Enhancing Community Led Restoration and Livelihoods Improvement

Baseline Survey Report

Dundori Forest and the Adjacent Community, Kenya

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Executive Summary

Dundori Forest is situated in the Southern part of Nakuru North Subcounty in Nakuru County, Kenya. The forest is an important catchment and a major source of livelihood for the local community. However, the forest and the adjacent areas are facing various threats that have led to serious environmental degradation, and hence the negative effects on local livelihoods. It is in addressing these problems that Wezesha CBO (Community Based Organization) in partnership with the ITF (International Tree Foundation) initiated the ‘‘Enhancing Community Led Restoration and Livelihoods Improvement’’ project targeting Dundori Forest and the adjacent community. In doing this, Wezesha CBO in partnership with ITF carried out a baseline survey to inform project planning, implementation, and monitoring and evaluation.

The baseline survey involved a socioeconomic survey and a biodiversity survey of the forest and the adjacent community. The approach and methodology of the baseline survey included the use of a household questionnaire survey, key informant interviews, focus group discussion, and socioeconomic and gender analysis participatory analysis tools. The biodiversity employed participatory forest resources mapping, land cover analysis, and a field-based vegetation survey. Data were analyzed using thematic analysis, participatory analysis, and descriptive analysis methods including percentages, mean, and range.

The study found that most local households are male-headed (82.7%). Crop production is the main source of income for most households (55.3%) followed by livestock production (13%). Most of the household’s farms are inadequate in supporting their livelihoods requirements. Local households thus depend on the forest as a source of livelihood including through crop cultivation, livestock rearing, and as a source of other wood and non-wood resources.

The ecological status of the forest and the adjacent area was however found to be poor and deteriorating. The degradation of the environment is driven by various factors including but not limited to high population pressure and demand for resources, unsustainable use of natural resources, and low institutional and individual capacity in natural resources management. The area is also marked by low adoption of environmental conservation, sustainable resource use, and good land use and agricultural practices.

Degradation in the area has negative effects on livelihoods. This is shown by the observed negative trends in the performance of livelihood activities and the availability of resources. The area is also experiencing climate change and variability which has severe effects on the livelihoods of most households. This calls for enhanced measures to restore the local landscape and improve livelihoods. This should employ a triple-bottom-line approach that addresses social, economic, and ecological issues to ensure that all factors that lead to degradation are addressed and also to promote sustainable use of the natural resource base. Landscape restoration should mainly focus on restoring the natural forests that form the main support system of the local ecosystem. The livelihood improvement activities should espouse sustainability and be aligned to the local socioeconomic and cultural context

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Abbreviations and acronyms

CBO	Community Based Organization
CFA	Community Forest Association
CSO	Civil Society Organization
DFO	District Forest Officer
ERDAS	Earth Resources Data Analysis System
FGD	Focus Group Discussion
GIS	Geographical Information System
GPS	Global Positioning System
ITF	International Tree Foundation
IUCN	International Union for the Conservation of Nature
KES	Kenya Shilling
KFS	Kenya Forest Service
KII	Key Informant Interview
KM	Kilometer
LPG	Liquefied Petroleum Gas
NEMA	National Environment Management Authority
NGO	Non-Governmental Orgnaization
NTFP	Non-Timber Forest Product
PELIS	Plantation Establishment and Livelihood Improvement Scheme
SEAGA	Socioeconomic and Gender Analysis
WRA	Water Resources Authority
WRUA	Water Resource Users Association

1. Introduction

1.1. Background

Dundori forest is situated in the Southern part of Nakuru North Subcounty, Nakuru County, Kenya (Fig 1). The forest borders Nyandarua County to the East, whose residents thus form part of the forest adjacent community. It's located about 20km east of Nakuru town and lies between 0.10 and 0.16 latitude and 36 10 and 36 16 longitudes. The highest point is along the boundary of the Rift valley province and central province. Dundori forest covers an area of 3,609.3, without taking into account the settled and degazetted areas. The forest is divided into two blocks namely Dundori and Kendurum which are further subdivided into five beats namely Wanyororo, Maculata, Centre, Kabatini, and Station.

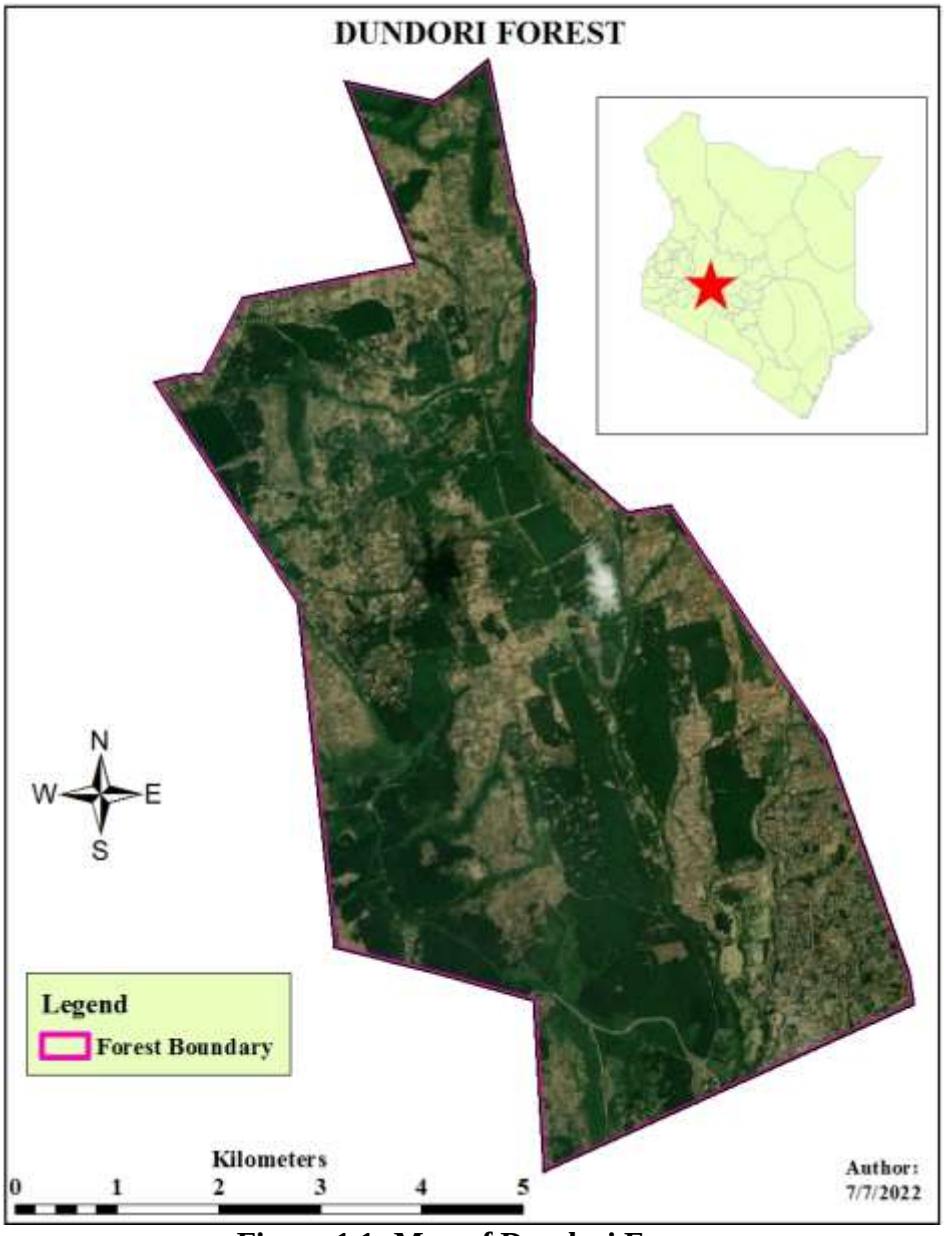

Figure 1.1: Map of Dundori Forest

The forest is located in a hilly area with an altitude that ranges from 2,200-3,000m above sea level. The main rift valley escarpment forms the eastern boundary where the ground falls steeply to the west. The dominating soils are the red loam soil which is found in areas that have been and are under high forest. Due to its fertility, it is suitable for a wide variety of tree species. The area next to Wanyororo is characterized by black cotton soil.

The forest forms an important water catchment, being the source of several rivers. These include Rivers Mbaruk and Mereroni that drain into Lake Elmentaita; Ngosur River and crater stream that drain into Lake Nakuru; and Chania and Ruiru streams that are tributaries for the Olobonata River which drains into Olpunyata swamp to the west towards Solai. The main feature of rivers draining into Lake Elmentaita and Lake Nakuru is that whereas they have surface flow inside the forest, they disappear underground when they enter the Rift Valley floor. Most of them appear as dry river beds on the surface.

The forest has a one community forest association (CFA) i.e. Dundori CFA. There are two water resource user associations (WRUA) in the area. These include the Ngosur Diwani Watershed WRUA and the Mbaruk Meleloni Watershed WRUA. The community forest association members are formed into forest user groups and community-based organizations focused on various activities. Dundori Forest currently has an ongoing Plantation Establishment and Livelihood Improvement Scheme (PELIS) program, a method of forest plantation establishment in which farmers tend young plantation trees as they produce food crops.

The forest faces various threats that have led to severe degradation including encroachment and over-exploitation of forest resources due to among other rapid population growth and poverty in forest adjacent areas which leads to greater dependence and demand for resources, inadequate institutional capacity for forest management, poor land use practices, lack of financial resources for forest management and restoration activities. This has led to the loss of biodiversity and negative effect on ecosystem services, unsustainability and low resilience levels of ecosystems and community livelihoods, and low capacity to mitigate and adapt to the effects of climate change and variability

In addressing these problems Wezesha Community Based Organization (CBO) in partnership with the International Tree Foundation (ITF) is implementing a landscape restoration project in Dundori Forest and the forest's adjacent areas. The project will engage children, the youth, and adults in local communities to conserve and restore natural ecosystems, secure food production, improve livelihoods and thus become more resilient to the vagaries of climate change. The project's expected outcomes include:

- Increased biodiversity in Donduri forest
- Improved livelihoods due to higher agricultural production and incomes and resilience to the effects of climate change for the local communities.
- Increased knowledge of environmental conservation and practices among pupils students and communities
- Increased local community participation in environmental decision-making and advocating for conservation as well as rehabilitation of the degraded areas in Nakuru County

As part of this process, Wezesha CBO in partnership with the ITF undertook a baseline survey of the target project area. This was not only to inform the planning and implementation of the project but also to inform the project monitoring and evaluation.

1.2. Objectives of the baseline survey

i. Undertake a socioeconomic survey of Dundori Forest adjacent community
ii. Undertake a biodiversity survey of Dundori Forest
iii. Undertake GIS mapping of the project's tree planting site in Dundori Forest

1.3. Scope of the work

- Socioeconomic survey of the community adjacent to Dundori Forest
- Biodiversity survey in Dundori Forest to identify existing vegetation species and their conservation status.
- Geographical Information System (GIS) mapping of the identified planting sites, develop shapefiles and develop GIS maps of the planting areas

1.4. Expected outputs

- Baseline survey report
- Checklist of plant species in Dundori Forest
- Land cover matrix of Dundori Forest
- GIS shapefiles and maps of the planning areas

1.5. Study team

The consultant undertook the survey together with assistants drawn from the study area. The team included 13 enumerators who undertook the household questionnaire survey. Also, two field assistants were involved in doing the field-based vegetation survey.

2. Approaches and methodology

2.1. Preliminary meeting, literature review, and reconnaissance survey

A meeting was held with the local leaders and community representatives, and the forester to inform them of the survey and also seek consensus. Further discussions were done with the area chiefs and the CFA officials to inform them of the survey and also on the logistics for the assignment.

The consultant carried out a review of the literature to form an informed basis of the vegetation state, landscape, ecological, livelihoods, institutional frameworks, and demography based on information availability. Field reconnaissance of the area was also done. The information generated from the literature review and field reconnaissance helped in refining the methodology for each component.

2.2. Socioeconomic survey

2.2.1. Participatory engagement meetings

This involved a socio-economic and gender analysis (SEAGA) that used various tools. These included:

2.2.1.1. Participatory resources mapping

This was done to identify forest cover types in Dundori Forest. It described the previous and the current state of the forest, including the identification of degraded areas. It was also used to describe the desired future state of the forest that the community desires.

2.2.1.2. Historical profile

The historical profile focused on the historical information of the community and attempts to organize that information into a systematic chronology of events. The historical profile begins in the early stages of the founding of the community and attempts to identify all landmark dates that have had a significant impact on people's lives.

2.2.1.3 Historical resources matrix

This was undertaken to study the trends in resources availability over time in the study area

2.2.1.4. Management of resources matrix

This studied the access and control of various resources by various groups in the community

2.2.1.5. Trend analysis

Trend analysis was done to study positive or negative changes in the landscape over time across various dimensions including demographic, social, and economic.

2.2.1.6. Farming/livelihoods systems diagram

This was used to identify livelihood activities and the different groups who are responsible for undertaking them.

2.2.1.7. Benefits analysis chart

This was used to analyze access and control of the use of the benefits of various livelihood activities for various groups in the community.

2.2.2. Household Questionnaire survey

The questionnaire survey was done using semi-structured questionnaires and targeted the community that is adjacent to the Dundori Forest. The number of respondents for the study was 385 as determined using Cochran's method. However, the number of filled questionnaires collected was 376.

The sampling of respondents for the study used a multi-stage sampling technique. The respondents were distributed proportionately to the 12 sublocations that border the forest based on the number of households (As per the Kenya 2019 Census). The houses involved in the study within the sublocations were then determined using a systematic sampling technique. The respondents were distributed as shown in Table 2.1.

Table 2. 1: Distribution of respondents in the study area

#	**Location**	**Sublocation**	**No. of households**	**No. of respondents**
1	Matunda	Matunda	910	21
2	Ngorika	Ngorika	1841	43
3	Milangine	Kurungu	884	21
4		Milangine	618	14
5	Dundori	Dundori	1393	32
6		Mugumo	847	20
7	Githioro	Giacong'e	1355	32
8		Githioro	2924	67
9		Mugwathi	1282	30
10	Kabatini	Kabatini	1528	36
11	Thayu	Thayu	1334	31
12		Wendo	1622	38
	Total		16538	385

The questionnaire survey was conducted with the aid of a georeferenced data collection system called kMACHO. The system allows the collection of data, attribute information, photos, and the geographical coordinates of specific data collection points.

2.2.3. Focused Group Discussion (FGD)

These constituted participants from different groups in the community including women, men, and the youth. The FGDs enabled deeper discussions on certain issues in the landscape to gain a better understanding. This enabled a better understanding of issues identified but not clearly explained by the other data collection methods. The FGD was guided by a schedule that was varied and adapted to align with various issues under discussion.

2.2.4. Key Informant Interview (KII)

This was done to get an in-depth understanding of the landscape and livelihoods in the study area. This targeted the various key people who are related to the project's activities including community leaders, government officers, and Civil Society Organizations (CSOs) leaders/officers. The KIIs also enabled deeper discussions on certain issues in the landscape to gain a better understanding. This enabled a better understanding of issues identified but not clearly explained by the other data collection methods. The KII was guided by a schedule that will be varied and adapted to align with the context of the various key informants and issues under discussion.

2.3. Vegetation survey

2.3.1. Vegetation stratification

The identification of areas where transects and the sampling plots were placed was informed by the vegetation stratification undertaken through participatory mapping and the use of satellite imagery. In stratification, a general description of the vegetation was documented including habitat types, species distribution, topography, conservation status, threats to conservation, and management practices. The identification and the number of lines transects and sampling plots were done in a manner that ensured a comprehensive representation of the landscape.

The transect lines and sampling plots were mapped and identified using Global Positioning System (GPS). The coordinates of the various points along the identified transect lines were derived from satellite images and logged into GPS as waypoints. These waypoints were used to navigate along the identified transect lines during the field vegetation survey. The coordinates for the identified sampling plots were also logged into GPS as waypoints. The waypoints were used to identify and navigate to the locations of the sampling plots (quadrats) during the field vegetation survey.

2.3.2. Vegetation sampling

Vegetation assessments were done along these pre-selected transects and sample plots located. Plants were sampled using a Point Centered Quadrant (PCQ) method following Bonham (1989). The method involves establishing a straight line of about 1000 m long, upon which after every 10m general vegetation and environmental parameters are recorded on the mobile GPS-enabled kMACHO App.

Sample plots measuring 20 by 20 m (0.04 ha) were established at intervals of 100 m along a benchmark transect line. All vascular plants encountered within 0.04 ha were recorded and species of conservation interest noted. Other data collected included vegetation community type, presence, and ground cover.

For species not directly identified in the field, herbarium voucher specimens were selectively collected where necessary, especially for plants that were difficult to identify in the field and processed. Specimen identification was carried out based on various inventories such as the Flora of Tropical East Africa (FTEAs), Kenya Trees Shrubs and Lianas (KTSL) (Beentje 1994), Useful Trees and Shrubs of Kenya (World Agroforestry Centre, 2005) and the Upland Kenya Wild Flowers (UKWF) (Agnew 2013).

Species uniqueness (endemism, rarity, and threat i.e. vulnerable, endangered) was analyzed using the IUCN Red List.

2.3.3. Vegetation mapping and inventory

An inventory listing all the identified species including their conservation status was produced. This includes lists of trees, shrubs, and herbs. The inventory has different fields including the family and genus of the identified species.

2.3.4. Land cover analysis

The spatial analysis helped in identifying and mapping the vegetation status, land cover, and degraded areas in Dundori Forest. This involved analysis of the change in land cover and land use over time to give a picture of the positive or negative land cover and land-use change that has occurred in the study area over time. The spatial analysis informed the forest conservation activities.

Spatial analysis was done using satellite images. These were processed and analyzed using ERDAS software. Training points were collected using GPS during the ground truthing exercise. The training points guided the spatial analysis process. Ground-truthing also involved discussions to help identify and ascertain the results of the spatial analysis at a finer scale. The spatial analysis was done at ten-year intervals to allow for detailed observation of trends in land use and land cover change.

2.3.4.1. Satellite data

The land cover analysis was carried out using Landsat images sourced from the United States Geological Survey. The specific Landsat satellites whose data was used include Landsat 5, Landsat 7, Landsat 8, and Landsat 9. The images were collected for similar seasons over the years to allow for good comparisons during the change detection.

2.3.4.2. Image classification

Image classification involved unsupervised classification and supervised classification. The results of the unsupervised classification were used to guide a field-based ground-truthing exercise. The training points collected during the ground-truthing exercise were used during the supervised classification.

Supervised classification involved the classification of the pixels in the dataset into classes corresponding to the user-defined classes. In doing this, representative samples of different land cover types were selected from the image, i.e. training areas, as defined by the training points and information obtained during the ground-truthing exercise. By doing this, the land cover and land use types were therefore classified into homogenous representative areas. Image classification also helped to quantify the extent of change between classes over time and identify the trends. Post-classification cleaning was then done to minimize the clutter in classification results providing finer results for improved visualization and spatial analysis.

2.3.4.3. Change detection

Change detection employed the thematic change method. This involves subtractive change detection between two or more classified images. This yielded a change matrix showing differences in land cover and land use between the different study periods. This differentiation enabled detection of the change in specific land cover and land use types within classes and between periods.

3. Results of the socio-economic survey

3.1. Household characteristics

Most of the households in the area are male-headed (82.7%) while 17.3% are female-headed. The average household size in the project area is 4 members. This includes 33.8% of the households that have 1-3 members, 43.1% that have >3-5 members, 20.4% that have >5-7 members, and 2.7% that have >7 household members.

The majority of the household heads were married (72.6%), while 14.1% were widowed, 7.4% were single, 4.8% were separated, and 1.1% were divorced. This is as shown in Table 3.1.

Table 3. 1: Marital status of the household head

Marital status of the household head		
Marital Class	**Frequency**	**Percent**
Divorced	4	1.1
Married	273	72.6
Separated	18	4.8
Single	28	7.4
Widowed	53	14.1
Total	376	100.0

The highest level of formal education attained for a majority of the household heads was secondary school. Thirty-eight percent have attained primary school level education, while 15.2% had attained tertiary level education, 2.7% had pre-primary level education, and 1.3% had attained no formal education. This is as shown in Table 3.2.

Table 3. 2: Household head highest level of formal education

Household head highest level of formal education		
Category	**Frequency**	**Percent**
None	5	1.3
Pre-primary	10	2.7
Primary	143	38.0
Secondary	161	42.8
Tertiary	57	15.2
Total	376	100.0

Moreover, the average age of the respondents was 51 years. This includes 11.7% who are 25-35 years old, 41% who are >35-50 years old, 34% who are >50-65 years old, and 13.3% of the household heads who are >65 years old. The average number of years households have settled in the study area was found to be 25 years. This includes 19.1% who have lived in the area for 1-10 years, 21.1% for >10-20 years, 25.8% for >20-30 years, 17% for >30-40 years, 10.1% for >40-50 years, and 6.9% who have lived in the area for >50 years.

3.2. Household sources of income

The households have diverse sources of income with the main sources being crop farming (55.3%), livestock keeping (13%), casual employment (12.5%), and permanent employment (12.2%). This is as shown in Table 3.3.

Table 3. 3: Household's main source of income

Household's main source of income		
Income Source	**Frequency**	**Percent**
Crop farming	208	55.3
Livestock keeping	49	13.0
Permanent employment	26	6.9
Casual employment	47	12.5
Business activity	46	12.2
Total	376	100.0

3.3. Household land ownership and management

The land is held under different types of tenure with 50.8% of the households holding their land under freehold tenure with a title deed. Besides, 34.3% of the households hold land under freehold tenure with an allotment letter, and 14.9% hold land under leasehold form of tenure. This is as shown in Table 3.4.

Table 3. 4: Household's type of land tenure

Type of land tenure		
Land Tenure	**Frequency**	**Percent**
Freehold with allotment letter	129	34.3
Freehold with title	191	50.8
Leasehold	56	14.9
Total	376	100.0

The average size of the household land was found to be 2.2 Acres. This includes 32.4% of the households who hold land >0-0.5 Acres of land, 22.1% holding >0.5-1.0 Acres, 13.6% holding >1-2 Acre, 22.9% holding >2-5 Acres, and 9% holding above 5 Acres of land.

As appertains to the adequacy of the land in meeting the household's livelihoods needs, 66% of the household's land is inadequate, while the land is very inadequate for 7.2% of the households. Moreover, the land is adequate for 22.3% of the households while the land is very adequate for 4.5% of the households. This is as shown in Table 3.5.

Table 3. 5: Adequacy of the household's land in meeting its livelihoods needs

Adequacy of the household's land in meeting its livelihood needs		
Level	**Frequency**	**Percent**
Adequate	84	22.3
Inadequate	248	66.0
Very adequate	17	4.5
Very inadequate	27	7.2
Total	376	100.0

Most of the households (60.6%) in the area don't have a land use plan, while 39.4% have a land use plan. Of the households that have a land use plan, 95.3% implement them while 4.7% don't implement their land use plans. Men make decisions on land use planning in 70.5% of the households, while women make the land use planning decisions in 13.3% of the households. Additionally, both men and women make land use planning decisions in 16.2% of the households.

3.4. Crop production

3.4.1. Type of crop production

Crop production is done for subsistence in 32.7% of the households whereas 67.3% practice crop production for subsistence and commercial purposes. This is as shown in Table 3.6.

Table 3. 6: Type of crop production practiced by the household

Type of crop production practiced by the household		
Production Type	**Frequency**	**Percent**
Subsistence	123	32.7
Subsistence and commercial	253	67.3
Total	376	100.0

Maize is the most important crop produced in 79.8% of the households followed by potatoes which is the most important crop in 14.6% of the households. However, the households grow a wide variety of crops. This is as shown in Table 3.7.

Table 3. 7: Type of crops produced by the households

Type of crops produced by the households			
Maize	Arrowroots	Wheat	Kahurura
Spinach	Potatoes	Sweet potatoes	Pyrethrum
Kales	Oats	Carrots	Beetroot
Bananas	Wheat	Dania	French beans
Tomatoes	Cabbages	Cassavas	Pumpkins
Beans	Green grams	Black nightshade	Pepper
Onions	Oats	Coffee	Sugarcane
	Peas	Sunflower	Garlic

3.4.2. Crop production under PELIS

Crop production under the PELIS program is undertaken by 40.4% of the households while 59.6% of the households don't produce crops in the forest under the program. The main crops grown in the forest program include potatoes, beans, and vegetables. Regarding satisfaction with the process of allocating farmland in the forest under the PELIS program, 0.7% of those involved said they are very unsatisfied, and 27.6% said they are unsatisfied. However, 60.5% said they are satisfied with the process while 11.2% said they are very satisfied with the process.

Crop production under the PELIS program is undertaken by 40.4% of the households while 59.6% of the households don't produce crops in the forest under the program. Various crops are grown in the forest farm plots under PELIS with the main crops grown being potatoes, beans, and vegetables. This is as shown in Table 3.8.

