apocynaceae	indigenous	tree	latex for healing wounds	13	3	4.3	M
413	Tamarindus indica L.	Muthithi	Fabaceae(c)	indigenous	tree	latex poisonous	27	25	1.1	E/M
414	Tarchonanthus camphoratus L.	Murirrisha/Muriricua	Compositae	indigenous	shrub	firewood/fodder	30	3	10.0	L/N
415	Tarenna graveolens (S.MOORE) BREMEK.	Muthethu	Rubiaceae	indigenous	tree/shrub	firewood	1	1	1.0	N
416	Teclea nobilis DELILE	Munderendu	Rutaceae	indigenous	tree	fruit/wood for bows & walking sticks/ leaves for pneumonia	3	2	1.5	K/N
417	Teclea simplicifolia (ENGL.) VERD.	Munderendu/Olgerai	Rutaceae	indigenous	shrub/tree	wood for roof beams/medicinal/handle/bow/firewood	19	10	1.9	L/N
418	Teclea trichocarpa (ENGL.) ENGL.	Munderendu	Rutaceae	indigenous	shrub/tree	fruits/charcoal	2	1	2.0	E
419	Tecoma capensis (THUNB.) SPACH	**	Bignoniaceae	introduced	tree/shrub	ornamental shrub/fence	20	1	20.0	N
420	Tecoma stans JUSS.	**	Bignoniaceae	introduced	shrub/tree	ornamental/leaves for dogs' scenting power	74	9	8.2	E/K/L/M/N
421	Tecomaria capensis (THUNB.) SPACH	**	Bignoniaceae	introduced	tree/shrub	fence/ornamental	140	7	20.0	N
422	Tephrosia vogelii HOOK.F.	**	Fabaceae(p)	indigenous	shrub	fodder/fish poison	20	1	20.0	K
423	Terminalia brownii FRESEN.	Mururuku	Combretaceae	indigenous	tree	medicinal/timber/charcoal/ornamental	139	29	4.8	E/M/N
424	Terminalia mentally L.	Terminaria	Combretaceae	introduced	tree	medicinal/timber/charcoal/shade /ornamental	28	13	2.2	E/K/M/N
425	Terminalia mollis M.A. LAWSON	**	Combretaceae	indigenous	tree/shrub	shade	1	1	1.0	E
426	Terminalia prunioides M.A.LAWSON	**	Combretaceae	indigenous	tree	charcoal	48	11	4.4	E/M
427	Tetradenia riparia (HOSHST.) CODD	Muaraka/Kiaraka/Thivea	Labiatae	indigenous	shrub	fence/wood for building/medicine for chicks	247	14	17.6	E/K/M
428	Thevetia peruviana (PERS.) SCHUMANN	Mahua	Apocynaceae	introduced	tree	ornamental/leaves for cataract	54	16	3.4	E/K/N

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429	Thrinax floridana SW.	**	Palmae	introduced	palm	**	1	1	1.0	K
430	Thunbergia holstii LINDAU	**	Acanthaceae	indigenous	shrub	**	10	1	10.0	N
431	Tinnea aethiopica KOTSCHY EX HOOK.F.	Mugandu	Labiatae	indigenous	shrub	fence/ornamental	91	5	18.2	E/L
432	Tipuana tipu (BENTH.) KUNTZE	**	Fabaceae(p)	introduced	tree	timber	1	1	1.0	L
433	Tithonia diversifolia(Wild sunflower) (HEMSL.) A.GRAY	Kirurite/Haraka	Compositae	indigenous	shrub	fence	870	52	16.7	E/K/M/N
434	Toona ciliata M.ROEM.	Mwarubaine	Meliaceae	introduced	tree	firewood/malaria medicine	2	1	2.0	L
435	Trema orientalis (L.) BLUME	Mwethu/Mutheu/Muthethu	Ulmaceae	indigenous	tree	medicinal/ fence/fodder/firewood	16	10	1.6	E/K/M/N
436	Trichilia dregeana SOND.	Mururi	Meliaceae	indigenous	tree	timber/firewood/medicinal	1	1	1.0	N
437	Trichilia emetica VAHL	Mutwati	Meliaceae	indigenous	tree	timber/firewood/fodder	25	9	2.8	K/M
438	Trimeria grandifolia (BURKILL) SLEUMER	Muhindahindi	Flacourtiaceae	indigenous	shrub/tree	firewood/medicinal	43	5	8.6	L/M/N
439	Triumfetta macrophylla K.SCHUM.	Mugio	Tiliaceae	indigenous	shrub	**	40	2	20.0	K
440	Triumfetta tomentosa BOJER	**	Tiliaceae	indigenous	shrub	fibre for rope	30	3	10.0	E
441	Turraea abyssinica A.RICH.	Murundo	Meliaceae	indigenous	shrub/tree	firewood	2	1	2.0	L
442	Vangueria infausta BURCH.	Kikomoa/Mubiru	Rubiaceae	indigenous	shrub/tree	fruit/firewood/rafter/medicinal/bark for insect repellent	80	21	3.8	E/K/L/M/N
443	Vangueria madagascariensis J.F.GMEL.	Mubiru	Rubiaceae	indigenous	tree	fruit edible	21	7	3.0	E/M
444	Verbena bonariensis L.	**	Verbenaceae	introduced	shrub	**	40	2	20.0	M
445	Vernonia auriculifera HIERN	Muchatha	Compositae	indigenous	shrub	medicinal/ornamental	100	5	20.0	K/N
446	Vernonia branchycalyx O.HOFFM.	Mutei	Compositae	indigenous	shrub	medicine	20	3	6.7	M/N
447	Vernonia galamensis sub affromonttana (R.E.FR.) M.G.GILBER	**	Compositae	introduced	shrub	**	20	1	20.0	K
448	Vernonia lasiopus O.HOFFM.	Muchatha	Compositae	indigenous	shrub	fence/firewood/medicinal/used for malaria, scabies and venereal disease	135	10	13.5	E/K/L/M
449	Vernonia sp. SCHREBER.	**	Compositae	indigenous	shrub	medicinal/firewood	20	1	20.0	N
450	Vitex keniensis(Meru oak) TURRILL	Muhuru/Mukananthi	Verbenaceae	indigenous	tree	timber/fodder/firewood/fruit edible/for flavouring beer	75	24	3.1	E/K/L/M/N
451	Vitex payos (LOUR.) MERR.	Mufufu	Verbenaceae	indigenous	tree/shrub	timber/firewood/fruit	33	13	2.5	E/M
452	Warburgia ugandensis SPRAGUE	Muthiga	Solanaceae	indigenous	shrub	timber/fruit/resin as glue/medicinal-malaria	27	6	4.5	M/N
453	Withania somnifera , (L.) DUNAL	**	Solanaceae	indigenous	shrub/herb	fence	60	3	20.0	L/M
454	Ximenia americana ssp. Caffra SOND.	Mutura	Olacaceae	indigenous	tree/shrub	fruit/timber	1	1	1.0	E
455	Xymalos monospora (HARV.) WARB.	Murendeti	Monimiaceae	indigenous	shrub	timber/fruit/seed oil	1	1	1.0	E
456	Zanha africana (RADLK.) EXELL	Mungothi	Sapindaceae	indigenous	tree	building material for ant resistant	6	3	2.0	E
457	Zanthoxylum chalybeum ENGL.	Mukenea	Rutaceae	indigenous	tree	medicinal-malaria	20	10	2.0	E/M

Appendix 6

List of family and species number in five areas of Mt. Kenya

Family Name	Total number	Number of species	Family Name	Total number	Number of species
Acanthaceae	92	6	Loganiaceae	236	7
Agaveaceae	192	1	Loranthaceae	20	1
Aloeaceae	160	4	Malvaceae	526	12
Amaranthaceae	85	2	Meliaceae	440	7
Anacardiaceae	1235	15	Melianthaceae	2	1
Annonaceae	69	4	Monimiaceae	1	1
Apocynaceae	239	7	Moraceae	306	14
Araliaceae	27	4	Musaceae	2636	2
Araucariaceae	5	2	Myricaceae	1	1
Asclepiadaceae	5	1	Myrsinaceae	6	3
Asparagaceae	118	4	Myrtaceae	1374	9
Asteraceae	100	1	Nyctaginaceae	182	1
Balanitaceae	110	2	Ochnaceae	7	3
Bignoniaceae	530	7	Olacaceae	1	1
Bombacaceae	9	2	Oleaceae	399	5
Boraginaceae	252	7	Oliniaceae	4	1
Burseraceae	1892	7	Onagraceae	21	2
Cactaceae	120	7	Palmae	29	4
Caesalpiniaceae	2	1	Papilionaceae	13	1
Capparaceae	315	10	Passifloraceae	5	1
Caprifoliaceae	50	1	Phytolaccaceae	21	1
Caricaceae	566	1	Pinaceae	151	2
Casuarinaceae	92	1	Podocarpaceae	2	1
Celastraceae	1339	8	Portulacaceae	20	1
Chrysobalanaceae	3	1	Proteaceae	6719	4
Combretaceae	667	10	Punicaceae	1	1
Compositae	2081	17	Rhamnaceae	342	5
Convolvulaceae	145	4	Rhizophoraceae	3	1
Crassulaceae	20	1	Rosaceae	359	13
Cupressaceae	2639	4	Rubiaceae	224	13
Dracaenaceae	25	3	Rutaceae	369	12
Ebenaceae	2259	3	Santalaceae	25	1
Euphorbiaceae	4827	33	Sapindaceae	176	6
Fabaceae(c)	1375	22	Sapotaceae	3	1
Fabaceae(m)	2322	29	Simaroubaceae	22	2
Fabaceae(p)	718	18	Solanaceae	1582	15
Flacourtiaceae	774	6	Sterculiaceae	43	5
Gramineae	11	2	Thymeleaceae	23	2
Guttiferae	25	2	Tiliaceae	324	9
Hydrangeaceae	1	1	Ulmaceae	17	2
Labiatae	1537	14	Umbelliferae	2	1
Laraceae	553	1	Verbenaceae	2675	13
Lauraceae	2	1	Vitaceae	20	1
Liliaceae	21	2	**Total family & species No**	**86**	**456**

Appendix 7

1) Major indigenous tree species list

Scientific Name	Family Name	Status	Total No.	Places of 265 plots	Avg.no/plot	District
Euclea divinorum HIERN	Ebenaceae	indigenous	1625	33	49.2	E/L/M/N
Boscia coriacea PAX	Capparaceae	indigenous	139	3	46.3	E
Catha edulis (VAHL) ENDL.	Celastraceae	indigenous	1111	25	44.4	E/K/M
Acacia drepanolobium HARMS EX SJOSTEDT	Fabaceae(m)	indigenous	374	11	34.0	E/L/M/N
Maytenus sp. MOLINA.	Celastraceae	indigenous	31	1	31.0	N
Achyranthes aspera L.	Amaranthaceae	indigenous	60	2	30.0	L
Rhus vulgaris MEIKLE	Anacardiaceae	indigenous	199	7	28.4	E/L/N
Commiphora africana (A.RICH.) ENGL.	Burseraceae	indigenous	491	18	27.3	E/K/M
Abutilon longicuspe A.RICH	Malvaceae	indigenous	120	5	24.0	L/N
Plectranthus barbatus ANDR.	Labiatae	indigenous	615	27	22.8	K/L/M/N
Solanum incanum L.	Solanaceae	indigenous	778	36	21.6	E/K/L/M/N
Dodonaea angustifolia L.F.	Sapindaceae	indigenous	147	7	21.0	L/M
Abutilon mauritianum (JACQ.) SWEET	Malvaceae	indigenous	40	2	20.0	L/N
Aloe kedongensis REYNOLDS	Aloaceae	indigenous	20	1	20.0	N
Aloe nyeriensis CHRISTIAN	Aloeaceae	indigenous	80	4	20.0	L/N
Aspilia pluriseta SCHWEINF.EX ENGL.	Asteraceae	indigenous	100	5	20.0	M
Clutia abyssinica JAUB.& SPACH	Euphorbiaceae	indigenous	20	1	20.0	N
Commiphora chimperi CHIOV.	Burseraceae	indigenous	20	1	20.0	M
Cotyledon barbeyi BAKER	Crassulaceae	indigenous	20	1	20.0	L
Crotalaria agatiflora SCHWEINF.	Fabaceae(p)	indigenous	20	1	20.0	N
Crotalaria axillaris AITON	Fabaceae(p)	indigenous	20	1	20.0	N
Dombeya burgessiae GERR. EX HARV. & SOND.	Sterculiaceae	indigenous	20	1	20.0	M
Erythrococca bongensis PAX	Euphorbiaceae	indigenous	20	1	20.0	N
Gutenbergia cordifolia BENTH. EX OLIV.	Compositae	indigenous	20	1	20.0	K
Indigofera garckeana VATKE	Fabaceae(p)	indigenous	20	1	20.0	L
Justicia whytei S.MOORE	Acanthaceae	indigenous	20	1	20.0	L
Keetia gueinzii (SOND.) BRIDSON	Rubiaceae	indigenous	20	1	20.0	N
Leonotis nepetifolia var. africana (P.BEAUV.) J.K.MORTON	Labiatae	indigenous	180	9	20.0	L/M/N
Leucas calostachys OLIV.	Labiatae	indigenous	20	1	20.0	L
Leucas grandis GURKE	Labiatae	indigenous	20	1	20.0	N
Microglossa pyrifolia (LAM.) KUNTZE	Compositae	indigenous	20	1	20.0	K
Ocimum suave L.	Labiatae	indigenous	40	2	20.0	E
Opuntia vulgaris MILL.	Cactaceae	indigenous	120	6	20.0	L/M
Pavetta sp. L.	Rubiaceae	indigenous	20	1	20.0	M
Pterolobium stellatum (FORSSK.) BRENAN	Fabaceae(c)	indigenous	40	2	20.0	N
Pycnostachys umbrosa (VATKE) PERKINS	Labiatae	indigenous	80	4	20.0	K/L/M/N
Rhoicissus tridentata (L.F.) WILD & R.B.DRUMM.	Vitaceae	indigenous	20	1	20.0	L
Rubus scheffleri ENGL.	Rosaceae	indigenous	60	3	20.0	K
Rubus sp. L.	Rosaceae	indigenous	20	1	20.0	N
Solanum mauritianum SCOP.	Solanaceae	indigenous	20	1	20.0	K
Tephrosia vogelii HOOK.F.	Fabaceae(p)	indigenous	20	1	20.0	K
Triumfetta macrophylla K.SCHUM.	Tiliaceae	indigenous	40	2	20.0	K
Vernonia auriculifera HIERN	Compositae	indigenous	100	5	20.0	K/N
Vernonia sp. SCHREBER.	Compositae	indigenous	20	1	20.0	N
Withania somnifera , (L.) DUNAL	Solanaceae	indigenous	60	3	20.0	L/M
Lantana camara L.	Verbenaceae	indigenous	1652	89	18.6	E/K/M/N
Lippia javonica (BURM.F.) SPRENG.	Verbenaceae	indigenous	354	19	18.6	L/M/N
Tinnea aethiopica KOTSCHY EX HOOK.F.	Labiatae	indigenous	91	5	18.2	E/L
Tetradenia riparia (HOSHST.) CODD	Labiatae	indigenous	247	14	17.6	E/K/M
Euphorbia tirucalli L.	Euphorbiaceae	indigenous	957	55	17.4	E/K/L/M
Lantana trifolia L.	Verbenaceae	indigenous	120	7	17.1	L/M/N
Croton megalocarpus HUTCH.	Euphorbiaceae	indigenous	1835	108	17.0	E/K/L/M/N
Solanum arundo MATTEI	Solanaceae	indigenous	17	1	17.0	M
Scutia myrtina (BURM.F.) KURZ	Rhamnaceae	indigenous	203	12	16.9	E/L/N
Tithonia diversifolia(Wild sunflower) (HEMSL.) A.GRAY	Compositae	indigenous	870	52	16.7	E/K/M/N
Buddleia polystachya FRESEN.	Loganiaceae	indigenous	162	10	16.2	L/N
Grewia villosa WILLD.	Tiliaceae	indigenous	80	5	16.0	E/M
Lycium europaeum L.	Solanaceae	indigenous	47	3	15.7	L
Commiphora eminii ssp.zimmermannii (ENGL.) GILLETT	Burseraceae	indigenous	1121	73	15.4	E/K/L/M/N
Clerodendrum myricoides (HOCHST.) VATKE	Verbenaceae	indigenous	106	7	15.1	E/K/L/M
Lippia kituiensis VATKE	Verbenaceae	indigenous	45	3	15.0	M
Rubus pinnatus WILLD.	Rosaceae	indigenous	45	3	15.0	L/N
Solanecio mannii (HOOK.F.) C.JEFFREY	Compositae	indigenous	148	10	14.8	E/K/L/M/N
Solanum aculeastrum DUNAL	Solanaceae	indigenous	116	8	14.5	K/L/M/N
Ricinus communis(Castor oil) L.	Euphorbiaceae	indigenous	827	61	13.6	E/K/L/M/N

Vernonia lasiopus O.HOFFM.	Compositae	indigenous	135	10	13.5	E/K/L/M
Asparagus buchanani BAKER	Asparagaceae	indigenous	40	3	13.3	L/N
Acacia hockii DE WILD.	Fabaceae(m)	indigenous	142	11	12.9	E/L/M
Cyathula polycephala BAKER	Amaranthaceae	indigenous	25	2	12.5	K
Duosperma kilimandscharica (LINDAU) DAYTON	Acanthaceae	indigenous	25	2	12.5	M
Osyris lanceolata HOCHST. & STEUDEL	Santalaceae	indigenous	25	2	12.5	L
Pavetta teitana K.SCHUM.	Rubiaceae	indigenous	25	2	12.5	K/L
Melia volkensii GURKE	Meliaceae	indigenous	342	28	12.2	E/M
Clerodendrum johnstonii OLIV.	Verbenaceae	indigenous	182	15	12.1	E/K/M/N
Ormocarpum kirkii S.MOORE	Fabaceae(p)	indigenous	35	3	11.7	E/M
Caesalpinia decapetala (ROTH) ALSTON	Fabaceae(c)	indigenous	211	18	11.7	E/K/M/N
Mystroxylon aethiopicum (THUNB.) LOES.	Celastraceae	indigenous	70	6	11.7	L/N
Croton dichogamus PAX	Euphorbiaceae	indigenous	23	2	11.5	L
Indigofera arrecta A.RICH.	Fabaceae(p)	indigenous	92	8	11.5	E/L/M
Ipomoea kituiensis VATKE	Convolvulaceae	indigenous	115	10	11.5	E/L/N
Psiadia punctulata (DC.) VATKE	Compositae	indigenous	276	24	11.5	L/M/N
Asparagus africanus LAM.	Asparagaceae	indigenous	66	6	11.0	E/L/N
Euphorbia friesiorum (HASSL.) S.CARTER	Euphorbiaceae	indigenous	11	1	11.0	E
Acacia ataxacantha DC.	Fabaceae(m)	indigenous	131	12	10.9	E/M
Senna sp. MILLER	Fabaceae(c)	indigenous	54	5	10.8	E
Flueggea virosa (WILLD.) VOIGT	Euphorbiaceae	indigenous	74	7	10.6	E/M
Hoslundia opposita VAHL	Labiatae	indigenous	21	2	10.5	E/M
Maytenus arbutifolia (A.RICH.) WILCZEK	Celastraceae	indigenous	21	2	10.5	E
Phytolacca dodecandra L'HER.	Phytolaccaceae	indigenous	21	2	10.5	M/N
Psydrax schimperiana (A.RICH.) BRIDSON	Rubiaceae	indigenous	21	2	10.5	L/N
Solanum anguivi LAM.	Solanaceae	indigenous	21	2	10.5	N
Arundinaria alpina(Mountain Bamboo) K.SCHUM.	Gramineae	indigenous	10	1	10.0	E
Asparagus sp. L.	Asparagaceae	indigenous	10	1	10.0	L
Asteranthe asterias (S.MOORE) ENGL. & DIELS	Annonaceae	indigenous	10	1	10.0	E
Barleria eranthemoides R.BR.	Acanthaceae	indigenous	10	1	10.0	E
Barleria sp. L.	Acanthaceae	indigenous	10	1	10.0	E
Capparis tomentosa LAM.	Capparaceae	indigenous	50	5	10.0	E
Clerodendrum spp. L.	Verbenaceae	indigenous	10	1	10.0	N
Pentas parvifolia HIERM	Rubiaceae	indigenous	10	1	10.0	E
Tarchonanthus camphoratus L.	Compositae	indigenous	30	3	10.0	L/N
Thunbergia holstii LINDAU	Acanthaceae	indigenous	10	1	10.0	N
Triumfetta tomentosa BOJER	Tiliaceae	indigenous	30	3	10.0	E
Sub-total species No. & trees No.		**102**	**18487**			

