

Assessing Regeneration Status of Indigenous Woody Species in Kata Forest, Horro Guduru Wollega Zone, Horro District, Doyo Beriso Kebele

Worku Ajema^{1, *}, Ebisa Likasa^{2, *}

¹Department of Soil Resource and Watershed Management, Oda Bultum University, Chiro, Ethiopia

²Department of Natural Resource Management, Wollega University, Shambu, Ethiopia

Email address:

workuajema@gmail.com (W. Ajema)

*Corresponding author

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Abstract: Natural forest is retaining due to the regeneration of seed bank and stump shoot and sprout. A study was conducted in Keta forest Horro Guduru Wollega Zone, western Ethiopia to assess the diversity, regeneration status of indigenous woody species. The natural regeneration of plant species in natural forest stand of Keta forest was studied by systematic sampling design since as Nov. 2019 E.C. Sample plots having 400m² area were taken from the forest. Result indicates that, there was 32 regenerating plant species investigated from the surveyed forest. The abundantly regenerating species is *Calputiana quera* (1722 seedling/hectare) followed by *Carissa edulis* (91102 seedling/hectare). Similarly, from their important value index (IVI) value, the over dominant species in terms of regenerating is found to be *Calputiana quera* (IVI 41.72). There was high species diversity seedling in the areas found apart from the municipality than the closer sites. Similarly, there is high species richness in the site apart from the town than closer to town which describes there is a highly significant difference between site categories. The woody species distribution of the two categories is almost fairly distributed. There is a significant difference between areas closer to the town and apart from the diversity indexes; species richness, and density. Contrarily, species distribution within the surveyed site is evenly distributed.

Keywords: Indigenous Tree, Natural Regeneration, Density, Distribution, Frequency

1. Introduction

Ethiopian forest has been cleared for a long period, for agricultural expansion, for exploitation of timber, charcoal, firewood, Urban and industrial expansion. This leads to extreme degradation of natural forests to a very small proportion [1, 2].

Degradation of the forest resource has been contributing to the intensification of the forest problems such as desertification and drought, land degradation, and flooding. This was consequently bad to a decline in Agriculture productivity and food security [3].

Forest regeneration is the act of renewing tree cover by establishing young trees naturally or artificially, generally promptly after the previous stand or forest has been removed

[4]. Forest regeneration includes practices such as changes in tree plant density through human-assisted natural regeneration, enrichment planting, reduced grazing of forested savannas, and changes in tree provenances genetics or tree species [5]. "Human assisted natural regeneration" means the establishment of a forest age class from natural seeding or sprouting after harvesting through selection cutting, shelter or seed trees harvest, soil preparation, or restricting the size of a clear cut stand to secure natural regeneration from surrounding trees [6, 7].

There are two possible methods of forest stand establishment namely natural and artificial regeneration [8]. Natural regeneration can be an effective means of regeneration of the forest when conditions are right (i.e. when Agro-ecological conditions, environmental and socio-

economic conditions are put in a good manner [9]. Although natural regeneration is usually reliable and ensures that only the tree suited to the sites (i.e. the species already on the site) are established, the time delays in achieving regeneration can be long [10].

The new ecological movements to word nature-oriented, nature-based, or semi-natural culture and forestry have brought increased interest in the natural regeneration of managed forest and the creation of various silviculture systems aiming at creating conducive environmental conditions of natural regeneration in Ethiopia [11].

Sustainable forest management can only be achieved if forest-dependent communities are involved in decision-making on how to manage the forest in their locality. In the study area in the past, the regeneration status of forest species does not identified and assessed, even if attention has been given to the forest in the case of its conservation, and management both from government and community concerning sustainable management to enhance the level of regeneration through area closure.

Due to such measurement, maintenance and protection of this forest have a significant contribution in a different dimension like ecological balance, protection of soil erosion, and biodiversity conservation. This study is designed and proposes to assess the natural regeneration and or the potential of naturally regenerated forest in Doyo Beriso Kebele, Horro district.