Table 3. 8: Types of crops produced by the households in the forest farmlands under PELIS

Types of crops produced by the households in the forest farmlands under PELIS	
Potatoes	Dania
Beans	Cabbages
Peas	Onions
Kales	Carrots
Spinach	Black nightshade

The average size of the household's forest farm plots under PELIS was found to be 0.8 acres. This includes 18.4% who hold >0-0.25 acres, 35.5% who hold >0.25-0.5 acres, 34.3% who hold >0.5-1 acre, 8.5% who hold >1-2 acres, and 3.3% who hold >2 acres of land under PELIS.

The average estimated proportion of household's totals crop production that is produced in the forest through PELIS was found to be 22%. This includes 59.6% whose proportion of total crop production produced through PELIS was zero, 3.7% of whom PELIS contributed >0-25 percent of their total crop production, 16.5% of whom PELIS contributed >25-50 percent of their total crop production, 13.3% of whom PELIS contributed >50-75 percent of their total crop production, and 6.9% of whom PELIS contributed >75-100 percent of their total crop production,

Households produce crops in the forest under PELIS for various reasons as shown in Table 3.9.

Table 3. 9: Reasons that motivate the households to cultivate crops in the forest under PELIS

Reasons that motivate households to cultivate crops in the forest under PELIS	
The forest soil is more fertile and has a better texture	PELIS farming helps in forest restoration
The forest has better climatic conditions and more rainfall	Forest land has higher crop yields
Forest farming land is easier and cheaper to access	Low incidences of crop pests and diseases in the forest
Farming under PELIS is a good source of income	Low production cost since forest land requires less fertilizer and agrochemical application
The household lacks adequate farming land	

Regarding satisfaction with the process of allocating farmland in the forest under the PELIS program, 0.7% of those involved said they are very unsatisfied, and 27.6% said they are unsatisfied. However, 60.5% said they are satisfied with the process while 11.2% said they are very satisfied with the process. This is as shown in Table 3.10.

Table 3. 10: Satisfaction with the process of allocating forest farming plots under PELIS

Satisfaction with the process of allocating forest farming plots under PELIS		
Level	**Frequency**	**Percentage**
Very unsatisfied	1	0.7
Unsatisfied	42	27.6
Satisfied	92	60.5
Very satisfied	17	11.2
Total	152	100.0

Most of those crops in the forest under PELIS feel that it is profitable as shown by 76.3% who said it is profitable and 15.1% that it is very profitable while 7.2% said it is unprofitable and 0.7% that it is very unprofitable. This is as shown in Table 3.11.

Table 3. 11: Profitability of crop production under PELIS

Profitability of crop production under PELIS		
Level	**Frequency**	**Percentage**
Very unprofitable	1	0.7
Unprofitable	11	7.2
Profitable	116	76.3
Very profitable	24	15.1

Total	152	100.0

3.4.3. Establishment of kitchen gardens

As appertains to having a kitchen garden, 55.6% of the households have a kitchen garden in the homestead while 43.4% don't have a kitchen garden. The local households plant various types of crops in their kitchen gardens with the main crops grown being kales, spinach, and onions. This is as shown in Table 3.12.

Table3. 12: Crops grown in the household's kitchen gardens

Crops grown in the household's kitchen gardens	
Kales	Beetroots
Spinach	Garlic
Onions	Carrots
Cabbages	Tomatoes
Dania	Bananas
Pepper	Sugarcane
Pumpkins	Black nightshade

3.4.4. Organic agriculture practice

Moreover, 40.7% of the households in the area practice organic farming while 59.3% don't practice organic farming. The households in the area engage in various forms of organic agriculture practices including the use of biofertilizers, use of biopesticides, using organic manure, composting, push and pull pest control, mulching, and cover crops, and use of indigenous seeds.

The average estimated proportion of the household's total crop production that is produced under organic agriculture was found to be 17.5%. This includes 59.3% of households whose contribution of organic agriculture to their total crop production is zero, 13% of whom organic agriculture contributes >0-25 percent of their total crop production, 15.5% of whom organic agriculture contributes >25-50 percent of their total crop production, 4.2% who organic agriculture contributes >50-75 percent of their total crop production, and 8% of whom organic agriculture contributes >75-100 percent of their total crop production.

The households that don't practice organic agriculture cited a number of reasons as shown in Table 3.13.

Table 3. 13: Reasons why some people refuse to practice organic farming

Reasons why some people refuse to practice organic agriculture	
• Lack of knowledge and skills	• It leads to low crop yields
• Not been trained in organic agriculture	• It is not profitable
• Lack of adequate land	• It is expensive
• It is time and labor intensive	• Lack of interest
• Lack of inputs and materials	• Preference for conventional agriculture

Only 14.4% of the people in the area attended training on organic agriculture while 85.6% have not attended training on organic agriculture. However, 87.6% of those who had not attended training on organic agriculture said they would like to attend the training while 12.4% said they wouldn't like to attend. The training that people in the area would like to attend on organic agriculture in the future are shown in Table 3.14.

Table 3. 14: Training on organic agriculture that local people would like to receive in future

Training on organic agriculture that local people would like to receive in future	
• What organic agriculture is and what it entails • Benefits of organic agriculture • Marketing of agriculture crop products • Crop rotation and mixed cropping • Best practices of crop planting • How to make organic agriculture sustainable • How to upscale production under organic agriculture • Organic fruit farming • Organic mushroom farming • Storage of organic agriculture inputs • Management of organic agriculture	• How to make biofertilizers • How to apply biofertilizers • How to make biopesticides • How to apply biopesticides • Best organic agriculture methods • Composting • Making farmyard manure • Mulching • How to apply organic manure • Indigenous seeds • Push and pull technology • Soil conservation methods

3.4.5. Trend in household's crop production

As appertains to the trend in household crop production over time, 51.6% of the households said that crop production has been decreasing, 42% said it has been increasing, and 6.4% said there has been no change in crop production. This is as shown in Table 3.15.

Table 3. 15: The trend in the household's crop production over time

The trend in the households crop production over time		
Trend	**Frequency**	**Percent**
Decreasing	194	51.6
Increasing	158	42.0
No change	24	6.4
Total	376	100.0

3.4.6. Challenges facing crop production and ways of improving it

Various challenges facing crop production in the area were also identified including ways of improving it as shown in Table 3.16.

Table 3. 16: Challenges facing crop production and ways of improving it

Challenges facing crop production and ways of improving it	
Challenges	**Way of improving**
• High cost of inputs • Lack of good quality seeds • Lack of adequate knowledge and skills • Climate change leading to inadequate rainfall • Lack of inputs for crop production • Lack of adequate irrigation water	• Lower or subsidize the cost of agricultural inputs • Training farmers in good agriculture practices • Training farmers in agricultural business • Improve extension services and access • Enhance pest and disease surveillance and control

• Poor soil conditions hence low fertility • Environmental degradation • Pests and diseases • Poor market access hence the low price for produce • Lack of financial capital • Theft of planted crops • Inadequate land	• Training on climate change adaptation and mitigation • Early land preparation and crop planting • Enhance access to weather forecasts information • Water harvesting on the farms • Supply water from areas having greater amounts • Promote the adoption of organic agriculture • Improve production of organic manure • Improved access to affordable financial capital • Enhance soil conservation practices • Improve crop marketing systems • Enhance soil testing to inform crop production • Enhance security in the area

3.5. Livestock production

3.5.1. Type of livestock production

Most of the households involved in livestock production undertake livestock production for both subsistence and commercial use (64.3%), while 35.7% do it for subsistence only. Moreover, 3.2% of the household don't undertake livestock production. This is as shown in Table 3.17.

Table 3. 17: Type of livestock production practiced by the household

Type of livestock production practiced by the household		
Production Type	**Frequency**	**Percent**
Subsistence	130	35.7
Subsistence and commercial	234	64.3
Total	364	100.0

The most important livestock in most households is cattle (56.6%), followed by poultry (20.5%), sheep (10.9%), goats (6.1%), donkeys (2.4%), and pigs (0.3%). However, some households also keep rabbits.

3.5.2. Sourcing livestock fodder/pasture from the forest

Some of the households involved in livestock production (42.6%) source fodder/pasture from the forest while 57.4% don't source livestock fodder/pasture from the forest. The average estimated proportion of fodder sourced from the forest to the total household's fodder requirements was found to be 25.2%. This includes 58.8% of the households whose forest sourced fodder contributes zero percent of their total fodder requirement, 4% of whom forest sourced fodder contributes >0-25 percent, 11.1% of whom forest sourced fodder contributes >25-50 percent, 14.7% of whom forest sourced fodder contributes >50-75 percent, and 11.4% of whom forest sourced fodder contributes >75-100 percent of the total households fodder requirements,

Households are motivated to source fodder from the forest for various reasons as shown in Table 3.18.

Table 3. 18: Reasons that motivate households to source fodder from the forest

Reasons that motivate households to source fodder from the forest	
• High availability of fodder/pasture • It offers a cheap source of fodder/pasture • Lack of adequate fodder/pasture on the household farm • Lack of adequate land for fodder/pasture production	• The high price of fodder/pasture outside the forest • Forest pasture has higher nutritional value and quality • Fodder/Pasture is available even during the dry season

3.5.3. Trend in livestock production

Appertaining to the trend in livestock production, 53.3% of the households involved in livestock production observed that it has a decreasing trend, 42.0% said it has an increasing trend, while 4.7% observed that has been no change in livestock production. This is as shown in Table 3.19.

Table 3. 19: The trend in the household's livestock production over time

The trend in the household's livestock production over time		
Trend	**Frequency**	**Percentage**
Decreasing	194	53.3
Increasing	153	42.0
No change	17	4.7
Total	364	100.0

3.5.4. Challenges facing livestock production and ways of improving it

Various challenges facing livestock production in the area were also identified including ways of improving it as shown in Table 3.20.

Table 3. 20: Challenges facing livestock production and ways of improving it

Challenges facing livestock production and ways of improving it	
Challenges	**Ways of improving**
• Lack of adequate fodder/pasture • Lack of adequate water • High cost of livestock feed and other inputs • Insecurity hence theft of livestock • Poor market access hence low products prices • Livestock pests and diseases • Climate change especially inadequate rainfall • Inadequate knowledge and skills • Inadequate land • Lack of good livestock breeds • Poor access to veterinary services • Poor access to extension services	• Improve water supply, harvesting, and storage • Enhance the growing of fodder on farms • Improve fodder preservation and storage • Improve security and law enforcement • Improved pasture use planning and management • Improve quality and access to veterinary services • Improve quality and access to extension services • Reduce/subsidize the cost of feeds and other inputs • Source high-quality livestock breeds and improve breeding services • Enhance research on livestock production • Enhance pest and disease surveillance and control • Increase government and partner's support • Promote and adopt modern and efficient livestock production methods

	• Enhance market systems and access • Provision of affordable financial capital • Sensitization on climate change and response as appertains to livestock production

3.6. Soil conservation

3.6.1. Status of soils in household farms

Soils in most of the household farms are degraded as observed by 50.5% of the households who said their farms have high soil degradation and 7.2% who said their farms have very high soil degradation. However, 36.7% of the households said their farms have low soil degradation while 5.6% said the farms have very low soil degradation. This is as shown in Table 3.21.

Table 3. 21: Level of soil degradation on the household's farm

Level of soil degradation on the household farm		
Level	**Frequency**	**Percent**
High	190	50.5
Low	138	36.7
Very high	27	7.2
Very low	21	5.6
Total	376	100.0

Regarding productivity of the soil in the household farms, 56.9% said that their farms are unproductive and 3.7% said their farms are very unproductive, while 37% said their household farms are productive and 2.4% said they are very productive. As appertains to the trend in the household farms soil productivity, 56.4% of the households said it is deteriorating, 37.2% that it is improving, and 6.4% said there has been no change in the productivity of the soil in their household's farms. This is as shown in Table 3.22.

Table 3. 22: The trend in the productivity of the soil in the household's farm

The trend in the productivity of the soil in the household farm		
Trend	**Frequency**	**Percent**
Deteriorating	212	56.4
Improving	140	37.2
No change	24	6.4
Total	376	100.0

3.6.2. Causes of soil degradation

The causes of soil degradation in the farmlands were identified as shown in Table 3.23.

Table 3. 23: Causes of soil degradation on farmlands

Causes of soil degradation on farmlands	
• Excess use of agricultural chemicals and fertilizers • Climate change through extreme heavy rain events	• Lack of soil cover/exposure on farms • Poor land use and development planning

• Low adoption of soil and water conservation practices • Lack of adequate knowledge and skills • Poor enforcement of environmental laws e.g. riparian protection • High population pressure on natural resources leads to unsustainable use • Deforestation/tree felling	• Inadequate land leading to unsustainable use e.g. cultivation on riparian land and steep slopes • Poor agronomic practices e.g. mono-cropping • Lack of financial capital • Lack of adequate time and labor • Overgrazing by livestock • Continuous cultivation without furrow periods

3.6.3. Adoption of soil conservation

Soil conservation is practiced in 46.4% of the households while 53.7% of the households don't practice soil conservation. The soil conservation methods practiced by farmers in the area include terracing, trash lines, grass strips, hedgerow tree planting, cover crops, mulching, cut-off drains, retention ditches, and planting furrows.

The average estimated proportion of the household's land that is covered with soil conservation structures was found to be 15.5%. This includes 53.7% whose proportion of land covered with soil conservation structures is zero percent, 22.6% whose proportion of land covered with the soil conservation structures is >0-25 percent, 13.3% whose proportion of land covered with the soil conservation structures is >25-50 percent, 4.8% whose proportion of land covered with the soil conservation structures is >50-75 percent, and 5.6% whose proportion of land covered with the soil conservation structures is >75-100 percent.

3.6.4. Challenges facing the practice of soil conservation and ways of improving it

The challenges facing the practice of soil conservation in the area and ways of improving it as shown in Table 3.24.

Table 3. 24: Challenges facing the practice of soil conservation and ways of improving it

Challenges facing the practice of soil conservation and ways of improving it	
Challenges	**Way of improving**
• Lack of adequate knowledge and skills • Poor land use and development planning • Poor coordination and conflicts over land use • Climate variability causing erratic rainfalls • Lack of adequate capital and resources • Lack of adequate labor and time • Lack of adequate land to allow space for soil conservation structures • Lack of extension services and training • Runoff from neighboring farms not undertaking soil conservation	• Improve agricultural extension services • Training of farmers on soil conservation • Enhance environmental awareness creation • Enforcement of environmental laws • Formulate and implement good land use plans • Enhance tree planting activities • Promote organic agriculture practices • Provide farmers with soil conservation materials • Provide farmers with affordable financial capital • Carry out studies to inform soil conservation practices

	• Establish community-wide soil conservation campaigns or projects • Establish or leverage farmer's groups to promote soil conservation • Identification of the most feasible methods putting in mind farmer's diversity

3.6.5. Training on soil conservation

Most of the people in the area have not attended training on soil conservation (79%) while 21% have attended. However, 89.9% of those who have not received training on soil conservation said they would like to be trained while 10.1% said they would not like to receive training on soil conservation. The local people identified various training they would like to receive in the future as shown in Table 3.25.

Table 3. 25: Training on soil conservation that locals would like to receive in future

Training on soil conservation that local people would like to receive in future	
• Soil conservation methods • Establishing wind-breaks • Planting cover crops • Organic farming methods • How to improve and maintain soil fertility • How to do mulching • How to build gabions • How to control soil acidity • On crop rotation and mixed cropping • Effects of soil degradation • How to control floods on farms	• Best crop for use in improving soils • The benefits of soil conservation • Land use planning • Establishing grass strips • Agroforestry practice • Zero tillage agriculture • Establishing cut-off drains • Conserving riparian buffers • Establishing terraces • Maintenance of soil conservation structures

3.7. Water harvesting

3.7.1. Adoption of water harvesting

Water harvesting is practiced by 76.3% of the households while 23.7% don't practice it. The water harvesting methods practiced by the households include roof water harvesting, water pans, and dams. The amount of water harvested relative to water requirement is high in 20.2% of the households that practice water harvesting and very high in 8.0% of those households, while it is low in 61.7% and very low in 10.1% of the households that practice water harvesting. This is as shown in Table 3.26.

Table 3. 26: Level of water harvested by the households relative to their water requirements

Level of water harvested by the households relative to their water requirements		
Level	**Frequency**	**Percent**
Very low	29	10.1
Low	177	61.7
High	58	20.2
Very high	23	8.0
Total	287	100.0

3.7.2. Challenges facing the practice of water harvesting and ways of improving it

The challenges facing local households in water harvesting and the ways of improving it were identified as shown in Table 3.27.

Table 3. 27: Challenges facing water harvesting and ways of improving it

Challenges facing water harvesting and ways of improving it	
Challenges	**Ways of improving**
• Lack of adequate water harvesting and storage facilities • Rusting of house roofs affect the quality of harvested water • Environmental degradation e.g. soil erosion • Siltation of water pans and dams • Poor quality of harvested water due to pollution • High cost of developing or purchasing water harvesting facilities • Lack of financial capacity to purchase or develop water harvesting facilities • Vandalism of water harvesting structures • Lack of diversity in water harvesting methods used to enable tapping all the existing potential • Poor quality of water harvesting facilities which could cause wastage • Poor maintenance and management of water harvesting facilities • Inefficient use of harvested and stored water • Climate change causes inadequate rainfall hence low water harvesting capacity • Lack of adequate knowledge and skills in water harvesting • Low government and partners support for water harvesting • Lack of proper plans/strategies to guide water harvesting • Lack of proper studies to inform water harvesting e.g. hydrological studies	• Training to improve knowledge and skills in water harvesting • Enhance government and partner's support • Diversification of water harvesting methods and structures • Provision of affordable financial capital for water harvesting • Provision of water harvesting facilities through donor or government support • Develop or purchase larger facilities to enhance the capacity • Construction of community dams to increase capacity • Formation of water harvesting community groups for collective action • Improve water harvesting technologies for enhanced capacity and efficiency • Undertake studies to inform local water harvesting • Develop local water harvesting plans/strategies • Enhance environmental management and conservation actions • Enhance the management and maintenance of water harvesting facilities

3.7.3. Training on water harvesting

Most people have not received training on water harvesting on water harvesting (87.2%) while 12.8% have received the training. The majority of those who have not attended training on water harvesting (85.7%) said they would like to receive the training while 14.3% said they would not

like to attend a training on water harvesting. The training on water harvesting that local people would like to be trained on in the future were identified and are shown in Table 3.28.

Table 3. 28: Training on water harvesting that local people would like to receive in future

Training on water harvesting that local people would like to receive in future	
• Water harvesting and storage methods • Benefits of water harvesting • Efficient use of harvested water • Cheap water harvesting methods • Treatment of harvested water • How best to install roof gutters • How best to harvest roof water • Formulation of water harvesting plans • How to harvest flood water	• Building of water dams • How to make water pans • Installation of dam liners • How to make cut-off drains • Management and maintenance of water harvesting facilities • Development of underground tanks • Water harvesting for irrigation purposes

3.8. Agroforestry practice

3.8.1. Adoption of agroforestry practice

The average number of trees planted on household farms was found to be 162 trees. This includes 54.5% of the households who had >0-50 trees growing on their farms, 13.6% who had >50-100 trees, 12.5% who had >100-200 trees, 12.2% who had >200-500 trees, and 8.2% of the households who had >500 trees growing on their farm.

The average tree density on the household farms, that is the number of trees per acre of land, was found to be 94 trees per acre. This included 48.4% of the households who had a tree density of >0-50 trees/acre, 25.8% who had a tree density of >50-100 trees/acre, 18.6% who had a tree density of >100-200 trees per acres, and 7.2% who a tree density of >200 trees per acre.

The average estimated survival rate of trees planted on household farms was 65.8%. This includes 31.6% of the households who had an estimated survival rate of >0 to 50 percent, 32.8% who had an estimated survival rate of >50 to 75 percent, and 35.6% who had an estimated survival rate of >75-100 percent.

3.8.2. Agroforestry patterns on household farms

Trees on household farms are grown using various patterns including boundary planting, woodlots, scattered on the farms, and hedgerows planting. The main pattern was boundary planting.

3.8.3. Current and future types of trees in household farms

The types of exotic trees currently grown on household farms and those exotic trees that they would like to grow in the future are shown in Table 3.29.

Table 3. 29: Types of exotic trees planted on the household farms and the ones they plan to grow in future

Types of exotic trees growing on the household farms and the ones they plan to grow in future	
Currently growing	**Plans to grow in future**
Grevillea robusta	*Grevillea robusta*
Cupressus lusitanica	*Cupressus lusitanica*
Casuorina equisetifolia	*Casuorina equisetifolia*
Pinus patula	*Pinus patula*
Eucalyptus Spp.	*Eucalyptus Spp.*
Acacia mearnsii	*Acacia mearnsii*
Fraxinus pennsylvannica	*Fraxinus pennsylvannica*
Fraxinus acrocarpus	*Jacaranda mimosifolia*
Jacaranda mimosifolia	*Acacia melanoxylon*
Acacia melanoxylon	*Callistemon Spp.*
	Dovyalis caffra

Moreover, the types of indigenous trees currently grown on household farms and those indigenous trees that they would like to grow in the future are shown in Table 3.30.

Table 3. 30: Types of indigenous trees growing on the household farms and the ones they plan to grow in future

Types of indigenous trees growing on the household farms and the ones they plan to grow in future	
Currently growing	**Plans to grow in future**
Croton macrostachyus	*Croton macrostachyus*
Ficus thonningii	*Ficus thonningii*
Acacia Spp.	*Acacia Spp.*
Podocarpus Spp.	*Podocarpus Spp.*
Olea capensis	*Schefflera volkensii*
Vernonia auriculifera	*Albizia gummifera*
Cussonia Spp.	*Cordia Africana*
Ficus sycamorous	*Zanthoxylum usambarensis*
Albizia gummifera	*Croton megalocarpus*
Cordia Africana	*Arundinaria alpina*
Zanthoxylum usambarensis	*Prunus Africana*
Croton megalocarpus	*Dombeya torrida*
Arundinaria alpina	*Rucinus communis*
Prunus Africana	*Olea Africana*
Dombeya torrida	*Juniperus procera*
Rucinus communis	*Azadirachta indica*
Olea Africana	
Juniperus procera	
Maytenus senegalensis	
Olinia rochetiana	

The types of fruit trees currently grown on household farms and those fruit trees that they would like to grow in the future are shown in Table 3.31.

Table 3. 31: Types of fruit trees growing on the household farms and the ones they plan to grow in future

Types of fruit trees growing on the household farms and the ones they plan to grow in future	
Currently growing	**Plans to grow in future**
Persea Americana	*Persea Americana*
Prunus domestica	*Prunus domestica*
Cairica papaya	*Cairica papaya*
Eriobotrya japonica	*Eriobotrya japonica*
Pyrus communis	*Pyrus communis*
Ribes nigrum	*Ribes nigrum*
Annona reticulata	*Annona reticulata*
Mangifera indica	*Mangifera indica*
Citrus sinensis	*Citrus sinensis*
Psidium guajava	*Psidium guajava*
Malus domestica	*Malus domestica*
Ficus carica	*Ficus carica*
Citrus limon	*Citrus limon*
Macadamia integrifolia	*Macadamia integrifolia*
Solanum betacium	*Solanum betacium*

The types of fodder trees currently grown on household farms and those fodder trees that they would like to grow in the future are shown in Table 3.32.

Table 3. 32: Types of fodder trees growing on household farms and the ones they plan to grow in future

Types of fodder trees growing on the farms and the ones they plan to grow in future	
Currently growing	**Plans to grow in future**
Leucaena leucacephala	*Leucaena leucacephala*
Fraxinus pennsylvanica	*Fraxinus pennsylvanica*
Calliandra calothyrsus	*Calliandra calothyrsus*
Sesbania sesban	*Sesbania sesban*
Gravillea robusta	*Gravillea robusta*
Acacia Spp	*Acacia Spp*
Morus alba	*Morus alba*
Moringa olifera	*Moringa olifera*
Gliricidia sepium	*Gliricidia sepium*
Faidherbia albida	*Faidherbia albida*

3.8.4. Source of tree seedlings for agroforestry

Households source the trees they grow on their farms from different sources including: their own tree nursery, the KFS tree nursery, private tree nurseries, provided by the government, provided by NGO, provided by friends/relatives.

3.8.5. Gender roles in tree growing and use

Men are responsible for planting trees in 19.7% of the households, women in 10.4% of the households, and both women and men plant trees in 69.9% of the households. This is as shown in Table 3.33.

Table 3. 33: Gender roles in the planting of trees in the household

Gender roles in the planting of trees in the household		
Responsible	**Frequency**	**Percent**
Men	74	19.7
Women	39	10.4
Women and Men	263	69.9
Total	376	100.0

However, men control the use of trees in 74% of the households, women in 16% of the households, and both women and men control the use of trees in 10.1% of the households. This is as shown in Table 3.34.

Table 3. 34: Gender roles in the control of the use of trees in the household

Gender roles in the control of the use of trees in the household		
Responsible	**Frequency**	**Percent**
Men	277	73.7
Women	60	16.0
Women and Men	38	10.1
Total	376	100.0

3.8.6. Trends in tree growing on household's farms

The trend in the number of trees growing on household farms was found to be decreasing in 68.1% of the households and increasing in 24.2% of the households while 7.7% of the households had observed no change in growing trees on the household farm. This is as shown in Table 3.35.