2) Minor indigenous tree species list

Scientific Name	Family Name	Status	Total No.	Places of 265 plots	Avg.no/plot	District
Commiphora sp. JACQ.	Burseraceae	indigenous	184	19	9.7	E
Jatropha curcas L.	Euphorbiaceae	indigenous	191	20	9.6	E/K/M/N
Combretum collinum FRESEN.	Combretaceae	indigenous	187	20	9.4	E/M
Senna didymobotrya (FRESEN.) IRWIN & BARNEBY	Fabaceae(c)	indigenous	166	18	9.2	L/M/N
Schinus molle(Pepper tree) L.	Anacardiaceae	indigenous	250	28	8.9	L/M/N
Clausena anisata (WILLD.) BENTH.	Rutaceae	indigenous	52	6	8.7	E/K/N
Senna singueana (DEL.) LOCK	Fabaceae(c)	indigenous	165	19	8.7	E/M
Trimeria grandifolia (BURKILL) SLEUMER	Flacourtiaceae	indigenous	43	5	8.6	L/M/N
Ocimum gratissimum SUAVE	Labiatae	indigenous	102	12	8.5	K/L/M/N
Rhus natalensis KRAUSS	Anacardiaceae	indigenous	249	30	8.3	E/L/M/N
Senna septemtrionalis (VIVIANI) IRWIN & BARNEBY	Fabaceae(c)	indigenous	25	3	8.3	N/L
Acacia mellifera (BURCH.) BRENAN	Fabaceae(m)	indigenous	123	15	8.2	E/M
Commiphora samharensis SCHWEINF.	Burseraceae	indigenous	49	6	8.2	E/M
Rhamnus staddo A.RICH.	Rhamnaceae	indigenous	98	12	8.2	L/M/N
Phyllanthus sp. L.	Euphorbiaceae	indigenous	40	5	8.0	E
Maytenus heterophylla (ECKL. & ZEYH.) N.ROBSON	Celastraceae	indigenous	79	10	7.9	E/L/N
Garcinia livingstonei T.ANDERSON	Guttiferae	indigenous	23	3	7.7	E/M
Acacia tortilis (FORSSK.) HAYNE	Fabaceae(m)	indigenous	272	37	7.4	E/K/M
Cadaba farinosa FORSSK.	Capparaceae	indigenous	22	3	7.3	E
Carrisa edulis (FORSSK.) VAHL	Apocynaceae	indigenous	109	15	7.3	L/M/N
Dracaena steudneri ENGL.	Dracaenaceae	indigenous	22	3	7.3	E/M
Grewia bicolor JUSS.	Tiliaceae	indigenous	102	14	7.3	E/L/M
Juniperus procera ENDL.	Cupressaceae	indigenous	159	22	7.2	L/M/N
Acacia nilotica WILLD.EX DELILE	Fabaceae(m)	indigenous	160	23	7.0	E/L/M
Balanites aegyptiaca (L.) DELILE	Balanitaceae	indigenous	97	14	6.9	E/L/M
Combretum zeyheri SOND.	Combretaceae	indigenous	48	7	6.9	E
Vernonia branchycalyx O.HOFFM.	Compositae	indigenous	20	3	6.7	M/N

Lonchocarpus bussei HARMS	Papilionaceae	indigenous	13	2	6.5	E
Phoenix reclinata JACQ.	Palmae	indigenous	26	4	6.5	N
Acacia senegal WILD	Fabaceae(m)	indigenous	87	14	6.2	E/M
Acacia polyacantha WILLD	Fabaceae(m)	indigenous	78	13	6.0	E/M
Bourreria nemoralis (GURKE) THULIN	Boraginaceae	indigenous	6	1	6.0	M
Maerua triphylla A.RICH.	Capparaceae	indigenous	54	9	6.0	E/L/M/N
Rubus keniensis STANDL.	Rosaceae	indigenous	6	1	6.0	N
Dyschoriste thunbergiiflora (S.MOORE) LINDAU	Acanthaceae	indigenous	17	3	5.7	E/K/M
Premna resinosa (HOCHST.) SCHAUER	Verbenaceae	indigenous	17	3	5.7	E
Albizia amara (ROXB.) BOIVIN	Fabaceae(m)	indigenous	11	2	5.5	E/N
Combretum molle G.DON	Combretaceae	indigenous	154	28	5.5	E/K/L/M
Maerua kirkii (OLIV.) F. WHITE	Capparaceae	indigenous	11	2	5.5	E
Ficus sycomorus L.	Moraceae	indigenous	27	5	5.4	E/M
Acacia gerrardii BENTH.	Fabaceae(m)	indigenous	16	3	5.3	L
Adenia globosa ENGL.	Passifloraceae	indigenous	5	1	5.0	E
Bourreria teitensis (GURKE) THULIN	Boraginaceae	indigenous	5	1	5.0	M
Calotropis procera (AITON) W.T.AITON	Asclepiadaceae	indigenous	5	1	5.0	M
Combretum adenogonium(fragrans) LOEFL.	Combretaceae	indigenous	5	1	5.0	M
Combretum sp. LOEFL.	Combretaceae	indigenous	5	1	5.0	K
Dombeya rotundifolia PLANCH.	Sterculiaceae	indigenous	10	2	5.0	E
Ipomoea hildebrandtii VATKE	Convolvulaceae	indigenous	5	1	5.0	N
Maerua edulis (GILG-BEN. & BENEDICT) DEWOLF	Capparaceae	indigenous	5	1	5.0	E
Ochna ovata O.HOFFM.	Ochnaceae	indigenous	5	1	5.0	E
Acokanthera schimperi (A.DC) SCHWEINF.	Apocynaceae	indigenous	48	10	4.8	L/M/N
Maytenus senegalensis (LAM.) EXELL	Celastraceae	indigenous	19	4	4.8	E/M
Terminalia brownii FRESEN.	Combretaceae	indigenous	139	29	4.8	E/M/N
Ficus natalensis HOCHST.	Moraceae	indigenous	81	18	4.5	E/M/N
Warburgia ugandensis SPRAGUE	Solanaceae	indigenous	27	6	4.5	M/N
Croton macrostachyus DELILE	Euphorbiaceae	indigenous	356	81	4.4	E/K/L/M/N
Gnidia latifolia (OLIV.) GILG	Thymeleaceae	indigenous	22	5	4.4	E
Sesbania sesban (L.) MERRILL	Fabaceae(p)	indigenous	40	9	4.4	E/L/M/N
Terminalia prunioides M.A.LAWSON	Combretaceae	indigenous	48	11	4.4	E/M
Balanites sp. DEL.	Balanitaceae	indigenous	13	3	4.3	E
Tabernaemontana ventricosa HOSCHST. EX A.DC.	Apocynaceae	indigenous	13	3	4.3	M
Acacia xanthophloea BENTH.	Fabaceae(m)	indigenous	38	9	4.2	L/M/N
Berchemia discolor (KLOTZSCH) HEMSL.	Rhamnaceae	indigenous	38	9	4.2	E/M
Harrisonia abyssinica OLIV.	Simaroubaceae	indigenous	21	5	4.2	E/M
Synadenium compactum N.E.BR.	Euphorbiaceae	indigenous	29	7	4.1	E/K/L/M/N
Acacia robusta BURCH	Fabaceae(m)	indigenous	4	1	4.0	E
Allophylus rubifolius (HOCHS.) ENGL.	Sapindaceae	indigenous	4	1	4.0	E
Combretum aculeatum VENT.	Combretaceae	indigenous	48	12	4.0	E/M
Combretum fragrans(adenogonium) F.HOFFM.	Combretaceae	indigenous	4	1	4.0	K
Grewia sp. L.	Tiliaceae	indigenous	20	5	4.0	E
Kigelia africana(Sausage tree) (LAM.) BENTH.	Bignoniaceae	indigenous	52	13	4.0	E/K/M
Lannea sp. A.RICH.	Anacardiaceae	indigenous	16	4	4.0	E
Schrebera alata (HOCHST.) WELW.	Oleaceae	indigenous	4	1	4.0	L
Bridelia micrantha (HOCHST.)BAILL.	Euphorbiaceae	indigenous	194	50	3.9	E/K/M/N
Bridelia taitensis VATKE & PAX	Euphorbiaceae	indigenous	27	7	3.9	E/M
Faurea saligna HARV.	Proteaceae	indigenous	15	4	3.8	E
Vangueria infausta BURCH.	Rubiaceae	indigenous	80	21	3.8	E/K/L/M/N
Albizia anthelmintica BRONGN.	Fabaceae(m)	indigenous	44	12	3.7	E/M
Grewia similis K.SCHUM	Tiliaceae	indigenous	33	9	3.7	L/M/N
Piliostigma thonningii(Camel's foot) (SCHUMACH.) MILNE-REDH.	Fabaceae(c)	indigenous	86	23	3.7	E/K/L/M/N
Rhus tenuinervis ENGL.	Anacardiaceae	indigenous	11	3	3.7	M
Commiphora habessinica (O.BERG) ENGL.	Burseraceae	indigenous	21	6	3.5	E
Crotalaria spp. L.	Fabaceae(p)	indigenous	7	2	3.5	E/N
Lonchocarpus eriocalyx HARMS	Fabaceae(p)	indigenous	56	16	3.5	E/K/M
Cordia africana LAM.	Boraginaceae	indigenous	201	59	3.4	E/K/L/M/N
Euphorbia candelabrum KOTSCHY	Euphorbiaceae	indigenous	17	5	3.4	E/N/M
Boscia angustifolia A.RICH	Capparaceae	indigenous	20	6	3.3	E/L
Markhamia lutea (BENTH.) K.SCHUM.	Bignoniaceae	indigenous	102	31	3.3	E/K/L/M/N
Vitex keniensis(Meru oak) TURRILL	Verbenaceae	indigenous	75	24	3.1	E/K/L/M/N
Acalypha fruticosa FORSSK.	Euphorbiaceae	indigenous	3	1	3.0	E
Antidesma venosum TUL.	Euphorbiaceae	indigenous	3	1	3.0	M
Calpurnea aurea (AITON) BENTH.	Fabaceae(p)	indigenous	6	2	3.0	N
Commiphora edulis (KLOTZSCH) ENGL.	Burseraceae	indigenous	6	2	3.0	M
Dalbergia melanoxylon GUILL.& PERR.	Fabaceae(p)	indigenous	6	2	3.0	E
Ozoroa insignis DELILE	Anacardiaceae	indigenous	18	6	3.0	E/M
Strychnos usambarensis GILG	Loganiaceae	indigenous	9	3	3.0	E
Vangueria madagascariensis J.F.GMEL.	Rubiaceae	indigenous	21	7	3.0	E/M

Acacia seyal var. seyal DELILE	Fabaceae(m)	indigenous	25	9	2.8	E/L/M
Trichilia emetica VAHL	Meliaceae	indigenous	25	9	2.8	K/M
Millettia dura DUNN	Fabaceae(p)	indigenous	41	15	2.7	E/M/N
Vitex payos (LOUR.) MERR.	Verbenaceae	indigenous	33	13	2.5	E/M
Acacia brevispica HARMS.	Fabaceae(m)	indigenous	26	11	2.4	E/M
Dichrostachys cinerea (L.) WIGHT & ARN.	Fabaceae(m)	indigenous	26	11	2.4	E/K/M
Prunus africana (HOOK.F.) KALKMAN	Rosaceae	indigenous	64	27	2.4	E/K/M/N
Acacia kirkii BRENAN	Fabaceae(m)	indigenous	9	4	2.3	K/M/N
Delonix elata (L.) GAMBLE	Fabaceae(c)	indigenous	9	4	2.3	E
Elaeodendron buchananii (LOES.) LOES.	Celastraceae	indigenous	7	3	2.3	L/N
Olea europaea ssp. Africana (MILL)	Oleaceae	indigenous	70	30	2.3	E/K/L/M/N
Lannea rivae (CHIOV.) SACLEUX	Anacardiaceae	indigenous	20	9	2.2	E/L/M
Maerua angolensis DC.	Capparaceae	indigenous	11	5	2.2	E/M
Sapium ellipticum (KRAUSS) PAX	Euphorbiaceae	indigenous	31	14	2.2	E/M
Erythrina abyssinica DC.	Fabaceae(p)	indigenous	75	36	2.1	E/K/L/M/N
Acacia seyal var. fistla OLIV.	Fabaceae(m)	indigenous	2	1	2.0	M
Bauhinia tometosa L.	Caesalpiniaceae	indigenous	2	1	2.0	N
Dracaena afromontana MILDBR.	Dracaenaceae	indigenous	2	1	2.0	K
Ensete ventricosum (WELW.) CHEESMAN	Musaceae	indigenous	4	2	2.0	K/N
Fagaropsis hildebrandtii (ENGL.) MILNE-REDH.	Rutaceae	indigenous	2	1	2.0	E
Grewia fallax K.SCHUM.	Tiliaceae	indigenous	8	4	2.0	K
Grewia tembensis FRESEN.	Tiliaceae	indigenous	10	5	2.0	E/L/M
Macaranga kilimandscharica PAX	Euphorbiaceae	indigenous	10	5	2.0	E/K/M/N
Maerua crassipes FORSSK.	Capparaceae	indigenous	2	1	2.0	E
Newtonia buchananii (BAKER) G.C.C.GILBERT & BOUTIQUE	Fabaceae(m)	indigenous	2	1	2.0	M
Ocotea usambarensis ENGL.	Lauraceae	indigenous	2	1	2.0	M
Olinia rochetiana A.JUSS.	Oliniaceae	indigenous	4	2	2.0	L
Pistacia aethiopica KOKWARO	Anacardiaceae	indigenous	2	1	2.0	N
Podocarpus falcatus MIRB.	Podocarpaceae	indigenous	2	1	2.0	L
Polyscias kikuyuensis SUMMERH.	Araliaceae	indigenous	2	1	2.0	N
Sclerocarya birrea (A.RICH.) HOCHST.	Anacardiaceae	indigenous	12	6	2.0	E
Scolopia zeyheri (NEES) HARV.	Flacourtiaceae	indigenous	8	4	2.0	E/M/N
Senna longiracemosa (VATKE) LOCK	Fabaceae(c)	indigenous	2	1	2.0	E
Teclea trichocarpa (ENGL.) ENGL.	Rutaceae	indigenous	2	1	2.0	E
Turraea abyssinica A.RICH.	Meliaceae	indigenous	2	1	2.0	L
Zanha africana (RADLK.) EXELL	Sapindaceae	indigenous	6	3	2.0	E
Zanthoxylum chalybeum ENGL.	Rutaceae	indigenous	20	10	2.0	E/M
Albizia gummifera (J.F.GMEL.) C.A.SM	Fabaceae(m)	indigenous	13	7	1.9	K/M/N
Cussonia holstii ENGL.	Araliaceae	indigenous	23	12	1.9	E/L/M/N
Pappea capensis ECKL. & ZEYH.	Sapindaceae	indigenous	17	9	1.9	E/L/M/N
Teclea simplicifolia (ENGL.) VERD.	Rutaceae	indigenous	19	10	1.9	L/N
Cordia monoica ROXB.	Boraginaceae	indigenous	14	8	1.8	E/K/L/M
Ehretia cymosa THONN.	Boraginaceae	indigenous	22	12	1.8	E/M/N
Ekebergia capensis SPARRM.	Rosaceae	indigenous	14	8	1.8	E/K/M/N
Ficus sur FORSSK.	Moraceae	indigenous	20	11	1.8	E/M
Rauvolfia caffra SOND.	Apocynaceae	indigenous	9	5	1.8	E/K/M
Caesalpinia volkensii HARMS	Fabaceae(c)	indigenous	5	3	1.7	E/L/M
Lannea alata (ENGL.) ENGL.	Anacardiaceae	indigenous	5	3	1.7	E/M
Margaritaria discoidea (BAILL.)	Euphorbiaceae	indigenous	10	6	1.7	E/K/M
Azanza garckeana (F.HOFFM.) EXCELL & HILLC.	Malvaceae	indigenous	45	29	1.6	E/K/M/N
Spathodea campanulata(Nandi frame) P.BEAUV.	Bignoniaceae	indigenous	31	20	1.6	E/K/M/N
Sterculia africana (LOUR.) FIORI	Sterculiaceae	indigenous	11	7	1.6	E
Trema orientalis (L.) BLUME	Ulmaceae	indigenous	16	10	1.6	E/K/M/N
Calodendrum capense (L.F) THUNB.	Rutaceae	indigenous	6	4	1.5	E/M/N
Casaeria battiscombei R.E.FR.	Flacourtiaceae	indigenous	3	2	1.5	M
Cassipourea malosana (BAKER) ALSTON	Rhizophoraceae	indigenous	3	2	1.5	E/N
Gardenia ternifolia SCHUMACH. & THONN.	Rubiaceae	indigenous	3	2	1.5	K/M
Lannea schimperi (A.RICH.) ENGL.	Anacardiaceae	indigenous	3	2	1.5	E
Neoboutonia macrocalyx PAX	Euphorbiaceae	indigenous	3	2	1.5	K/N
Pachystela brevipes (BAKER) ENGL.	Sapotaceae	indigenous	3	2	1.5	M
Parinari curatellifolia PLANCH. EX BENTH	Chrysobalanaceae	indigenous	3	2	1.5	E
Teclea nobilis DELILE	Rutaceae	indigenous	3	2	1.5	K/N
Zanthoxylum usambarense (ENGL.) KOKWARO	Rutaceae	indigenous	15	10	1.5	K/L/M/N
Adansonia digitata L.	Bombacaceae	indigenous	7	5	1.4	E/M
Dovyalis abyssinica (A.RICH.) WARB.	Flacourtiaceae	indigenous	5	4	1.3	E/L/N
Erythrina melanacantha HARMS	Fabaceae(p)	indigenous	4	3	1.3	E
Ficus thonningii BLUME	Moraceae	indigenous	19	15	1.3	E/K/L/M/N
Newtonia hildebrandtii (VATKE) TORRE	Fabaceae(m)	indigenous	4	3	1.3	E/M
Lannea schweinfurthii (ENGL.) ENGL.	Anacardiaceae	indigenous	7	6	1.2	E/M
Tamarindus indica L.	Fabaceae(c)	indigenous	27	25	1.1	E/M