1.1. Statement of the Problem

Different factors hinder the regeneration status of forest sites. From this agricultural expansion, illegal cutting, animal interference, and gully formation for soil erosion are among the major constraint. As we have seen even though. The site was under area closure, some farmers who hold the land around the site would be expanding their farmland toward the enclosed areas. Then, this result of encroachment of the forest was destructed and trampled by human interference and animals respectively. These could prolong the period of regeneration of the forest site. In addition, these gullies which are formed in the interior part of the area also contribute a great role in affecting or delaying the regeneration status of the forest. The specified area was exposed to gully distribution of species variety. Furthermore, this previous absence of research activities on the identification of species regeneration status also has an impact on determining the process of the site now a day.

For the above constraints some measurement action should be taken into account:-

1. Creating awareness concerning the economical, ecological, and social benefits of the forest for the surrounding community.
2. Either physical or biological gully rehabilitation measures should be carried out.
3. This research seeks to access the progress of forest regeneration in general. But further research should be conducted in the Kata forest site in particular.

1.2. Objective

1.2.1. General Objective

The overall aim of the study is to assess the natural regeneration status of indigenous woody species in Kata forests.

1.2.2. Specific Objective

1. To assess the structure of regenerating vegetation.
2. To identify woody species regenerating from the Kata forest.

1.3. Significance of the Study

As far as natural forest regeneration of Doyo Beriso peasant association is considered and visualize interference drawn from this study would enable the researcher who is interested to carry out their research on this issue and policymakers to bring meaning full conclusion and recommendation about assessment of forest regeneration. The major significance of the study will be used as a source of information for further research as a document to the need or used for those who are required such information and it would be used as planning tools for development initiators. Hence, the significance of the study will be used for sustainable development of Kata forest regeneration in Doyo Beriso peasant association, Horro District is real.

1.4. Limitation of the Study

Despite the wide peasant association “Kebele” being found in Horro district with the abundance of naturally regenerated forest, this study will be confined or limited to the assessment of kata forest regeneration in Doyo Beriso peasant association of Horro district. As a result, the formation provided from the area forest regeneration forest in other parts of the district. For this reason, there is a probability of gap creation in knowledge and information regarding the various site of the district as far as the forest regeneration assessment is carried out. In addition to this, the time is given for carrying out the study also has no sufficient description and detailed provision of information in the selected site. Lack of allocated budget is also one of the major constraints to take parts in the study as much as possible. The non-availability of data recorded and information were also the main constraints. So, within the absence of the above-mentioned problem or challenges, the study may not be easy to carry out.

2. Methodology

2.1. Description of the Study Area

The study was conducted at Doyo Bariso Kebele which is located at a distance of 336 km from Addis Ababa, within the Oromia National state in 2019. It's located at the latitude of 10° 58' 57"N North and longitude of 29° 78' 00" East at an altitude about 2250m above sea level. The rainfall is bimodal with a long-term average annual rainfall of 1050mm, about

85% of which from June to September and the rest from January to May, and average minimum and maximum air temperatures of 19°C and 22°C, respectively. The soil of the

area was characterized by loam type in texture and grey loam in color. The slope of the area was found to be moderate slope to moderate flat.