Table 3. 35: The trend in the number of trees growing on household farms over time

The trend in the number of trees growing on household farms over time		
Trend	Frequency	Percent
Decreasing	256	68.1
Increasing	91	24.2
No change	29	7.7
Total	376	100.0

3.8.7. Challenges facing agroforestry practice and ways of improving it

The challenges that face the households in agroforestry practice and ways of improving it as shown in Table 3.36.

Table 3. 36: Challenges facing households in agroforestry practice and ways of improving it

Challenges facing households in agroforestry practice and ways of improving it	
Challenges	**Ways of improving**
• Lack of good quality tree seedlings • Climate change leading to inadequate rainfall • Mechanical damage during farming activities • Poor soil conditions due to degradation • Flooding during extremely heavy rainfall events • Lack of proper fencing to protect the trees • Scarcity of water hindering watering of tree seedlings • Cutting of planted trees/deforestation • Poor land use planning hence no space set for tree growing • Land conflicts with neighbors for boundary planting • Lack of adequate knowledge and skills • Grazing on trees by livestock • Lack of adequate capital for planting trees • Damage to trees by moles • Pests and diseases that affect trees • Theft of planted tree seedlings • Damage to trees during fire outbreaks • Inadequate land hence lack of enough space to plant trees • Insecure land tenure leading to uncertainty	• Establish tree nurseries to increase seedlings availability • Soil conservation to improve conditions for tree growth • Training on agroforestry and tree management • Conduct research to inform tree planting activities • Conduct soil testing to inform tree species site matching and soil improvement • Develop land use plans allocation spaces for tree growing • Develop community tree nursery and tree planting groups • Develop flood control structure to protect trees • Flood control to protect trees from damage by floods • Early land preparation and early planting to enhance survival • Efficient watering of trees during the dry season • Enhance water harvesting and improve supply • Use water conservation approaches e.g. mulching and monsoon bands • Enforce laws and bylaws to protect trees • Provision of good quality tree seedlings to farmers • Fencing off trees planted sites to avoid destruction • Improve silvicultural practices such as pruning • Community sensitization to promote tree planting • Enhance pest and disease surveillance and control

3.8.8. Training in agroforestry practice

Most people had not received training in agroforestry (88.6%) while 11.4% have received the training. Among those who had not received training on agroforestry, 82.3% said they would like to receive the training while 17.7% said they would not like to receive the training. The training on agroforestry that people would like to receive in the future are shown in Table 3.37.

Table 3. 37: Training on agroforestry that local people would like to receive in the future

Training on agroforestry that local people would like to receive in the future	
• Agroforestry methods • Benefits of agroforestry • Choosing the best crop to grow in an agroforestry system • Choosing the best tree to grow in an agroforestry system • How best to integrate trees and livestock in agroforestry • Soil management for improved tree growth • Soil water conservation techniques	• Vegetative propagation methods e.g. grafting • Tree nursery management • Land use planning for agroforestry • Fodder trees growing and management • Fruit trees growing and management • Trees management/silvicultural techniques • How best to plant trees e.g. pitting and spacing • Management of agroforestry as a business

3.9. Tree seedlings production

3.9.1. Adoption of tree seedlings production

Only 6.4% of the households in the study area are involved in tree seedlings production while 93.6% are not involved. Of those involved in tree seedlings production, 58.3% produced tree seedlings individually, 29.2% as part of a tree nursery group, while 12.5% produced tree seedlings both individually and in a tree nursery group.

The average number of tree seedlings produced per household was found to be 1722 tree seedlings. This includes 93.6% of the households who had produced zero tree seedlings, 3.7% who had produced >0-1000 tree seedlings, 1.1% who had produced >1000-2000 tree seedlings, and 1.6% who had produced >2000 tree seedlings

3.9.2. Trend in tree seedlings production

The trend in the number of tree seedlings produced was found to be increasing by 70.8% of the households involved in tree seedlings production, decreasing by 16.7% of the households, while no change in the number of tree seedlings produced over time was observed by 12.5% of the households involved in tree seedlings production. This is as shown in Table 3.38.

Table 3. 38: The trend in the number of tree seedlings produced over time

The trend in the number of tree seedlings produced over time		
Trend	**Frequency**	**Percent**
Decreasing	4	16.7
Increasing	17	70.8
No change	3	12.5
Total	24	100.0

3.9.3. Sale of tree seedlings

Of the households involved in tree seedlings production, 91.7% sell tree seedlings while 8.3% don't sell tree seedlings. The average number of tree seedlings sold by the households involved in the sale of tree seedlings in the last year was 19850 tree seedlings. This includes 36.4% who sold

>0 to 1000 tree seedlings, 45.4% who sold >1000-2000 tree seedlings, 13.7% who sold >2000-6000 tree seedlings, and 4.5% who sold > 6000 tree seedlings in the last year.

The trend in the demand for tree seedlings over time was observed to be increasing by 81.8% of the households involved in the sale of tree seedlings, to be decreasing by 13.6% of the households, while 4.6% of the households observed no change in the demand of tree seedlings over time. This is as shown in Table 3.39.

Table 3. 39: The trend in the demand for tree seedlings over time

The trend in the demand for tree seedlings over time		
Trend	**Frequency**	**Percent**
Decreasing	3	13.6
Increasing	18	81.8
No change	1	4.6
Total	22	100.0

3.9.4. Challenges facing tree seedlings production and ways of improving it

The study identified various challenges facing tree seedlings production in the area and ways of improving it as shown in Table 3.40.

Table 3. 40: Challenges facing tree seedlings production in the area and ways of improving it

Challenges facing tree seedlings production in the area and ways of improving it	
Challenges	**Ways of improving**
• Lack of adequate knowledge and skills • Lack of good tree nursery equipment and materials • Lack of potting bags • Lack of adequate space for tree nurseries • Poor management of tree nursery groups • Brokers who exploit tree seedlings producers • Poor market access and low seedling prices • Lack of good quality seeds • Lack of adequate water • Lack of adequate financial capital • Theft of tree seedlings • Pests and diseases • Lack of good quality potting soils	• Training on tree nursery management • Develop good marketing systems for tree seedlings • Provision of good quality seeds • Enhance conservation of local indigenous trees to provide locally adapted seeds • Treatment of tree nursery soil to improve quality • Provide adequate water supply to tree nursery sites • Employ water-saving technologies at tree nursery sites e.g. sunken beds, or shading nets • Provide accessible and affordable financial capital • Fence and enhance the security of tree nursery sites • Enhance pest and diseases surveillance and control • Provide more public spaces for tree nurseries • Improve the management capacity of tree nursery groups

• Poor climatic conditions e.g. extreme cold or inadequate rainfall	

3.9.5. Training on tree seedlings production

Most of the people have not been trained in tree nursery management (82.2%) while 17.8% have been trained in tree nursery management. Of those who have not been trained in tree nursery management, 77% said they would like to receive the training while 23% said they did not like to receive the training. The training on tree nursery management that local people would like to receive in the future are shown in Table 3.41.

Table 3. 41: Training on tree nursery management that local people would like to receive in the future

Training on tree nursery management that local people would like to receive in the future	
• How to initiate/establish a tree nursery • Tree nursery management • Benefits of running a tree nursery • Marketing of tree seedlings • Tree nursery bed preparation • Planning of a tree nursery site • Vegetative propagation methods e.g. grafting • Types and use of tree nursery growing mediums • Pests and diseases management	• Proper watering of tree seedlings • Root pruning methods • Seed sowing and pricking out • Seed treatment techniques • Seed collection • Seed sorting and grading • How to transplant seedlings • How to choose the best tree seedlings species to produce • Types of tree species

3.10. Conservation and management of Dundori Forest

3.10.1. Ecological status and trends of Dundori Forest

The current ecological state was described to be poor by 60.9% of the people and very poor by 11.7%, while 22.6% described it as good and 4.8% as very good. This is as shown in Table 3.42.

Table3. 42: Current ecological status of Dundori Forest

Current ecological status of Dundori Forest		
Status	**Frequency**	**Percent**
Good	85	22.6
Poor	229	60.9
Very good	18	4.8
Very poor	44	11.7
Total	376	100.0

The trend in the state of the ecological state of Dundori Forest over time was said to be deteriorating by 65.2% of the people, and increasing by 30.1% while 4.8% had observed no change in the ecological state of Dundori Forest over time. This is as shown in Table 3.43.

Table 3. 43: The trend in the ecological status of Dundori Forest over time

The trend in the ecological state of Dundori Forest over time		
Trend	**Frequency**	**Percent**
Deteriorating	245	65.2
Improving	113	30.1
No change	18	4.8
Total	376	100.0

3.10.2. Causes of forest degradation and ways of restoring it

Several factors causing the degradation of Dundori Forest and the ways of restoring the forest were identified as shown in Table 3.44.

Table 3. 44: Causes of the degradation of Dundori Forest and ways of restoring the forest

Causes the degradation of Dundori Forest and ways of restoring the forest	
Causes	**How to restore**
• Poor farming practices in the forest • Poorly planned allocation of PELIS farming plots • Soil degradation leading to soil erosion • Grazing on planted seedlings in the forest • Damage/uprooting of planted tree by farmers • Theft of planted tree seedlings in the forest • Tree pests and diseases • Increasing demand for forest resources • Human encroachment into the forest • Mining and quarrying activities in the forest • Use of agricultural chemicals in the forest • Pollution through waste dumping in the forest • Climate change leading to inadequate rainfall • Inadequate policing and law enforcement • Poor silvicultural practices e.g. poor tree pruning • Deforestation or tree felling • Charcoal burning • Forest fires • Overgrazing in the forest	• Enhance tree planting activities in the forest • Avoid the dumping of wastes in the forest • Enhance the capacity for policing and law enforcement • Strictly enforce the ban against tree felling/deforestation • Improve and enhance forest monitoring activities • Improve tree management and silvicultural skills • Control and curb human encroachment into the forest • Clearly demarcate and mark the forest boundaries • Enhance community participation in forest management • Engage community scouts and policing in forest protection • Promote alternative income-generating activities in the forest e.g. ecotourism • Reduce community dependence on forest wood products by promoting agroforestry on farms • Proper planning and management of PELIS e.g. tying allocation of plots to initiation of tree planting • Ban PELIS farming in Dundori Forest • Enhance pests and diseases surveillance and control • Control invasive and alien species in the forest • Early site preparation and planting of tree seedlings • Better after-care and follow-up of planted trees • Avoiding the use of agrochemicals in the forest • Use good agricultural practices to avoid soil degradation • Research on drivers of forest's degradation

3.10.3 Tree planting in Dundori forest

On tree planting activities in Dundori Forest, 42.8% of the people were found to have participated while 57.2% had not participated. The average number of trees planted in Dundori Forest in the last year per person was 84 trees including 57.2% who had planted zero trees, 18.9% who had planted >0-100 trees, 18% who had planted >100-200 trees, 4.8% who had planted >200-1000 trees, and 1.1% who had planted >1000 trees in Dundori Forest in the last year. The survival rate of trees planted in Dundori Forest was estimated to be 58.7%.

Of those who had planted trees in Dundori Forest in the last year, 60.2% had planted exotic trees only, 5.6% had planted indigenous trees, and 34.2% had planted both exotic and indigenous trees. This is as shown in Table 3.45.

Table 3. 45: Types of trees planted in Dundori Forest in the last year

Type of trees planted in Dundori Forest in the last year		
Trend	**Frequency**	**Percent**
Exotic	97	60.2
Indigenous	9	5.6
Both exotic and indigenous	55	34.2
Total	161	100.0

3.10.4. Tree planting in Dundori Forest under PELIS

Tree planting under PELIS had been done by 79.6% of those who had participated in tree planting in Dundori Forest while 20.4% of them had not planted trees under the PELIS program. The average number of trees currently growing per individual PELIS participant's farm plot is 144 trees. This includes 26.6% with >0-50 trees growing on their PELIS farm plot, 19.5% with >50-100 trees, 14.8% with >100-150 trees, 29.7% with >150-200 trees, and 9.4% who have >200 trees growing on their PELIS farm plot.

Tree planting in the forest under PELIS is based on various conditions as shown in Table 3.46.

Table 3. 46: Conditions that guide the planting of trees under PELIS

Conditions that guide the planting of trees under PELIS	
• The planted trees belong to the government • The planted trees should be cut or uprooted • The farmer must participate in planting trees • The farmer takes care of trees in their plot • The tree planting space is three by three meter • The farmer should properly conserve their plot • The use of herbicides is not allowed • Maize should not be planted on the PELIS plot	• The farmer does beating up of trees on their plot • The farmer should vacate the PELIS plot after three years • There should be no grazing on the PELIS plot • The farmer should use mechanical cultivation e.g. tractors • Farming should not be done on hills and riparian areas

Most of the farmers planting trees in the forest under PELIS (82%) are satisfied with the set conditions for planting and 14% are very satisfied while 4% are unsatisfied with the conditions for planting trees under PELIS. This is shown in Table 3.47.

Table 3. 47: Level of satisfaction with the conditions for planting trees under PELIS

Level of satisfaction with the conditions for planting trees under PELIS		
Level	**Frequency**	**Percent**
Very unsatisfied	0	0
Unsatisfied	5	3.9
Satisfied	104	81.9
Very satisfied	18	14.2
Total	127	100.0

3.10.5. Impact of PELIS on the ecological status of Dundori Forest

As appertains to the impact of PELIS on the ecological status of Dundori Forest, 56.6% of the people feel it has a positive impact, while 42.8% feel it has a negative impact, and 0.5% feel it has no impact. This is as shown in Table 3.48.

Table 3. 48: Impact of PELIS on the ecological status of Dundori Forest

Impact of PELIS on the ecological status of Dundori Forest		
Impact	**Frequency**	**Percent**
Negatively	161	42.8
No impact	2	0.5
Positively	213	56.6
Total	376	100.0

3.10.6. Threats facing trees planted in the forest and ways of protecting them

Planting trees in Dundori Forest faces various threats including grazing by livestock, uprooting and damage during crop cultivation, damage by animal pests e.g. moles and monkeys, forest fires, stealing of planted tree seedlings, drying up due to inadequate rains, damage by agricultural chemicals e.g. herbicides, and pests and diseases. Various people and institutions are involved in the protection of the planted trees including paid community forest scouts, KFS forest guards, owners of PELIS farm plots, the CFA, environmental CSOs involved in tree planting, and volunteer community members.

The protection of trees planted in the forest could be improved in various ways as shown in Table 3.49.

Table 3. 49: Ways of improving the protection of trees planted in the forest

Ways of improving the protection of trees planted in the forest
• Avoid grazing livestock near tree planting sites • Enhancing pest and disease surveillance and control • Sensitization of the importance of the forest and its conservation • Enhance security and the enforcement of forest laws • Improving the after-care and follow-up of planted trees • Enhancing capacity and action in control of forest fires

- Avoid planting crops at the base of tree seedlings
- Enhance community participation in forest management
- Better management of PELIS and enforcement of set conditions
- Engaging community scouts in the aftercare of planted trees
- Enhancing the capacity of the KFS in forest management

3.10.7. Community participation in forest management

The level of community involvement in forest management is low according to 56.9% of the people and very low according to 5.9% while 34.6% feel it is high and 2.7% feel that it is very high. This is as shown in Table 3.50.

Table 3. 50: Level of community participation in forest management

Level of community participation in forest management		
Level	**Frequency**	**Percent**
High	130	34.6
Low	214	56.9
Very high	10	2.7
Very low	22	5.9
Total	376	100.0

Appertaining to the involvement of women in forest management, 63.6% feel it is low and 5.1% feel it is very low while 34.6% feel the involvement of women is high and 2.7% that it is very high. This is as shown in Table 3.51.

Table 3. 51: Level of women's participation in forest management

Level of women's participation in forest management		
Level	**Frequency**	**Percent**
High	105	27.9
Low	239	63.6
Very high	13	2.7
Very low	19	5.1
Total	376	100.0

Moreover, 57.4% of the people feel the involvement of the youth in forest management is low and 11.2% feel it is very low, while 26.1% feel it is high and 5.3% feel that it is very high. This is as shown in Table 3.52.

Table 3. 52: Level of youth participation in forest management

Level of youth participation in forest management		
Level	**Frequency**	**Percent**
High	98	26.1
Low	216	57.4
Very high	20	5.3
Very low	42	11.2

Total	376	100.0

The community is involved in various forest management activities as shown in Table 3.53.

Table 3. 53: Forest management activities the local community is involved in

Forest management activities the local community is involved in
• Tree planting • Tree management e.g. pruning • Controlling forest fires • Supporting security activities • Planted trees aftercare work • Tree seedlings production

Community involvement in forest management has been decreasing over time according to 53.7% of the people, and increasing according to 41.2%, while 5.1% feel that there has been no change in community involvement in forest management over time. This is as shown in Table 3.54.

Table 3. 54: The trend in participation of the community in forest management over time

The trend in participation of the community in forest management over time		
Impact	**Frequency**	**Percent**
Decreasing	202	53.7
Increasing	155	41.2
No change	19	5.1
Total	376	100.0

3.10.8. Challenges facing community involvement in forest management and ways of improving it

Challenges facing community involvement in forest management and ways of improving it as shown in Table 3.55.

Table 3. 55: Challenges facing community participation in forest management and ways of improving it

Challenges facing community involvement in forest management and ways of improving it	
Challenges	**Ways to improve**
• Low benefits to community members for involvement • Low government commitment to involving the community • The perception that forest management is the role of the government • Low awareness of the importance of the forest and its conservation • Corruption hinders and puts off the community from participating	• Enhance community benefits from forest management • Involve communities in more forest management activities • Improve communication on forest management activities • Better community involvement in forest management decision making • Better community involvement in the formulation of the forest management plans and strategies

• Discrimination and nepotism in forest management activities • Inequitable sharing of forest resources hinders participation • Poor communication on forest management activities • Poor relationship between the KFS and the community • Low capacity in leadership and participatory forest management • Non-diversity of activities the community is involved in i.e. it mainly entails tree planting • Poor community involvement in developing forest management plans • Local political interference in forest management activities • The perception that only those involved in PELIS should participate • Most community members lack PELIS plots and thus do not participate • Disunity and conflicts between leaders and hence community members • Weak community forest management structures e.g. CFA and user groups • The directive against cultivating maize in the forest demotivated the community from participating • Low awareness of policy provisions and the role of communities in forest management • Lack of knowledge and skills in forest management • Low interest by the community in forest conservation activities	• A greater commitment of the community to forest conservation and management • Improve the capacity of community-based forest management institutions • Improve policy and legal provisions for community participation in forest management • Create awareness of policy provisions and the role of communities in forest management • Employ effective mechanisms to address conflicts in forest resource use and management • Employ the local youth in forest management roles e.g. by the KFS • Ensure equitable sharing of forest resources and opportunities • Develop and implement systems to curb corruption in forest management • Training of community leaders and members on forest management • Improve the relationship between the community and the KFS • Sensitize the community on the importance of the forest and its conservation

3.10.9. Community membership in the CFA

On membership to the Dundori Forest CFA, 34.6% of the people said they are members while 65.4% are not members. Members of the CFA identified the various benefits they get from their membership as shown in Table 3.56.

Table 3. 56: Benefits of being a member of the CFA

Benefits of being a member of the CFA	
• Access to forest farmland through PELIS • Better access to forest resources e.g. firewood	• Greater involvement and benefits from forest projects • Access to tree seedlings to plant on the household farm

• Networking opportunities hence social capital • Knowledge and skills improvement e.g. training • Income earning opportunities	• Support on beekeeping activities

Community members who don't belong to the CFA cited various reasons why they haven't joined as shown in Table 3.57.

Table 3. 57: Reasons why some community members refuse to join the CFA

Reasons why some community members refuse to join the CFA	
• Lack of interest in joining the CFA • Lack of a PELIS farming plot • Never had the opportunity to join • Not aware of the existence of the CFA • There is no benefit in being a member	• The CFA lacks good management • Don't understand the role of the CFA • The high membership fee charged to join • Lack of physical capacity to engage in CFA activities

3.10.10. Effectiveness of the CFA in forest management

Regarding the effectiveness of the CFA as a community-based institution for forest management, 43.9% of the people said it was effective and 8% said it was very effective, while 40.2% said it was ineffective and 7.2% said it was very ineffective. This is as shown in Table 3.58.

Table 3. 58: Effectiveness of the CFA forest management activities

Effectiveness of the CFA in forest management activities		
Level	**Frequency**	**Percent**
Very ineffective	27	7.2
Ineffective	154	41.0
Effective	165	43.9
Very effective	30	8.0
Total	376	100.0

The challenges affecting the effectiveness of the CFA in its work and ways of improving it were also identified as shown in Table 3.59.

Table 3. 59: Challenges facing the effectiveness of the CFA in its work and ways of improving it

Challenges affecting the effectiveness of the CFA in its work and ways of improving it	
Challenges	**Ways to improve**
• Lack of adequate financial capital to fund activities • Lack of remuneration for the CFA leaders e.g. stipends • Wrangles within the CFA leadership • Divisions/disunity between the community members	• Enhance government and other partner's support of CFA activities • Support a suitable alternative crop to address the gap created by the ban on maize farming under PELIS • Create environmental awareness in the community to foster their participation in conservation work

• Uncooperative and inactive community members • Threats that affect tree planting being its key activity • Inadequate leadership and management capacity • Corrupt practices in CFA leadership • Conflicts between the CFA leadership and the KFS • Inadequate community involvement in CFA decision making • Inadequate involvement of women and the youth in forest management • The low commitment of some CFA officials in leadership • Poor communication to the community on forest management • Inequitable sharing of benefits which puts off community members • Discrimination and nepotism in sharing of benefits • Inadequate support by the government and partners • Lack of means of transport hence mobility CFA activities • Low community morale due to the ban on maize farming in the forest • Rising population pressure on forest resources and associated challenges	• Recruitment of more community members to join the CFA • Improve the collaboration between the CFA and the KFS • Greater community involvement in CFA decision-making processes • Foster gender equality in CFA activities and decision making • Develop effective participatory management strategies to guide CFA work • Improve communication on CFA and forest management activities • The regular election of CFA leaders to allow change and vibrancy in leadership • Recruitment of competent staff in CFA work • Leverage the forest's diverse economic potential and initiate alternative income-generating activities e.g. ecotourism for financial sustainability • The CFA to engage in fundraising activities e.g. writing funding proposals • Payment of a monthly stipend to CFA leaders for sustenance and motivation • Improve equitability in sharing of resources and opportunities • Improve implementation of policy provisions on community participation in forest management • Curb corruption and take legal action against offenders • Enforce laws for forest protection to enable conservation work • Continuous training of the CFA to improve capacity in leadership and management • Employ effective mechanisms to address conflicts that affect CFA activities

3.10.11. Membership and activities of forest user groups and CBOs

The study found that 11.7% of the people are members of forest user groups while 88.3% are not members. The forest user groups are involved in various activities including tree seedlings production, tree planting, farming, beekeeping, grazing, firewood collection, informal microfinance, and poultry rearing.

Of those who are members of forest user groups, 72.3% said their groups undertake income-generating activities while 27.7% said they do not. The income-generating activities that the forest user groups engage in include selling food crops, selling honey, selling poultry, and selling tree seedlings.

The success of the group's incoming generating activities was rated as high by 37.5% of the members of the groups engaged in income-generating activities and very high by 3.1%, while 56.3% rated the success as low and 3.1% rated the success of their group's income generating activities as very low. This is as shown in Table 3.60.

Table 3. 60: Level of success of forest user groups or CBOs income generating activities

Level of success of the forest user groups or CBOs income generating activities		
Level	**Frequency**	**Percent**
Very low	1	3.1
Low	18	56.3
High	12	37.5
Very high	1	3.1
Total	32	100.0

3.10.12. Challenges facing forest user groups and CBOs in their activities and ways of improving them

Various challenges facing forest user groups in their activities including ways of improving them were identified as shown in Table 3.61.

Table 3. 61: Challenges facing forest user groups in their activities and ways of improving them

Challenges facing forest user groups in their activities and ways of addressing them	
Challenges	**Ways to improve it**
• Low government and partners support • Climate change leading to inadequate rainfall • Lack of adequate water for group activities • Environmental degradation e.g. soil and bee habitat degradation • Lack of land/space to undertake activities • Insecurity hence theft e.g. of tree seedlings • Lack of financial capital and resources • Inadequate leadership and management capacity • Inadequate knowledge and skills in group activities • Poor market access for group products	• Implement supportive laws and policies for an enabling environment • Lower/subsidize the price of inputs for group activities • Provision with financial grants to foster group activities • Providing the groups with accessible and affordable loan facilities • Support with equipment and materials for the group's activities • Provision with better poultry breeds • Provide the beekeeping groups with modern bee hives and equipment • Provide the tree nursery groups with materials and equipment • Provide more land/space for groups activities • Enhance environmental conservation efforts e.g. tree planting • Enhance community involvement in development decision making • Training to improve knowledge and skills in group activities • Training to improve group leadership and management capacity • Enhance extension support services to the groups

• Pests and diseases e.g. for crops and poultry • Corruption leads to the embezzlement of funds meant to support the groups	• Improve the resilience of group activities e.g. adoption of resilient breeds, climate-smart technologies and diversification Enhance pest and diseases surveillance and control • Improving security in the area • Enhance efforts to curb corruption in development activities

3.10.13. Dundori forest management plan and its implementation

Regarding awareness of the Dundori Forest management plan, 40.7% of the people said they were aware while 59.3% said they were not aware of the management plan. The implementation of the management plan was described as effective by 44.4% of the people who were aware of the plan and very effective by 15.7% of them. Moreover, 33.3% of those who were aware of the plan described its implementation as ineffective and 5.9% described the implementation of the plan as very ineffective. This is as shown in Table 3.62.