Albizia schimperiana OLIV.	Fabaceae(m)	indigenous	4	4	1.0	E/N
Aloe sp. L.	Liliaceae	indigenous	1	1	1.0	E
Annona senegalensis PERS.	Annonaceae	indigenous	1	1	1.0	E
Anthocleista grandifolia GILG	Loganiaceae	indigenous	1	1	1.0	N
Artocarpus heterophyllus(Jackfruit) LAM.	Moraceae	indigenous	1	1	1.0	M
Bersama abyssinica FRESEN.	Melianthaceae	indigenous	2	2	1.0	E/N
Brachylaena huillensis O.HOFFM.	Compositae	indigenous	2	2	1.0	N
Brucea antidysenterica LAM.	Simaroubaceae	indigenous	1	1	1.0	N
Canavalia sp. DC.	Capparaceae	indigenous	1	1	1.0	E
Cassia abbreviata OLIV.	Fabaceae(c)	indigenous	1	1	1.0	K
Cassia floribunda CAV.	Fabaceae(c)	indigenous	1	1	1.0	N
Celtis africana BURM.F.	Ulmaceae	indigenous	1	1	1.0	N
Clerodendron eriophyllum GURKE	Verbenaceae	indigenous	1	1	1.0	K
Cordia sinensis LAM.	Boraginaceae	indigenous	2	2	1.0	E
Cussonia arborea A.RICH.	Araliaceae	indigenous	1	1	1.0	E
Cussonia spicata THUNB.	Araliaceae	indigenous	1	1	1.0	L
Diospyros abyssinica (HIERN) F.WHITE	Ebenaceae	indigenous	1	1	1.0	N
Dracaena ellenbeckiana ENGL.	Dracaenaceae	indigenous	1	1	1.0	M
Embelia schimperi VATKE	Myrsinaceae	indigenous	1	1	1.0	N
Entada abyssinica STEUD.EX A.RICH.	Fabaceae(m)	indigenous	1	1	1.0	M
Euphobia cryptospinosa P.R.O.BALLY	Euphorbiaceae	indigenous	1	1	1.0	N
Euphorbia heterochroma PAX	Euphorbiaceae	indigenous	1	1	1.0	N
Euphorbia matabelensis PAX	Euphorbiaceae	indigenous	1	1	1.0	E
Ficus capreifolia DELILE	Moraceae	indigenous	1	1	1.0	M
Ficus lutea VAHL	Moraceae	indigenous	3	3	1.0	E/K
Ficus sp. L.	Moraceae	indigenous	2	2	1.0	E
Ficus vasta FORSSK.	Moraceae	indigenous	1	1	1.0	M
Filicium decipiens (WRIGHT & ARN.) THWAITES	Sapindaceae	indigenous	1	1	1.0	K
Galiniera saxifraga (HOSHST.) BRIDSON	Rubiaceae	indigenous	1	1	1.0	N
Gardenia fiorii CHIOV.	Rubiaceae	indigenous	1	1	1.0	M
Gnidia subcordata MEISN.	Thymeleaceae	indigenous	1	1	1.0	L
Grewia forbesii HARV. EX MAST.	Tiliaceae	indigenous	1	1	1.0	M
Hagenia abyssinica (BRUCE) J.F.GMEL.	Rosaceae	indigenous	2	2	1.0	N
Harungana madagascariensis LAM. EX POIR.	Guttiferae	indigenous	2	2	1.0	M
Hermannia uhligii ENGL.	Sterculiaceae	indigenous	1	1	1.0	E
Hymenodictylon parvifolium OLIV.	Euphorbiaceae	indigenous	1	1	1.0	E
Lannea triphylla (A.RICH.) ENGL.	Anacardiaceae	indigenous	1	1	1.0	E
Lecaniodiscus fraxinifolius BAKER	Sapindaceae	indigenous	1	1	1.0	K
Maesa lanceolata FORSSK.	Myrsinaceae	indigenous	3	3	1.0	M/N
Maytenus putterlickioides (OLIV.) EXELL & MENDONCA	Celastraceae	indigenous	1	1	1.0	M
Milicia excelsa(WELW.) C.C. BERG	Moraceae	indigenous	1	1	1.0	M
Myrianthus holstii ENGL.	Moraceae	indigenous	1	1	1.0	M
Myrica salicifolia HOSCHST. EX. A. RICH	Myricaceae	indigenous	1	1	1.0	E
Ochna inermis (FORSSK.) SCHWEINF.	Ochnaceae	indigenous	1	1	1.0	M
Ochna insculpta SLEUMER	Ochnaceae	indigenous	1	1	1.0	E
Olea laurifolia L.	Oleaceae	indigenous	3	3	1.0	L
Oncoba spinosa FORSSK.	Flacourtiaceae	indigenous	1	1	1.0	N
Phiranthus sepians	Euphorbiaceae	indigenous	1	1	1.0	K
Phyllanthus sepialis MULL.ARG.	Euphorbiaceae	indigenous	1	1	1.0	K
Rapanea melanophloeos (L.) MEZ	Myrsinaceae	indigenous	2	2	1.0	M
Rhamnus prinoides L'HER.	Rhamnaceae	indigenous	1	1	1.0	N
Rothmannia longiflora SALISB.	Rubiaceae	indigenous	1	1	1.0	M
Solanum renschii VATKE	Solanaceae	indigenous	1	1	1.0	E
Steganotaenia araliacea HOSCHST.	Umbelliferae	indigenous	2	2	1.0	E
Strychnos henningsii GILG	Loganiaceae	indigenous	1	1	1.0	M
Strychnos madagascariensis POIR.	Loganiaceae	indigenous	3	3	1.0	E/K
Syzygium guineense (WILLD.) DC.	Myrtaceae	indigenous	2	2	1.0	N
Tabernaemontana stapfiana BRITTEN	Apocynaceae	Indigenous	5	5	1.0	M/N
Tarenna graveolens (S.MOORE) BREMEK.	Rubiaceae	indigenous	1	1	1.0	N
Terminalia mollis M.A. LAWSON	Combretaceae	indigenous	1	1	1.0	E
Trichilia dregeana SOND.	Meliaceae	indigenous	1	1	1.0	N
Ximenia americana ssp. Caffra SOND.	Olacaceae	indigenous	1	1	1.0	E
Xymalos monospora (HARV.) WARB.	Monimiaceae	indigenous	1	1	1.0	E
Ziziphus abyssinica A.RICH.	Rhamnaceae	indigenous	2	2	1.0	E/M
Sub-total species No. & trees No.		**231**	**6816**			
Indigenous total		**333**	**25303**			

3) Exotic tree species list

Scientific Name	Family Name	Status	Total No.	Places of 265 plots	Avg.no/plot	District
Eucalyptus paniculata SM.	Myrtaceae	exotic	100	1	100.0	N
Musa sapientum(Banana) L.	Musaceae	exotic	2632	57	46.2	E/L/M/N
Pinus sp. L.	Pinaceae	exotic	124	3	41.3	E
Eucalyptus sp. L'H'ERIT.	Ebenaceae	exotic	633	16	39.6	E/N
Grevillea robusta R.BR.	Proteaceae	exotic	6313	192	32.9	E/K/L/M/N
Cupressus lustianica MILLER	Cupressaceae	exotic	2331	72	32.4	E/K/L/M/N
Dovyalis caffra(Kei-apple) (HOOK.F. & HARVEY)	Flacourtiaceae	exotic	714	35	20.4	E/K/L/M/N
Ambrosia maritima L.	Compositae	exotic	40	2	20.0	K
Buddleia madagascariensis L.	Loganiaceae	exotic	40	2	20.0	K/N
Buddleia salviifolia (L.) LAM	Loganiaceae	exotic	20	1	20.0	N
Canthium soligocarpam LAM.	Rubiaceae	exotic	20	1	20.0	K
Cestrum elegans SCHLTDL.	Solanaceae	exotic	20	1	20.0	K
Fuchsia magellanica DC (MEX.)	Onagraceae	exotic	20	1	20.0	N
Gamolepsis chrysanthemoides LESS.	Compositae	exotic	320	16	20.0	K/L/M/N
Gloriosa simplex L.	Liliaceae	exotic	20	1	20.0	K
Jasminum sp. L.	Oleaceae	exotic	300	15	20.0	K/M/N
Leucas martinicensis (JACQ.) R.BR.	Labiatae	exotic	40	2	20.0	L
Malva parviflora L.	Malvaceae	exotic	20	1	20.0	N
Melanthera scandens (SCHUMACH. & THONN.)	Compositae	exotic	20	1	20.0	M
Phragmanthera rufescens (DC.) BALLE	Loranthaceae	exotic	20	1	20.0	L
Portulacaria afra L.	Portulacaceae	exotic	20	1	20.0	L
Rosa vulgaris L.	Rosaceae	exotic	20	1	20.0	N
Salvia microphylla KUNTH	Labiatae	exotic	60	3	20.0	M/N
Senecio petitianus A.RICH.	Compositae	exotic	20	1	20.0	N
Solanecio nandensis (S.MOORE) C.JEFFREY	Compositae	exotic	20	1	20.0	N
Stachytarpheta jamaicensis (L.) VAHL	Verbenaceae	exotic	40	2	20.0	K
Tecoma capensis (THUNB.) SPACH	Bignoniaceae	exotic	20	1	20.0	N
Tecomaria capensis (THUNB.) SPACH	Bignoniaceae	exotic	140	7	20.0	N
Verbena bonariensis L.	Verbenaceae	exotic	40	2	20.0	M
Vernonia galamensis sub affromonttana (R.E.FR.) M.G.GILBERT	Compositae	exotic	20	1	20.0	K
Acacia mearnsii DE WILD.	Fabaceae(m)	exotic	471	25	18.8	E/K/L/M/N
Cestrum nocturnum L.	Solanaceae	exotic	101	6	16.8	M/N
Aloe secundiflora ENGL.	Aloeaceae	exotic	50	3	16.7	L/N
Cupressus sp. L.	Cupressaceae	exotic	148	9	16.4	E
Eucalyptus saligna SM.	Myrtaceae	exotic	757	48	15.8	E/K/L/M/N
Melaleuca armillaris SM.	Myrtaceae	exotic	15	1	15.0	N
Agave sisalana(sisal) PERR. EX ENGELM	Agaveaceae	exotic	192	13	14.8	E/L/M/N
Calliandra calothyrsus MEISSNER (C AM.)	Fabaceae(m)	exotic	101	7	14.4	K/M/N
Cassia tomentosa L.	Fabaceae(c)	exotic	83	6	13.8	L/N
Eucalyptus citriodora HOOK.	Myrtaceae	exotic	68	5	13.6	K
Acacia melanoxylon R.BR.	Fabaceae(m)	exotic	27	2	13.5	M/N
Datura stramonium L.	Solanaceae	exotic	53	4	13.3	E/N
Delonix regia (HOOK.)	Fabaceae(c)	exotic	40	3	13.3	E/M
Cestrum aurantiacum LINDL.	Solanaceae	exotic	25	2	12.5	K
Sambucus nigra L.	Caprifoliaceae	exotic	50	4	12.5	K
Euphorbia sp. L.	Euphorbiaceae	exotic	89	8	11.1	E
Hibiscus spp. L.	Malvaceae	exotic	301	27	11.1	E/K/L/N
Malus domestica BORKH.	Rosaceae	exotic	22	2	11.0	K/M
Cassia siamea L.	Fabaceae(c)	exotic	185	17	10.9	E/M
Pyrus communis(Pear) L.	Rosaceae	exotic	43	4	10.8	N
Salvia merjamie FORSSK.	Labiatae	exotic	21	2	10.5	L/M
Aloe latifolia (AITON) HAW.	Aloaceae	exotic	10	1	10.0	L
Ipomoea sp. L.	Convolvulaceae	exotic	10	1	10.0	L
Senna siamea (LAM.) IRWIN & BARNEBY	Fabaceae(c)	exotic	90	9	10.0	K/M/N
Eucalyptus globulus LABILL.	Myrtaceae	exotic	122	13	9.4	L/M/N
Hakea saligna SCHRADER.	Proteaceae	exotic	28	3	9.3	M/N
Callistemon spectabilis R.BR.	Myrtaceae	exotic	9	1	9.0	N
Datura suaveolens(Angel's trumpet) HUMB. & BONPL. EX WILLD	Solanaceae	exotic	52	6	8.7	K/N
Tecoma stans JUSS.	Bignoniaceae	exotic	74	9	8.2	E/K/L/M/N
Cyphomandra betacea(Tree tomato) SENDTN.	Solanaceae	exotic	244	31	7.9	E/K/M/N
Ipomoea obscura (L.) KER GAWL.	Convolvulaceae	exotic	15	2	7.5	E
Bougainvillea sp. COMM.EX JUSS.	Nyctaginaceae	exotic	182	25	7.3	E/K/L/M/N

Euphorbia cotinifolia(Red euphorbia) L.	Euphorbiaceae	exotic	27	4	6.8	K/M/N
Macadamia spp. F.MUELL.	Proteaceae	exotic	363	56	6.5	E/K/M/N
Carica papaya(Papaya) L.	Caricaceae	exotic	566	91	6.2	E/K/L/M/N
Cassia occidentalis L.	Fabaceae(c)	exotic	5	1	5.0	K
Erythrina lysistemon HUTCH	Fabaceae(p)	exotic	10	2	5.0	L/M
Prunus persica (L) BATSCH	Rosaceae	exotic	5	1	5.0	N
Cassia spectabilis L.	Fabaceae(c)	exotic	153	32	4.8	E/K/L/M/N
Leucaena luecocephala (LAM.) DE WIT	Fabaceae(m)	exotic	125	27	4.6	E/K/L/M/N
Fraxinus pennsylvanica MARSHALL	Oleaceae	exotic	22	5	4.4	K/M/N
Persea americana(Avocado) MILL.	Laraceae	exotic	553	127	4.4	E/K/L/M/N
Mangifera indica(Mango) L.	Anacardiaceae	exotic	441	111	4.0	E/K/L/M/N
Morus alba(Mulberry) L.	Moraceae	exotic	139	36	3.9	E/K/L/M/N
Citrus sinensis(Orange) (L.) OSBECK	Rutaceae	exotic	161	45	3.6	E/K/L/M/N
Casuarina cunninghamiana MIQ.	Casuarinaceae	exotic	92	26	3.5	E/K/L/M/N
Pinus patula SCHLECT. & CHAM.	Pinaceae	exotic	27	8	3.4	L/M/N
Thevetia peruviana (PERS.) SCHUMANN	Apocynaceae	exotic	54	16	3.4	E/K/N
Melia azedarach L.	Meliaceae	exotic	56	17	3.3	E/K/L/M/N
Callistemon citrinus(Bottole brush) R.BR.	Myrtaceae	exotic	128	41	3.1	E/L/M/N
Eriobotrya japonica (THUNB.)	Fabaceae(p)	exotic	262	85	3.1	E/K/L/M/N
Araucaria columnaris(Pine) JUSS.	Araucariaceae	exotic	3	1	3.0	N
Caesalpinia spinosa (MOLINA) KUNTZE	Fabaceae(c)	exotic	3	1	3.0	M
Acrocarpus fraxinifolius ARN.	Fabaceae(c)	exotic	23	8	2.9	E/K/M/N
Prunus domestica(plum) L.	Rosaceae	exotic	55	19	2.9	E/L/M/N
Annona muricata L.	Annonaceae	exotic	8	3	2.7	K/M
Jacaranda mimosofolia D.DON	Bignoniaceae	exotic	111	42	2.6	E/K/L/M/N
Psidium guajava(Guava) L.	Myrtaceae	exotic	173	67	2.6	E/K/L/M/N
Citrus limon(Lemon) (L.) BURM.F.	Rutaceae	exotic	81	32	2.5	E/K/M/N
Terminalia mentally L.	Combretaceae	exotic	28	13	2.2	E/K/M/N
Annona cherimola(Custard apple) MILLER	Annonaceae	exotic	50	25	2.0	E/K/L/M/N
Asparagus racemosus WILLD.	Asparagaceae	exotic	2	1	2.0	N
Azadirachta indica(Neem tree) A.JUSS	Meliaceae	exotic	12	6	2.0	E/K/M/N
Toona ciliata M.ROEM.	Meliaceae	exotic	2	1	2.0	L
Euphorbia pulcherrima(Poinsettia) WILLD.EX KLOTZSCH	Euphorbiaceae	exotic	15	8	1.9	E/M/N
Leucaena sp. BENTH.	Fabaceae(m)	exotic	5	3	1.7	E
Pisum sativum L.	Fabaceae(p)	exotic	3	2	1.5	M
Ficus benjamina L.	Moraceae	exotic	8	6	1.3	E/M
Manihot glaziovii(Tree cassava) MULL.ARG.	Euphorbiaceae	exotic	7	6	1.2	E/K
Aleurites moluccana (L.) WILLD	Euphorbiaceae	exotic	1	1	1.0	L
Anacardium occidentale L.	Anacardiaceae	exotic	1	1	1.0	M
Araucaria heterophylla (SALISB.)	Araucariaceae	exotic	2	2	1.0	K
Bambusa vulgaris SCHRADER EX WENDL.	Gramineae	exotic	1	1	1.0	L
Brachychiton acerifolium F.MUELL.	Sterculiaceae	exotic	1	1	1.0	E
Calliandra haematocephala BENTH	Fabaceae(m)	exotic	1	1	1.0	K
Casimiroa edulis(White sapote) LLAVE & LEX.	Rutaceae	exotic	6	6	1.0	K/L/M/N
Chorisia speciosa GIBBS & SEMIR	Bombacaceae	exotic	2	2	1.0	N
Citrus aurantium L.	Rutaceae	exotic	2	2	1.0	K/N
Cordia myxa L.	Boraginaceae	exotic	2	2	1.0	K
Cupressus sempervirens L.	Cupressaceae	exotic	1	1	1.0	N
Ficus elastica L.	Moraceae	exotic	2	2	1.0	E/N
Fuchsia arborescens SIMS	Onagraceae	exotic	1	1	1.0	K
Hevea brasiliensis (Rubber tree) (A.JUSS.) MULL.ARG.	Euphorbiaceae	exotic	1	1	1.0	E
Hydrangea macrophylla (THUNB.) SER.	Hydrangeaceae	exotic	1	1	1.0	M
Malus sylvestris(Apple) (L.) MILLER')	Rosaceae	exotic	2	2	1.0	N
Phoenix roebelenii O'BRIEN EX C.ROEBELEN	Palmae	exotic	1	1	1.0	K
Phoenix sp. L.	Palmae	exotic	1	1	1.0	L
Plumeria rubra L.	Apocynaceae	exotic	1	1	1.0	K
Prunus sp. L.	Rosaceae	exotic	1	1	1.0	N
Punica granatum L.	Punicaceae	exotic	1	1	1.0	N
Senna occisdentalis (L.) LINK	Fabaceae(c)	exotic	1	1	1.0	K
Thrinax floridana SW.	Palmae	exotic	1	1	1.0	K
Tipuana tipu (BENTH.) KUNTZE	Fabaceae(p)	exotic	1	1	1.0	L
Sub-total species No. & trees No.		**123**	**21638**			