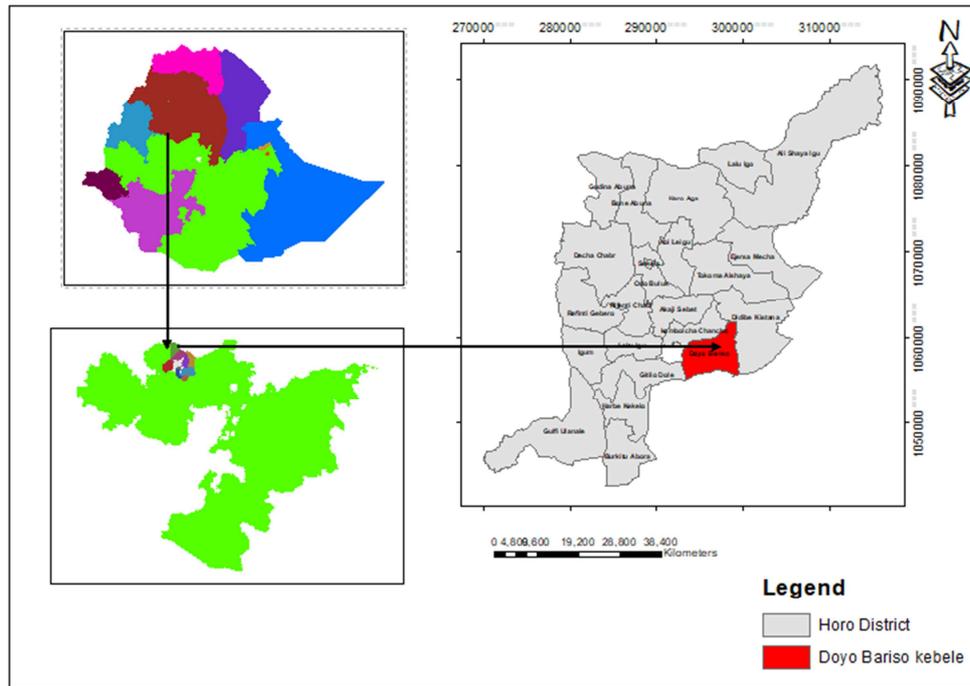


Figure 1. Map of Ethiopia showing location of the study area.

The specific name for the forest in kebele is Kata forest which is found in Horro district in Horro Guduru Wollega Zone. The boundary of the Kata was at the west shambu town, at the North Jimma Geneti Woreda, at the East farmland of the Doyo Beriso peasant association, and the south farmland followed by Shambu Hospital. The forest covers areas of 28.8 hectares with indigenous and non-endogenous forests.

These conditions permit suitable for crops like teff, wheat, corn, bean, pea, etc, and also the major tree dominated to the area was *Acacia* species, *Podocarpus calculus*, *Albizia gumifera*, *Culpuriana aurea* species, etc, and major dominated shrubs such as *Carissa edullis*, *Mytenus arbutifolia* and like type forests are distributed in the area.

2.2. Data Collection Method

Transect line walk step

During this step, fixing a place where the sample plot was taken within 100m intervals over the transect true. Based on this method, the information needed was gathered from a 20m * 20m sample plot. This step aimed to get an overview of the forest and its structure and composition (Heterogeneity of homogeneity) and other relevant information.

2.3. Field Data Collection Stage

A systematic sampling method was used to collect data for this study. This becomes a systematic sampling scheme that is more efficient in the natural or non-homogeneous forest provide population estimate that has a smaller standard error, and yield separate estimate for each sample plot having different species by

counting the type of special determining age class and identification of species by name and as well as an overall estimate for the whole population. At this point with five transect line, twenty (20) sample plot was taken according to their interval and 150m interval in between transect. A plot of 20m*20m a sample area and shape mostly used in different afro mountain forests of Ethiopia. In each sample plot type, age and number of the individual were determined with an average diameter of seedling >2.5cm of weedy plants has collected the aspects like distance and sample plot area was fixed by tape meter.

2.4. Data Analysis and Interpretation

2.4.1. Structure Analysis

The structural analysis of the forest has been done species having a height between 0.3 to 1.3 m termed as a seedling, 1.3-3m termed as a sapling and >3m classify as shrubs. The frequency and density of shrubs, saplings, and seedlings in the forest were calculated using the following methods.

IVI (Important Value Index).