Table 3. 62: Effectiveness in implementation of the Dundori Forest management plan

Effectiveness in implementation of the Dundori Forest management plan		
Level	**Frequency**	**Percent**
Very ineffective	9	15.7
Ineffective	52	33.3
Effective	68	44.4
Very effective	24	5.9
Total	153	100.0

3.10.14. Forest management laws and bylaws and their implementation

As appertains to awareness of forest management laws and bylaws in Dundori Forest, 43.6% said they were aware of the laws and bylaws while 43.6% said they were unaware. The forest management laws and bylaws they are aware of are shown in Table 3.63.

Table 3. 63: Identified forest management laws and bylaws in Dundori Forest

Identified forest management laws and bylaws in Dundori Forest	
• No felling of trees • No charcoal burning • No lighting fires • PELIS farming guidelines • No using herbicides • No forest encroachment	• On wildlife protection • Riparian areas and hills protection • No damaging trees • Grazing rules • On user permits • No waste pollution

The forest management laws and bylaws were described as suitable by 76.8% of the people and very suitable by 12.2% of them, while 11% described the forest management laws and bylaws as unsuitable. This is shown in Table 3.64.

Table 3. 64: Suitability of the forest management laws and bylaws

Suitability of the forest management laws and bylaws		
Level	**Frequency**	**Percent**

Very unsuitable	0	0
Unsuitable	18	11
Suitable	126	76.8
Very suitable	20	12.2
Total	164	100.0

The implementation of the forest management laws and bylaws was described as ineffective by 53% of those who were aware of the laws and 11.6% described their implementation as very ineffective. Besides, 28.7% of those who were aware of the laws described their implementation as effective while 6.7% described their implementation as very effective. This is shown in Table 3.65.

Table 3. 65: Effectiveness in implementation of the forest management laws and bylaws

Effectiveness in implementation of the forest management laws and bylaws		
Level	**Frequency**	**Percent**
Very ineffective	19	11.6
Ineffective	87	53.0
Effective	47	28.7
Very effective	11	6.7
Total	164	100.0

3.10.15. Forest resources sharing

The sharing of forest resources was described as inequitable by 31.9% of the people and very inequitable by 8.5%, while 31.9% described the sharing of resources as equitable and 5.3% described the sharing as very equitable. This is as shown in Table 3.66.

Table 3. 66: Equitability in sharing forest resources

Equitability in sharing forest resources		
Level	**Frequency**	**Percent**
Very inequitably	32	8.5
Inequitably	204	54.3
Equitably	120	31.9
Very equitably	20	5.3
Total	376	100.0

The various causes of inequitably in sharing of forest resources and how to address them were also identified as shown in Table 3.67.

Table 3. 67: Causes of inequitable sharing of forest resources and how to address them

Causes of inequitable sharing of forest resources and how to address them	
Challenges	**How to address them**
• Corruption in sharing of forest resources • Discrimination and nepotism	• Improve implementation of the forest management laws and bylaws • Curb discrimination and nepotism in sharing of forest resources

• Poor planning and coordination of resources sharing • Poor infrastructure impedes access for some people • Inadequate community involvement in decision making • Low diversity of the exploited forest resources which limits access • Increasing pressure and demand on forest resources leading to unfair competition • The degradation that has led to the depletion of the resources hence unfair competition • Poor enforcement of laws and bylaws which leads to unscrupulous activities • Low or unequal awareness of the available forest resource base • Unawareness of forest user rights and related policy provisions • Poor leadership and management practices of the institutions involved • Unequal representation of different groups and areas in leadership • Poor communication on forest resources sharing related activities	• Curb corrupt practices in forest management activities • Improve and implement modalities for the election of leaders to ensure equal representation • Hiring/election of ethical/competent officials and officers • The exploitation of alternative forest resources to diversify opportunities • Provide grants and good credit facilities to enable investment in alternative forest resources e.g. NTFPs • Improve community participation in decision-making processes • Improve communication on forest resources sharing opportunities • Training to build leadership and management capacity • Improve forest management systems and strategies • Improve forest boundary access infrastructure to enable access • Employ effective forest resource use conflict resolution mechanisms • Improve community awareness on policy provisions and user rights over forest resources • Improve efficiency in the use of forest resources to ensure sustainable use hence availability • Develop and implement inclusive forest resources sharing strategies and agreements • Enhance the conservation of the forest to improve the forest resource base • Conduct surveys and develop a comprehensive inventory of the forest's resources • Create awareness of the forest and the available resources

3.10.16. Forest resources use conflicts

Forest resource use conflicts in Dundori Forest exist in different forms as shown in Table 3.68.

Table 3. 68: Forms of forest resources use conflicts in Dundori Forest

Forms of forest resources use conflicts in Dundori Forest
• Between farmers and livestock herders • Between farmers and tree planters • Between livestock herders and tree planters • Between the community forest encroachers and the government

- Between the KFS and forest resource destroyers
- Between pro-conservationists and forest destroyers
- Between community members
- Between leaders of community forest resource management institutions
- Between the CFA and community members
- Between the CFA and the KFS
- Between different resource management institutions e.g. those on water and forest resources

The frequency of occurrence of forest resource use conflicts was described to be rare by 50% of the people and very rare by 6.9%, while 32.7% of the people described the frequency of occurrence of forest resource use conflicts as often and 10.4% described the frequency as very often. This is as shown in Table 3.69.

Table 3. 69: Frequency of occurrence of conflicts over forest resources in Dundori Forest

Frequency of occurrence of conflicts over forest resources in Dundori Forest		
Level	**Frequency**	**Percent**
Very rarely	26	6.9
Rarely	188	50.0
Often	123	32.7
Very often	39	10.4
Total	376	100.0

The trend in the occurrence of forest resource use conflicts was said to be increasing by 62.5% of the people, decreasing by 31.9%, and not changing by 5.6% of the people. This is as shown in Table 3.70.

Table 3. 70: The trend in the occurrence of the forest resources use conflicts over time

The trend in the occurrence of the forest resources use conflicts over time		
Trend	**Frequency**	**Percent**
Decreasing	120	31.9
Increasing	235	62.5
No change	21	5.6
Total	376	100.0

Various institutions are involved in resolving forest resource use conflicts including the KFS, the CFA, the chief's office, forest user groups or CBOs, community elders, civil society organizations, and the court of law. These institutions employ various mechanisms in addressing forest resource use conflicts including mediation, arbitration, instituting fines, ensuring clarity of tenure over resources, and prosecution by the court of law.

The effectiveness of the conflict management institutions was described as effective by 60.1% of the people, very effective by 12.5%, ineffective by 22.9%, and very ineffective by 4.5% of the people. This is as shown in Table 3.71.

Table 3. 71: Effectiveness of the forest resource use conflicts resolution mechanisms

Effectiveness of the forest resource use conflicts resolution mechanisms		
Level	**Frequency**	**Percent**
Very ineffective	17	4.5
Ineffective	86	22.9
Effective	226	60.1
Very effective	47	12.5
Total	376	100.0

3.11. Conservation and management of water resources

3.11.1. Ecological status and trends of water resources

The current ecological state of water resources in the area was described as poor by 70.5% of the people and very poor by 11.7%, while 15.4% described their ecological state as good and 1.3% as being in a very good ecological state. This is as shown in Table 3.72.

Table **3. 72: Current ecological status of local water resources**

Current ecological status of the local water resources		
Level	**Frequency**	**Percent**
Very poor	44	11.7
Poor	269	71.5
Good	58	15.4
Very good	5	1.3
Total	376	100.0

The trend in the ecological state of the water resources over tie was observed to be deteriorating by 80.6% of the people, improving by 13%, and not to have changed over time by 6.4% of the people. This is as shown in Table 3.73.

Table 3. 73: The trend in the ecological status of the local water resources over time

The trend in the ecological status of the local water resources over time		
Trend	**Frequency**	**Percent**
Deteriorating	303	80.6
Improving	49	13.0
No change	24	6.4
Total	376	100.0

3.11.2. Causes of water resources degradation and ways of restoring them

Various causes of the degradation of local water resources and ways of restoring them were identified as shown in Table 3.74.

Table 3. 74: Causes of the degradation of local water resources and ways of restoring them

Causes of the degradation of water resources and ways of restoring them	
Causes	**Way of restoring**
• Farming on steep slopes at headwaters • Poorly planned land use/development activities • Poor enforcement of environmental laws and regulations	• Stop farming activities on steep catchments and riparian areas • Proper regulation of mining and quarrying activities • Control the use of agricultural chemicals • Promote organic farming in the watersheds

• Use of agrochemicals especially in the catchment areas • Local capacity for water resources management • Population increases hence pressure on water resources • Climate change leading to inadequate rainfall • Encroachment of riparian areas for development • Farming activities in the riparian areas • Soil erosion leads to siltation • Deforestation especially in riparian and catchment areas • Waste pollution including effluents and solid wastes • Excess and unplanned abstraction of water resources • Mining and quarrying activities	• Training to improve the management capacity of water resources management institutions • Improve government and partner's support of water resource management institutions • Undertake hydrological surveys on water resources • Continuous hydrological monitoring and installation of gauging stations • Undertake the mapping of water resources and their users • Develop water resources use and allocation plans • Proper demarcation and marking of riparian boundaries • Improve coordination between agencies involved in water resources management • Enhance community participation in water resources management • Water harvesting to improve water availability reduce dependence on rivers • Improve efficiency in water use • Enhance soil conservation activities • Engage in water conserving agriculture practices • Enhance planting of trees, especially in catchment and riparian areas • Emphasize the planting of indigenous trees to restore natural forests • Improve the enforcement of environmental laws to protect riparian areas • Enhance sensitization of communities on environmental issues • Control of pollution and curb dumping of solid wastes and effluents • Develop and implement environmentally conscious land use and development plans • Develop and implement participatory water resources management plans

3.11.3. Tree planting on water resources

As appertains to tree planting on water resources, 25.5% of the people have participated in tree planting activities in riparian areas and springs while 74.5% have not participated. The average estimated survival rate of trees planted in riparian areas and springs was found to be 58.1%.

3.11.4. Threats facing trees planted on water resources and ways of protecting them

Threats facing tree planting in riparian areas and springs in the area include grazing by livestock, destruction through farming, destruction by rodents e.g. moles, damage by flash floods, theft of planted tree seedlings, climate change leading to inadequate rain, encroachment of riparian land, and tree pest and diseases. Protection of trees planted in riparian areas and springs are protected by various people and institutions including paid community scouts, the WRA (Water Resources

Authority), farmers cultivating along the riparian areas and springs, the WRUA, volunteer community members, the CFA, county government authorities, CSOs involved in conservation work, and the chief's office.

The protection of trees planted in riparian areas and springs could be improved in various ways as shown in Table 3.75.

Table 3. 75: Ways of improving the protection of trees planted in riparian areas and springs

Ways of improving the protection of trees planted in riparian areas and springs
• Avoiding grazing activities in riparian areas • Enhance tree follow-up and after-care work • Giving a stipend to community scouts involved in aftercare • Avoiding farming activities in riparian areas • Enforcing environmental laws that protect riparian areas • Proper demarcation and marking of riparian areas • Fencing off riparian planting sites to control access • Involvement of community members in conservation activities • Enhancing security to protect planted seedlings • Timely planting site preparation and tree planting

3.11.5. Community participation in water resources management

Local community involvement in water resources management was described as low by 62.5% of the people and very by 10.9%, while 21.8% described the involvement as high and 4.8% described it as very high. This is as shown in Table 3.76.

Table 3. 76: Level of community participation in water resources conservation and management

Level of local community participation in water resources conservation and management		
Level	**Frequency**	**Percent**
Very low	41	10.9
Low	235	62.5
High	82	21.8
Very high	18	4.8
Total	376	100.0

Most of the people in the area (84.8%) do not belong to a WRUA while 15.2% are WRUA members.

3.11.6. Effectiveness of the WRUA in water resources management

Concerning the effectiveness of the WRUA as a community-based institution for water resources management, 62% said that it is ineffective and 11.2% said it is very ineffective while 20.5% said it is effective and 6.4% said that the WRUA is very effective as a community-based institution for water resources management. This is as shown in Table 3.77.

Table 3. 77: Effectiveness of the WRUA in water resources management

Effectiveness of the WRUA in water resources management		
Level	**Frequency**	**Percent**
Very ineffective	42	11.2
Ineffective	233	62.0
Effective	76	20.5
Very effective	24	6.4
Total	376	100.0

The various challenges that affect the effectiveness of the WRUA in its work and ways of improving it were identified as shown in Table 3.78.

Table 3. 78: Challenges affecting the effectiveness of the WRUA in its work and ways of improving it

Challenges affecting the effectiveness of the WRUA in its work and ways of improving it	
Challenges	**Ways of improving**
• Lack of financial capital and resources • The low commitment of some WRUA leaders in their work • Lack of adequate leadership and management capacity • Poor enforcement of laws meant to create an enabling environment • Poor coordination of agencies involved in water resource management • The degradation and pollution of water resources affect water availability in quantity and quality • Climate change leads to inadequate rainfall which affects water availability and restoration activities • Low partners and government support for the WRUA in its work • High population pressure and thus the demand on available water resources • Inadequate management and leadership capacity • Many community members are unaware of its role	• Improve government and other partner's support of the WRUA • Training to enhance the management and leadership capacity • Develop mutual and inclusive plans/agreements for sharing of water resources • Improve coordination between partners in the management of water resources • Employ effective mechanisms to resolve conflicts and wrangles in water • Enhance security as appertains to the protection of water resources • Enhance conservation activities including soil conservation and tree planting and pollution control • Improve land use/development planning by putting into consideration the integrity of water resources • Develop and implement better management strategies and systems for the WRUA • Fundraising through the writing of project proposals and other approaches • Firms and agencies that use and sell water resources from the local watersheds invest some money in the conservation of the resource • Develop and implement guidelines for the election and recruitment of competent WRUA officials and personnel

• Community members who don't recognize the WRUAs and their mandate • Low involvement of the community in water resources management • Corruption within the WRUA affects its work • Discrimination and nepotism affects its work • Conflicts over water resources cause divisions • Leadership wrangles within the WRUA leadership	• Develop and implement modalities to motivate WRUA officials and personnel in their work • Improved communication and dissemination of information on WRUA work and water resources • Environmental sensitization of community members and on the importance of conservation of the water resources • Sensitize the community on the role of the WRUA and recruit more members • Enhance wider community involvement in water resources management decision-making processes • Develop integrated participatory water resources management strategies • Participatorily develop and implement effective bylaws to govern local water resources • Enhance the enforcement of environmental laws to create an enabling environment • Establish an office for the WRUA and provide means of mobility

3.12. Environmental conservation in local institutions and public areas

3.12.1. Environmental status and trends of local institutions and public areas

The current environmental status of local institutions and public areas was described as poor by 59% of the people and very poor by 2.9%, while 33.8% described their environmental status as good and 4.3% described the status as very good. This is as shown in Table 3.79.

Table 3. 79: Current environmental status of local institutions and public areas

Current environmental status of local institutions and public areas		
Level	**Frequency**	**Percent**
Very poor	11	2.9
Poor	222	59.0
Good	127	33.8
Very good	16	4.3
Total	376	100.0

The trend in the environmental status of local institutions and public areas was said to be deteriorating by 58.2% of the people, improving by 23.7%, and not to have changed over time by 18.1% of the people. This is as shown in Table 3.80.

Table 3. 80: The trend in the environmental status of local institutions and public areas over time

The trend in the environmental status of local institutions and public areas over time		
Level	**Frequency**	**Percent**
Decreasing	219	58.3
Improving	89	23.7
No change	68	18.1

Total	376	100.0

3.12.2. Causes of degradation in local institutions and public areas and ways of restoring them

The study identified various factors that cause environmental degradation in local institutions and public areas and ways of restoring them. This is as shown in Table 3.81.

Table 3. 81: Causes of environmental degradation in local institutions and public areas and ways of improving them

Causes of environmental degradation in local institutions and public areas and ways of restoring them	
Causes	**Ways of restoring**
• Poverty which drives degradation • Population pressure on available land resources • Inadequate land leads to overuse and crowding • Inadequate protection and security of public areas • Poor management and governance of public lands • Low environmental awareness among the public • Pollution through poor waste management • Land degradation due to poor land use practices • Destruction of planted tree seedlings hindering restoration • Deforestation or tree felling in institutions and public areas • Poorly planned and environmentally destructive developed development activities • Fire outbreaks and illegal burning on public lands • Poor agricultural practices in institutions and public spaces • Illegal and uncontrolled grazing	• Tree planting in institutions and public spaces • Build capacity for sustainable land management • Control deforestation or tree felling • Improve protection and security • Good agricultural practices • Control pollution and curb illegal dumping of waste • Improve planning and control of development activities • Involve the public in management and conservation activities • Create environmental awareness among the public • Control and regulate grazing in public areas

3.12.3. Community involvement in conservation activities in local institutions and public areas

The level of community involvement in conservation activities in local institutions and public areas was described as low by 62.8% while 6.4% described it as very low. Besides, 26.1% of the people described community involvement in conservation activities in local institutions and public areas as high while 4.8% described it as very high. This is as shown in Table 3.82.

Table 3. 82: Level of local community participation in conservation activities in local institutions and public areas

Level of local community participation in conservation activities in local institutions and public areas		
Level	**Frequency**	**Percent**
Very low	24	6.4
Low	236	62.8

High	98	26.1
Very high	18	4.8
Total	376	100.0

3.12.4. Tree planting in local institutions and public areas

As appertains to tree planting activities in local institutions and public areas, only 12% of the people said they had participated while 88% said they had not participated. The average estimated survival rate of trees planted in local institutions and public spaces was 56.1%.

3.12.5. Threats facing trees planted in local institutions and public lands and ways of protecting them

Tree planting in local institutions and public spaces faces various threats including trampling by human beings, damage during development activities, stealing of planted tree seedlings, damage by grazing livestock, damage through farming activities, damage by rodents e.g. moles, inadequate rainfall, and poor tree planting practices. The protection of trees planted in local institutions and public spaces is done by various actors including community scouts, government environment agencies e.g. NEMA, members, and administrators of institutions, infrastructure development agencies, county government authorities, and CSOs involved in conservation work, and volunteer community members.

The protection of trees planted in local institutions and public areas could be improved in various ways as shown in Table 3.83.

Table 3. 83: Ways of improving the protection of trees planted in local institutions and public areas

Ways of improving the protection of trees planted in local institutions and public areas
• Improve government and other partners support the tree planting activities
• Training to enhance capacity for environmental conservation and management
• Develop environmental conscious land use and development plans
• Enhance the regulation and control of development and land use activities
• Improve coordination between partners in the management of public lands
• Enhance security and protection of public lands and resources
• Enhance the enforcement of environmental laws to protect the trees
• Enhance control of pollution and illegal waste disposal
• Develop and implement regulations on agricultural activities on public lands
• Improve coordination between agencies involved in the management of public lands
• Enhance the public environmental awareness creation
• Enhance community involvement in the management of public lands
• Develop participatory environmental management strategies for public lands
• Participatorily develop and implement effective bylaws to govern activities on public lands

3.13. Energy use at the domestic level

3.13.1. Amount of energy used by households

The average amount of firewood used by local households at the domestic level for cooking per month is 7 backloads. This includes 3.7% of the households who had used zero backloads, 34.3% who use 1-4 backloads, 22.6% who had used >4-7 backloads, 19.5% who had used >7-10

backloads, 15.6% who had used >10-15 backloads, and 4.3% who had used >15 backloads of firewood per month.

3.13.2. Households sources of firewood

Most of the households (84.3%) use firewood sourced from their household farms while 15.7% don't use firewood sourced from the household farms. On how adequately the household farm meets their firewood requirements, 48.1% said that it is inadequate and 17% said that it is very inadequate, while 29.6% said that it is adequate and 5.3% said that the household farm is very adequate in meeting their firewood requirements. This is as shown in Table 3.84.

Table 3. 84: Adequacy of the household farms in meeting their firewood needs

Adequacy of the household farms in meeting their firewood needs		
Level	**Frequency**	**Percent**
Very inadequately	64	17.0
Inadequately	181	48.1
Adequately	111	29.6
Very adequately	20	5.3
Total	376	100.0

Firewood sourced from the forest is used by 60.4% of the household while 39.6% of the households don't use firewood sourced from the forest. The average proportion of the household's totals firewood use that is sourced from the forest is 41 backloads. This includes 37.8% of the households who had sourced zero percent of their firewood needs from the forest, 4.2% of whom had sourced >0-25 percent of their firewood needs from the forest, 14.4% of whom had sourced >25-50 percent of their firewood needs from the forest, 22.1% of whom had sourced >50-75 percent of their firewood needs from the forest, and 21.5% of whom had sourced >75-100 percent of their firewood needs from the forest.

3.13.3. Household's use of charcoal

Charcoal is used at the domestic level for cooking by 77.9% of the households while 22.1% of the households don't use charcoal for cooking. The average amount of charcoal used by households per month for cooking is 1.2 sacks. This includes 22.3% of the households who use zero sacks, 52.7% who use one sack, 15.2% who use 2 sacks, and 9.8% who use >2 sacks of charcoal per month.

3.13.4. Types and use of alternative energy sources for cooking

Alternative sources of energy for cooking at the domestic level (other than firewood and charcoal) are used in 65.4% of the households while 34.6% of the households don't use alternative sources of energy for cooking. The alternative sources of energy used for cooking by households include LPG gas, electricity, solar, biogas, briquettes, and kerosene. The main source of alternative source of energy for cooking used in the area is LPG gas.

The average number of times that the households use alternative sources of energy for cooking per week is 3 times. This includes zero times per week for 36.4% of the households, 1-3 times per

week for 24.2% of the households, >3-5 times per week for 10.9% of the households, >5-7 times per week for 24.7% of the households, and >7 times per week for 4.8% of the households

3.13.5. Use of energy-efficient jikos

Energy-efficient jikos are used for cooking by 25.5% of the households while 74.5% of the households don't use energy-efficient jikos for cooking. The average number of times the households use energy-efficient jikos for cooking per week is one time. This includes zero times for 74.5% of the households, 1-3 times for 10.3% of the households, 4-5 times for 4.6% of the households, and 5-7 times for 10.4% of the households

Households use different sources of light for lighting at the domestic level including electricity, solar fixed lamp, solar portable lamp, kerosene lamp, biogas, candles, and torches. The main source of energy for lighting in the area is electricity.

3.14. Timber tree resources

3.14.1. Sources of timber tree materials

Local households source their timber tree materials from various sources including from the household farm, from the forest, and purchase from timber dealers. However, purchase from dealers is the main source of timber tree products.

3.14.2. Level and trend in availability of timber tree materials

The level of availability of timber tree materials (rafters, poles, timber) was described as low by 63.6% of the people and very by 13.6%, while 16.2% described the availability of timber tree materials as high and 6.6% described the level of the availability timber tree materials as very high. This is as shown in Table 3.85.

Table 3. 85: Level of availability of timber tree materials in the area

Level of the availability of timber tree materials in the area		
Level	**Frequency**	**Percent**
Very low	51	13.6
Low	239	63.6
High	61	16.2
Very high	25	6.6
Total	376	100.0

As appertains to the trend in the availability of timber tree materials over time, 66.8% of the people said that their availability has been decreasing over time, 28.7% said that it has been increasing, while 4.5% said that there has been no change in the availability of timber tree products over time. This is as shown in Table 3.86.

Table 3. 86: The trend in the availability of timber tree materials in the area over time

The trend in the availability of timber tree materials in the area over time		
Level	**Frequency**	**Percent**
Decreasing	251	66.8
Increasing	108	28.7
No change	17	4.5

Total	376	100.0

3.15. Non-timber forest products

3.15.1. Use and types of non-timber forest products

Non-timber forest products (e.g. honey, gums, resins, wild vegetables, etc.) were sourced from Dundori Forest by 9.6% of the households while 90.4% of the households said they don't source non-timber forest products from the forest. The non-timber forest products sourced from Dundori Forest include honey, medicinal herbs, wild fruits and nuts, gums and resins, spices and flavorings, oils, and wild vegetables.

3.15.2. Trend in the availability of non-timber forest products

Of those who said that they source non-timber forest products from Dundori Forest, 83.3% said that the availability of the products has decreased over time and 8.3% said that the availability of the products has been increasing, while 8.3% said there has been no change in the availability of the products of the non-timber forest products over time. This is shown in Table 3.87.