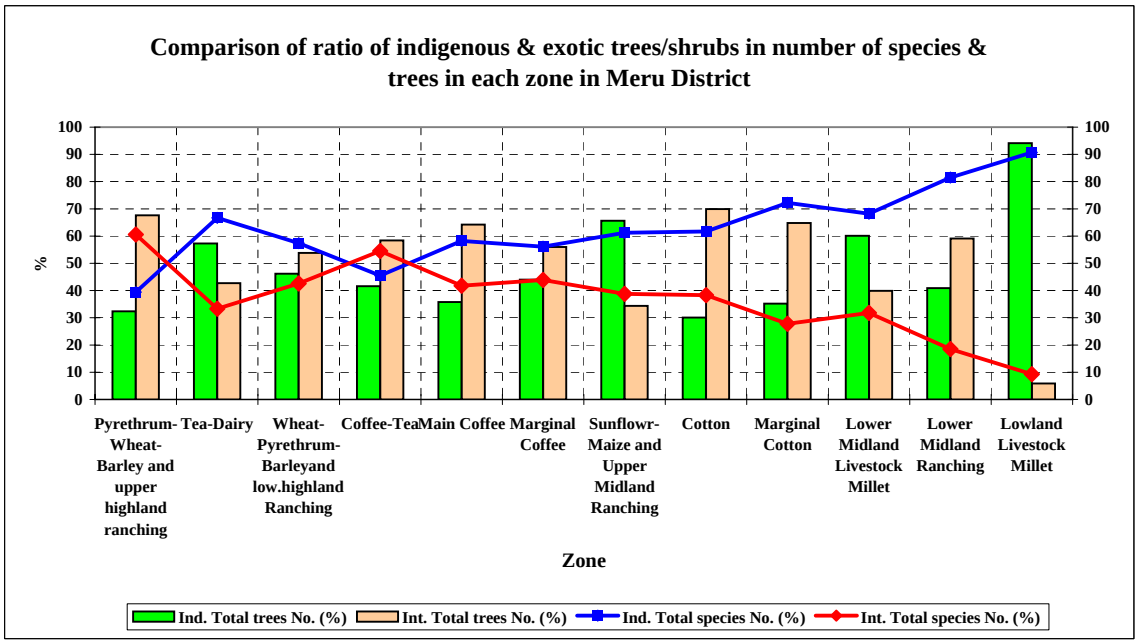
Appendix 8

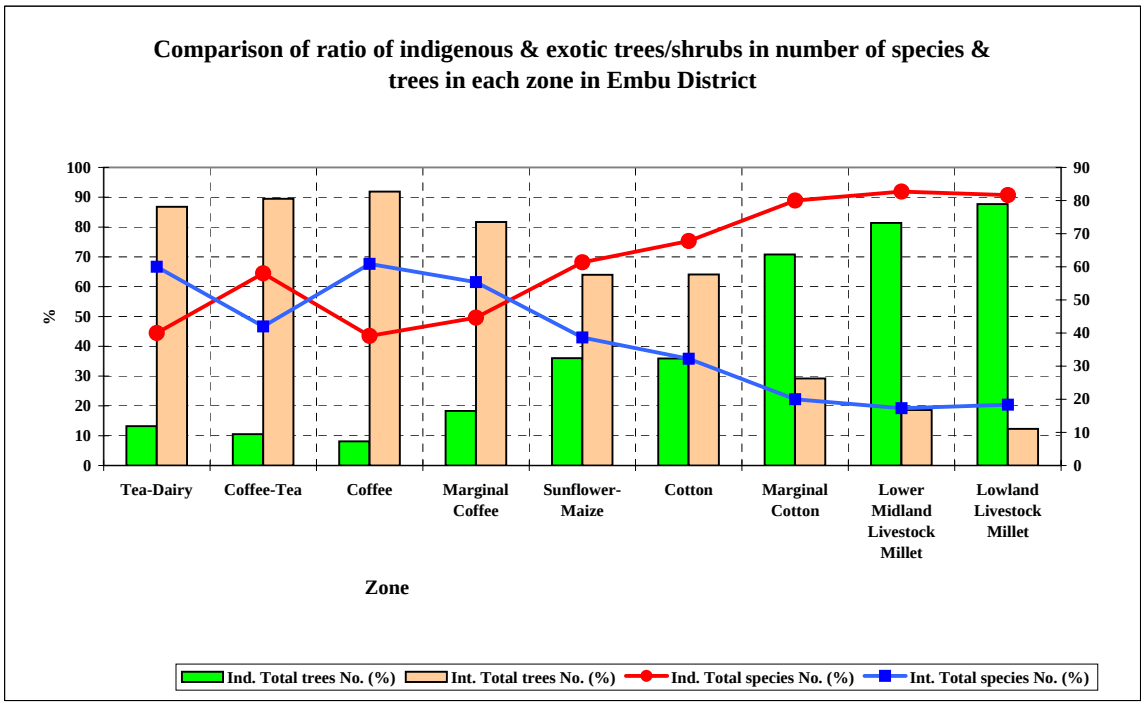
List of least number of indigenous trees & shrubs

Species name	Family	Type	Uses
1. *Albizia gummifera*	Mimosaceae	Shrub/tree	A bark decoction against malaria
2. *Caesalpinia volkensii*	Caesalpiniaceae	Shrub	Used as malaria medicine by Kikuyu
3. *Clausena anisata*	Rutaceae	Shrub/tree	A root decoction is used against a wide variety of complaints, such as whooping cough, malaria and various aches
4. *Ehretia cymosa*	Boraginaceae	Tree	Roots and leaves have a reputation as an aphrodisiac. The leaf juice is styptic and is used for healing wounds.
5. *Euphorbia friesiorum*	Euphorbiaceae	Tree	The latex may cause blindness when it gets into the eye. Root for medicine
6. *Grewia tembensis*	Tiliaceae	Shrub	Turkana use a root decoction against cough
7. *Myrica salicifolia*	Myricaceae	Tree	Intoxicating stuff
8. *Rauvolfia caffra*	Apocynaceae	Shrub/tree	Latex for malaria cure; root decoction for medicine
9. *Steganotaenia araliacea*	Umbelliferae	shrub/tree	An infusion of this plant is strongly emetic; the bark is chewed by the Turkana against fever.
10. *Xymalos monospora*	Monimiaceae	Shrub	ant resistant

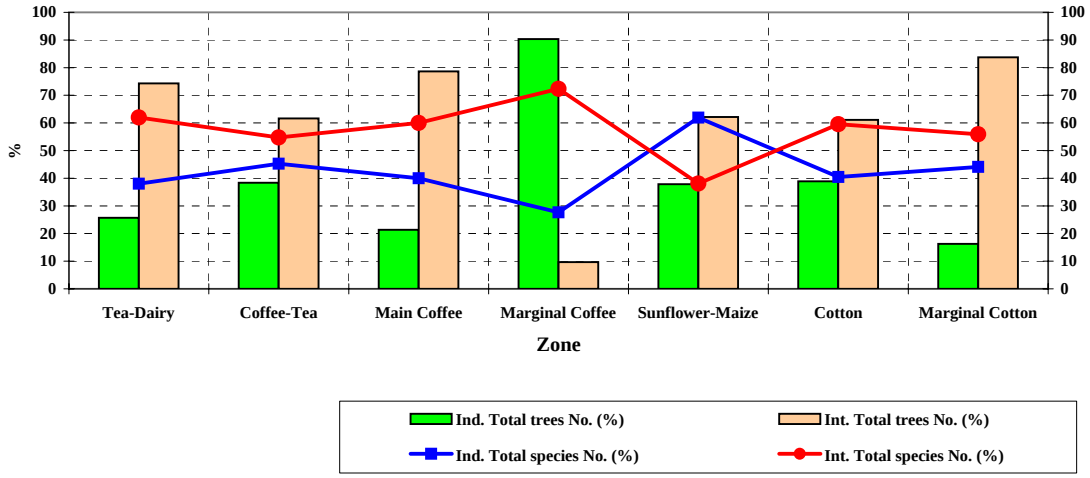
(Data source: Beentje H. J., 1994)

Comparison of ratio of indigenous & exotic trees/shrubs in number of species & trees in each zone in 5 districts

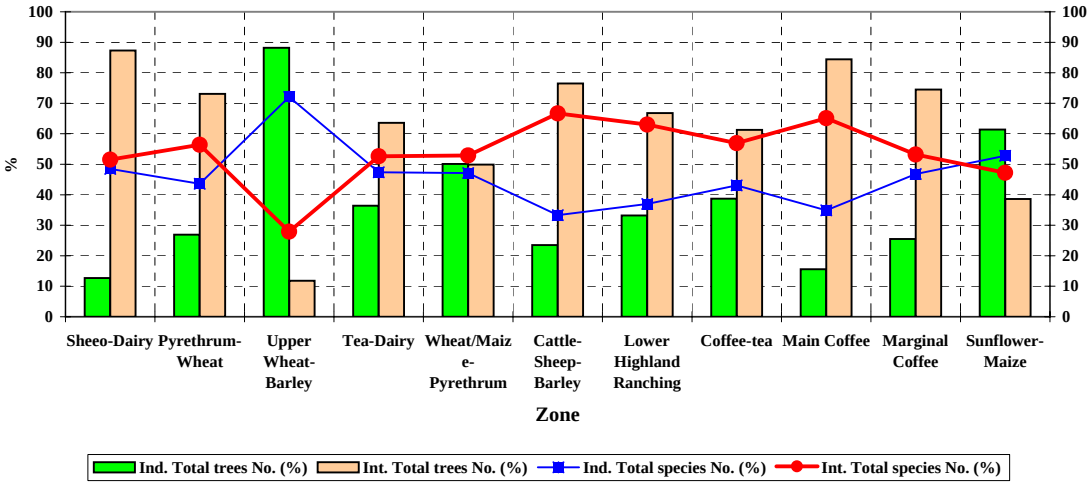


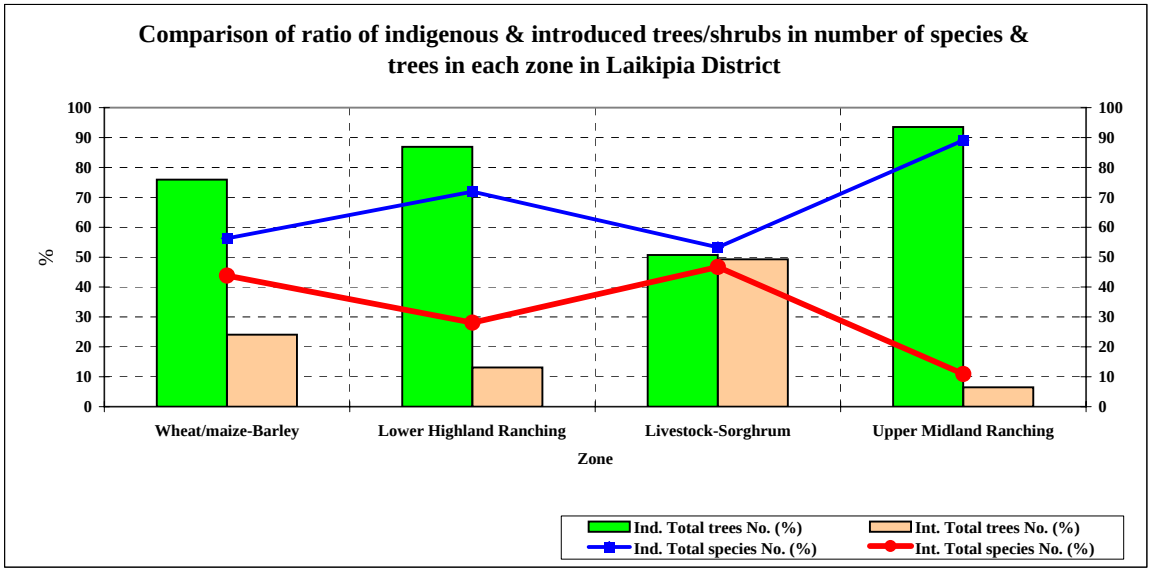


Comparison of ratio of indigenous & exotic trees/shrubs in number of species & trees in each zone in Kirinyaga District



Comparison of ratio of indigenous & exotic trees/shrubs in number of species & trees in each zone in Nyeri District




Comparison of ratio of indigenous & introduced trees/shrubs in number of species & trees in each zone in Laikipia District
%
100
90
80
70
60
50
40
30
20
10
0
Wheat/maize-Barley
Lower Highland Ranching
Livestock-Sorghrum
Upper Midland Ranching
Zone
Ind. Total trees No. (%)
Int. Total trees No. (%)
Ind. Total species No. (%)
Int. Total species No. (%)

Appendix 10

Total number of trees of major species in each district

Species Name	Meru	Embu	Kirinyaga	Nyeri	Laikipia	Total
*Grevillea robusta**	1040	1774	1571	1367	561	6313
*Musa sapientum(Banana)**		828		1658		2486
*Cupressus lusitanica**	344	633		1225		2202
*Lantana camara**	380	592	400	280		1652
Euclea divinorum				597	1006	1603
Croton megalocarpus				978	593	1571
Eucalyptus spp.*		587	102	327		1016
Catha edulis		943				943
Commiphora eminii	418		156	321		895
Euphorbia tirucalli	301	243	303			847
*Ricinus communis**	466		178			644
*Dovyalis caffra**				361	108	469
Commiphora africana		456				456
*Carica papaya(Papaya)**		323	106			429
Solanum incanum	200				200	400
*Acacia mearnsii**				378		378
*Tithonia diversifolia**	370					370
Melia volkensii		334				334
Acacia drepanolobium					328	328
*Tithonia diversifolia**			300			300
Tetradenia riparia	220					220
Psiadia punctulata					187	187
*Persea americana**	172					172
Plectranthus barbatus					170	170
Lippia javanica					160	160
Leonotis nepetifolia					120	120
*Gamolepsis chrysanthemoides**			100			100

*: exotic species

Appendix 11

Soil analysis results

Data No.	Code-no	Soil-no	Name of zone	pH in water	Clay(%)	Sand (%)	Silt (%)	Carbon (%)	EXCA	EXMG	EXK	EXP	Alt
1	E-1	LH1-1	Tea-dairy	4.7	14	52	34	3.16	3.8	1.3	0.95	11.6	1847
2	E-2	LH1-2	Tea-dairy	4.9	20	42	38	2.27	1.7	0.6	0.35	2.6	1780
3	E-3	LH1-3	Tea-dairy	5.1	29	44	27	2.90	2.4	0.7	0.39	17.1	1785
4	E-4	LH1-4	Tea-dairy	5.0	19	52	29	2.07	0.6	0.2	0.17	14.2	1746
5	E-5	LH1-5	Tea-dairy	4.5	47	32	21	3.81	0.4	0.2	0.29	8.3	1775
6	E-6	LH1-6	Tea-dairy	4.2	33	44	23	3.64	0.7	0.3	0.12	10.9	1785
7	E-7	UM1-1	Coffee-tea	5.6	24	48	28	1.94	6.3	1.8	1.24	13.4	1670
8	E-8	UM1-2	Coffee-tea	5.0	32	37	31	1.77	3.1	1.3	0.15	7.8	1595
9	E-9	UM1-3	Coffee-tea	4.9	35	30	35	2.42	1.1	0.3	0.24	2.5	1748
10	E-10	UM1-4	Coffee-tea	4.9	56	24	20	1.69	1.5	0.4	0.45	10.4	1730
11	E-11	UM1-5	Coffee-tea	5.1	43	28	29	2.09	3.3	1.2	0.42	49.9	1635
12	E-12	UM1-6	Coffee-tea	4.1	33	40	27	3.67	0.7	0.2	0.12	5.6	1780
13	E-13	UM1-7	Coffee-tea	5.1	35	42	23	1.84	5.3	2.2	1.46	12.3	1590
14	E-14	UM1-8	Coffee-tea	4.3	35	40	25	3.50	0.8	0.2	0.09	8.4	1735
15	E-15	UM1-9	Coffee-tea	4.7	37	30	33	2.72	1.0	0.5	0.67	22.6	1690
16	E-16	UM2-1	Main coffe	6.3	28	34	38	3.18	7.3	4.2	2.22	26.2	1497
17	E-17	UM2-2	Main coffe	5.9	36	30	34	2.21	9.5	3.8	1.47	23.6	1495
18	E-18	UM2-3	Main coffe	4.9	40	26	34	2.25	3.7	1.2	0.28	13.6	1520
19	E-19	UM2-4	Main coffe	5.8	48	24	28	2.02	6.5	2.7	0.50	6.5	1465
20	E-20	UM2-5	Main coffe	6.7	55	20	25	1.40	5.6	2.1	0.69	20.8	1600
21	E-21	UM2-6	Main coffe	5.5	42	34	24	1.68	5.0	1.5	0.59	20.9	1560
22	E-22	UM2-7	Main coffe	4.6	51	29	20	1.54	1.1	0.7	0.73	8.5	1580
23	E-23	UM2-8	Main coffe	6.5	43	36	21	1.80	7.8	2.8	1.06	30.7	1545
24	E-24	UM2-9	Main coffe	6.2	73	14	13	1.42	5.0	2.1	0.93	12.0	1485
25	E-25	UM3-1	Marginal coffee	6.9	50	15	35	1.61	11.7	3.3	0.80	41.4	1450
26	E-26	UM3-2	Marginal coffee	6.5	45	30	25	2.46	8.4	5.8	1.81	47.5	1450
27	E-27	UM3-3	Marginal coffee	6.0	46	22	32	1.87	8.0	2.7	0.98	20.9	1325
28	E-28	UM3-4	Marginal coffee	5.5	48	24	28	1.75	5.5	2.2	1.32	36.1	1460
29	E-29	UM3-5	Marginal coffee	6.6	58	12	30	1.32	9.1	2.5	1.06	25.5	1280
31	E-31	UM3-7	Marginal coffee	6.5	45	19	36	1.82	9.9	3.5	1.01	14.0	1530
32	E-32	UM3-8	Marginal coffee	6.3	46	19	35	2.36	8.8	4.3	1.01	13.0	1455
33	E-33	UM4-1	Sunflower-maize	6.5	22	46	32	1.77	5.7	2.5	1.13	8.7	1323
34	E-34	UM4-2	Sunflower-maize	6.4	48	26	26	1.76	6.9	2.8	0.87	4.9	1305
35	E-35	UM4-3	Sunflower-maize	5.5	33	33	34	1.28	3.6	2.0	0.50	19.0	1371
36	E-36	UM4-4	Sunflower-maize	6.0	45	28	27	1.54	5.4	2.4	0.22	3.5	1368
37	E-37	UM4-5	Sunflower-maize	6.6	38	28	34	2.00	5.4	2.4	0.88	3.5	1253
38	E-38	UM4-6	Sunflower-maize	5.9	36	24	40	1.98	5.4	2.4	0.94	3.6	1258
39	E-39	UM4-7	Sunflower-maize	5.1	47	24	29	1.47	5.4	2.4	0.46	7.6	1251
40	E-40	UM4-8	Sunflower-maize	6.2	47	21	32	1.67	5.4	2.4	1.04	23.7	1269
41	E-41	UM4-9	Sunflower-maize	6.7	33	29	38	1.60	5.4	2.4	1.86	13.5	1269
42	E-42	LM3-1	Cotton	6.4	28	36	36	2.16	8.4	4.0	1.39	6.6	1280
43	E-43	LM3-2	Cotton	6.9	48	18	34	2.67	12.4	3.3	0.79	41.3	1265
44	E-44	LM3-3	Cotton	7.2	36	32	32	3.26	14.8	5.5	1.57	6.8	1215
45	E-45	LM3-4	Cotton	7.1	46	26	28	1.93	8.2	4.6	1.30	5.6	1250
46	E-46	LM3-5	Cotton	6.7	38	31	31	1.87	8.0	3.3	1.05	4.0	1158
47	E-47	LM4-1	Marginal cotton	6.7	30	38	32	1.52	6.0	2.8	1.28	5.1	1207
48	E-48	LM4-2	Marginal cotton	6.4	36	42	22	1.38	6.1	3.2	0.95	6.3	1200
49	E-49	LM4-3	Marginal cotton	6.8	20	40	40	1.61	12.0	5.6	2.22	177.1	1104
50	E-50	LM4-4	Marginal cotton	7.8	58	18	24	1.88	49.7	21.1	0.57	2.4	1171
51	E-51	LM4-5	Marginal cotton	8.5	38	33	29	1.20	40.5	3.8	0.18	2.2	1114
52	E-52	LM4-6	Marginal cotton	5.9	40	30	30	1.27	7.0	1.7	0.82	6.0	1100
53	E-53	LM4-7	Marginal cotton	6.0	12	76	12	0.48	0.9	0.4	0.24	4.4	1100
54	E-54	LM4-8	Marginal cotton	7.1	24	62	14	0.91	2.8	0.9	0.48	2.8	1220
55	E-55	LM4-9	Marginal cotton	7.2	22	62	16	1.08	3.3	0.9	0.67	3.9	1236
56	E-56	LM4-10	Marginal cotton	6.8	37	44	19	1.08	3.9	1.4	0.53	2.7	1205
57	E-57	LM4-11	Marginal cotton	6.0	46	24	30	1.66	6.1	4.0	0.73	4.3	1110
58	E-58	LM4-12	Marginal cotton	7.6	20	66	14	1.13	4.9	1.6	1.21	14.6	1165
59	E-59	LM4-13	Marginal cotton	6.3	20	54	26	1.06	7.1	1.5	0.46	8.0	1125
60	E-60	LM4-14	Marginal cotton	7.7	18	64	18	0.48	10.9	2.1	0.16	7.5	1160
61	E-61	LM4-15	Marginal cotton	6.1	44	34	22	1.60	6.0	3.4	0.80	1.8	1140
62	E-62	LM4-16	Marginal cotton	6.6	60	16	24	2.03	15.9	9.5	0.78	1.6	1160
63	E-63	LM4-17	Marginal cotton	8.5	19	44	37	0.55	17.4	1.5	0.17	5.4	1170
64	E-64	LM5-1	Lower midland livestock millet	7.0	14	74	12	0.99	4.2	0.9	0.61	59.3	1307
65	E-65	LM5-2	Lower midland livestock millet	7.3	32	44	24	1.53	10.8	4.5	1.62	9.5	1025
66	E-66	LM5-3	Lower midland livestock millet	6.8	28	42	30	2.47	13.7	5.1	1.67	59.6	1117
67	E-67	LM5-4	Lower midland livestock millet	8.2	36	42	22	1.26	33.4	6.1	0.30	7.0	1110
68	E-68	LM5-5	Lower midland livestock millet	8.0	20	51	29	1.59	13.3	2.6	1.34	162.0	1060
69	E-69	LM5-6	Lower midland livestock millet	7.7	20	64	16	0.90	6.1	1.8	1.33	60.7	845
70	E-70	LM5-7	Lower midland livestock millet	7.4	30	44	26	0.75	16.3	2.8	0.54	5.1	1133

Data No.	Code-no	Soil-no	Name of zone	pH in water	Clay(%)	Sand (%)	Silt (%)	Carbon (%)	EXCA	EXMG	EXK	EXP	Alt
71	E-71	LM5-8	Lower midland livestock millet	7.5	28	47	25	1.23	14.3	4.2	0.91	25.8	1115
72	E-72	LM5-9	Lower midland livestock millet	7.1	36	26	38	1.86	16.5	5.9	1.28	79.1	1132
73	E-73	LM5-10	Lower midland livestock millet	6.8	36	32	32	0.83	10.5	3.7	0.60	57.9	1087
74	E-74	LM5-11	Lower midland livestock millet	6.3	26	54	20	1.43	8.1	1.9	0.47	5.9	995
75	E-75	LM5-12	Lower midland livestock millet	7.1	24	58	18	0.73	4.9	1.2	0.70	18.5	845
76	E-76	LM5-13	Lower midland livestock millet	7.1	40	38	22	1.35	12.6	4.7	1.18	43.7	1080
77	E-77	LM5-14	Lower midland livestock millet	6.8	26	52	22	0.99	8.7	3.2	0.87	48.6	870
78	E-78	LM5-15	Lower midland livestock millet	7.0	21	73	6	0.60	2.7	0.9	0.24	3.2	940
79	E-79	IL5-1	Lowland livestock millet	8.1	16	68	16	0.86	12.9	1.1	0.47	28.3	698
80	E-80	IL5-2	Lowland livestock millet	7.3	20	64	16	1.00	6.8	1.8	0.80	29.0	700
82	E-82	IL5-4	Lowland livestock millet	7.2	17	68	15	1.25	5.2	1.5	0.45	9.2	700
83	E-83	IL5-5	Lowland livestock millet	7.7	19	63	18	1.10	6.6	1.4	0.85	376.1	730
84	K-1	LH1-1	Tea-dairy	5.1	15	55	30	8.09	4.2	1.8	1.18	179.3	2011
85	K-2	LH1-2	Tea-dairy	5.7	21	39	40	3.73	5.3	1.7	0.34	99.4	1762
86	K-3	LH1-3	Tea-dairy	5.2	21	49	30	4.14	2.1	1.0	0.66	102.7	1865
87	K-4	LH1-4	Tea-dairy	4.8	29	39	32	3.42	2.4	1.0	0.43	27.4	1651
88	K-5	LH1-5	Tea-dairy	5.2	33	39	28	2.92	4.3	1.2	0.85	45.3	1510
89	K-6	UM1-1	Coffee-tea	5.4	27	35	38	3.25	4.3	1.5	0.81	25.6	1593
90	K-7	UM1-2	Coffee-tea	5.3	27	39	34	2.11	4.8	1.7	0.31	69.2	1661
91	K-8	UM1-3	Coffee-tea	6.4	33	29	38	2.39	12.4	3.6	1.62	215.8	1556
92	K-9	UM1-4	Coffee-tea	5.0	21	45	34	2.73	2.3	1.0	0.64	129.2	1656
93	K-10	UM1-5	Coffee-tea	4.5	27	43	30	3.11	0.5	0.1	0.22	16.0	1726
94	K-11	UM2-1	Main coffee	5.3	41	33	26	2.21	4.7	2.1	0.31	18.4	1539
95	K-12	UM2-2	Main coffee	5.7	31	33	36	2.03	8.5	1.8	0.83	137.9	1502
96	K-13	UM2-3	Main coffee	6.2	45	23	32	1.63	5.8	2.9	0.18	56.9	1464
97	K-14	UM2-4	Main coffee	5.7	41	27	32	1.99	6.9	2.4	0.29	109.0	1448
98	K-15	UM2-5	Main coffee	5.6	33	33	34	2.20	7.5	2.7	0.38	77.0	1431
99	K-16	UM3-1	Marginal coffee	5.1	37	33	30	2.29	3.4	1.2	0.15	23.5	1290
100	K-17	UM3-2	Marginal coffee	5.4	35	31	34	2.98	6.2	2.4	0.49	10.9	1380
101	K-18	UM3-3	Marginal coffee	5.6	35	33	32	2.30	6.2	2.9	1.11	26.9	1280
102	K-19	UM3-4	Marginal coffee	5.9	11	79	10	1.87	8.3	3.4	0.38	23.5	1334
103	K-20	UM3-5	Marginal coffee	5.8	25	49	26	2.40	8.0	2.8	0.19	177.1	1245
104	K-21	UM4-1	Sunflower-maize	5.9	33	31	36	2.60	8.4	4.2	0.40	200.9	1337
105	K-22	UM4-2	Sunflower-maize	5.8	31	25	44	1.81	5.9	3.2	0.47	189.4	1267
106	K-23	UM4-3	Sunflower-maize	6.3	49	19	32	3.04	6.5	3.1	1.09	9.9	1226
107	K-24	UM4-4	Sunflower-maize	6.0	33	29	38	1.70	3.7	1.4	0.88	9.2	1270
108	K-25	UM4-5	Sunflower-maize	6.0	43	21	36	2.67	6.9	2.8	0.54	15.5	1305
109	K-26	LM3-1	Cotton	6.3	41	23	36	2.52	3.2	3.8	1.32	31.5	1137
110	K-27	LM3-2	Cotton	5.8	61	15	24	1.32	4.6	2.8	0.27	6.3	1275
111	K-28	LM3-3	Cotton	6.0	57	19	24	2.28	9.5	5.1	0.76	24.6	1253
112	K-29	LM3-4	Cotton	6.3	29	39	32	1.20	5.1	2.2	0.94	137.6	1230
113	K-30	LM3-5	Cotton	5.6	41	25	34	1.83	5.0	2.4	0.56	47.6	1337
114	K-31	LM4-1	Marginal cotton	5.7	51	17	32	2.10	5.3	3.3	1.07	13.3	1547
115	K-32	LM4-2	Marginal cotton	6.3	31	25	44	2.22	9.6	4.4	1.49	169.5	1017
116	K-33	LM4-3	Marginal cotton	5.2	41	23	36	1.96	4.3	2.8	0.91	9.8	1031
117	K-34	LM4-4	Marginal cotton	6.1	47	19	34	2.04	8.8	5.7	2.17	50.9	1031
118	K-35	LM4-5	Marginal cotton	6.0	41	29	30	1.59	4.5	2.3	1.35	13.3	1137
119	N-1	UH1-1	Sheep-dairy	5.5	4	67	29	4.19	10.2	4.0	2.60	51.8	2285
120	N-2	UH1-2	Sheep-dairy	4.8	6	67	27	5.74	4.9	1.1	1.33	10.5	2283
121	N-3	UH1-3	Sheep-dairy	5.6	6	69	25	3.47	7.1	2.2	1.52	41.6	2265
122	N-4	UH1-4	Sheep-dairy	6.1	12	39	49	3.41	10.1	2.6	1.90	31.3	2108
123	N-5	UH1-5	Sheep-dairy	5.5	16	37	47	2.53	13.3	3.6	0.45	5.5	2087
124	N-6	UH2-1	Pyrethrum-wheat	6.4	8	59	33	3.21	9.2	3.1	2.63	32.0	2086
125	N-7	UH2-2	Pyrethrum-wheat	6.3	10	51	39	2.79	8.3	2.5	1.94	39.5	2095
126	N-8	UH2-3	Pyrethrum-wheat	6.4	10	39	51	4.59	12.7	3.3	2.68	40.2	2305
127	N-9	UH2-4	Pyrethrum-wheat	6.2	6	69	25	3.67	11.3	2.1	0.38	7.8	2430
128	N-10	UH2-5	Pyrethrum-wheat	5.1	8	57	35	2.68	3.5	1.1	0.55	3.7	2516
129	N-11	LH4 -1	Cattle-sheep-barley	6.0	26	37	37	1.67	27.1	4.7	0.54	5.2	1977
130	N-12	LH4 -2	Cattle-sheep-barley	5.5	14	37	49	2.55	10.9	2.6	0.89	50.5	1980
131	N-13	LH4 - 3	Cattle-sheep-barley	6.6	12	41	47	1.62	25.4	2.4	0.96	17.3	2044
132	N-14	LH4 - 4	Cattle-sheep-barley	7.1	12	43	45	1.95	35.7	4.8	1.21	10.7	2159
133	N-15	LH4 - 5	Cattle-sheep-barley	6.7	14	47	39	3.05	20.0	7.2	1.00	5.6	1989
134	N-16	LH5 - 1	Lower highland ranching	6.2	16	41	43	3.08	29.7	6.0	1.02	17.2	1989
135	N-17	LH5 - 2	Lower highland ranching	6.0	14	49	37	2.36	23.8	3.9	0.81	23.5	2034
136	N-18	LH5 - 3	Lower highland ranching	6.4	12	41	47	1.58	25.2	3.8	0.94	22.4	1985
137	N-19	LH5 - 4	Lower highland ranching	5.8	14	35	51	2.19	50.2	10.5	2.34	25.8	1996
138	N-20	LH5 - 5	Lower highland ranching	6.8	16	37	47	3.21	48.9	8.5	2.65	29.7	2017
139	N-21	LH2-1	Wheat/maize-pyrethrum	6.0	6	75	19	3.45	8.5	2.9	2.84	11.4	1980
140	N-22	LH2-2	Wheat/maize-pyrethrum	5.8	5	65	30	3.61	11.2	2.3	2.33	20.9	1970
141	N-23	LH2-3	Wheat/maize-pyrethrum	6.2	7	59	34	3.90	14.1	4.7	3.24	105.6	1932
142	N-24	LH2-4	Wheat/maize-pyrethrum	6.2	5	67	28	3.61	11.9	3.1	2.35	11.5	2015

Data No.	Code-no	Soil-no	Name of zone	pH in water	Clay(%)	Sand (%)	Silt (%)	Carbon (%)	EXCA	EXMG	EXK	EXP	Alt
143	N-25	LH2-5	Wheat/maize-pyrethrum	6.0	5	69	26	2.47	7.1	3.0	3.06	10.7	2015
144	N-26	UH3-1	Wheat/(maize)-barley	5.7	7	61	32	4.12	9.5	3.1	2.27	23.7	2491
145	N-27	UH3-2	Wheat/(maize)-barley	7.4	7	59	34	5.16	34.6	4.0	1.04	10.1	2285
146	N-28	UH3-3	Wheat/(maize)-barley	6.3	13	39	48	2.67	10.5	2.8	2.53	30.9	2205
147	N-29	UH3-4	Wheat/(maize)-barley	6.2	11	47	42	2.73	10.8	2.9	1.12	16.9	2119
148	N-30	UH3-5	Wheat/(maize)-barley	7.4	7	67	26	6.94	32.2	4.7	1.83	14.3	1994
149	N-31	LH1-1	Tea-dairy	3.9	7	69	24	5.14	1.1	0.3	0.35	8.6	2131
150	N-32	LH1-2	Tea-dairy	4.3	5	79	16	4.84	2.7	0.7	0.79	4.9	1968
151	N-33	LH1-3	Tea-dairy	4.4	5	71	24	3.13	2.8	1.1	1.26	13.8	2018
152	N-34	LH1-4	Tea-dairy	4.9	7	67	26	3.75	5.5	2.6	0.90	18.8	1955
153	N-35	LH1-5	Tea-dairy	4.9	5	73	22	3.53	7.1	2.6	1.01	15.3	2003
154	N-36	UM1-1	Coffee-tea	5.4	5	77	18	2.86	4.1	1.4	0.89	12.2	1862
155	N-37	UM1-2	Coffee-tea	5.5	5	79	16	2.74	4.3	1.9	0.91	22.4	1849
156	N-38	UM1-3	Coffee-tea	5.6	5	77	18	3.06	6.7	1.8	1.15	12.0	1847
157	N-39	UM1-4	Coffee-tea	5.4	5	79	16	3.13	4.2	1.4	0.46	6.0	1896
158	N-40	UM1-5	Coffee-tea	4.5	5	75	20	3.93	1.5	0.8	0.52	33.2	1806
159	N-41	LH3-1	Wheat/(maize)-barley	5.8	7	65	28	2.92	12.7	3.7	0.52	17.1	2028
160	N-42	LH3-2	Wheat/(maize)-barley	5.9	9	55	36	3.21	11.3	3.0	1.80	14.5	2045
161	N-43	LH3-3	Wheat/(maize)-barley	6.1	8	47	45	3.10	11.5	2.7	1.51	8.6	1996
162	N-44	LH3-4	Wheat/(maize)-barley	7.4	12	49	39	5.09	39.2	6.1	1.04	13.7	1996
163	N-45	LH3-5	Wheat/(maize)-barley	7.3	8	53	39	4.25	33.9	5.0	1.67	14.9	2053
164	N-46	UM2-1	Main coffee	5.9	10	61	29	2.16	1.9	0.9	0.15	8.2	1748
165	N-47	UM2-2	Main coffee	6.2	8	61	31	3.20	7.5	2.5	0.68	21.4	1821
166	N-48	UM2-3	Main coffee	6.2	8	63	29	2.70	7.4	2.6	1.22	14.6	1708
167	N-49	UM2-4	Main coffee	5.1	10	59	31	2.60	4.0	2.3	0.40	4.7	1620
168	N-50	UM2-5	Main coffee	5.4	6	57	37	3.08	6.7	2.2	1.23	23.1	1798
169	N-51	UM3-1	Marginal coffee	5.8	8	59	33	3.48	8.2	2.2	1.41	8.9	1728
170	N-52	UM3-2	Marginal coffee	5.8	10	45	45	2.41	8.0	1.9	1.29	13.8	1778
171	N-53	UM3-3	Marginal coffee	5.9	8	61	31	3.95	7.5	3.2	3.19	8.1	1753
172	N-54	UM3-4	Marginal coffee	6.2	6	59	35	3.83	11.4	3.4	3.02	31.7	1711
173	N-55	UM3-5	Marginal coffee	5.9	8	61	31	3.64	9.6	2.9	2.31	28.4	1723
174	N-56	UM4-1	Sunflower-maize	7.0	8	59	33	4.52	19.6	3.6	1.75	14.8	1840
175	N-57	UM4-2	Sunflower-maize	5.7	14	43	43	2.55	11.8	2.5	1.15	12.3	1899
176	N-58	UM4-3	Sunflower-maize	7.0	10	47	43	5.74	26.0	3.2	1.69	104.0	1940
177	N-59	UM4-4	Sunflower-maize	6.5	8	59	33	4.26	16.6	3.7	1.32	16.0	1847
178	N-60	UM4-5	Sunflower-maize	6.3	8	59	33	2.59	11.6	3.9	1.32	27.6	1830
179	L-1	LH5-1	Lower highland ranching	6.2	14	51	35	1.40	11.5	3.5	1.05	3.7	1914
180	L-2	LH5-2	Lower highland ranching	6.2	14	37	49	2.69	13.4	4.6	1.59	32.0	1891
181	L-3	LH5-3	Lower highland ranching	6.8	12	45	43	1.72	14.9	4.7	2.56	20.9	2050
182	L-4	LH5-4	Lower highland ranching	6.5	10	45	45	2.60	18.6	5.1	2.19	35.0	2017
183	L-5	LH5-5	Lower highland ranching	7.5	8	53	39	2.19	30.5	4.6	2.23	10.0	2062
184	L-6	LH5-6	Lower highland ranching	6.6	12	39	49	2.79	18.1	6.2	1.48	26.9	2166
185	L-7	LH5-7	Lower highland ranching	6.8	8	49	43	3.47	15.4	5.1	2.21	27.9	2163
186	L-8	LH5-8	Lower highland ranching	6.8	8	55	37	3.81	21.2	4.6	3.53	30.3	1990
187	L-9	LH5-9	Lower highland ranching	5.9	8	53	39	3.17	12.3	2.8	1.05	4.7	2132
188	L-10	LH5-10	Lower highland ranching	6.0	12	53	35	3.30	24.9	11.0	0.44	5.6	2182
189	L-11	UM6-1	Upper midland ranching	6.7	8	73	19	2.29	9.1	2.3	1.06	322.0	1798
190	L-12	UM6-2	Upper midland ranching	6.9	8	85	7	1.03	4.7	1.3	0.52	16.4	1798
191	L-13	UM6-3	Upper midland ranching	7.6	10	75	15	3.51	10.9	3.8	3.64	431.5	1688
192	L-14	LH3-1	Wheat/(maize)-barley	6.3	8	67	25	2.09	3.9	2.4	2.11	11.0	1814
193	L-15	LH3-2	Wheat/(maize)-barley	6.4	10	59	31	1.82	7.7	2.7	1.32	6.3	1814
194	L-16	LH3-3	Wheat/(maize)-barley	6.2	6	57	37	1.31	6.3	3.3	1.70	15.2	1771
195	L-17	LH3-4	Wheat/(maize)-barley	5.4	6	59	35	2.82	3.0	1.8	0.75	14.5	1821
196	L-18	LH3-5	Wheat/(maize)-barley	6.0	8	59	33	2.12	5.5	2.7	2.55	29.6	1821
197	L-19	UM5-1	Livestock-sorghum	6.5	10	57	33	2.64	13.6	4.1	2.93	75.4	1821
198	L-20	UM5-2	Livestock-sorghum	6.3	14	51	35	1.43	27.1	6.4	0.84	10.0	2037
199	L-21	UM5-3	Livestock-sorghum	6.0	10	43	47	3.38	14.7	3.4	1.12	27.2	2019
200	L-22	UM5-4	Livestock-sorghum	4.8	14	35	51	2.50	15.6	4.1	1.64	19.7	1787
201	L-23	UM5-5	Livestock-sorghum	6.8	10	45	45	2.61	16.3	3.4	3.75	150.8	1765
202	M-1	LM3-1	Cotton	6.6	8	73	19	2.33	8.8	3.7	1.33	5.0	970
203	M-2	LM3-2	Cotton	6.2	43	25	32	2.26	7.9	2.9	0.49	13.2	985
204	M-3	LM3-3	Cotton	6.3	55	19	26	2.83	10.3	4.2	0.97	6.2	1026
205	M-4	LM3-4	Cotton	6.1	41	23	36	2.45	9.6	2.6	1.53	69.1	1103
206	M-5	LM3-5	Cotton	6.1	41	27	32	1.66	5.4	2.2	1.62	43.9	1178
207	M-6	UM456-1	Sunflower-maize-Livestock-sorghum-Upper midland ranching	6.3	45	19	36	1.77	16.1	6.9	1.38	79.5	1550
208	M-7	UM456-2	Sunflower-maize-Livestock-sorghum-Upper midland ranching	6.5	61	17	22	1.86	28.3	10.0	0.74	21.9	1625
209	M-8	UM456-3	Sunflower-maize-Livestock-sorghum-Upper midland ranching	6.1	61	15	24	1.65	20.9	8.2	0.76	62.3	1834
210	M-9	UM456-4	Sunflower-maize-Livestock-sorghum-Upper midland ranching	6.7	33	25	42	2.16	16.5	6.3	3.35	259.1	1843