Table 3. 87: The trend in the availability of non-timber forest products in the forest over time

The trend in the availability of non-timber forest products in the forest over time		
Level	**Frequency**	**Percent**
Decreasing	30	83.3
Increasing	3	8.3
No change	3	8.3
Total	36	100.0

3.15.3. Value addition and sale of non-timber forest products

Value addition of the non-timber forest products is done by 11.1% of the households who source them from the forest while 88.9% of those households don't undertake any value addition of the products. However, all the households (100%) who source the non-timber forest products from Dundori Forest said they would like to learn value addition skills. The value addition skills they would like to learn include: processing, packaging, branding, preservation, and certification.

Moreover, 66.7% of the households who source non-timber forest products from Dundori said they sell the products while 33.3% of those households don't sell the products. The non-timber forest products that are sold by these households include honey, medicinal herbs, wild fruits and nuts, gums and resins, and wild vegetables.

3.15.4. Forest ecological services

The study found that the forest provides various non-physical ecosystem services including: carbon sequestration/climate change mitigation, soil erosion control, hydrological/water catchment functions, biodiversity/wildlife habitat, aesthetic value functions, cultural values e.g. sacred sites, and climate regulation.

3.15.5. Trend in the forest's capacity to provide ecological services

Regarding the trend in the capacity of the forest in providing ecosystems services over time, the capacity was observed to be decreasing by 74.2% of the people and increasing by 14.4% of the people, while 11.4% observed there has been no change in the capacity of the forest in providing the ecosystems services over time. This is as shown in Table 3.88.

Table 3. 88: The trend in the capacity of the forest in providing non-physical ecosystem services over time

The trend in the capacity of the forest in providing non-physical ecosystem services over time		
Level	**Frequency**	**Percent**
Decreasing	279	74.2
Increasing	54	14.4
No change	43	11.4
Total	376	100.0

3.16. Food security

The level of self-sufficiency of the households in meeting their food requirements was described as low by 49.2% of the households and very low by 6.9% of the households, while the level was described as high by 37.5% of the households and very high by 6.4% of the households. This is as shown in Table 3.89.

Table 3. 89: Level of self-sufficiency of the households in meeting their food requirements

Level of self-sufficiency of the households in meeting their food requirements		
Level	**Frequency**	**Percent**
Very low	26	6.9
Low	185	49.2
High	141	37.5
Very high	24	6.4
Total	376	100.0

When asked if there were days when the household was not able to provide all the three main daily meals in the last three months, 29.3% of the households said there were days when they were not able to provide the three main daily meals while 70.7% said there were no days when they were not able to provide the three main daily meals in the last three months. The average number of days that households were not able to provide the three main meals taken per day in the last three months was found to be 3 days. This includes 70.5% who had not been able to provide the three main meals taken per for zero days in the last three months, 11% who had not been able to provide the three main meals for 1-5 days in the last three months, 12.3% who had not been able to provide for 6-10 days, 4.3% who had not been able to provide for 11-15 days, and 1.9% who had not been able to provide the three main meals taken per day for >15 days in the last three months.

The level of the dietary diversity of the food taken by a household per day was observed to be low by 50.5% of the households and very low by 4.5% of the households, while 42.3% of the households observed that the dietary diversity was high and 2.7% observed that the dietary diversity of the food they took per day was very high. This is as shown in Table 3.90.

Table 3. 90: Level of dietary diversity of the food taken by the households per day

Level of dietary diversity of the food taken by the households per day		
Level	**Frequency**	**Percent**
Very low	17	4.5
Low	190	50.5
High	159	42.3
Very high	10	2.7
Total	376	100.0

3.17. Climate change and variability

3.17.1. Extent and trends of change of the local climate and climate patterns

The extent to which the local climate and climate patterns had changed over time was observed to be high by 66.5% of the people and very high by 12% of the people, while 19.4% observed the extent of change in local climate and climate patterns to be low and 2.1% observed it to be very low. This is as shown in Table 3.91.

Table 3. 91: The extent to which local climate and climatic patterns have changed over time

The extent to which the local climate and climatic patterns have changed over time		
Level	**Frequency**	**Percent**
Very low	8	2.1
Low	73	19.4
High	250	66.5
Very high	45	12.0
Total	376	100.0

The trend in the frequency of occurrence of rainy seasons without adequate rainfall over time was said to increase by 84.6% of the people, decrease by 14.1%, and not to have changed by 1.3% of the people. This is as shown in Table 3.92.

Table 3. 92: The trend in the frequency of occurrence of rainfall seasons with inadequate rainfall amounts locally over time

The trend in the frequency of occurrence of rainfall seasons with inadequate rainfall amounts locally over time		
Level	**Frequency**	**Percent**
Decreasing	53	14.1
Increasing	318	84.6
No change	5	1.3
Total	36	100.0

3.17.2. Causes and effects of climate change and variability

Various factors were said to be the cause of climate change and variability locally including deforestation/felling of trees, environmental pollution, poor agricultural practices, forest fires, and inadequate environmental conservation efforts.

Climate change has various effects on local people's livelihoods as shown in Table 3.93.

Table 3. 93: Effects of climate change on local people's livelihoods

Effects of climate change on local people's livelihoods	
• Low crop production • Low livestock production • High food prices • Famines • Causes scarcity of fodder/pasture • Floods hence infrastructural damage • Negatively affect tree growth hence tree cover	• Causes drying up of water resources • Water scarcity • Reduction in income earnings • An increase in disease incidences • An increase in pests infestations • Increased conflicts over resources

The severity of the effect of climate change and variability was said to be high by 61.7% of the people and very high by 14.4% of the people. Moreover, 21.5 said the severity was high while 2.4% said that the severity of the effect of climate change and variability was very low. This is as shown in Table 3.94.

Table 3. 94: The severity of the effect of climate change on the household's livelihoods

Severity of the effect of climate change on the household's livelihoods		
Level	**Frequency**	**Percent**
Very low	9	2.4
Low	81	21.5
High	232	61.7
Very high	54	14.4
Total	376	100.0

3.17.3. Responses to climate change and variability

Local households respond to the effects of climate change and variability in various ways as shown in Table 3.95.

Table 3. 95: Local household's response to the effects of climate change

Local households response to the effects of climate change	
• Undertake tree planting activities • Undertake forest conservation activities • Adopt irrigation farming during the dry periods • Undertake water harvesting and storage • Practice efficient water use e.g. reduction and reuse	• Preservation and storage of food reserves • Fodder preservation and storage • Source fodder/pasture from the forest • Seek knowledge on climate change adaptation • Engage in business to diversify income sources

• Practice efficient energy use e.g. energy saving jikos • Use of renewable/alternative energy sources • Dig wells and boreholes to source water • Practice water conserving agriculture practices • Undertake soil conservation practices	• Reduce the size and number of meals taken per day • Control of environmental pollution • Mixed cropping to diversify crop production • Growing fast-growing crops • Growing drought-tolerant crops • Keeping diverse livestock types • Keeping smaller livestock e.g. poultry

3.17.4. Support needed by local people in addressing effects of climate change

The study identified how the local people would like to be supported in addressing climate change and variability as shown in Table 3.96.

Table 3. 96: Support needed by local people in addressing the effects of climate change

Support needed by local people in addressing the effects of climate change	
• Provision with tree seedlings • Training in good agricultural practices • Training in organic agriculture • Training in agroforestry • Provision with good quality/improved seeds • Support with livestock feeds • Provision with food • Training on efficient irrigation technologies • Support to establish an irrigation system • Sensitization on environmental matters • Community involvement in climate change mitigation and adaptation decision making • Support to establish a tree nursery • Be given job opportunities • Control of environmental pollution • Support in environmental conservation work • Provision with water storage tanks	• Support with accessible financial capital • Lowering and stabilization of food prices • Support in construction of a greenhouse • Provision with good security • Training on soil conservation • Support in water harvesting • Construction of dams and water pans • Supply with adequate water in the homestead • Flood control mechanisms e.g. drainage • Training on efficient use of water • Provision with energy-saving jikos • Provision with fertilizers • Training on agribusiness • Support in starting a business • Training on climate change mitigation and adaptation

3.17.5. Organization addressing climate change and variability locally and their activities

Regarding awareness of the organizations that are in climate change and variability response activities in the area, 81.2% of the people said they were not aware, while 18.8% said they were aware of such organizations. The organizations involved in climate change and variability response activities in the area were found to include: the Greenbelt Movement, Wezesha CBO, NEMA, and Ministry of environment, Dundori Forest CFA, KFS, and Egerton University. These organizations are involved in various activities including tree planting, research, soil and water conservation, training, environmental sensitization, and control of environmental pollution.

3.17.6. Training on climate change and variability

Most of the people in the area (84.3%) have not received training on climate change and variability while 15.7% have received the training. Of those who have not received training on climate change and variability, 97.2% said they would like to receive the training while 2.8% said they didn't want to receive the training. The training on climate change that the local people would like to receive in future as shown in Table 3.97.

Table 3. 97: Training on climate change that local people would like to receive in future

Training on climate change that local people would like to receive in future	
• Climate change adaptation and mitigation • Integration of climate change in development • What is climate change and how does it occur • Causes of climate change • On climate change education • Water harvesting and storage • Food preservation and storage • Fodder preservation and storage • Impacts/effects of climate change • Choosing the right crops under climate change • Weather forecasting • Control of environmental pollution	• Waste management • How to improve crop production • Climate risk assessment • Crop irrigation technologies • Conservation agriculture • Efficient water use • Energy saving technologies • Efficient energy use • Tree planting/agroforestry • Soil conservation methods • Landscape restoration

4. Results of the participatory analysis

4.1. Historical profile

The historical profile focuses on the historical information of the community and the forest and attempts the information into a systematic chronology of events. It begins in the late 19th Century and attempts to identify all landmark dates that have had a significant impact on the people's lives, especially concerning Dundori Forest. The historical profile of Dundori Forest and the surrounding community is explained in Table 4.1.

Table 4. 1: Historical profile of Dundori Forest and the adjacent community

HISTORICAL PROFILE OF DUNDORI FOREST AND THE ADJACENT COMMUNITY	
YEAR	**EVENT(S)**
Before 1895	The Dundori forest and surrounding areas were settled by indigenous communities. These communities living in the forest were mainly hunters and gatherers. However, the area also had interactions with pastoralist communities at the time, especially the Maasai. The word Nakuru is actually derived from the Maasai word *Nakurro* in reference to barren scrubland that surrounds the lake and also the dust storm that occur in the area i.e. ''the place of dust storms''. Besides, the name of the subcounty on the Nyandarua side is Ol Kalou, a Maasai word meaning ''the place of big ants''. The forest was managed through a system of traditional rules and rights.
1895	Kenya was declared a British Protectorate. This was the onset of British colonization which saw the management of the forest taken over by the colonial government.
1897	Formulation of forest regulations by the colonial government consolidated its governance of forestlands. This saw the beginning of the establishment of exotic forest plantations to supply wood fuel for use by railway locomotives and for development purposes
1902	Sir Charles Elliot, the British commissioner of the protectorate, initiated a policy of settling Europeans in the White Highlands which included Nakuru and Nyandarua. Settlers started settling in the area. The settlers preferred settling around the forested areas.
1902	Enactment of the East African forestry regulations saw the transfer of forest management to the forest department. The regulations provided for the protection and gazzettement of forest land. It also enabled the nationalization of forest land and the establishment of forest reserves that prevented people from settling in forested areas.
1904	Founding of Nakuru Town. It was established within a one-mile radius of the main entrance to the railway station. The future growth of this town had a lot of influence on the dynamics of the forest and the adjacent areas
1914-1918	The first world war. This period saw the movement of many white settlers into Kenya, especially from South Africa. Many settlers settled in Nakuru and Nyandarua
1919	The UK government launched the ex-soldier settlement scheme. This led to the largest allocation of land for European settlement in Kenya, and increased the white settled area by a third. Many ex-soldiers were settled in Nakuru and Nyandarua.
1920	The Shamba System of planting trees in forests was introduced in Kenya. Dundori Forest was one of the pioneer forests for the system in Kenya. It was seen as a tool for forest development and community empowerment. The system then mainly involved the clearing of indigenous forests and replacement with the fast-growing exotic plantation forests.
1920's	The political movement in Kenya gained heat especially due to forced labour, and the enlightenment of Kenyans, especially returnees from the first world war and those who had gained formal education
1930	The native forests ordinance was established. This led to the displacement of indigenous people from forests and confinement in forest native reserves. This restriction caused overexploitation of forest resources around the reserves. The people settled in the forest native reserves were involved in the establishment of the plantation forests under the shamba system. They would however remain in the forest even after the trees had matured since they had nowhere to go.
1932	Gazzettement of Dundori Forest as a forest protected area under proclamation No 44 of 1932. At this time Dundori Forest was under the DFO (District Forest Officer) Thomson falls division Nyahururu as a sub-station of Bahati forest

1941	Kinare Primary School opened for the people who settled in the forest native reserves and worked in the forest. It was called Munroe Primary School then.
1943	The establishment of plantation forests in Dundori Forest continued. A pine plantation was established at an elephant nursery site in the now compartment 8H. The indigenous forest was removed to establish the pine plantation.
1950's	The *MauMau* Movement gathered pace in Kenya as local people fought for independence. At this time the colonial government started moving people, especially young men, from Central Kenya to Dundori Forest native reserve to farm and plant trees in the forest. This was also meant to prevent them from joining the *MauMau* Movement. Some were settled at Kinare and Sodom forest native reserves. There were other reserves including *Kia Njiru, Kia Kieni,* and *Kia Njihia* among others. This increased the population in the reserves. Those who were brought to the forest reserves invited others leading to an increase in the number of people living in the settlements
1950	In 1950 the Dundori Market center was established in Dundori Forest.
1954	Declaration of a state of emergency in Kenya. This tightened restriction on access to the forests
1954	The Dundori Forest Station was established.
1957	Establishment of the Dundori Open-air market at a place then called Social Hall. A hospital and a police cell were also established.
1950's	The people settled in the forest native reserves achieved squatter rights. The government, therefore, excised forest land to settle the squatters which led to a loss of forest land.
1962	Granting of independence to Kenya from British Colonial rule. This led to many white settlers considering to move elsewhere since the conditions for independence were not favourable for their occupation.
1962	Initiation of the World Bank-funded postcolonial small-scale settlement scheme called the ''one million acre scheme''. Kenyans were given loans to buy settler's land under a willing buyer willing seller scheme. This enabled the settlement of people who had been displaced in the 1950s' struggles against British rule. Many people bought the land and settled in areas around Nyandarua and Nakuru. The settlement schemes continued into the 1980s'. Upon settlement, people would be given cattle and other things to help them settle. A loan to help them to settle was also given. The settled people had problems repaying the loans and some even sold land to repay.
1960's	As people moved and settled in the area, and also invited others to settle, the area's population increased People cleared the farmlands to settle and practice agriculture which lessened the tree cover.
1971	People started moving and settling in the Wanyororo and Kabatini areas. They were moving from the remnant white settlers farms that were still in the area and from other areas. These areas were by then not attractive for settlement due to the presence of water marshes that extended to a place called Free area near the shore of Lake Nakuru. This movement of people into the area continued leading to an increase in the human population. The increase in the population led to rehabilitation and degradation of the existing wetlands and degradation of rivers.
1970's	By this time the reduction in tree cover as people cleared the land to settle and cultivate was very noticeable. There was a noticeable change in the local climatic conditions. The population in the forest native reserves had highly grown which meant the increased capacity to establish plantation forests and thus clearing the natural forest. More reserves such as Bonde and Highland settlements were established then. The intensified replacement of the indigenous forest to establish exotic forest plantations had led to the depletion of natural forests.
1972	The destruction of indigenous forests became more rampant, not only for the establishment of the exotic forest plantations but also for charcoal burning. This was also driven by the rising population in the area, and of the surrounding urban places.
1980's	The frequency of droughts in the area increased, occasioned by climate change. A major drought and famine were experienced in the area in 1984, just as in other parts of Kenya.
1982	Excision of the established exotic forest plantations started. However, the excised areas would be replaced by the planting of new trees through the Shamba system then.

Mid 1980's	The clearing of indigenous natural forests intensified. This continued to the 1990s and saw the destruction of the natural forest including on hills, riparian areas, and sources of springs. This also seriously degraded the water resources and wildlife habitats.
1986	The forest settlements previously established as forest native reserves and where people had lived as squatters planting trees under the shamba system were abolished. Those who had bought land under the settlement schemes moved there. However, some had no land to move to and mainly went to settle around Dundori Market Centre.
1987	The government set aside 200 Hectares of Dundori Forest for the settlement of the people who had been evicted from the forest settlements. The trees in this land were excised to pave way for the people to settle.
1992	Elections held in the year led to post-election violence in the region. Many people who were evicted from their land moved to settle in the Dundori area. The population increased which led to land scarcity. This also exacerbated the degradation of the environment.
1994	The 200 Hectares set aside for settlement of the displaced people were subdivided. People were allocated the plots upon paying KES 2000 to KES 4000 to the then county council. This led to some of the rightful beneficiaries not getting the land but other people getting allocations.
1997	The evictees who did not benefit from the allocation of the land set aside for them peacefully demonstrate to the then Rift valley Province Commissioner. They were promised that action would be taken to address their grievances.
1997-2000	This time saw the intense excision of the exotic plantation forest but without replacement. There was no replacement mainly because the settled people who used to plant trees under the shamba system had been evicted from the forest.
2000	To address the wanton degradation of the forest. Local people started mobilizing to restore the forest. They mobilized into 52 groups. Each group gave KES 2800 to buy seeds for tree nursery establishment. The planted trees were planted in the forest. Such actions were also led by environmental NGOs.
2000	More land, that is 164 Hectares, was set aside in Dundori Forest to increase space for settlement of people. People paid money to the county council to get allocated land plots. However, this land was not degazetted.
2001	The established groups brought back the shamba system to Dundori Forest and start establishing plantations. However, they operate from their homesteads as they plant the trees.
2005	Enactment of the Forest Act of 2005 in Kenya. The Act provided for forest adjacent communities to play an integral role in forest conservation and management. It also provided for the formation of community forest associations (CFA's)
2006	The Dundori Forest CFA is formed. PELIS (Plantation Establishment and Livelihood Improvement Scheme) initiated following enactment of the Forest Act of 2015.
2007	Post-election violence occurred in Kenya again. People displaced in the region moved to the area increasing the local population and pressure on natural resources.
2008	Tree planting under Shamba System now called PELIS continued. High population pressure meant great demand for the forest farming plots. A trend set in for allocating farming plots without accompanying the allocation with tree planting. This led to the current situation where there are vast areas opened for farming but have no trees planted on them.
2009	The Dundori forest participatory management plan 2009-2014 was approved. The forest management plan also provided a zonation of the forest. The government signed a forest management agreement with the Dundori forest CFA.
2009	Establishment of local Water resource users associations (WRUA).
2011	The Mbaruk-Mereroni WRUA plants trees along the riparian of River Mbaruk. The conservation of the riparian areas is however hindered by the encroachment of riparian areas that was mainly caused by scarcity of land.
2015	Clear felling of plantation forest trees occurs in Dundori Forest
2018	The government banned the felling of trees in public and community forests This however increased the demand for trees planted on farmlands
2020's	The planting of trees in the forest under PELIS continued. This has however been negatively affected by the increased frequency of seasons without adequate rainfall and longer dry periods being experienced in the area.

	The review of the Dundori Forest management plant started
2022	Wezesha CBO and International Tree Foundation (ITF) starts planting trees in Dundori Forest

4.2. Historical resources matrix

The historical resources matrix was also done in a participatory manner to analyze the trend in the availability and status of the identified natural resources. The analysis also confirmed the dynamics of use and management of resources related to the historical periods indicated in the Historical profile. Participants rated the amount of a resource available at a particular period on a scale of one to ten over the period ranging from the 1950s to the 2020s. The participants said they desire a perfect state of all the resources in the future i.e. a rating of 10. The historical resources matrix of the study area is shown in Table 4.2.

Table 4. 2: Historical resources matrix of Dundori Forest and the adjacent community

HISTORICAL RESOURCES MATRIX OF DUNDORI FOREST AND THE ADJACENT COMMUNITY										
#	**RESOURCE**	**1950's**	**1960's**	**1970's**	**1980's**	**1990's**	**2000's**	**2010's**	**2020's**	**FUTURE**
1	Indigenous natural forest cover	10	9	7	4	3	1	2	2	10
2	Plantation exotic forest cover	4	5	9	8	4	5	6	7	10
3	Wetlands	10	9	8	6	4	2	1	1	10
4	Rivers and springs	10	9	8	7	5	3	2	1	10
5	Water	10	10	9	7	5	4	3	2	10
6	Wild vegetables	10	9	8	6	5	3	2	1	10
7	Wild fruits and nuts	10	9	8	5	4	2	1	1	10
8	Honey	10	9	8	6	5	3	3	2	10
9	Herbs	10	9	8	6	4	3	2	1	10
10	Fodder/pasture	10	10	8	6	5	4	3	2	10
11	Stones/quarry	9	8	7	6	5	4	3	3	10
12	Sand	9	8	8	8	8	8	8	8	10
13	Scenic sites (status)	10	10	9	7	5	4	3	3	10
14	Wild animals	10	9	8	6	4	3	2	1	10
15	Indigenous trees seeds	10	10	8	7	6	4	3	2	10
16	Soil (Status)	10	9	8	7	6	5	4	3	10

4.2.1. Indigenous natural forest cover

The indigenous natural forest was found to have been on a decline from the 1950s to the present (Table 2). The decline in indigenous trees from the 1950s to the 1970s was mainly attributed to clearance to pave way for the establishment of exotic tree plantations under the shamba system. The decline gathered pace in the 1960s when there is an increase in population in the area. The increase in the number of people settled in the forest reserves meant an increase in effort for establishing the exotic plantation forest under the Shamba system hence increasing the clearing of the indigenous natural forest. This gathers greater pace in the 1970s when there was rampant destruction of indigenous trees not only for the establishment of the shamba system but for other uses such as charcoal burning. The decreasing trend continues in the 1980s when the excision of indigenous forests started being done on previously preserved areas such as hills and riparian areas. This continues to the 1990s and the 2000s when indigenous trees in the forest continue being excised in the forest. However, conservation efforts in the forest may have caused a slight improvement in the indigenous vegetation from the 2010s to the present in the remnant areas. The natural forest is however still in a very poor state. It still mainly exists as narrow riverine forest strips along streams and as mainly regenerating vegetation on a few hills that closely resemble dense shrub lands.

4.2.2. Indigenous tree seeds

The decline in the indigenous natural forests also explains the negative trend in the availability of indigenous tree seeds in the forest. However, the seeds have not shown any recovery since the number and diversity of mature indigenous trees is still very low.

4.2.3. Exotic plantation forest cover

The exotic plantation forest increases from the 1950s to the 1970s when there is the establishment of plantations under the shamba system. In this period there is minimal felling of the planted trees. As the population in the forest reserves grows faster in the 1960s, there is an increased effort in the establishment of the plantations under the shamba system hence their steep increase towards the 1970s. However, in the 1980s the harvesting of the exotic forested plantations started leading to a decline. The decline increased in the 1980s when settlements in the forest reserved were abolished leading to the end of plantation establishment under the shamba system. In the 1980s there was also an increase in excision of the exotic plantation forests but without any planting going on, a trend that continued into the 1990s. However, in the 2000s the local community mobilized into groups and started planting trees in the forest which led to an increase. Around this time there was the initiation of the establishment of plantation forests in Dundori Forest under PELIS which also led to the increase. This increase continued into the 2010s and the 2020s.

4.2.4. Wetlands

The wetlands have been declining over time. In the 1950s and earlier the wetlands were in a good state. This could be because the catchment areas were still substantially healthy. The decline however occurs towards the present as the catchment areas are degraded especially with the clearing of the indigenous natural forests surrounding the wetlands. Thus the decline is seen to gather pace from the 1970s when excision of the indigenous natural forests increased. In the 1970s there was also an increased movement of people to the Kabatini and Wanyororo areas which previously were mainly occupied by wetlands. The increase in population in these areas meant an increased reclamation of the wetlands which added to their decline. This continued to the present whereby wetlands are almost completely depleted in areas outside the forest. The wetland areas in the forest are also highly degraded and are mainly occupied by *Cenchrus cladestinus* grass or invading shrub and tree species such as *Indigofera Spp*, and *Acacia Spp.*

4.2.5. Rivers and springs

The rivers and springs in the areas have also declined over time. This has been caused by the destruction of the catchment areas, especially through the excision of the indigenous natural forests. It was also occasioned by the increasing establishment of the plantation forests which led to a decline in the riverine forests and a reduction in areas occupied by the indigenous natural forests. As the population increased there was an increase in the abstraction of water from the rivers, which was mostly unregulated. The decline is steep in the 1980s, a period which saw an increase in excision of the indigenous natural forest including in previously restricted areas such as hills and riparian areas.

The degradation of the rivers and springs continued from the 2000s to the present, a period that also saw an increase in the clearing of the forest land for farming under PELIS. Unplanned allocation of the farming plots and increased demand due to population pressure hence increased demand has caused allocation in ecologically fragile areas such as riverine and hills. There has also been an increase in degradation of the rivers and streams in areas outside the forest over time

as people cultivated along riparian areas and the stream channels became degraded due to increased siltation of stream channels also caused by farming activities in the catchment areas.