Data No.	Code-no	Soil-no	Name of zone	pH in water	Clay(%)	Sand (%)	Silt (%)	Carbon (%)	EXCA	EXMG	EXK	EXP	Alt
211	M-10	UM456-5	Sunflower-maize-Livestock-sorghum-Upper midland ranching	6.2	61	13	26	1.76	19.1	9.2	0.95	48.1	1907
212	M-11	UM2-1	Main coffee	4.5	29	49	22	2.54	2.9	0.9	0.53	30.4	1390
213	M-12	UM2-2	Main coffee	5.2	53	19	28	3.04	5.7	2.2	1.26	25.0	1259
214	M-13	UM2-3	Main coffee	6.2	43	37	20	2.25	7.5	1.9	0.70	4.6	1364
215	M-14	UM2-4	Main coffee	6.0	55	19	26	2.98	7.4	1.9	1.28	33.3	1411
216	M-15	UM2-5	Main coffee	5.5	49	19	32	3.03	6.3	2.1	1.07	9.0	1464
217	M-16	LH1-1	Tea-dairy	4.3	41	39	20	3.39	0.8	0.4	0.36	5.2	1560
218	M-17	LH1-2	Tea-dairy	5.0	53	21	26	3.18	5.1	1.9	0.72	29.0	1713
219	M-18	LH1-3	Tea-dairy	4.5	41	41	18	3.41	1.3	0.4	0.08	4.0	1706
220	M-19	LH1-4	Tea-dairy	5.5	53	19	28	3.25	7.3	2.8	0.65	23.6	1745
221	M-20	LH1-5	Tea-dairy	5.3	27	45	28	5.44	10.1	3.7	1.24	27.6	1678
222	M-21	LM4-1	Marginal cotton	5.9	47	27	26	2.74	7.1	1.7	1.20	22.7	812
223	M-22	LM4-2	Marginal cotton	6.8	31	33	36	3.66	12.9	3.1	2.27	44.7	856
224	M-23	LM4-3	Marginal cotton	5.5	55	23	22	2.11	3.2	1.8	0.15	5.2	897
225	M-24	LM4-4	Marginal cotton	6.2	41	33	26	2.28	7.4	2.8	1.08	6.1	915
226	M-25	LM4-5	Marginal cotton	6.5	23	59	18	1.45	6.3	1.5	0.91	26.4	984
227	M-26	UM3-1	Marginal coffee	5.5	43	31	26	1.59	4.0	1.9	0.71	4.4	1353
228	M-27	UM3-2	Marginal coffee	5.6	41	29	30	2.93	6.1	2.7	1.44	21.0	1322
229	M-28	UM3-3	Marginal coffee	4.4	45	31	24	2.55	1.1	0.4	0.27	15.1	1259
230	M-29	UM3-4	Marginal coffee	4.9	41	33	26	2.93	4.3	1.6	0.22	4.7	1305
231	M-30	UM3-5	Marginal coffee	4.9	45	29	26	2.03	3.7	1.5	0.73	13.7	1316
232	M-31	UM1-1	Coffee-tea	6.8	21	39	40	3.05	9.7	3.0	1.21	11.2	1572
233	M-32	UM1-2	Coffee-tea	4.8	61	19	20	1.47	2.4	1.2	0.37	14.8	1554
234	M-33	UM1-3	Coffee-tea	5.4	69	17	14	1.18	3.4	3.1	0.92	4.1	1560
235	M-34	UM1-4	Coffee-tea	5.3	41	31	28	3.16	7.5	2.3	0.40	22.9	1496
236	M-35	UM1-5	Coffee-tea	4.3	27	49	24	3.53	1.0	0.4	0.27	12.7	1384
237	M-36	LH234-1	Wheat/maize-pyrethrum-Wheat/(maize)-barley-Cattle-sheep-barley	6.1	31	31	38	3.51	14.3	3.1	2.21	82.2	2100
238	M-37	LH234-2	Wheat/maize-pyrethrum-Wheat/(maize)-barley-Cattle-sheep-barley	5.7	21	29	50	5.24	15.9	3.4	2.18	171.2	2029
239	M-38	LH234-3	Wheat/maize-pyrethrum-Wheat/(maize)-barley-Cattle-sheep-barley	6.2	29	19	52	2.70	12.7	4.8	0.85	156.3	2011
240	M-39	LH234-4	Wheat/maize-pyrethrum-Wheat/(maize)-barley-Cattle-sheep-barley	6.2	41	25	34	1.77	10.0	4.0	1.91	45.2	1996
241	M-40	LH234-5	Wheat/maize-pyrethrum-Wheat/(maize)-barley-Cattle-sheep-barley	6.3	41	19	40	1.98	8.0	4.8	1.59	45.9	2078
242	M-41	LM6-1	Lower midland ranching	7.5	31	27	42	3.21	30.7	5.6	1.89	40.1	1272
243	M-42	LM6-2	Lower midland ranching	7.0	41	15	44	1.60	15.2	5.8	1.53	153.2	1406
244	M-43	LM6-3	Lower midland ranching	7.0	41	19	40	2.25	21.6	6.5	2.01	121.1	1466
245	M-44	LM6-4	Lower midland ranching	7.9	15	51	34	3.04	30.7	4.6	2.73	18.4	1348
246	M-45	LM6-5	Lower midland ranching	7.1	27	33	40	2.20	30.7	6.7	2.41	97.6	1301
247	M-46	UH234-1	Pyrethrum-wheat-Upper Wheat-Barely-Upper Highland Ranching	5.8	29	35	36	2.77	5.5	2.8	1.76	36.8	2244
248	M-47	UH234-2	Pyrethrum-wheat-Upper Wheat-Barely-Upper Highland Ranching	6.2	45	25	30	1.51	16.3	3.7	0.83	6.7	2488
249	M-48	UH234-3	Pyrethrum-wheat-Upper Wheat-Barely-Upper Highland Ranching	5.7	21	33	46	5.26	8.2	2.1	2.20	91.9	2559
250	M-49	UH234-4	Pyrethrum-wheat-Upper Wheat-Barely-Upper Highland Ranching	5.8	25	37	38	3.94	12.3	4.0	1.24	70.7	2447
251	M-50	UH234-5	Pyrethrum-wheat-Upper Wheat-Barely-Upper Highland Ranching	5.2	25	37	38	2.76	6.3	1.9	1.04	63.2	2446
252	M-51	IL5-1	Lowland livestock millet	6.2	11	83	6	0.30	1.4	0.4	0.86	3.1	603
253	M-52	IL5-2	Lowland livestock millet	6.4	19	75	6	0.75	3.9	1.3	0.54	3.9	664
254	M-53	IL5-3	Lowland livestock millet	6.4	15	79	6	0.60	2.5	0.7	0.23	4.0	658
255	M-54	IL5-4	Lowland livestock millet	6.7	11	77	12	0.65	3.9	0.9	0.51	29.5	689
256	M-55	IL5-5	Lowland livestock millet	6.9	15	71	14	0.84	6.1	1.4	1.54	167.3	611
257	M-56	LM5-1	Lower midland livestock-millet	6.3	29	19	52	2.29	8.4	4.1	0.78	97.4	801
258	M-57	LM5-2	Lower midland livestock-millet	6.2	31	19	50	2.44	14.1	4.4	2.13	241.8	858
259	M-58	LM5-3	Lower midland livestock-millet	6.9	31	15	54	2.99	14.4	4.7	2.16	217.8	854
260	M-59	LM5-4	Lower midland livestock-millet	6.6	33	19	48	2.54	13.1	7.5	0.99	38.3	1372
261	M-60	LM5-5	Lower midland livestock-millet	6.5	35	27	38	2.03	13.5	7.4	1.86	45.0	1250

Appendix 12

General Farm Survey Form – Farmer Questionnaire

Interviewer

Sheet No. Farm Code No.

Introduction: The World Agroforestry Centre (ICRAF) is carrying out a survey on trees on the farms in order to establish more details of tree species found on the farms, how they benefit the farmer and how best the productivity of these species can be increased in order to meet more needs of the farmer. I would be grateful if you could spare some time and answer the following questions that will be valuable in achieving the objectives of this survey. I assure you this information will be treated as confidential.

1. Household Data

District

Division

Location

Village

Agro-ecological zone

Farm Location Latitude( ), Longitude( ), Altitude(m)

Name of owner/Household head
M F

Age of owner/household head _____ Years

Name of interviewee/Manager (if not owner)
M F

Interviewee relationship to owner/Household head

How many are you in your family including yourself (strictly Household head family only)? _____

How many dependants does household head have in his family (including his relatives)? (use the table below).

Primary school	Secondary school	Higher school	Others	Total

What is the household head's level of education?

Primary school (Standard_____)
Secondary school (Form_____)
Diploma
Degree
Other(specify): _____

What is your occupation _____

Farm size Acres/ha

Land use Home consumption(food crops only) Acres/ha

Area used for cash crops only Acres/ha

Others (specify)_____ Acres/ha

Number of cows _____ Number of goats _____ Others(Specify) _____

2 Species Data (High-Value Trees on the farm)

2.1 Which are the main(many in number) tree species in your farm?, how do you establish and manage them?, and what are their products?

	Species Name	Establis-hment	Primary purpose	Main product	Secondary products	Main Species Niche	Total trees No.	Average tree height	Oldest tree(age)	How do you Manage the species	Why do you manage this species?
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

Establishment: Planted(PL), Natural Regeneration(NR), Existed before owning farm(EX).
Niche: External boundary(EB), Internal Boundary(IB), Home Garden(HG), Scattered in Crops(SC), Contour(CT), Woodland(WL).
Products/purposes: Medicine(MD), Fruit or Food(FF), Poles(PO), Fuel wood(FW), Animal Fodder(AF), Soil Improvement (SI), Shade(SH), Yams support(YS), Timber(TM)
Management: Replacement(RP=plant again same species after harvest), Substitution(SS=plant another species), Expansion(EP=increase number of same species), Better Management(BM=expect better products of same species)

2.2 Would you like to plant more tree species other than the species listed above?

Yes **1** No **2**

If yes proceed to 2.3, if no go to 2.4

2.3 Which other species do you want to plant?, how many do you want to plant and for what purposes and where do you want to plant them?

Species	Number	Purposes	Niche

2.4 Where is most used tree nursery or source of seedlings closest to you located(Distance in km) _____

2.5 Are there any high-value trees that you would like to plant but cannot get seeds/ Seedlings for ? _____ , _____ , _____ , _____

2.6 What other factors limit the number /type of high-value trees planted? (e.g. Lack of space, cost of seedling, lack of water etc)

_____

2.7 In order of priority, what four tree species would you prefer to plant for timber, Food/Fruit or Medicinal purposes? (including species not currently on farm)

Timber species	Food /Fruit species	Medicinal Species

2.8 Who decides which species to plant?_____

2.9 what criteria are used to make the decision of which species to plant? E.g. Suitability of tree to that area, Speed of growth, Seed availability, Suitability of tree to crop etc.

_____

_____

_____

_____

2.10 How far is your farm from a gazetted forest?_____ km

3. Economy/Market

3.1 What five main timber, Food/fruit and Medicinal species do you sell?, where do you sell them?, and how do you transport them?

Species name	Market(where do you sell)	Transport				Harvesting/ cutting		Influencing factor	Price information source	Marketing problems
Timber species		Mode	Distance	Unit	Cost	size	age			
Food/Fruit species										
Medicinal species										

Market: Timber yard, Sawmill, Trader, Market, Neighbor's, Homestead, Roadside, Others (specify)
Source of prices information: Other farmers/traders, Ext. worker, others (specify)

3.2 What are the main problems you face in your activities of tree farming?

3.3 If you are interviewing the owner;
Which other income generating activities are you involved in?

Activity	Portion of income/amount

4. General

4.1 Where or through which channels have you learnt about tree farming?

4.2 How old is your tree farming (from when first tree was planted to date)?

4.3 What is your future plans for the tree farming?

4.5 Thank you for answering our questions. What else would you like to say about your tree farming?

Thank the farmer for his/her time in voluntarily answering the questions and giving out the information needed for the survey.

End

Appendix 13

Encountered species with number of occurrences and average total trees on farm

Botanical name	Places where species was encountered & Average trees number on farm per species			
	#	%	rank	Average trees number per farm
Grevillea robusta	183	13.2	1	70
Persea Americana	105	7.6	2	8
Musa sapientum	103	7.5	3	110
Eucalyptus saligna	100	7.2	4	56
Cupressus lusitanica	89	6.4	5	30
Mangifera indica	82	5.9	6	10
Croton megalocarpus	74	5.4	7	31
Carica papaya	57	4.1	8	53
Citrus sinensis	37	2.7	9	18
Eriobotrya japonica	36	2.6	10	9
Macadamia tetraphylla	35	2.5	11	12
Citrus limon	27	2.0	12	3
Commiphora eminii	27	2.0	12	45
Cordia Africana	27	2.0	12	9
Jacaranda mimosifolia	27	2.0	12	13
Psidium guajava	27	2.0	12	7
Schinus molle	24	1.7	17	9
Acacia mearnsii	19	1.4	18	89
Croton macrostachyus	18	1.3	19	13
Senna siamea	16	1.2	20	88
Vitex keniensis	16	1.2	20	13
Azadirachta indica	15	1.1	22	4
Bridelia micrantha	15	1.1	22	9
Terminalia brownii	13	0.9	24	23
Casuarina cunninghamiana	12	0.9	24	21
Juniperous procera	12	0.9	24	22
Acacia xanthophloea	11	0.8	27	27
Melia volkensii	11	0.8	27	7
Acacia tortilis	10	0.7	29	25
Acrocarpus fraxinifolius	10	0.7	29	2
Markhamia lutea	10	0.7	29	14
Tamarindus indica	9	0.7	29	9
Annona cherimola	8	0.6	33	7
Erythrina abyssinica	8	0.6	33	2
Acacia nilotica	7	0.5	35	77
Ficus natalensis	7	0.5	35	17
Ficus sycomorus	7	0.5	35	8
Prunus Africana	7	0.5	35	5
Kigelia Africana	6	0.4	39	2
Olea Africana	6	0.4	39	4
Pinus patula	6	0.4	39	25
Senna spectabilis	6	0.4	39	54
Berchemia discolor	5	0.4	39	5

Leucaena leucocephala	5	0.4	39	30
Balanites aegyptiaca	4	0.3	45	4
Commiphora Africana	3	0.2	46	9
Eucalyptus saligna	3	0.2	46	18
Podocarpus falcatus	3	0.2	46	4
Sapium ellipticum	3	0.2	46	25
Spathodea campanulata	3	0.2	46	5
Acacia polyacantha	2	0.1	51	4
Calliandra calothyrsus	2	0.1	51	7
Milicia excelsa	2	0.1	51	2
Milletia dura	2	0.1	51	49
Piliostigma thonningii	2	0.1	51	11
Terminalia mentally	2	0.1	51	2
Trichilia emetica	2	0.1	51	9
Zyzigium guinesis	2	0.1	51	4
Acockanthera chemperi	1	0.1	51	4
Albizia gummifera	1	0.1	51	3
Catha edulis	1	0.1	51	46
Celtis mildbraedii	1	0.1	51	5
Croton dichogamous	1	0.1	51	1
Cussonia holstii	1	0.1	51	7
Ehretia cymosa	1	0.1	51	6
Euclea divinorum	1	0.1	51	3
Fagara microphylla	1	0.1	51	1
Ficus benjamina	1	0.1	51	1
Rawsonia lucida	1	0.1	51	4
Sesbania sesban	1	0.1	51	5

Appendix 14

Ranking of tree species on farms in each district by percent

Meru

Species name	Frequency /362	%
Grevillea robusta	46	12.7
Persea americana	28	7.7
Mangifera indica	27	7.5
Musa sapientum	27	7.5
Eucalyptus saligna	22	6.1
Carica papaya	17	4.7
Cupressus lusitanica	13	3.6
Cordia africana	13	3.6
Senna siamea	12	3.3
Acacia xanthophloea	11	3.0
Schinus molle	9	2.5
Commiphora eminii	8	2.2
Tamarindus indica	8	2.2
Macadamia tetraphylla	7	1.9
Terminalia brownii	7	1.9
Acacia nilotica	7	1.9
Psidium guajava	6	1.7
Citrus sinensis	6	1.7
Croton megalocarpus	5	1.4
Acacia tortilis	5	1.4
Vitex keniensis	4	1.1
Balanites aegyptiaca	4	1.1
Acacia mearnsii	3	0.8
Eriobortya japonica	3	0.8
Citrus limon	3	0.8
Jacaranda mimosifolia	3	0.8
Croton macrostacyus	3	0.8
Azadirachta indica	3	0.8
Kigelia africana	3	0.8
Markhamia lutea	3	0.8
Leucaena leucocephala	3	0.8
Sapium ellipticum	3	0.8
Senna spectabilis	3	0.8
Ficus natalensis	2	0.6
Erythrina abyssinica	2	0.6
Ficus sycomorous	2	0.6
Pinus patula	2	0.6
Prunus africana	2	0.6
Annona cherimola	2	0.6
Eucalyptus globulus	2	0.6
Zyzigium guineensis	2	0.6
Trichilia emetica	2	0.6
Milletia dura	2	0.6
Milicia excelsa	2	0.6
Piliostigma thonningii	2	0.6
Acacia polyacantha	2	0.6
Berchemia discolor	2	0.6
Bridelia micrantha	1	0.3
Calliandra calothyrsus	1	0.3
Juniperous procera	1	0.3
Melia volkensii	1	0.3
Celtis mildbraedii	1	0.3
Ehretia cymosa	1	0.3
Cussonia holstii	1	0.3
Rawsonia lucida	1	0.3
Catha edulis	1	0.3
Total	**362**	**100**

Embu

Species name	Frequency /263	%
Grevillea robusta	27	10.3
Musa sapientum	21	8.0
Persea americana	20	7.6
Mangifera indica	20	7.6
Eucalyptus saligna	18	6.8
Commiphora eminii	15	5.7
Macadamia tetraphylla	15	5.7
Carica papaya	12	4.6
Cupressus lusitanica	11	4.2
Vitex keniensis	9	3.4
Bridelia micrantha	8	3.0
Eriobortya japonica	7	2.7
Croton macrostacyus	6	2.3
Melia volkensii	6	2.3
Acacia mearnsii	5	1.9
Ficus natalensis	5	1.9
Croton megalocarpus	5	1.9
Cordia africana	5	1.9
Acacia tortilis	5	1.9
Citrus limon	4	1.5
Jacaranda mimosifolia	4	1.5
Psidium guajava	4	1.5
Ficus sycomorous	4	1.5
Casuarina cunnighamiana	3	1.1
Erythrina abyssinica	3	1.1
Commiphora africana	3	1.1
Berchemia discolor	3	1.1
Podacarpus falcatus	2	0.8
Juniperous procera	2	0.8
Senna siamea	2	0.8
Citrus sinensis	2	0.8
Calliandra calothyrsus	1	0.4
Spathodea campanulata	1	0.4
Ficus benjamina	1	0.4
Terminalia brownii	1	0.4
Azadirachta indica	1	0.4
Terminalia mentaly	1	0.4
Kigelia africana	1	0.4
Total	**263**	**100**

Kirinyaga

Species name	Frequency/ 193	%
Grevillea robusta	33	17.1
Musa sapientum	27	14.0
Mangifera indica	24	12.4
Persea americana	18	9.3
Eucalyptus saligna	17	8.8
Carica papaya	14	7.3
Croton megalocarpus	8	4.1
Macadamia tetraphylla	7	3.6
Bridelia micrantha	5	2.6
Eriobortya japonica	4	2.1
Cupressus lusitanica	4	2.1
Cordia africana	4	2.1
Psidium guajava	4	2.1
Citrus sinensis	3	1.6
Senna spectabilis	3	1.6
Citrus limon	2	1.0
Croton macrostacyus	2	1.0
Azadirachta indica	2	1.0
Kigelia africana	2	1.0
Acrocarpus fraxinifolius	2	1.0
Markhamia lutea	2	1.0
Commiphora eminii	1	0.5
Vitex keniensis	1	0.5
Acacia mearnsii	1	0.5
Erythrina abyssinica	1	0.5
Ficus sycomorous	1	0.5
Tamarindus indica	1	0.5
Total	**193**	**100**

Nyeri

Species name	Frequency/ 193	%
Grevillea robusta	41	14.4
Cupressus lusitanica	32	11.2
Eucalyptus saligna	31	10.9
Croton megalocarpus	25	8.8
Persea americana	24	8.4
Musa sapientum	24	8.4
Eriobortya japonica	18	6.3
Jacaranda mimosifolia	9	3.2
Mangifera indica	7	2.5
Macadamia tetraphylla	7	2.5
Carica papaya	7	2.5
Citrus sinensis	6	2.1
Acrocarpus fraxinifolius	6	2.1
Prunus africana	6	2.1
Commiphora eminii	5	1.8
Acacia mearnsii	5	1.8
Citrus limon	4	1.4
Croton macrostacyus	4	1.4
Cordia africana	4	1.4
Juniperous procera	3	1.1
Azadirachta indica	3	1.1
Markhamia lutea	3	1.1
Podacarpus falcatus	2	0.7
Psidium guajava	2	0.7
Bridelia micrantha	1	0.4
Casuarina cunnighamiana	1	0.4
Erythrina abyssinica	1	0.4
Spathodea campanulata	1	0.4
Terminalia mentaly	1	0.4
Pinus patula	1	0.4
Annona cherimola	1	0.4
Total	**285**	**100.0**

Laikipia

Species name	Frequency/ 193	%
Grevillea robusta	36	13.3
Croton megalocarpus	33	12.2
Cupressus lusitanica	20	7.4
Citrus sinensis	20	7.4
Eucalyptus saligna	17	6.3
Persea americana	16	5.9
Schinus molle	15	5.5
Citrus limon	14	5.2
Psidium guajava	11	4.1
Musa sapientum	8	3.0
Casuarina cunnighamiana	8	3.0
Carica papaya	7	2.6
Jacaranda mimosifolia	6	2.2
Azadirachta indica	6	2.2
Olea africana	6	2.2
Acacia mearnsii	5	1.8
Mangifera indica	5	1.8
Juniperous procera	5	1.8
Annona cherimola	5	1.8
Eriobortya japonica	4	1.5
Croton macrostacyus	3	1.1
Vitex keniensis	2	0.7
Macadamia tetraphylla	2	0.7
Acrocarpus fraxinifolius	2	0.7
Pinus patula	2	0.7
Markhamia lutea	2	0.7
Leucaena leucocephala	2	0.7
Calliandra calothyrsus	1	0.4
Cordia africana	1	0.4
Spathodea campanulata	1	0.4
Acocanthera chimperi	1	0.4
Euclea divinorum	1	0.4
Sesbania sesban	1	0.4
Albizia gummifera	1	0.4
Eucalyptus globulus	1	0.4
Fagara microphylla	1	0.4
Total	**271**	**100.0**

Appendix 15

Ranking of tree species on farms in each zone category by percent

Upper highland (UH1- 3)

Species name	Frequency	%
Grevillea robusta	20	17.2
Cupressus lusitanica	18	15.5
Eucalyptus saligna	16	13.8
Persea americana	11	9.5
Croton megalocarpus	9	7.8
Musa sapientum	5	4.3
Jacaranda mimosifolia	5	4.3
Pinus patula	4	3.4
Citrus sinensis	4	3.4
Carica papaya	4	3.4
Eriobotrya japonica	4	3.4
Juniperous procera	3	2.6
Acacia mearnsii	2	1.7
Citrus limon	2	1.7
Acrocarpus fraxinifolius	2	1.7
Eucalyptus globulus	1	0.9
Cordia africana	1	0.9
Casuarina cunninghamiana	1	0.9
Podocarpus falcatus	1	0.9
Psidium guajava	1	0.9
Macadamia tetraphylla	1	0.9
Schinus molle	1	0.9
Total	**116**	**100.0**

Upper highland (UH1- 3)

Species name	Frequency	%
Grevillea robusta	20	17.2
Cupressus lusitanica	18	15.5
Eucalyptus saligna	16	13.8
Persea americana	11	9.5
Croton megalocarpus	9	7.8
Musa sapientum	5	4.3
Jacaranda mimosifolia	5	4.3
Pinus patula	4	3.4
Citrus sinensis	4	3.4
Carica papaya	4	3.4
Eriobotrya japonica	4	3.4
Juniperous procera	3	2.6
Acacia mearnsii	2	1.7
Citrus limon	2	1.7
Acrocarpus fraxinifolius	2	1.7
Eucalyptus globulus	1	0.9
Cordia africana	1	0.9
Casuarina cunninghamiana	1	0.9
Podocarpus falcatus	1	0.9
Psidium guajava	1	0.9
Macadamia tetraphylla	1	0.9
Schinus molle	1	0.9
Total	**116**	**100.0**

Upper midland (UM1 - 6)

Species name	Frequency	%
Grevillea robusta	79	12.8
Musa sapientum	56	9.1
Persea americana	51	8.3
Mangifera indica	46	7.5
Eucalyptus saligna	42	6.8
Cupressus lusitanica	32	5.2
Macadamia tetraphylla	28	4.6
Croton megalocarpus	27	4.4
Carica papaya	24	3.9
Commiphora eminii	19	3.1
Cordia africana	19	3.1
Schinus molle	18	2.9
Psidium guajava	14	2.3
Eriobotrya japonica	13	2.1
Croton macrostachyus	11	1.8
Bridelia micrantha	11	1.8
Citrus sinensis	10	1.6
Citrus limon	9	1.5
Jacaranda mimosifolia	8	1.3
Acacia mearnsii	6	1.0
Acacia nilotica	6	1.0
Markhamia lutea	6	1.0
Vitex keniensis	6	1.0
Acacia xanthophloea	5	0.8
Ficus sycomorus	5	0.8
Olea africana	5	0.8
Azadirachta indica	5	0.8
Ficus natalensis	4	0.7
Prunus africana	4	0.7
Casuarina cunninghamiana	3	0.5
Sapium ellipticum	3	0.5
Leucaena leucocephala	3	0.5
Annona cherimola	3	0.5
Erythrina abyssininca	3	0.5
Eucalyptus globulus	2	0.3
Senna spectabilis	2	0.3
Trichilia emetica	2	0.3
zyzigium guinesis	2	0.3
Acrocarpus fraxinifolius	2	0.3
Podocarpus falcatus	2	0.3
Juniperous procera	2	0.3
Spathodea campanulata	2	0.3
Milletia dura	1	0.2
Calliandra calothyrsus	1	0.2
Ehretia cymosa	1	0.2
Celtis mildbraedii	1	0.2
Terminalia brownii	1	0.2
Acacia tortilis	1	0.2
Albizia gummifera	1	0.2
Senna siamea	1	0.2
Melia volkensii	1	0.2
Pinus patula	1	0.2
Terminalia mentaly	1	0.2
Fagara microphylla	1	0.2
Ficus benjamina	1	0.2
Kigelia africana	1	0.2
Milicia excelsa	1	0.2
Total	**615**	**100.0**

Lower midland (LM3 - 6)

Species name	Frequency	%
Mangifera indica	27	12.4
Grevillea robusta	25	11.5
Carica papaya	22	10.1
Musa sapientum	17	7.8
Senna siamea	14	6.5
Persea americana	12	5.5
Citrus sinensis	8	3.7
Acacia xanthophloea	6	2.8
Eucalyptus saligna	6	2.8
Tamarindus indica	6	2.8
Melia volkensii	5	2.3
Senna spectabilis	4	1.8
Terminalia brownii	4	1.8
Azadirachta indica	4	1.8
Croton megalocarpus	4	1.8
Psidium guajava	4	1.8
Citrus limon	4	1.8
Kigelia africana	4	1.8
Acacia tortilis	3	1.4
Berchemia discolor	3	1.4
Cordia africana	3	1.4
Balanites aegyptiaca	3	1.4
Leucaena leucocephala	2	0.9
Cupressus lusitanica	2	0.9
Piliostigma thonningii	2	0.9
Croton macrostachyus	2	0.9
Acacia polyacantha	2	0.9
Acrocarpus fraxinifolius	2	0.9
Bridelia micrantha	2	0.9
Catha edulis	1	0.5
Jacaranda mimosifolia	1	0.5
Markhamia lutea	1	0.5
Schinus molle	1	0.5
Vitex keniensis	1	0.5
Acacia nilotica	1	0.5
Commiphora africana	1	0.5
Rawsonia lucida	1	0.5
Annona cherimola	1	0.5
Casuarina cunninghamiana	1	0.5
Milicia excelsa	1	0.5
Eriobotrya japonica	1	0.5
Erythrina abyssininca	1	0.5
Ficus sycomorus	1	0.5
Terminalia mentaly	1	0.5
Total	**217**	**100.0**

Lowland (IL5)

Species name	Frequency	%
Terminalia brownii	8	24.2
Acacia tortilis	6	18.2
Melia volkensii	5	15.2
Tamarindus indica	3	9.1
Commiphora africana	2	6.1
Berchemia discolor	2	6.1
Carica papaya	2	6.1
Balanites aegyptiaca	1	3.0
Kigelia africana	1	3.0
Mangifera indica	1	3.0
Azadirachta indica	1	3.0
Senna siamea	1	3.0
Total	**33**	**100.0**

Appendix 16

General Nursery Survey Form

Questionnaire No. ☐ Nursery Code No. ☐ Interviewer Name ☐

Introduction: The World Agroforestry Centre (ICRAF) is carrying out a nursery survey on species on the nursery in order to establish more details of tree species found on the nursery, how they are raised, managed, their productivity and the problem encountered in raising of these nurseries and how best these nurseries can be improved in order to meet more needs of the farmers. I would be grateful if you could spare some time and answer the following questions that will be valuable in achieving the objectives of this survey. I assure you that the information will be treated as confidential.

Nursery Owner's Characteristics/Data

District ☐

Division ☐

Location ☐

Village ☐

Agroecological zone ☐

Nursery Location ☐ Latitude( ), Longitude( ), Altitude(m)

Type of nursery ☐ e.g. family, group, cooperative, company, other specified

Name of owner /institution ☐

Gender of owner or manager ☐ M ☐ F

Respondent Name (if not owner) ☐

Gender M ☐ F ☐

Relationship to Owner ☐

Age of respondent ☐ Years

What is the level of education of owner or manager?

Primary school(standard_____)
Secondary school(form_____)
Diploma
Degree
Other(specify):_____

Nursery size _____ M^2

Age of the Nursery _____ years

How far is the nursery from the nearest gazetted forest? _____ Km

How many staff do you have in the nursery? _____

How many people depend on this nursery business? _____

1 Production

1.1 Which tree species (not ornamental) are you raising?

Species Name	How many seedlings Currently in nursery?	price per Seedling (Kshs)	means of production (Pot, direct sowing, etc)	Propagation techniques (seed, cutting, grafted)	Potting mix (ratio of forest soil & manure)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

1.2 Would you like to raise more seedlings other than the species listed above? Yes 1 No 2

If yes proceed to 1.3, if no go to 1.4

1.3 Which other species do you want to plant?, how many do you want to plant and for what purposes and why had you not planted them earlier?

Species	Number	Purposes	Why not earlier

1.4 Which three species in order of rank have the highest demand/turnover (numbers grown and sold/planted)?

1 _____

2 _____

3 _____

1.5 Who decides which species to raise?_____

1.6 What criteria are used to make the decision on what species to raise?_____

_____

_____

1.7 Where/what is your source of water for the nursery?

River 1 Borehole 2 Tap 3 Other(Specify) _____

1.8 Do you use any pesticides?
☐ No ☐ Yes

If Yes, name/kind of product, in which species and why you are using it.

Pesticide	Species	Reason
_____	_____	_____
_____	_____	_____

1.9 What type of soil do you use for seedbed? _____

1.10 Do you use compost? if yes from what?, _____ _____

1.11 Do you make compost yourself? If yes what is the ratio of soil: compost? _____ , _____

1.12 Do you use any chemical fertilizer? If yes which one? _____ , _____

2. Plant material

2.1 For the 2 main seed propagated species: From where did you get your plant material for the current planting stock?

Species 1).....

☐ Own farm ☐ Neighbour's farm ☐ Communal land ☐ Roadside
☐ Other village ☐ Other nursery ☐ Forest
☐ KEFRI/FD ☐ NGK/other agencies ☐ Private dealer
Other. _____

Species 2).....

☐ Own farm ☐ Neighbour's farm ☐ Communal land ☐ Roadside
☐ Other village ☐ Other nursery ☐ Forest
☐ KEFRI/FD ☐ NGO/other agencies ☐ Private dealer
Other. _____

If not collected,

2.2 What is the price for seed (Kshs per Kg)?
Species 1) _____ .Species 2) _____ .

Then proceed to 2.5

If collected or as additional species if both main species are bought,

2.3 Who collects the seed?
Species 1):
☐ Nursery manager ☐ Staff ☐ Family member ☐ Other. _____

Species 2):
☐ Nursery manager ☐ Staff ☐ Family member ☐ Other. _____

2.4 Question about the number of mother trees from which collected: Relate to species.
e.g *Grevillea*: From how many different trees did you collect seeds? E.g *paw paw or non-grafted mango*: From how many different trees or otherwise fruits did you collect seeds?
Species 1)_____ .Species 2) _____ .

And why did you collect from this number –X- of trees (and not X +1 or X-1 trees)?
Species 1)_____ .

Species 2) _____

2.5 Why did you choose that/those particular mother tree/s (seed-dealer in the case of bought seed) for propagation?

Species 1)		Species 2)
☐	Information on seed supplied	☐
☐	Only tree (/fruit) Available	☐
☐	More dealings with him	☐
☐	Known variety	☐
☐	Price of seeds good	☐
☐	Other_____	☐

2.6 (if answer is "Known variety" or "Selection/Appears good"): What are the criteria?