4.2.6. Water for use

The decline in the availability of water over time is largely explained by the trends in the status of wetlands, rivers, and springs. The water resource has also become scarcer due to an increase in population hence greater demand in the backdrop of wanton degradation of the water resources.

4.2.7. Non-timber forest products

The NTFPs in the forest including medicinal herbs, honey, wild fruits, and nuts have also declined over time as the natural indigenous forest was degraded. In the early years, these products were highly available since the indigenous natural vegetation in the forest which not very degraded. However, as the natural forest is replaced by exotic plantation forests in the 1960s there is a decline in the availability of these resources. Their decline increases in the 1970s when there is excision of the natural forests and which starts occurring even in previously restricted areas in the 1980s. This decline continues to the present where these products are largely unavailable in the forest. The decline in the natural forest has meant the loss of bee habitats hence low honey production. An increase in the population under the backdrop of degradation of the natural vegetation also led to increased exploitation of resources such as wild fruits and nuts, herbs, and wild vegetation. This is in addition to the degradation of their natural habitats.

4.2.8. Pasture/fodder

Livestock pasture in the forest has also decreased in the forest over time. This was due to the continued replacement of previously natural vegetation which offered grazing areas with exotic forest plantations that lack undergrowth that mainly provides the pasture. The trend in pasture availability thus mainly aligns with the trends in the natural forest vegetation. Increased allocation of PELIS plots in the forest and thus croplands has also meant a decline in areas for grazing of livestock. The decline in the pasture in the forest is also explained by the increase in population pressure which meant increased demand and thus use. The resultant decline in land sizes coupled with a reduction of vegetation cover on farmlands also meant an increased decline of pasture on farmlands and hence increased reliance on forest pasture to feed livestock. This increased demand coupled with unregulated access and use has thus driven the decreasing trend in the availability of pasture. The decline could also be explained by the increased frequency of periods without adequate rainfall which also affects the growth of livestock pasture.

4.2.9. Stone quarries

The quarry stones in the forest were also observed to have declined over time. This was caused by increased demand for building materials as the area continued to develop. This was mainly driven by the increasing population and expansion of urban areas such as Nakuru Town, now a city, in the area. Quarrying activities in the forest used to take place in places such as Karandi Hill but were banned in the 1990s.

4.2.10. Sand deposits

Sand deposits in the forest have largely remained the same since they are mainly not used.

4.2.11. Soil

The soil conditions in the forest have also declined over time. This has largely been caused by poor farming practices in the forest which has caused soil degradation. Farming also means depletion of the organic matter and cover of the forest soils hence a decline in soil fertility. Overgrazing and

trampling by livestock also cause soil degradation in the forest. The excision of the natural forest in the steep areas and riparian areas also caused an increase in soil erosion. Farming on steep and riparian areas as demand for the forest farming plots increased coupled with unplanned allocations also increased soil degradation. Soil has also been degraded by the increased use of agrochemicals as crop pests and disease infestations have increased in the forest lands and the increased use of fertilizers to address the declining soil fertility. Soil conditions in the surrounding areas have also been on the decline due to low adoption of soil conservation practices, poor agricultural practices, and unsustainable use as land becomes scarcer and demand is driven by the rising population hence pressure on land resources.

4.2.12. Scenic sites

The scenic sites in the forest have declined over time. This was largely caused by the increasing degradation of the forest, especially indigenous natural forests which meant the degradation of the aesthetic value and hence the scenic sites. The increase in areas occupied by farmlands has led to the loss of the forest's natural appeal. The degradation of rivers and springs in the forest also caused the degradation of related scenic sites. An example is *Kirurumo Falls* along *Mariru Stream* whose water volume has depleted over the years degrading its appeal. The clearing of indigenous forests and farming on the hills and riverine areas also led to the decline in the forest's aesthetic values and hence scenic sites. Currently, the scenic sites are also degraded through unregulated use as shown by the dumping of waste observed in the forest e.g. the dumping of food wrappings at *Kirurumo Falls.*

4.2.13. Wildlife

Wild animal populations have plummeted over the years to the present situation where hardly any can be found. For example, only a few monkeys were observed along the *Mariru stream* during the field survey of the forest over six days. In the 1950s there was a high abundance of wild animals in the area. This is evidenced by stories of the existence of elephant nurseries in the forest meaning previous occupation by elephants. Places such as *Kia Ngari Hill* (Hill of the leopards) were associated with high leopard numbers which means their prey herbivore animals also previously thrived in the forest. The population declined over time with the destruction of their natural habitats, including the resultant decline in forage. Increased population pressure also meant increased exploitation of the wild animals, and increased disturbance as the human population in the forest rose.

4.3. Trend analysis

The trend analysis uses trend lines to capture changes in the community on various dimensions including environmental, social, economic, institutional, and demographic dimensions. It looks at what is getting better and what is getting worse including the expected or desired future scenario. This involved use of a scale of one to ten to score the status of the variable being analyzed. The expected future scenario/state for all the variables analyzed was scored as ten i.e. reinstatement or improvement to the perfect state. The trend analysis of the area is shown in Table 4.3.

Table 4. 3: Trend analysis of Dundori forest and the adjacent community

TREND ANALYSIS OF DUNDORI FOREST AND THE ADJACENT COMMUNITY										
#	TREND	1950's	1960's	1970's	1980's	1990's	2000's	2010's	2020's	FUTURE
1	Land availability	1	8	7	6	5	3	2	1	10
2	Income levels	2	4	5	6	6	7	6	4	10
3	Tree cover on farmlands	10	9	7	6	4	5	6	4	10

4	Community participation in forest management	1	2	4	4	4	8	6	5	10
5	Community participation in water resources management	1	2	3	3	3	4	5	2	10
6	Women empowerment	1	1	2	4	5	6	7	8	10
7	Youth empowerment	1	1	2	3	4	5	6	7	10
8	Conflicts over water resources	1	1	2	3	5	7	8	9	1
9	Conflicts over forest resources	1	1	2	2	5	7	8	9	1
10	Environmental awareness	1	2	3	4	6	7	8	8	10
11	Ecological status of water resources	10	9	8	6	4	3	2	1	10
12	Ecological status of forest resources	10	9	8	6	4	3	2	1	10
13	Conservation status on farmlands	10	9	8	6	5	3	2	2	10
14	Climatic conditions of the area	10	10	9	7	5	3	2	1	10
15	Tree seedlings production	2	3	4	5	7	8	9	9	10
16	Food crops production per capita	7	8	9	8	6	5	5	3	10
17	Livestock production per capita	5	6	8	7	6	5	5	4	10
18	Availability of timber materials	10	9	7	8	8	5	3	2	10
19	Availability of firewood	10	9	7	8	7	5	3	2	10
20	Availability of charcoal	10	9	8	8	7	6	4	2	10

4.3.1. Land availability

Land availability was shown to have been scarce in the 1950s. This is because the land was then held by the white settlers who had settled in the area. The local community then largely lived on forest native reserves or lived on settler's farms as workers. Land availability increased in the 1960s upon attainment of independence as the settlers left the country and local people were allocated land under the ''one million acre scheme''. However, as the population in the area increased land availability started declining over time. This continues to the present when there is acute land scarcity as the local population has grown mainly driven by natural growth, expansion of urban areas, and immigration. The continued dependence on agriculture as the main source of livelihood and the need for human settlement has meant increased demand for land in the backdrop of the growing population.

4.3.2. Income levels

Financial income levels were low in the 1950s since locals had few income earning streams and mainly didn't own land to practice agricultural production. The main source of income was cultivation in Dundori Forest under the Shamba system and working on the settlers farms. However, upon the allocation of land to Africans in the 1960s, incomes had an upward trend. Increased practice of agriculture, and improvement of the business environment meant a continued increase in incomes. Stagnation in growth is observed in the 1980s and 1990s which could be due to the poor state of the country's economy in those years. However, the income levels show a negative trend in the 2000s which is driven by factors such as the acute scarcity of land resources,

depletion of resources such as the plantation forests that also drove the local economy and climate change which had a negative impact on agricultural production due to increased frequency of droughts.

4.3.3. Women empowerment

Women empowerment was low in the 1950s and 1960s a situation that was mainly driven by the local culture and gender stereotypes that were discriminatory towards women. The government's policy was also largely silent on the issue of gender equality and there were few provisions for their empowerment. The improved access to education by women increased their empowerment over time. In the mid-1970s there was however an increased drive to integrate women into development processes in Kenya which led to a steeper increase in their empowerment in the 1980s. This was also brought about by increased exposure to the outside world and cultural erosion. Women empowerment initiatives brought about by landmark events such as the Beijing Conference on women of 1995 also played a key role in the increasing trend observed in women empowerment from the 1990s.

The promulgation of a new constitution in Kenya in 2010 that had great provisions for women's empowerment increased their empowerment. This includes affirmative action which requires consideration of gender balance in public appointments and leadership. Improvements in the policy environment also created an enabling environment for women's empowerment in the country. This includes the development of policies such as the national policy and gender and development of 2019. Initiatives meant to empower women such as the Women enterprise fund and the proliferation of CSO initiatives aimed at empowering women also drove the positive trend in women empowerment. The increased appointment of women leaders in government administration positions locally has also driven the positive trend in women empowerment. However, women's control of resources especially at the domestic level remains low despite their greater involvement in development processes.

4.3.4. Youth empowerment

Also, youth empowerment was low in the 1950s and 1960s since decision-making was largely a preserve of elders. However, as the traditional governance structures were eroded and gave way to the government led administration there was an increase in youth empowerment. This is because it provided an opportunity for the youth's participation in leadership and decision-making processes. Increased use of technology in development and governance processes also provided greater space for involvement and thus empowerment of the youth. This also provided them with greater access to information and thus empowerment. Government initiatives meant to empower the youth such as the youth empowerment fund drove greater empowerment of the youth from the 2000s to the present. Policies such as the National youth policy of 2007 and the Kenya youth development policy of 2019 have also played a role in the observed increase in youth empowerment.

4.3.5. Local climatic conditions

The status of the local climatic conditions has experienced a negative trend. The 1950s and the 1960s to have exhibited good climatic conditions, especially regarding suitability for agricultural production. The area experienced adequate rainfalls and climatic patterns were predictable. The

decline in climatic conditions began in the 1970s and is tied to the status and degradation of the local environment. The clearing of vegetation that occurred in the 1960s to 1970s and the beginning of the excision of natural forests in the 1970s is associated with the observed decline in climatic conditions then. The decline gathered pace in the 1980s and 1990s when there was an increase in excision of both the indigenous natural forest and exotic plantation forest. The high population pressure on the land and unsustainable land-use practices also meant there was a steep increase in environmental degradation being experienced in areas surrounding the forest. This trend continues to the present when the local climatic conditions are largely described as poor and deteriorating. The area is currently by erratic climatic patterns, increased frequency of rainfall seasons with inadequate rainfall, and longer dry periods. This is especially in the 2020s when all the rainy seasons have been marked by inadequate rainfall amounts.

4.3.6. Ecological status of the forest

There has been a negative trend in the ecological status of forests over time. The forest was in a good state in the 1950s since not much damage had been done. However, in the 1960s as the population increased with the settlement of people in the area the demand for forest resources increased. Forest in the newly settled farms was cleared for cultivation and the demand of forest resources in Dundori Forest started increasing. In the 1960s the population in the forest native reserves had risen thus increasing the demand for resources around the forest settlement areas. The increase in population in the forest settlement also increased the effort for clearing natural forests to establish exotic plantation forests.

In the 1970s there was excision of indigenous natural forests for other uses including charcoal production. This increased in the 1980s when the excision of natural forests occurred even in previously restricted areas such as the hills. In the 1980s excision of the planted exotic plantation forests occurred. The eviction of people settled in the forest settlements meant that excision started occurring without replacement.

Although the community started forming groups to engage in conservation activities in the forest in the 2000s, the high increase in population locally and land scarcity meant there was a high demand for forest resources. This created a high demand for forest farming plots when PELIS was introduced. PELIS plots were then allocated even in areas where no planting of trees was taking place, and farming plots were even established in ecologically sensitive areas such as steep areas, hills, and riparian areas. Poor agricultural practices and the high pressure on forest resources thus led to the continued degradation of the forest.

The planting of trees under PELIS also mainly involved the planting of exotic tree plantation forests with little restoration activities of natural forests. The degradation of the natural forests continued further contributing to the declining ecological state of the forest. This continued to the current status where the forest is mainly comprised of croplands marked with declining soil conditions and monoculture exotic tree plantations. Remnants of natural forests mainly exist as narrow bands of primary forest growth along streams in the forest or highly degraded regenerating natural forest vegetation on a few hills such as *Karandi* and *Kia Muthanga*.

4.3.7. Ecological status of water resources

There has also been a negative trend in the ecological status of water resources in the area. Although water resources were in a good state in the 1950s when there was a minimal ecological disturbance. An increase in population in the 1960s meant degradation within the watershed. This included the felling of trees to clear land for cultivation and opening of land which increased susceptibility to soil erosion. The increased effort of exotic tree plantations planting in the forest also meant an increased proliferation of trees such as Eucalyptus that contribute to drying up of water resources. The excision of natural forest in the catchment areas in Dundori forest in the 1970s meant damage in the water catchment areas which had a negative effect on water resources. Increased settlement in Wanyororo and Kabatini areas in the 1970s led to the drying up of wetlands that largely occupied the area as people rehabilitated the wetlands to allow for cultivation.

Continued excision of the natural forests on hills and riparian areas inside the forest in the 1980s and 1990s further drove the negative trend in the ecological status of the water resources as the catchment areas were destroyed. The increase in population and land scarcity also meant that people started cultivating including undertaking development activities on riparian areas due to lack of adequate space. This also led to increased demand on water resources leading to unsustainable use e.g. the excessive unregulated abstraction of water on the river inside the forest which interfered with their ecological structure and functions especially when it caused the streams to dry up.

The increased cultivation in the forest catchment area through PELIS has also led to increased soil degradation due to poor agricultural practices a situation that has led to excessive siltation of stream channels. The use of agrochemicals in the forest farm plots also means an increase in water resource pollution. Poor conservation activities and the declining tree cover on farmlands also lead to further depletion of the water resources. Currently, most of the springs and wetlands in the area have dried up. Streams have either dried up or dry before they reach the forest boundary. Any existing surface water flows are highly depleted intermittent flows.

4.3.8. Availability of timber materials

The availability of timber materials, firewood, and charcoal has had a negative trend over time. In the 1950s there was high availability given the high abundance of forest resources. This continued in the 1960s since the resources were also highly available on the farmlands. In the 1970s a reduction in trees on the farms led to a reduction in the availability of the products. This is because by then the excision in Dundori Forest was high enough to stabilize the supply. In the 1980s and 1990s excision of plantation forests stabilized the supply of the products leading to a slight increase in availability. However, this decreased in the late 1990s as the trees in the forest reduced yet the tree cover in the farmlands was low.

In the 2000s there was a steep decline of the products as supply from the forest declined following the wanton excision of the 1980s and 1990s. The tree cover on the farms was also low to stabilize the supply of the products. This trend continued in the 2010s especially in the latter part of the decade and the 2020s when the government banned the felling of trees in government and community forests. This continued to the present situation that is marked by low availability due to a lack of adequate sources from the forest and the farmlands.

4.3.9. Conflicts over water resources

There has been a positive trend in conflicts over water resources in the area. The conflicts over the use of water and forest resources were low in the 1950s and 1960s. There was a great abundance of water resources due to low degradation. However, following the increase in population observed in the 1960s and the resultant increase in demand, there is a positive trend in the incidence of conflicts over water resources since the 1970s. Expansion of the surrounding urban areas also drove up demand and abstraction leading to depletion of the resources. The degradation of natural forests that were observed in the 1970s and increased settlement in areas such as Wanyororo and Kabatini that were previously largely covered by wetlands also drove the positive trend in the water resources conflicts.

The continued degradation of catchment areas and riparian areas especially in Dundori forest where large swathes of forest land are now covered with croplands that extend to riverine and hilly areas has meant a continued positive trend in scarcity and hence conflicts over the resources. The trend could also be explained by the erosion of traditional governance mechanisms that were key in resource addressing issues related to resource sharing and conflicts resolution mechanism in the backdrop of nonviable regulatory and resolution alternatives.

4.3.10. Conflicts over forest resources

The forest resource use conflicts have also been increasing over time. This has also been mainly driven by the increase in population which has meant increased demand. There is thus increased competition among different users of the forest even as the resources dwindle. The spike in conflicts observed in the 1980s could have been due to the eviction of the community that had settled in forest native forest since the 1930s from the forest, yet many of them had no other land to go to, which could have led to conflicts between the evictees and the government. This is especially since they mainly settled and continued to depend directly on the forest to this day.

The increased excision of the forest in the 1980s and 1990s hiked depletion of the resource amidst the increasing demand hence increasing conflicts over use. Also, the increase in conflicts could have been driven by the increasing demand for forest farmlands as land scarcity and the population grew. This demand especially increased following the post-election violence of 2002 and 2007 as many of the displaced people came and settled in the area.

Furthermore, as the demand for farming land increased amidst the rising demand for other uses such as livestock grazing, conflicts increased e.g. between farmers and grazers of livestock. The increased dependency on the forest by the community and hence greater tendency to engage in unsustainable use also increase conflicts between the government management and regulatory agencies on one part and the local community.

4.3.11. Community participation in forest management

Community involvement in forest management in the 1950s was low since forests were controlled by the government. Locals were only involved in forest management through tree planting activities in the forest under the shamba system. Community involvement in forest management starts to grow in the 1960s upon Kenya's attainment of independence. However, the forest was still mainly managed by the government through the forest department. In the 2000s there was a steep increase in community involvement in forest management, especially upon enactment of the

Forest Act of 2005 which provided for participatory forest management and the formation of CFAs.

In 2002 the local community had also mobilized into 52 groups that were involved in planting trees in the forest. The shamba system was also brought back then as PELIS which allowed communities to again cultivate in the forest and establish exotic forest plantations. However, the provisions allowing participatory forest management have been stifled over the years to the current state whereby the community feels they are not adequately involved in forest management. This caused a decline in community involvement in forest management from the 2010s to the present.

4.2.12. Community participation in water resources management

Community involvement in water resources management was also low in the 1950s when the management of the resources was mainly done by the government and locals mainly didn't own the land. There was a slight increase in community involvement in the 1960s as local people started owning land. A steep increase in community involvement is seen in the 2000s when there was an improvement in participatory natural resources management in the country. An increase in 2010 was brought about by the enactment of the Water Act of 2016 which provided for the formation of WRUAs as institutions for community-based water resources management. However, the continued weakening of the WRUAs, low support, and poor implementation of provisions for community-based water resources management meant a decline in community involvement in the 2010s and the 2020s.

4.2.13. Conservation status of the farmlands

The conservation status of the farmlands has been on a negative trend. In the 1950s the farmlands were mainly owned by the settlers. Local people engaged in farming through the shamba system in the forest. A low population and occupation by the settlers meant there was enough land hence no pressure which could lead to unsustainable use. However, as people settled in the area in the 1960s, there was clearing on farmlands to allow for cultivation and settlement. Unsustainable land management practices at that point set the stage for the degradation of the farmlands especially as the local population grew either naturally or through immigration.

In the 1970s, more people moved into the local farmlands including in previously largely unoccupied areas such as Wanyororo that were considered unsuitable due to the existence of extensive marshlands. As the population increased under the backdrop of high dependence on agriculture, unsustainable land-use practices intensified including increased use of agricultural chemicals and fertilizers and cutting of trees on farmlands hence low tree cover. The ban of the shamba system in the 1980s and eviction of people from forest settlements meant increased demand on the local farmlands for cultivation despite the fact there was still low adoption of good agricultural practices. This has continued to the current status where local farmlands experience high population pressure and demand on resources, are marked by degradations and the adoption of conservation practices is still low.

4.2.14. Agricultural production per capita

Agricultural production per capita, including crop and livestock production, was lower in the 1950s as compared to the 1960s. This is because there was lower access to farming since the cultivation of the land by local people was restricted to forest farming plots under the shamba system. Local

people also lacked the resources to invest in agricultural production. Allocation of farming land in the 1960s, especially in the Nyandarua side of the forest, including provision with loan capital to initiate agricultural practices led to an increase in production. This positive trend continued into the 1970s as access to information and extension services and good markets also drove to increase in production.

In the 1980s changes in local climatic conditions were beginning to affect agricultural production e.g. the prolonged drought of 1984 which led to famine. The decline continued into the 1990s which was also caused by the declining economic situation in the country. The ban on the forest settlements and shamba system also meant reduced access to land for production as most of those who had been evicted didn't have alternative farmlands. Degradation in the farmlands was also causing a reduction in the productivity of the land. The increase in the local population especially in the 2000s also reduced the land that was available for cultivation.

Wanton environmental degradation in the area was also having a detrimental effect on the local climate e.g. the observed reduction in rainfall amounts. This negative trend has continued to the 2020s as land, including forest farming land becomes more degraded and hence more unproductive, there is an acute scarcity of land for agricultural production, and the area continues to experience an increased frequency of seasons without adequate rainfall and longer dry periods.

4.2.15. Environmental awareness

Environmental awareness has been increasing linearly over time. In the 1950s and the 1960s there was a lower understanding on the linkage between the forest and livelihoods. This is because a majority of the local people were newly settled in the area and hence hadn't related much with or gained a great understanding of the local environment. However, as people became more educated and gained greater access to information and knowledge through extension services, the media, and environmental conservation initiatives, environmental awareness increased over time. Environmental awareness could also have been driven by the negative impacts of degradation which increased people's efforts to understand the cause and also enhanced efforts to address environmental issues.

4.2.16. Tree seedlings production

Tree seedlings production was low in the 1950s and 1960s. By then seedlings were mainly produced for the ongoing plantation establishment within the forest. Trees in farmlands by then were natural growth forests and thus there was minimal planting through agroforestry. However, as the local environmental conditions declined and people became environmentally aware there was an observed increase in the establishment of tree nurseries. The tree planting campaigns that gained pace in the 1970s led to an increase in seedlings production. This was in an attempt to restore degraded areas in the wider region, especially in the Mau Forests and even as far as Mount Elgon Forest. Organizations like the Greenbelt Movement and the KFS have been instrumental in promoting tree seedlings production in the area.

An increase in environmental awareness could also have contributed to the increase in tree seedlings production. As forest landscape restoration campaigns gathered pace in the country leading to establishment of more tree planting projects, tree seedlings production increased in an attempt to leverage the related funding and hence the market. The trend has continued to date,

although currently tree seedlings production is being faced with various challenges including a lack of markets for tree seedlings among others. Also, it is important to note that most of the tree seedlings produced are sold for planting in other areas. Therefore, the high tree seedlings production doesn't reflect the level of tree planting in Dundori Forest.

4.4. Gender analysis of natural resources access and control

Gender analysis of the access and control of natural resources in Dundori Forest and the forest adjacent areas used a combination of methods including livelihoods systems diagrams, benefits analysis chart, and the management of resources matrix. This helped to understand the gender-based responsibilities in undertaking natural resources-oriented livelihood activities, and the access and control to the benefits. The analysis is shown in Table 4.4.

Table 4. 4: Gender analysis of natural resources management, access, and control in Dundori Forest and the adjacent community

GENDER ANALYSIS OF NATURAL RESOURCES MANAGEMENT, ACCESS AND CONTROL IN DUNDORI FOREST AND THE ADJACENT COMMUNITY											
#	NATURAL RESOURCE	RESPONSIBLE FOR COLLECTION AND PRODUCTION		WHO USES		WHO CONTROLS USE		IF SOLD		WHO CONTROLS MONEY IF SOLD	
		MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	YES	NO	MEN	WOMEN
1	Timber materials	M		M		M		Y		M	
2	Firewood		W		W	M	W	Y		M	W
3	Charcoal	M	W		W		W	Y		M	
4	Wild fruits and nuts	M	W	M	W				N		
5	Honey	M		M	W	M		Y		M	
6	Herbs	M	W	M	W	M		Y		M	
7	Wild vegetables		W	M	W		W	Y			W
8	Water		W	M	W	M	W	Y		M	W
9	Fodder/pasture	M	W	M	W	M	W	Y		M	W
10	Stones/quarry	M		M		M		Y		M	
11	Sand	M		M		M		Y		M	
12	Tree seeds	M	W	M	W	M	W	Y		M	W
13	Tree seedlings	M	W	M	W	M	W	Y		M	W
14	Soil	M	W	M	W	M		Y		M	
15	Trees	M	W	M	W	M		Y		M	
16	Scenic sites	M	W	M	W	M	W	Y		M	

The analysis identified sixteen natural resources that are currently sourced and used by people in the local community. Women were found to be responsible for the collection and production of 75% of the natural resources while men were responsible for the collection and production of 81% of the identified natural resources.

As appertains to use, men use 88% of the natural resources identified while women use 81% of the natural resources. Further, men were found to control the use of 81% of the identified natural resources while women control the use of 50% of the natural resources.

The analysis found that 94% of the natural resources identified are sold to earn money. Regarding the control of money earned from the sale of the natural resources, women were found to control money earned from 40% of the sold natural resources while men control money earned from 93% of the sold natural resources. This show that gender disparities exist in the control of natural resources in Dundori Forest and the adjacent areas.

4.5. Gender analysis of agricultural production access, and control

Gender analysis was done to gain an understanding of gender roles in agricultural production including access, and control of agricultural products. The analysis of crop production is shown in Table 4.5.

Table 4. 5: Gender analysis of crop production, access and control in Dundori Forest and the adjacent community

GENDER ANALYSIS OF CROP PRODUCTION ACCESS, AND CONTROL IN DUNDORI FOREST AND THE ADJACENT AREAS											
#	RESOURCE	RESPONSIBLE FOR PRODUCTION		WHO USES		WHO CONTROLS USE		IF SOLD		WHO CONTROLS MONEY IF SOLD	
		MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	YES	NO	MEN	WOMEN
1	Fruits	M	W	M	W	M	W	Y		M	W
2	Vegetables	M	W	M	W	M	W	Y		M	W
3	Maize	M	W	M	W	M		Y		M	
4	Irish potatoes	M	W	M	W	M	W	Y		M	
5	Beans	M	W	M	W		W	Y			W
6	Peas	M	W	M	W		W	Y			W
7	Wheat	M	W	M	W	M		Y		M	
8	Pyrethrum	M	W	M	W	M		Y		M	
9	Sweet potatoes	M	W	M	W		W	Y			W

Gender analysis of the access and control of crop production in Dundori Forest and the forest adjacent areas used a combination of methods including livelihood systems diagrams, benefits analysis chart, and the management of resources matrix. This helped to understand the gender-based responsibilities in undertaking crop production-oriented livelihood activities, and the access and control to the benefits.

The analysis identified nine crops that are mainly grown and used by people in the local community. Women were found to be responsible for the production of 100% of the crops while men were also responsible for the production of 100% of the identified crops.

As appertains to use, men use 100% of the crops identified while women use 100% of the crops. Further, men were found to control the use of 67% of the identified crops while women also control the use of 67% of the crops.

The analysis found that 100% of the crops identified are sold to earn money. Regarding the control of money earned from the sale of the crops, women were found to control money earned from 56% of the sold crops while men control money earned from 67% of the sold crops. Therefore, there is no great gender disparity in crop production in the area

Moreover, the gender analysis was done regarding livestock production as shown in Table 4.6.

Table 4. 6: Gender analysis of livestock production, access, and control in Dundori Forest and the adjacent community

GENDER ANALYSIS OF LIVESTOCK PRODUCTION ACCESS, AND CONTROL IN DUNDORI FOREST AND THE ADJACENT AREAS											
#	RESOURCE	RESPONSIBLE FOR PRODUCTION		WHO USES		WHO CONTROLS USE		IF SOLD		WHO CONTROLS MONEY IF SOLD	
		MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	YES	NO	MEN	WOMEN
1	Cattle	M	W	M	W	M		Y		M	
2	Sheep	M	W	M	W	M		Y		M	
3	Goats	M	W	M	W	M		Y		M	

4	Pigs	M	W	M	W	M		Y		M	
5	Donkeys	M	W	M	W	M	W	Y		M	
6	Fish	M	W	M	W	M	W	Y		M	W
7	Poultry	M	W	M	W		W	Y			W
8	Bees	M	W	M	W	M		Y		M	

Gender analysis was also done on access and control of livestock in Dundori Forest and the forest adjacent areas using a combination of methods including livelihood systems diagrams, benefits analysis chart, and the management of resources matrix. This helped to understand the gender-based responsibilities in undertaking livestock production-oriented livelihood activities, and the access and control to the benefits.

The analysis identified eight livestock animals that are mainly kept and used by people in the local community. Women were found to be responsible for the production of 100% of the livestock while men were also responsible for the production of 100% of the identified livestock.

As appertains to use, men use 100% of the livestock identified while women use 100% of the livestock. Further, men were found to control the use of 86% of the identified livestock while women also control the use of 38% of the livestock. The analysis found that 100% of the livestock identified are sold to earn money. Regarding the control of money earned from the sale of the livestock, women were found to control money earned from 25% of the sold livestock while men control money earned from 88% of the sold livestock. This shows that gender disparities exist in the control of livestock production in Dundori Forest and the adjacent areas

5. Results of the biodiversity survey

The biodiversity survey involved participatory resources mapping, satellite image analysis, and a field based vegetation survey of Dundori Forest.

5.1. Participatory forest resource mapping

The participatory resources mapping was done to map the forest resources in Dundori Forest. This involved the community members drawing a map of what the forest looked like in 1980 and then how it looks like currently. The participatory mapping shows that in 1980 the forest was mainly covered with trees. This is because there was little forest excision going on in the period. Trees were also quickly planted in areas cleared for farming under the shamba system.

Although there was the felling of natural forests in the past to allow for the establishment of exotic plantation forests and some destruction of the natural forest had occurred in the 1970s, natural forests remained, especially along the riparian areas and on the hills and steep areas. Therefore, the map shows the hills of *Karandi, Kia Muthanga, Kia Ngari*, and others having indigenous natural forests. In his time, the streams were flowing beyond the forest boundary and wetlands still existed. The forest settlements initially established as forest nature reserves were still in existence. People settled in these settlements were undertaking the planting of trees in the exotic forest plantations through the shamba system. At this time trees were quickly planted in any cleared areas.

However, in 2022 there is a great area that is covered with cropland and fewer areas covered with trees. This is caused by the allocation of areas for cultivation without clear plans for the immediate planting of trees. This has led to the situation whereby large swathes of land in the forest have existed as cropland for many years without any tree planting taking place. The natural forest only remains in small patches. These are however mainly marked by regenerating trees and tall trees from the old forest are rare. The forest in the riparian area also exist as narrow strips with most of the riverine natural forest having been excised.

The remnants of the natural forest on the hills mainly exist as low regenerating vegetation that has close semblance to thick shrub lands. Most of the hills are however bear with these remaining patches of the natural forest only existing in a few hills such as *Karandi Hill, Kia Muthanga Hill,* and *Kieni Hill*. The areas that were previously covered by natural forests are now covered with croplands, exotic plantation forests, or firebreaks that harbor grass. The wetlands have been degraded and now largely appear as grasslands after they dried up.

The settlements that existed in the forest were abolished in the mid-1980s. Therefore in 2022 the human settlements, previously forest native reserves, no longer exist inside the forest. However, institutions that had been established inside the forest remain there, for example, Kinare Primary School and Dundori Secondary School. Dundori Market which was established inside the forest still remains there. However, the population of the town has grown increasing the tendency to encroach on the forest. An example is 154 Hectares of land that wasn't officially degazetted but on which people are still settled to date. The participatory resources mapping of Dundori Forest is as shown in Figures 5.1.

5.2. Land cover analysis

The results of the land cover analysis largely align with the explained trends of Dundori Forest. The analysis showed a decline in the natural forest from 1979 to the present. However, there was a slight increase in the indigenous natural forest in 2011 which could be explained by the conservation activities that started in the year 2000, and which could have involved some natural forest restoration activities.

The plantation forests decrease from 1979 to 2000 but an increase is seen in 2011. This increase could also be largely explained by the planting of trees after the community-led tree planting activities initiated in the year 2000. The plantations are still largely intact in 2022 since there has been a ban on tree felling in public and community forests in Kenya. The grasslands don't show much change over time since they have always existed as patches within the forested areas, along firebreak areas, and around wetlands. The wetlands however show a linear decline over time. This could be largely driven by the degradation of natural forests, and also by the increased frequency of rainfall seasons without adequate rainfall in the latter years.

Croplands fluctuate based on the allocation of land for cultivation under the exotic forest plantation establishment programs and the expansion of the plantations. The areas covered by bare lands are also influenced by the farming activities occurring on forest farm plots when the satellite images were taken. Those taken during the ploughing period would show greater bareland areas. However, the observed increase in bareland in the year 2000 shows that the bareland extent could also be an indicator of the forest conservation status at a particular period.

The built-up areas have increased over time. Also, as the tree cover reduces on the encroached land, the built areas become more visible. The settlements previously established in the forest are visible in the years 1979, 1989, and 2000. This is especially 1989 and 2000 following the increased excision of the forest which increases visibility of previous settlements. From year 2000 there is increased settlement in Dundori market. This is because of population growth especially as most of the people who were evicted from the forest settlements continued to settle there even after the failed gazzettement of the extra land that was set aside for them in 2000. The observed increase in the built up area around the market could also be due to the building of the Nakuru-Dundori-Oljororok tarmac road in the early 2010s which led to an increase in development activities.

The classification maps of the land cover analysis are as shown in Figures 5.2 and 5.3. The land cover matrix is shown in Table 5.1.

Table 5. 1: Land cover matrix of Dundori Forest

Land cover matrix of Dundori Forest							
Period	**Natural Forest**	**Plantation Forest**	**Crop Land**	**Grassland**	**Bareland**	**Wetland**	**Built-up areas**
1979	1286.64	1366.67	496.09	174.29	372.08	37.72	41.47
1989	975.52	961.56	1143.41	157.32	448.59	29.47	72.13
2000	400.41	701.31	1469.88	166.86	763.64	18.68	187.27
2011	504.32	864.40	1450.39	183.12	583.79	12.26	139.49
2020	558.41	1202.40	1261.52	158.05	410.01	7.18	124.20
2022	598.09	1233.61	1218.04	166.91	349.93	6.66	144.81

Figure 5. 1: Participatory mapping of Dundori Forest resources in 1980 and 2022

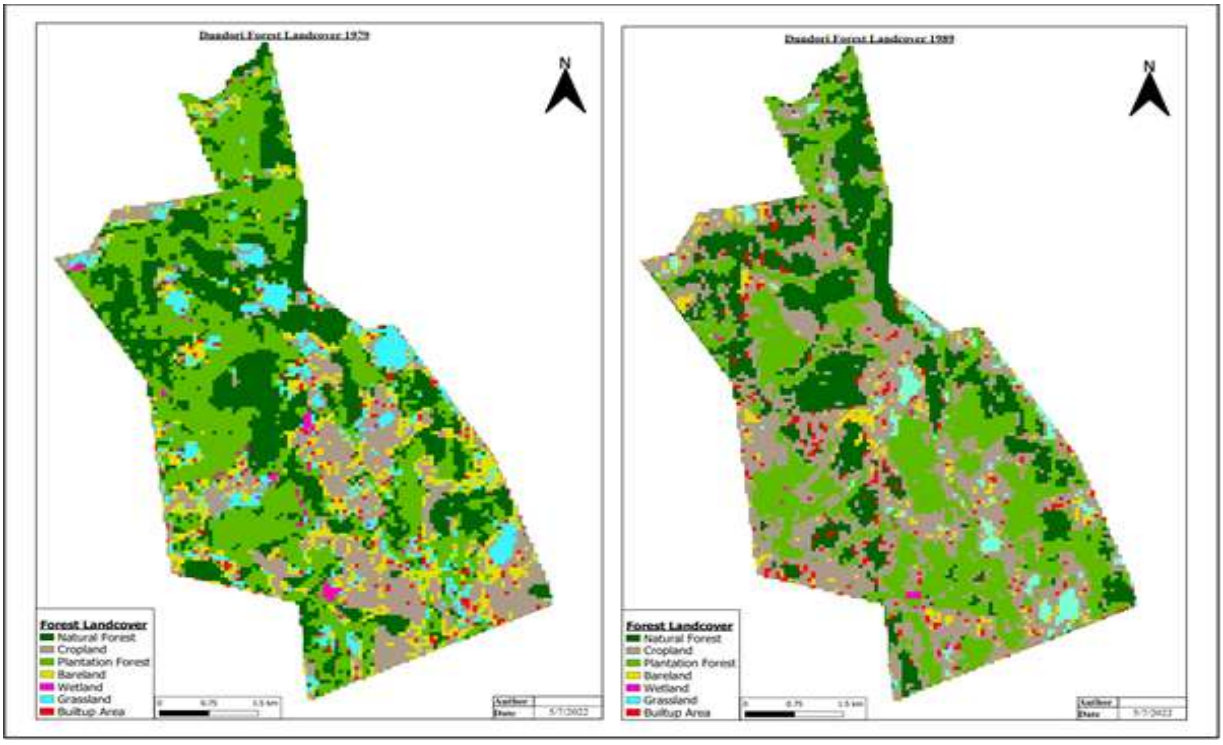

Figure 5. 2: Land cover maps of Dundori Forest for years 1979 and 1989

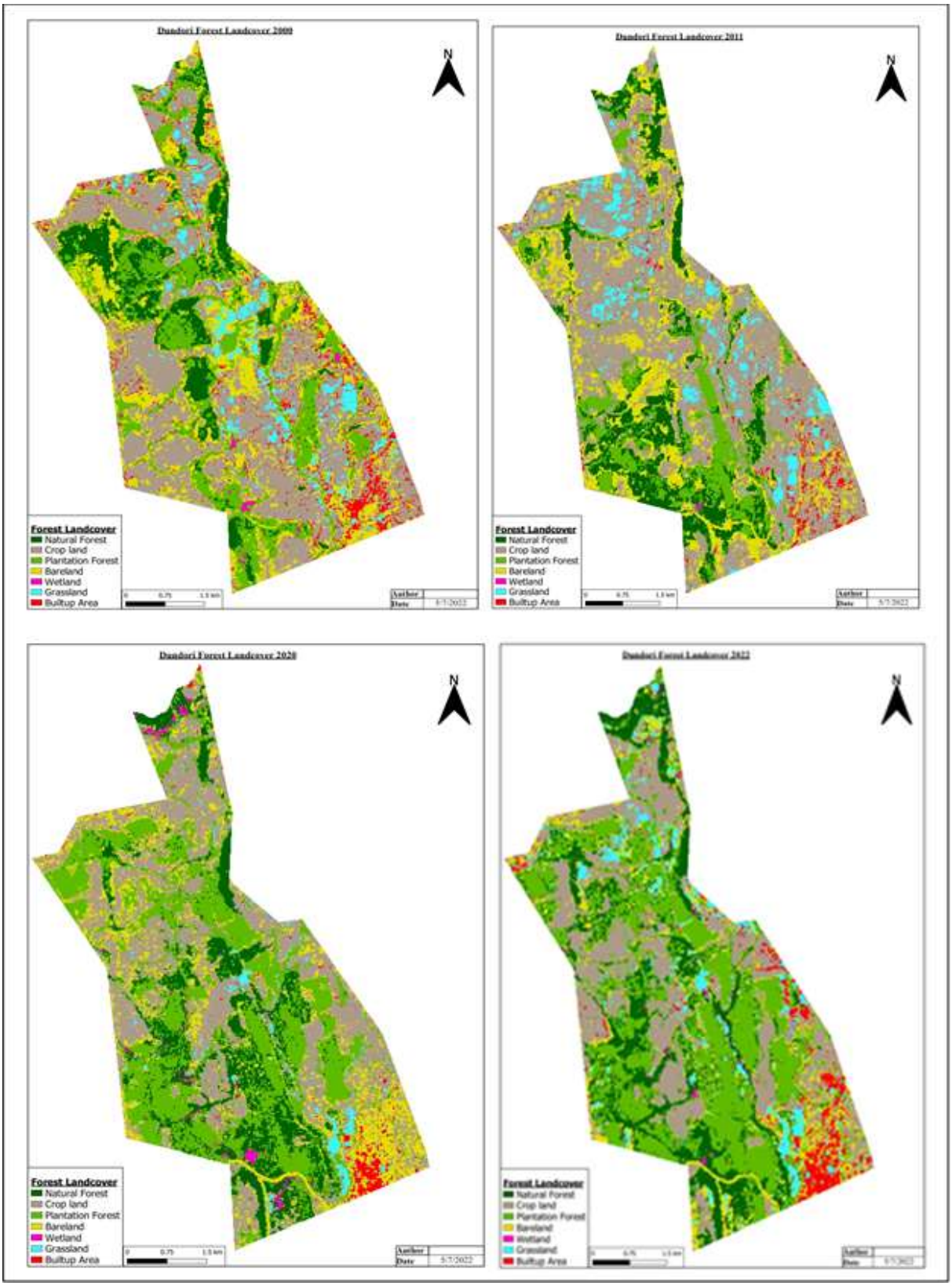

Figure 5. 3: Land cover maps of Dundori Forest for years 2000, 2011, 2020, and 2022

5.3. Vegetation survey

The vegetation survey was meant to identify and come up with a checklist of the plant species in Dundori Forest. Secondly, it was also supposed to identify the conservation status of the identified species. The survey mainly focused on areas that bear remnants of the natural forest that once covered the forest. These areas included the strips of riverine forests along the streams in the forest and hills that still harbor natural vegetation. The survey also identified herb species in croplands since they mainly thrive there as weeds.

The forest is marked by various vegetation types including monoculture exotic plantation forests, natural forests, grasslands, cropland vegetation, riverine forests, and wetlands. The forest is highly degraded and is mainly covered by the croplands and the monoculture exotic plantation forest. The exotic tree species planted in the forest include *Cupressus lusitanica, Pinus patula, Fraxinus pennsylvanica,* and *Eucalyptus Spp.* The exotic plantation forests are not vibrant and lack other forms of biodiversity. However, mosses were observed to be growing on the floor of the tall plantation forests. The croplands have a high diversity of herb species that exist as weeds.

The old natural forest has been almost been completely excised. Only a few patches remain especially in some hills and as strips of riverine forest along streams in the forest. The riverine are marked by higher dominance of *Dombeya torrida,* and also *Nuxia congesta* and *Allophylus abbyssinicus.* The remnants of the forests found in the hills mainly exist as regenerating short trees that closely resemble shrub lands although some tall trees from the old forest exist. The forest vegetation in the hills is highly diverse. Identification of the indigenous tree species thus mainly involved identifying the small regenerating trees including from shoots of old stumps. However, the number of species identified within the 5 days of the survey and the remaining old trees show the area must have previously harbored a vibrant natural forest that resembled the montane forests that are found in Aberdares forest. Also, it shows the forest must have been an important plant area.

During the study many old but now dry springs were observed. The forest also has many dry streams. The flowing streams are marked by intermittent flows. Some of these intermittently flowing streams dry up before they reach the forest boundary. Some of the flowing streams observed include *River Mbaruk*, *River Mai Mahiu*, *River Ngosur*, *River Mariru*, and *River Diwani*. The degradation of the rivers is mainly caused by the excision of the forests at the river sources, over-abstraction, and sedimentation due to soil degradation on croplands, and poor zonation that left a narrow space for the riverine forest vegetation. However, the forest is an important water catchment area that needs to be restored.

Most of the wetlands in the forest have been highly degraded and dried up. Most of the previous wetland areas are now mainly covered by grass species, especially *Cenchrus cladestinus.* They are also invaded by shrubs including *Indigofera Spp*, and tree species especially *Acacia Spp.* The remnant wetland vegetation only exists as a small patch and is mainly marked by the presence of *Cyperus Spp.* which is highly degraded due to overgrazing. The only wetland that exists as a water marsh is *Iria ria gwa Singh* although it is threatened given that Eucalyptus species have been planted on the slopes surrounding it. Its presence to date could, however, be due to the presence of an indigenous natural forest on its edges.

The forest is marked by the presence of many alien and invasive species. These include *Cestrum aurantiacum* which has invaded vast areas of the forest. The plantation forest species are also exotic non-native species. Many herbs growing in the croplands are also introduced alien species. Some of the tree species were found to be of special conservation status based on the IUCN Red List. These include *Afrocanthium keniense* (Vulnerable), *Casearia battiscombei* (Vulnerable), *Warburgia ugandensis* (Critically endangered), *Polyscias kikuyuensis* (Near threatened), *Prunus africana* (Vulnerable). However, conservation activities in the case of Dundori Forest should focus on the restoration of all the indigenous species since they have all been highly degraded and depleted.

Moreover, the observations made during the biodiversity survey clearly show that restoration activities in Dundori Forest should be enhanced. The restoration activities should particularly focus on the indigenous natural forest which form the main support system of the forests ecosystem. The zonation of the forest should be reviewed to widen the riparian areas and provide more spaces at all springs for the establishment of indigenous natural forests. Besides, there is to enhance the planting of trees on all hills and steep areas, including other parts of the forest with the aim of restoring its ecological integrity. There is also a need for continuous biodiversity surveys in the future during the wet and the dry seasons. Future biodiversity surveys should also involve ornithology, herpetology, and entomology studies to allow the survey of other species that could serve as indicators of the forests' ecological status.

The species identified in the forest are shown in Table 5.2.

Table 5. 2: Checklist of plant species identified in Dundori Forest

PLANT SPECIES IDENTIFIED IN DUNDORI FOREST DURING THE BIODIVERSITY SURVEY							
#	**FAMILY**	**GENUS**	**SPECIES**	**LIFE FORM**	**CONSERVATION STATUS**	**ENGLISH NAME**	**LOCAL NAME**
1	Musaceae	*Ensete*	*ventricosum*	Tuber	LC	Abyssinian banana	Ihindu
2	Aquifoliaceae	*Ilex*	*mitis*	Tree	LC	Cape holly	Munyamati
3	Araliaceae	*Cussonia*	*spicata*	Tree	NE	Spiked cabbage tree	Mwenyiere
4	Araliaceae	*Cussonia*	*holstii*	Tree	LC		Mwenyiere
5	Araliaceae	*Polyscias*	*kikuyuensis*	Tree	NT	Parasol tree	Mutati
6	Araliaceae	*Schefflera*	*volkensii*	Tree	NE	Schefflera	Muthai
7	Araucariaceae	*Araucaria*	*cunninghamii*	Tree	LC	Hoop pine	
8	Asparagaceae	*Dracaena*	*steudneri*	Tree	LC	Northern large-leaved dragon-tree	Muthare
9	Asteraceae	*Tarchonanthus*	*camphoratus*	Tree	LC	Camphor bush	Muririchwa
10	Bignoniaceae	*Markhamia*	*lutea*	Tree	LC	Nile tulip	Muu
11	Boraginaceae	*Cordia*	*africana*	Tree	LC	East African cordia	Muringa
12	Boraginaceae	*Cordia*	*monoica*	Tree	LC	Sandpaper saucer-berry	Mukuo
13	Campanulaceae	*Lobelia*	*giberroa*	Tree	NE	Giant lobelia	Manoria
14	Canellaceae	*Warburgia*	*ugandensis*	Tree	CR	Ugandan greenheart	Muthiga
15	Cannabaceae	*Celtis*	*africana*	Tree	LC	White stinkwood	Murundu
16	Cannabaceae	*Trema*	*orientalis*	Tree	LC	Charcoal-tree	Muhethu
17	Capparaceae	*Maerua*	*triphylla*	Tree	LC	Small bead bean	Mununga mai
18	Combretaceae	*Combretum*	*molle*	Tree	LC	Velvet bushwillow	Murama
19	Cornaceae	*Cornus*	*volkensii*	Tree	LC	African dogwood	Mucemeki
20	Cupressaceae	*Juniperus*	*procera*	Tree	LC	African pencil cedar	Mutarakwa
21	Cupressaceae	*Cupressus*	*lusitanica*	Tree	LC	Mexican cedar	muthithinda
22	Ebenaceae	*Euclea*	*divinorum*	Tree	LC	Diamond-leaved euclea	Mukinyai
23	Euphorbiaceae	*Croton*	*megalocarpus*	Tree	LC	Croton	Mukinduri