Species 1)		Species 2)
☐	Fruit quality	☐
☐	Fast growing	☐
☐	Straight stem	☐
☐	Crown	☐
☐	Resistance to pest	☐
☐	Mature tree	☐
☐	Other_____	☐

3. Economy/Market

3.1 Who are the buyers of your seedling?

Men	1
Women	2
Farmer's groups	3
Women's groups	4
Other(specify) _____	

3.2 How far do majority of your clients travel to purchase your seedlings?

0-1 Km	1
1-5 km	2
> 5 km	3

3.3 How far from a surfaced road is the nursery?

0-100m	1
100-1km	2
1-3 km	3
3-5 km	4
> 5 km	5

3.4 How many buyers did you have for the previous 2 main species last season?
Species 1)_____

Species 2) _____

3.5 When choosing between seedlings of one species, what do the buyers look for?

☐ Cheap price ☐ Large size ☐ Health ☐ Height ☐ They don't select ☐ Other _____

3.6 Last season, how many seedlings were produced?_____ How many were sold/given out to farmers? _____
What happened to the seedlings you could not sell/give out to farmers? _____

3.7 Would you yourself be willing to pay more for higher productive (improved) varieties?
☐ No ☐ Yes
If Yes, what kind of species? 1 _____
2 _____
3 _____
4 _____
5 _____

3.8 What are the main problems you face in the nursery?

_____
_____
_____
_____

3.9 If you are interviewing the owner:
Which other income generating activities are you involved in?

Activity	Portion of income/amount
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

If you are not interviewing the owner:
Is this nursery profitable? No 1 Yes 2

4. General

4.1 Where or through which channels have you learnt about managing a nursery?

4.2 What are your future plans for the nursery?

4.3 Thank you for answering our questions. What else would you like to say or comment about your nursery?

Thank the farmer for his/her time in voluntarily answering the questions and giving out the information needed for the survey.

Appendix 17

Encountered species with number of occurrences and average total seedlings per nursery

Botanical name	Places where species was encountered & Average trees number in nursery per species			
	#	%	rank	Average seedlings number per nursery
Grevillea robusta	81	12.5	1	7432
Eucalyptus saligna	49	7.6	2	2235
Cupressus lusitanica	43	6.6	3	3038
Casuarina cunnighamiana	32	4.9	4	7162
Prunus Africana	31	4.8	5	1896
Markhamia lutea	27	4.2	6	1227
Cordia Africana	26	4.0	7	561
Carica papaya	23	3.6	8	549
Vitex keniensis	23	3.6	8	1220
Persea Americana	20	3.1	10	160
Mangifera indica	17	2.6	11	1420
Podocarpus falcatus	16	2.5	12	599
Bridelia micrantha	15	2.3	13	872
Calliandra calothyrsus	14	2.2	14	616
Jacaranda mimosifolia	14	2.2	14	506
Juniperous procera	13	2.0	16	510
Pinus patula	13	2.0	16	3507
Citrus limon	12	1.9	18	1194
Eucalyptus glandis	12	1.9	18	2510
Croton megalocarpus	11	1.7	20	733
Terminalia mantally	11	1.7	20	278
Citrus sinensis	10	1.5	22	1250
Dovyalis caffra	10	1.5	22	2178
Acacia meansii	9	1.4	24	508
Olea Africana	9	1.4	24	578
Leucaena leucocephala	8	1.2	26	591
Macadamia tetraphylla	8	1.2	26	88
Acrocarpus fraxinifolius	7	1.1	28	381
Azadirachta indica	7	1.1	28	148
Croton macrostachyus	7	1.1	28	373
Ficus sycomorous	7	1.1	28	226
Senna siamea	7	1.1	28	611
Zyzigium guinenzii	6	0.9	33	3083
Acacia xanthophloea	5	0.8	34	1028
Psidium guajava	5	0.8	34	263
Eriobotrya japonica	4	0.6	36	210
Erythrina abyssinica	3	0.5	37	350
Eucalyptus globulus	3	0.5	37	4167
Ficus thonningii	3	0.5	37	85
Milletia dura	3	0.5	37	108
Newtonia buchananii	3	0.5	37	272
Octea usambarensis	3	0.5	37	61

Spathodea campanulata	3	0.5	37	480
Albizia gummifera	2	0.3	44	1050
Melia volkensii	2	0.3	44	9
Trichilia ementica	2	0.3	44	325
Annona cherimola	1	0.2	47	20
Erhetia cymosa	1	0.2	47	20
Morus alba	1	0.2	48	50
Pinus radiata	1	0.2	48	2000
Sapium ellipticum	1	0.2	48	106
Schinus molle	1	0.2	48	20
Senna spectabilis	1	0.2	48	397
Teclea trichocarpa	1	0.2	48	4000

Appendix 18

Species ranked in the nurseries in five districts by percent

Meru

Species name	Frequency /132	%
Grevillea robusta	11	8.3
Markhamia lutea	10	7.6
Prunus africana	9	6.8
Vitex keniensis	9	6.8
Eucalyptus saligna	8	6.1
Cupressus lusitanica	6	4.5
Cordia africana	6	4.5
Bridelia micrantha	5	3.8
Pinus patula	5	3.8
Carica papaya	4	3.0
Citrus sinensis	4	3.0
Leucaena leucocephala	4	3.0
Casuarina cunnighamiana	3	2.3
Mangifera indica	3	2.3
Persea americana	3	2.3
Calliandra calothysus	3	2.3
Citrus limon	3	2.3
Eucalyptus glandis	3	2.3
Croton megalocarpus	3	2.3
Dovyalis caffra	2	1.5
Podocarpus falcatus	2	1.5
Zyzigium guinensii	2	1.5
Jacaranda mimmosifolia	2	1.5
Milletia dura	2	1.5
Juniperus procera	2	1.5
Acacia mearnsii	1	0.8
Senna siamea	1	0.8
Terminalia mantally	1	0.8
Azadirachta indica	1	0.8
Acrocarpus fraxinifolius	1	0.8
Ficus sycomorus	1	0.8
Eucalyptus globulus	1	0.8
Olea africana	1	0.8
Acacia xanthophloea	1	0.8
Psidium guajava	1	0.8
Croton macrostachyus	1	0.8
Albizia gummifera	1	0.8
Sapium ellipticum	1	0.8
Senna spectabilis	1	0.8
Morus alba	1	0.8
Newtonia buchananii	1	0.8
Trichilia ementica	1	0.8
Erhetia cymosa	1	0.8
Total	**132**	**100.0**

Embu

Species name	Frequency /130	%
Grevillea robusta	15	11.5
Carica papaya	10	7.7
Mangifera indica	8	6.2
Calliandra calothysus	8	6.2
Eucalyptus saligna	7	5.4
Dovyalis caffra	7	5.4
Persea americana	7	5.4
Vitex keniensis	7	5.4
Terminalia mantally	6	4.6
Cordia africana	6	4.6
Prunus africana	6	4.6
Senna siamea	5	3.8
Casuarina cunnighamiana	4	3.1
Macadamia tetraphylla	4	3.1
Podocarpus falcatus	3	2.3
Cupressus lusitanica	3	2.3
Melia vokensii	2	1.5
Citrus limon	2	1.5
Bridelia micrantha	2	1.5
Jacaranda mimmosifolia	2	1.5
Markhamia lutea	2	1.5
Acrocarpus fraxinifolius	2	1.5
Ficus sycomorus	2	1.5
Acacia mearnsii	1	0.8
Citrus sinensis	1	0.8
Leucaena leucocephala	1	0.8
Octea usambarensis	1	0.8
Zyzigium guinensii	1	0.8
Pinus patula	1	0.8
Azadirachta indica	1	0.8
Milletia dura	1	0.8
Schinus molle	1	0.8
Juniperus procera	1	0.8
Total	**130**	**100.0**

Kirinyaga

Species name	Frequency /127	%
Grevillea robusta	18	14.2
Eucalyptus saligna	13	10.2
Cupressus lusitanica	9	7.1
Markhamia lutea	7	5.5
Bridelia micrantha	6	4.7
Pinus patula	6	4.7
Carica papaya	5	3.9
Cordia africana	5	3.9
Croton megalocarpus	5	3.9
Casuarina cunnighamiana	4	3.1
Mangifera indica	4	3.1
Podocarpus falcatus	4	3.1
Prunus africana	4	3.1
Croton macrostachyus	4	3.1
Vitex keniensis	3	2.4
Jacaranda mimmosifolia	3	2.4
Eriobortya japonica	3	2.4
Citrus sinensis	2	1.6
Persea americana	2	1.6
Octea usambarensis	2	1.6
Zyzigium guinensii	2	1.6
Juniperus procera	2	1.6
Newtonia buchananii	2	1.6
Dovyalis caffra	1	0.8
Senna siamea	1	0.8
Calliandra calothysus	1	0.8
Citrus limon	1	0.8
Macadamia tetraphylla	1	0.8
Acrocarpus fraxinifolius	1	0.8
Eucalyptus glandis	1	0.8
Olea africana	1	0.8
Psidium guajava	1	0.8
Erythrina abyssinica	1	0.8
Trichilia ementica	1	0.8
Teclea trichocarpa	1	0.8
Total	**127**	**100.0**

Nyeri

Species name	Frequency /135	%
Grevillea robusta	18	13.3
Casuarina cunnighamiana	11	8.1
Eucalyptus saligna	10	7.4
Cupressus lusitanica	10	7.4
Cordia africana	7	5.2
Prunus africana	6	4.4
Eucalyptus glandis	6	4.4
Markhamia lutea	5	3.7
Juniperus procera	5	3.7
Olea africana	5	3.7
Persea americana	4	3.0
Carica papaya	3	2.2
Citrus limon	3	2.2
Macadamia tetraphylla	3	2.2
Jacaranda mimmosifolia	3	2.2
Acrocarpus fraxinifolius	3	2.2
Podocarpus falcatus	2	1.5
Terminalia mantally	2	1.5
Bridelia micrantha	2	1.5
Vitex keniensis	2	1.5
Leucaena leucocephala	2	1.5
Ficus sycomorus	2	1.5
Eucalyptus globulus	2	1.5
Croton megalocarpus	2	1.5
Ficus thonningii	2	1.5
Acacia xanthophloea	2	1.5
Psidium guajava	2	1.5
Croton macrostachyus	2	1.5
Erythrina abyssinica	2	1.5
Mangifera indica	1	0.7
Pinus patula	1	0.7
Azadirachta indica	1	0.7
Spathodea campanulata	1	0.7
Pinus radiata	1	0.7
Annona cherimola	1	0.7
Eriobortya japonica	1	0.7
Total	**135**	**100.0**

Laikipia

Species name	Frequency /123	%
Grevillea robusta	19	15.4
Cupressus lusitanica	15	12.2
Eucalyptus saligna	11	8.9
Casuarina cunnighamiana	10	8.1
Acacia mearnsii	7	5.7
Prunus africana	6	4.9
Podocarpus falcatus	5	4.1
Persea americana	4	3.3
Azadirachta indica	4	3.3
Jacaranda mimmosifolia	4	3.3
Citrus sinensis	3	2.4
Citrus limon	3	2.4
Markhamia lutea	3	2.4
Juniperus procera	3	2.4
Calliandra calothysus	2	1.6
Terminalia mantally	2	1.6
Cordia africana	2	1.6
Vitex keniensis	2	1.6
Ficus sycomorus	2	1.6
Eucalyptus glandis	2	1.6
Olea africana	2	1.6
Acacia xanthophloea	2	1.6
Spathodea campanulata	2	1.6
Carica papaya	1	0.8
Mangifera indica	1	0.8
Leucaena leucocephala	1	0.8
Zyzigium guinensii	1	0.8
Croton megalocarpus	1	0.8
Ficus thonningii	1	0.8
Psidium guajava	1	0.8
Albizia gummifera	1	0.8
Total	**123**	**100.0**

Appendix 19

Species ranked in the nurseries in the zones by percent

Upper highland (UH1- 3)

Species name	Frequency /64	%
Cupressus lusitanica	9	14.1
Grevillea robusta	9	14.1
Eucalyptus saligna	6	9.4
Acacia meansii	4	6.3
Jacaranda mimosifolia	4	6.3
Prunus africana	4	6.3
Casuarina cunnighhamiana	3	4.7
Eucalyptus glandis	3	4.7
Citrus sinensis	2	3.1
Juniperous procera	2	3.1
Markhamia lutea	2	3.1
Olea africana	2	3.1
Persea americana	2	3.1
Podocarpus falcatus	2	3.1
Azadirachta indica	1	1.6
Calliandra calothyrsus	1	1.6
Citrus limon	1	1.6
Cordia africana	1	1.6
Ficus thonningii	1	1.6
Leucaena leucocephala	1	1.6
Pinus patula	1	1.6
Pinus radiata	1	1.6
Spathodea campanulata	1	1.6
Vitex keniensis	1	1.6
Total	**64**	**100.0**

Lower highland (LH1,3,4,5)

Species name	Frequency /172	%
Grevillea robusta	23	13.4
Cupressus lusitanica	19	11.0
Eucalyptus saligna	16	9.3
Casuarina cunnighhamiana	13	7.6
Podocarpus falcatus	9	5.2
Juniperous procera	8	4.7
Prunus africana	8	4.7
Cordia africana	5	2.9
Persea americana	5	2.9
Vitex keniensis	5	2.9
Acacia meansii	4	2.3
Citrus limon	4	2.3
Eucalyptus glandis	4	2.3
Markhamia lutea	4	2.3
Olea africana	4	2.3
Acacia xanthophloea	3	1.7
Azadirachta indica	3	1.7
Croton megalocarpus	3	1.7
Ficus sycomorous	3	1.7
Jacaranda mimosifolia	3	1.7
Zyzigium guinensiii	3	1.7
Calliandra calothyrsus	2	1.2
Citrus sinensis	2	1.2
Leucaena leucocephala	2	1.2
Mangifera indica	2	1.2
Octea usambarensis	2	1.2
Pinus patula	2	1.2
Spathodea campanulata	2	1.2
Terminalia mantaly	2	1.2
Acrocarpus fraxinifolius	1	0.6
Albizia gummifera	1	0.6
Carica papaya	1	0.6
Croton macrostachyus	1	0.6
Ficus thonningii	1	0.6
Psidium guajava	1	0.6
Trichilia ementica	1	0.6
Total	**172**	**100.0**

Upper midland (UM1 - 6)

Species name	Frequency /378	%
Grevillea robusta	41	10.8
Eucalyptus saligna	24	6.3
Markhamia lutea	21	5.6
Cordia africana	20	5.3
Carica papaya	19	5.0
Prunus africana	19	5.0
Vitex keniensis	17	4.5
Bridelia micrantha	14	3.7
Casuarina cunnighhamiana	14	3.7
Cupressus lusitanica	14	3.7
Mangifera indica	11	2.9
Persea americana	11	2.9
Dovyalis caffra	10	2.6
Pinus patula	10	2.6
Calliandra calothyrsus	9	2.4
Terminalia mantaly	9	2.4
Croton megalocarpus	8	2.1
Jacaranda mimosifolia	7	1.9
Macadamia tetraphylla	7	1.9
Acrocarpus fraxinifolius	6	1.6
Citrus limon	6	1.6
Croton macrostachyus	6	1.6
Citrus sinensis	5	1.3
Eucalyptus glandis	5	1.3
Leucaena leucocephala	5	1.3
Podocarpus falcatus	5	1.3
Eriobotrya japonica	4	1.1
Ficus sycomorous	4	1.1
Psidium guajava	4	1.1
Azadirachta indica	3	0.8
Erythrina abyssinica	3	0.8
Eucalyptus globulus	3	0.8
Juniperous procera	3	0.8
Milletia dura	3	0.8
Newtonnia buchananii	3	0.8
Olea africana	3	0.8
Senna siamea	3	0.8
Zyzigium guinensiii	3	0.8
Acacia xanthophloea	2	0.5
Melia volkensii	2	0.5
Acacia meansii	1	0.3
Albizia gummifera	1	0.3
Annona cherimola	1	0.3
Erhetia cymosa	1	0.3
Ficus thonningii	1	0.3
Morus alba	1	0.3
Octea usambarensis	1	0.3
Sapium ellipticum	1	0.3
Schinus molle	1	0.3
Senna spectabilis	1	0.3
Teclea trichocarpa	1	0.3
Trichilia ementica	1	0.3
Total	**378**	**100.0**

Lower midland (LM3 - 4)

Species name	Frequency /33	%
Grevillea robusta	8	24.2
Mangifera indica	4	12.1
Senna siamea	4	12.1
Carica papaya	3	9.1
Eucalyptus saligna	3	9.1
Calliandra calothyrsus	2	6.1
Casuarina cunnighhamiana	2	6.1
Persea americana	2	6.1
Bridelia micrantha	1	3.0
Citrus limon	1	3.0
Citrus sinensis	1	3.0
Cupressus lusitanica	1	3.0
Macadamia tetraphylla	1	3.0
Total	**33**	**100.0**

ICRAF Working Papers

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2. Biodiversity conservation through agroforestry: managing tree species diversity within a network of community-based, nongovernmental, governmental and research organizations in western Kenya.

3. Invasion of *prosopis juliflora* and local livelihoods: Case study from the Lake Baringo area of Kenya

4. Leadership for change in Farmers Organizations: Training report: Ridar Hotel, Kampala, 29th March to 2nd April 2005

5. Domestication des espèces agroforestières au Sahel : situation actuelle et perspectives

6. Relevé des données de biodiversité ligneuse: Manuel du projet biodiversité des parcs agroforestiers au Sahel

7. Improved Land Management in the Lake Victoria Basin: TransVic Project's Draft Report

8. Livelihood capital, strategies and outcomes in the Taita hills of Kenya

9. Les espèces ligneuses et leurs usages: Les préférences des paysans dans le Cercle de Ségou, au Mali

10. La biodiversité des espèces ligneuses: Diversité arborée et unités de gestion du terroir dans le Cercle de Ségou, au Mali

11. Bird diversity and land use on the slopes of Mt. Kilimanjaro and the adjacent plains, Tanzania

12. Water, women and local social organization in the Western Kenya Highlands

13. Highlights of ongoing research of the World Agroforestry Centre in Indonesia

14. Prospects of adoption of tree-based systems in a rural landscape and its likely impacts on carbon stocks and farmers' welfare: the FALLOW Model Application in Muara Sungkai, Lampung, Sumatra, in a 'Clean Development Mechanism' context

15. Equipping Integrated Natural Resource Managers for Healthy Agroforestry Landscapes.

16. Are they competing or compensating on farm? Status of indigenous and exotic tree species in a wide range of agro-ecological zones of Eastern and Central Kenya, surrounding Mt. Kenya.

Who we are

The World Agroforestry Centre is the international leader in the science and practice of integrating 'working trees' on small farms and in rural landscapes. We have invigorated the ancient practice of growing trees on farms, using innovative science for development to transform lives and landscapes.

Our vision

Our Vision is an 'Agroforestry Transformation' in the developing world resulting in a massive increase in the use of working trees on working landscapes by smallholder rural households that helps ensure security in food, nutrition, income, health, shelter and energy and a regenerated environment.

Our mission

Our mission is to advance the science and practice of agroforestry to help realize an 'Agroforestry Transformation' throughout the developing world.

FUTURE HARVEST CGIAR

A Future Harvest Centre supported by the CGIAR

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