24	Euphorbiaceae	*Croton*	*macrostachyus*	Tree	LC	Broad leaved croton	Mutundu
25	Euphorbiaceae	*Ricinus*	*communis*	Tree	NE	Castor oil plant	Mwariki
26	Euphorbiaceae	*Euphorbia*	*candelabrum*	Tree	LC	Candelabra tree	Kithuri
27	Euphorbiaceae	*Croton*	*macrostachyus*	Tree	LC	Broad-leaved croton	Mutundu
28	Euphorbiaceae	*Synadenium*	*compactum*	Tree	LC	African milk bush	Waatha
29	Euphorbiaceae	*Macaranga*	*kilimandscharica*	Tree	NE	Macaranga	Mukuhakuha
30	Fabaceae	*Acacia*	*xanthophloea*	Tree	LC	Yellow back acacia	Murera
31	Fabaceae	*Erythrina*	*abyssinica*	Tree	LC	Abyssinian coral	Muhuti
32	Fabaceae	*Acacia*	*polycantha*	Tree	NE	Hook thorn	Mugaa
33	Fabaceae	*Acacia*	*nilotica*	Tree	LC		Mugaa
34	Fabaceae	*Acacia*	*lahal*	Tree	NE	Red thorn	Mugaa
35	Fabaceae	*Acacia*	*kirkii*	Tree	NE		Mugaa
36	Fabaceae	*Acacia*	*abyssinica*	Tree	NE		Mugaa
37	Fabaceae	*Acacia*	*melanoxylon*	Tree	NE	Australian blackwood	Kanunga
38	Fabaceae	*Dalbergia*	*lactea*	Tree	LC	Chencheni	Mwaritha
39	Fabaceae	*Albizia*	*gummifera*	Tree	LC	Peacock flower	Mukorwe
40	Fabaceae	*Acacia*	*gerrardii*	Tree	NE	Grey-haired acacia	Muthi
41	Hamamelidaceae	*Trichocladus*	*ellipticus*	Tree	LC	White witch-hazel	Mbarakira
42	Hypericaceae	*Harungana*	*madagascarensis*	Tree	LC	Dragon's blood tree	Munyamwe
43	Lauraceae	*Persea*	*americana*	Tree	LC	Avocado tree	Mukorobia
44	Loganiaceae	*Strychnos*	*henningsii*	Tree	LC	Coffee hard pear	Muteta
45	Malvaceae	*Dombeya*	*torrida*	Tree	LC	Forest dombeya	Mukeu
46	Malvaceae	*Dombeya*	*rotundofolius*	Tree	LC	Wild pear	Mukeu
47	Meliaceae	*Ekebergia*	*capensis*	Tree	LC	Ekerbergia	Mununga
48	Moraceae	*Ficus*	*sycomorus*	Tree	LC	Sycamore fig	Mukuyu
49	Moraceae	*Ficus*	*thonningii*	Tree	LC	Strangler fig	Mugumo
50	Myrtaceae	*Syzygium*	*guineense*	Tree	LC	Guinea waterberry	Mukoe
51	Myrtaceae	*Eucalyptus*	*saligna*	Tree	LC	Sydney blue gum	Mubau
52	Myrtaceae	*Eucalyptus*	*globulus*	Tree	LC	Southern blue gum	Mubau
53	Myrtaceae	*Eucalyptus*	*maculata*	Tree	LC		Mubau
54	Myrtaceae	*Syzygium*	*cordatum*	Tree	LC	Water berry	Muriru
55	Olacaceae	*Strombosia*	*Scheffleri*	Tree	LC	Strombosia	Munyenye
56	Oleaceae	*Olea*	*africana*	Tree	LC	African olive	Mutamaiyu
57	Oleaceae	*Fraxinus*	*Pennsylvanica*	Tree	LC	Mexican green ash	Munyokwe
58	Oleaceae	*Olea*	*capensis*	Tree	LC	Black ironwood	Mucarage
59	Oleaceae	*Schrebera*	*alata*	Tree	LC	Wild jasmine	Mutoma
60	Penaeaceae	*Olinia*	*rochetiana*	Tree	NE		Mwathathia
61	Peraceae	*Clutia*	*abyssinica*	Tree	LC	Large lightning-bush	Muthima mburi
62	Phyllanthaceae	*Margaritaria*	*discoidea*	Tree	LC	Pheasant-berry	Muharara
63	Phyllanthaceae	*Bischofia*	*javanica*	Tree	LC	Bishop wood	
64	Pinaceae	*Pinus*	*patula*	Tree	LC	Mexican weeping pine	Muchinda nugu
65	Pittosporaceae	*Pittosporum*	*viridiflorum*	Tree	LC	Cape cheesewood	Munyamati
66	Podocarpaceae	*Podocarpus*	*falcatus*	Tree	LC	Bastard yellowwod	Muthengera
67	Podocarpaceae	*Podocarpus*	*latifolius*	Tree	LC	Broad-leaved yellowwood	Muthengera
68	Primulaceae	*Rapanea*	*melanaphloeos*	Tree	LC	Cape beech	Mugaita
69	Proteaceae	*Protea*	*guguedi*	Tree	NE	African sugarbush	
70	Proteaceae	*Grevillea*	*robusta*	Tree	LC	Silky oak	Mubariti
71	Proteaceae	*Faurea*	*Saligna*	Tree	LC	Willow beechwood	Mutorothua
72	Putranjivaceae	*Drypetes*	*gerardii*	Tree	LC	Forest ironplum	Munyenye
73	Rhamnaceae	*Rhamnus*	*prinoides*	Tree	LC	Walking stick	Mukara kinga
74	Rhizophoraceae	*Cassipourea*	*malosana*	Tree	LC	Pillar wood	Muthaithi
75	Rosaceae	*Hagenia*	*abyssinica*	Tree	LC	East African rosewood	Muinyeri
76	Rosaceae	*Prunus*	*africana*	Tree	VU	African cherry	Muiri
77	Rubiaceae	*Vangueria*	*Madagascarensis*	Tree	LC	Spanish-tamarind	Mubiru
78	Rubiaceae	*Vangueria*	*apiculata*	Tree	LC	Tangle-flowered wild-medlar	Mubiru
79	Rubiaceae	*Afrocanthium*	*keniense*	Tree	VU	Afrocanthium	Mubiru wa thi
80	Rutaceae	*Teclea*	*nobiliis*	Tree	LC	Small fruited teclea	Munderendu

81	Rutaceae	*Teclea*	*grandifolia*	Tree	LC		Munderendu
82	Salicacae	*Oncoba*	*Spinosa*	Tree	LC	Snub-box tree	Muigaigua
83	Salicaceae	*Trimeria*	*grandifolia*	Tree	LC	Wild mulberry	Muhindanindi
84	Salicaceae	*Casearia*	*battiscombei*	Tree	VU	Forest sword-leaf Casearia	Muirongi
85	Sapindaceae	*Allophylus*	*abyssinicus*	Tree	LC	Forest velvet false-currant	Muchami
86	Sapindaceae	*Dodonaea*	*Viscosa*	Tree	LC	Hopbush	Murema muthwa
87	Sapotaceae	*Pouteria*	*adolfi-friedericii*	Tree	LC	Aningeria	Muna
88	Stilbaceae	*Nuxia*	*congesta*	Tree	LC	Brittle wood	Muchorue
89	Stilbaceae	*Nuxia*	*oppositifolia*	Tree	LC	River nuxia	Muchorue
90	Acanthaceae	*Justicia*	*Spp.*	Shrub			
91	Acanthaceae	*Acanthus*	*eminems*	Shrub		Bear's breeches	Mutemani
92	Anacardiaceae	*Rhus*	*natalensis*	Shrub	LC		Muthigio
93	Anacardiaceae	*Rhus*	*vulgaris*	Shrub	LC		Muthigio
94	Anacardiaceae	*Rhus*	*ruspolii*	Shrub	LC		Muthigio
95	Apocynaceae	*Pterolobium*	*stellatum*	Shrub	LC		Mutanda mbogo
96	Apocynaceae	*Gomphocarpus*	*physocarpus*	Shrub		Balloon cotton-bush	
97	Asteraceae	*Solanecio*	*mannii*	Shrub	LC		Muthakwa wa athi
98	Asteraceae	*Vernonia*	*auriculifera*	Shrub	LC		Mucatha
99	Asteraceae	*Tithonia*	*diversifolia*	Shrub		Mexican sunflower	Maruru
100	Asteraceae	*Artemisia*	*Spp.*	Shrub		Mugworts	Muhato
101	Asteraceae	*Microglossa*	*pyrifolia*	Shrub			Muteei
102	Asteraceae	*Vernonia*	*lasiopus*	Shrub		Common vernonia	Mwatha
103	Boraginaceae	*Heliotropium*	*shoabense*	Shrub	DD	Garden heliotrope	Mugwata Ng'ondu
105	Calastraceae	*Maytenus*	*heterophylla*	Shrub	LC	Spike thorn	Muthuthi
104	Calastraceae	*Maytenus*	*senegalensis*	Shrub		Spike thorn	Muthuthi
106	Compositae	*Vernonia*	*auriculifera*	Shrub	LC		Muthakwa
107	Euphorbiaceae	*Tragia*	*brevipes*	Shrub			Mucegeni
108	Euphorbiaceae	*Erythrococca*	*bongensis*	Shrub	LC		Muhare ngware
109	Fabaceae	*Indigofera*	*insculpta*	Shrub	LC		Mucugucugu
110	Fabaceae	*Indigofera*	*occidentalis*	Shrub	LC		Mucugucugu
111	Fabaceae	*Acacia*	*Brevispica*	Shrub		Wait-a-bit	Mwikunya
112	Fabaceae	*Crotalaria*	*goodiiformis*	Shrub		Flat-top acacia	Muchingiri
113	Fabaceae	*Cassia*	*didymobotrya*	Shrub		African senna	Mwinu
114	Fabaceae	*Crotaleria*	*Incana*	Shrub		Shakeshake	
115	Fabaceae	*Indogofera*	*sufftruticosa*	Shrub		Guatemalan indigo	
116	Fabaceae	*Indigofera*	*lupatana*	Shrub			Mugiti
117	Flacourtiaceae	*Dovyalis*	*abyssinica*	Shrub	LC	Abyssinian Gooseberry	Mukambura
118	Labiatae	*Ocimum*	*lamiifolium*	Shrub	LC		Mukuri
119	Labiatae	*Achyrospermum*	*carvalhi*	Shrub			Muki
120	Lamiacae	*Rotheca*	*myricoides*	Shrub	LC	Cats-whiskers	Munjuga iria
121	Lamiaceae	*Leonotis*	*neptiflora*	Shrub			Mucii
122	Lamiaceae	*Ocimum*	*americanum*	Shrub		Lime basil	Mutaa
123	Lamiaceae	*Ocimum*	*gratissimum*	Shrub		Clove basil	Makandu
124	Malavaceae	*Hibiscus*	*calliphyllus*	Shrub	LC	Lemon yellow rose mallow	
125	Malvaceae	*Dombeya*	*kirkii*	Shrub	LC		Mukeu
126	Malvaceae	*Hibiscus*	*diversifolius*	Shrub		Swamp hibiscus	Mugutha
127	Malvaceae	*Grewia*	*similis*	Shrub			Mutheregendi
128	Malvaceae	*Waltheria*	*Indica*	Shrub	LC	Sleepy morning	Eanjiru wa ngamba
129	Malvaceae	*Hibiscus*	*fuscus*	Shrub		Rosemallow	Mugere
130	Phytolaccaceae	*Phytolacca*	*dodecandra*	Shrub		Pokeweed	Muhoko
131	Piperaceae	*Piper*	*capense*	Shrub	LC	African long pepper	Muruiya
132	Polygonaceae	*Rumex*	*usambarensis*	Shrub		Red rumex	Mugagatio
133	Primulaceae	*Myrsine*	*africana*	Shrub	LC	African boxwood	Mugaita
134	Rhamnaceae	*Rhamnus*	*staddo*	Shrub	LC	Buckthorn rhamnus	Mubura
135	Rhamnaceae	*Scutia*	*myrtina*	Shrub	LC	Cat-thorn	Mulangari
136	Rosaceae	*Rubus*	*volkensii*	Shrub	LC		Mutare

137	Rosaceae	*Rubus*	*apetalus*	Shrub	LC		Mutare
138	Rosaceae	*Rubus*	*pinnatus*	Shrub	LC		Mutare
139	Rubiaceae	*Keetia*	*gueinzii*	Shrub		Climbing turkey-berry	Mugukuma
140	Rutaceae	*Clausena*	*anisata*	Shrub	LC	Horsewood	Mutathi
141	Rutaceae	*Zanthoxylum*	*usambarense*	Shrub			Muguchwa
142	Santalaceae	*Osyris*	*lanceolata*	Shrub	LC	East Africa sandalwood	Muthithi
143	Solanaceae	*Solanum*	*aculeastrum*	Shrub	LC	Goat bitter apple	Gitura
144	Solanaceae	*Cestrum*	*aurantiacum*	Shrub	LC	Yellow cestrum	
145	Solanaceae	*Withania*	*somnifera*	Shrub		Ashwagandha	Murumbae
146	Thymelaeaceae	*Gnidia*	*glauca*	Shrub	LC	Fish poison bush	Mucingiri
147	Verbenaceae	*Lantana*	*trifolia*	Shrub		Shrub Verbena	Mukenia
148	Apocynaceae	*Landolphia*	*buchananii*	Liana		Nandi rubber	Mugu
149	Apocynaceae	*Periploca*	*linearifolia*	Liana			Muhimba iguru
150	Asparagaceae	*Asparagus*	*falcatus*	Liana		Sicklethorn Asparagus	Murura
151	Celastraceae	*Hippocratea*	*africana*	Liana			Mugu wa nyakamwe
152	Connaraceae	*Rourea*	*thomsonii*	Liana	LC		Mataigu
153	Cucurbitaceae	*Zehneria*	*scabra*	Liana		Cape Zehneria	Rwegethia
154	Fabaceae	*Caesalpinia*	*decapetala*	Liana		Mysore thorn	Mubagi
155	Menispermaceae	*Stephania*	*abyssinica*	Liana			Muriira
156	Passifloraceae	*Passiflora*	*ligularis*	Liana		Sweet granadilla	Hondo
157	Rutaceae	*Toddalia*	*asiatica*	Liana			Mururue
158	Sapindaceae	*Cardiospermum*	*halicacabum*	Liana	LC	Balloon vine	Mukunyi
159	Vitaceae	*Cissus*	*petiolata*	Liana	NE		Munyenyenga
160	Vitaceae	*Rhoicissus*	*tridentata*	Liana	LC	Common forest grape	
161	Acanthacae	*Thunbergia*	*elata*	Herb		Black-eyed Susan	Kanyanya
162	Amaranthaceae	*Achyranthes*	*aspera*	Herb	LC	Devils horseweep	Mutegenye
163	Amaranthaceae	*Dysphania*	*schraderiana*	Herb		Scented goosefoot	
164	Amaranthaceae	*Amaranthus*	*cruentus*	Herb		Red amaranth	Terere
165	Amaranthaceae	*Amaranthus*	*Dubius*	Herb		Red spinach	Terere
166	Amaranthaceae	*Amaranthus*	*Spinosa*	Herb		Spiny amaranth	Terere
167	Amaranthaceae	*Amaranthus*	*graecizans*	Herb		Mediterranean amaranth	Terere
168	Amaranthaceae	*Amaranthus*	*Blitum*	Herb		Purple amaranth	Terere
169	Amaranthaceae	*Amaranthus*	*hybridus*	Herb		Green amaranth	Terere
170	Amaranthaceae	*Chenopodium*	*Album*	Herb		White goosefoot	
171	Amaranthaceae	*Chenopodium*	*Murale*	Herb		Nettle-leaved Goosefoot	
172	Amaranthaceae	*Cyathula*	*schimperana*	Herb			Gitegenya
173	Amaryllidaceae	*Crinum*	*macananii*	Herb		Poison bulb	Gitunguru kia ngoma
174	Apiaceae	*Angelica*	*sylivistris*	Herb		Wild angelica	
175	Asphodelaceae	*Aloe*	*Spp.*	Herb			Muthunju
176	Asphodelaceae	*Kniphofia*	*Spp*	Herb		Red hot poker plant	
177	Asteraceae	*Matricaria*	*discoidia*	Herb	LC	Pineappleweed	
178	Asteraceae	*Ageratum*	*conyzoides*	Herb	LC	billygoat-weed	
179	Asteraceae	*Anthemis*	*cotula*	Herb	LC	Stinking chamomile	
180	Asteraceae	*Gutenbergia*	*cordifolia*	Herb			Uruti
181	Asteraceae	*Aspilia*	*mossambicensis*	Herb		Wild sunflower	Muuti
182	Asteraceae	*Laggera*	*elatior*	Herb		Torch ginger	Murika
183	Asteraceae	*Senecio*	*madagascarensis*	Herb		Madagascar ragwort	
184	Asteraceae	*Cirsium*	*vulgare*	Herb		Spear thistle	
185	Asteraceae	*Tagetes*	*Minuta*	Herb		Mexican marigold	Mubangi
186	Asteraceae	*Bidens*	*Pilosa*	Herb		Black jack	Mucege
187	Asteraceae	*Conyza*	*canadensis*	Herb		Horseweed	Murunga anake
188	Asteraceae	*Galinsoga*	*parviflora*	Herb		Gallant soldier	Mung'ei
189	Asteraceae	*Sonchus*	*oleraceus*	Herb		Common sow thistle	Muthunga
190	Asteraceae	*Gerbera*	*viridifolia*	Herb		Blushing daisy	
191	Asteraceae	*Conyza*	*bonariensis*	Herb		Hairy fleabane	
192	Asteraceae	*Helichrysum*	*luteoaibum*	Herb		Jersey cudweed	
193	Astraceae	*Launaea*	*cornuta*	Herb	LC	Sow thistle	Muthunga
194	Astraceae	*Cineraria*	*deltoidea*	Herb		Common ragweed	
195	Basellaceae	*Basella*	*alba*	Herb		Malabar spinach	Nderema

196	Brassicaceae	*Capsella*	*Bursa-pastoris*	Herb	LC	Shepherd's Purse	
197	Brassicaceae	*Rorippa*	*slyvestris*	Herb		Creeping yellowcress	Muthwani
198	Brassicaceae	*Erucastrum*	*arabicum*	Herb		African dogmustard	Togotia
199	Brassicaceae	*Raphanus*	*raphanistrum*	Herb	LC	Jointed churlock	
200	Commelinaceae	*Commelina*	*benghalensis*	Herb	LC	Wandering Jew	Mukengeria
201	Compositae	*Conyza*	*pyriflora*	Herb	LC		Mutei
202	Convolvulaceae	*Ipome*	*purpurea*	Herb	LC	Common morning glory	
203	Convolvulaceae	*Cucuscuta*	*campestris*	Herb		Field dodder	Thina
204	Crassulaceae	*Kalanchoe*	*densiflora*	Herb			Muhuithia
205	Cucurbitaceae	*Cucumis*	*africanus*	Herb		Africa wild cucumber	
206	Cucurbitaceae	*Cucurbita*	*ficifolia*	Herb		Fig leaf gourd	Kahurura
207	Cucurbitaceae	*Cucumis*	*eculeatus*	Herb			Gakungui
208	Dennstaedtiaceae	*Pteridium*	*Spp.*	Herb	LC	Fern	Ruthiru
209	Euphorbiacee	*Neuboutonia*	*macrocalyx*	Herb			
210	Fabaceae	*Crotalaria*	*occidentalis*	Herb			Muchingiri
211	Fabaceae	*Mimosa*	*pudica*	Herb		Shameplant	Kagiriki
212	Lamiaceae	*Leonotis*	*molissima*	Herb	LC		Mucii
213	Lamiaceae	*Plectranthus*	*barbatus*	Herb			Maigoya
214	Lamiaceae	*Ajuga*	*remota*	Herb		Bugleweed	Wanjiru
215	Lamiaceae	*Mentha*	*pulegium*	Herb	LC	Pennyroyal	
216	Lamiaceae	*Leucas*	*mollis*	Herb		White-felt leucas	Mucii mweru
217	Malvaceae	*Sida*	*alba*	Herb		Jelly leaf	Muhinga
218	Malvaceae	*Malva*	*parviflora*	Herb	NE	Cheese weed	
219	Malvaceae	*Triumfetta*	*tomentosa*	Herb	LC	Burbark	Mugio
220	Malvaceae	*Malva*	*verticillata*	Herb		Chinese mallow	Muiganjo
221	Orchidoideae	*Spiranthes*	*mauritiana*	Herb		Lady's tresses	Gathara ita
222	Oxalidaceae	*Oxalis*	*latifolia*	Herb		Garden pink-sorrel	Ndabibi
223	Polygonaceae	*Oxygonum*	*sinuatum*	Herb		Double thorn	Cong'e
224	Polygonaceae	*Fallopia*	*convolvulus*	Herb		Black bindweed	
225	Portulacaceae	*Portulaca*	*oleracea*	Herb	LC	Pursley	
226	Rubiaceae	*Galium*	*aparine*	Herb	LC	Cleavers	
227	Rubiaceae	*Pentas*	*longiflora*	Herb			Muhuha
228	Rubiaceae	*Galium*	*spurium*	Herb		Stickwilly	Gakaraku
229	Solanaceae	*Solanum*	*incanum*	Herb	LC	Sodom apple	Mutongu
230	Solanaceae	*Datura*	*stramonium*	Herb		Jimsonweed	Mugurukia
231	Solanaceae	*Physalis*	*peruviana*	Herb		Peruvian ground cherry	Munathi
232	Solanaceae	*Solanum*	*nigrum*	Herb		Black nightshade	Managu
233	Solanaceae	*Physalis*	*angulata*	Herb	LC	Cutleaf groundcherry	
234	Urticaceae	*Urtica*	*massaica*	Herb	LC	Stinging nettle	Thabai
235	Verbenaceae	*Verbena*	*officianalis*	Herb		Common verbena	
236	Cyperaceae	*Cyperus*	*articulatus*	Sedge		Jointed flat sedge	Muthanje
237	Cyperaceae	*Cyperus*	*rotundas*	Sedge		Nut grass	
238	Poaceae	*Digitaria*	*africana*	Grass		East African Couch grass	
239	Poaceae	*Setaria*	*pumila*	Grass		Yellow foxtail	
240	Poaceae	*Urochloa*	*decumbens*	Grass		Signal grass	
241	Poaceae	*Eleusine*	*multiflora*	Grass	LC	Fat spike-yard grass	
242	Poaceae	*Bromus*	*pectinatus*	Grass			
243	Poaceae	*Eleusine*	*indica*	Grass	LC	False star grass	
244	Poeaceae	*Arundinaria*	*alpina*	Grass		Mountain bamboo	Murangi
245	Poeceae	*Cenchrus*	*cladestinus*	Grass	LC	Kikuyu grass	Witima

NB: For conservation status:
NE – Not Evaluated
DD – Data Deficient
LC – Least Concern
NT – Near Threatened
VU – Vulnerable
EN – Endangered
CR – Critically Endangered

6.0. Map of the Wezesha CBO and ITF tree planting site

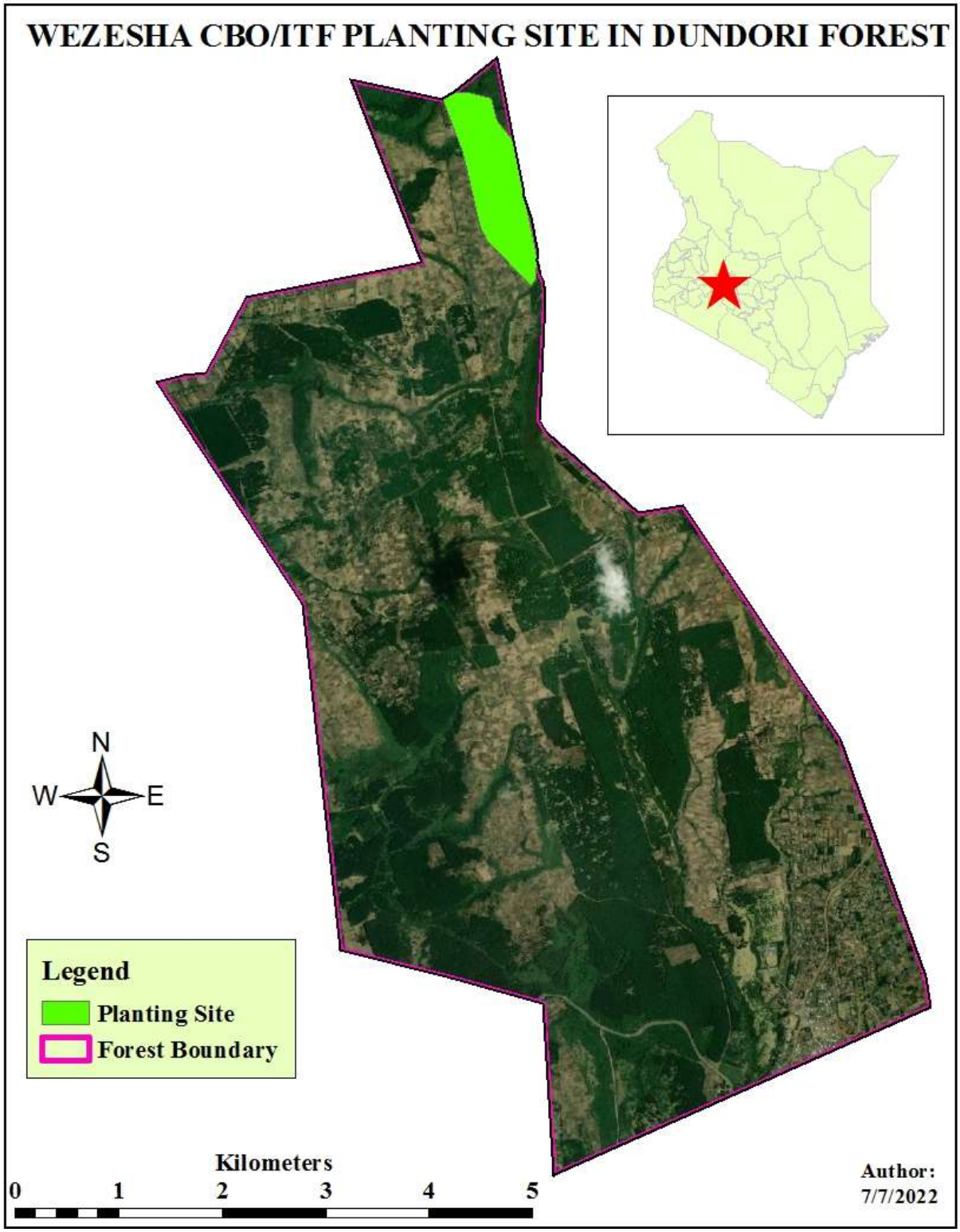

Figure 5. 4: Wezesha CBO/ITF tree planting site in Dundori Forest