The important value Index was calculated using:

$$IVI = \text{the sum of Relative density} + \text{Relative dominance} + \text{Relative frequency}$$

$$\text{Relative density} = \frac{\text{density of individual species}}{\text{total species}}$$

$$\text{Relative dominance} = \frac{\text{dominance of individual spp}}{\text{total dominance of all species}}$$

$$\text{Relative frequency} = \frac{\text{frequency of Individual species}}{\text{total frequency of all species}}$$

2.4.2. Similarity Analysis

Jaccard coefficient was used to determine the similarity of woody species in Shambu town wards and Shambu town outwards of Kata forest.

Using formula

$$Ccs = \frac{c}{[(S1+S2)-c]}$$

Where

S1 = number of species in "1" category;

S2 = number of species in the "2" category;

C = number of species common for community one and two.

2.4.3. Diversity and Evenness Analysis

Diversity

Using Shannon's weaver diversity index techniques the woody species diversity and evenness of Shambu town wards with Shambu outwards was assessed.

Diversity was calculated as

$$H' = - [\sum(pi \ln pi)]$$

Where

Pi = proportion of individuals during inventory;

The product of $pi \ln pi$ for each species in the site was summed up and multiplied by a negative sign (-) to obtain a positive result.

$J' = \frac{H'}{\ln S}$, where S is the total number of species.

The above formula was used for determining the evenness

of two compartments of Kata forests.

To analyze the diversity, Evenness, density and species richness mean separation was carried out using ANOVA Lukey test and LSD from SPSS version 20 at 95% confidence interval [12].

3. Result and Discussion

The structure of the natural forest regeneration was explained based on density and relative density, dominance and Relative dominance, frequency, and relative frequency, and Shannon's diversity and Jaccards coefficient.

3.1. Density, Abundance, and Frequency of Forest

The study was indicated that an important value index (IVI) is obtained by ending the result of relative density, relative frequency, and relative dominance of each species. Which are assumed from relative density, relative frequency, and relative dominance which constitute IVI result in the highly dominated species: *Calputiana qurea*, *Carris edulis*, *croton macrostchys*, and *Rubus Steuduri* (table 1).

Those species dominantly exist in the site from all species that exist in the study area. Hence, the IVI of *Calputiana qurea* (41.72), *Carris edulis* (27.03), *Croton macrostachyus* (23.60), and *Rubus Steuderi* (18.03), and also the abundance of those species are viewed dominantly among all species that exist in the study area (appendix Table 2).

Table 1. Structural analysis of the forest.

No	Species name	Relative density (%)	Relative frequency (%)	Relative dominance (%)	IVI
1	<i>Vernonia uriculifera</i>	3.55	5.93	4.64	14.12
2	<i>Brucea antdy seniferica</i>	3.24	5.93	3.57	12.74
3	<i>Hypericum revulutum</i>	1.67	3.39	0.92	5.98
4	<i>Calputiana gurea</i>	16.94	8.47	16.31	41.72
5	<i>Acacia abyssinia</i>	1.98	2.12	2.04	6.14
6	<i>Crofon macrostchys</i>	6.90	7.20	9.50	23.60
7	<i>Rubus steudneri</i>	7.67	5.08	5.28	18.03
8	<i>Bersema abyistuica</i>	5.33	6.35	6.24	17.92
9	<i>LN. Dodota</i>	0.29	0.42	0.85	1.56
10	<i>Carisse edulis</i>	10.84	6.35	10.44	27.63
11	<i>Myrinne Africana</i>	3.24	4.24	3.12	10.60
12	<i>Pittos porum species</i>	5.94	4.24	4.90	13.30
13	<i>Albizia pumifera</i>	4.33	5.08	5.06	14.47
14	<i>Duranta erecta</i>	4.62	5.50	5.40	15.52
15	<i>Clausena anisata</i>	1.47	2.96	0.81	5.24
16	<i>Afro corpus falctus</i>	3.59	5.50	4.20	13.29
17	<i>Dodonea viscose</i>	6.12	3.39	5.89	15.40
18	<i>Buddesia polystechya</i>	0.42	1.69	0.37	2.48
19	<i>Allophylus macrobotrys</i>	2.37	2.52	2.45	6.94
20	<i>Draceana ellaubedna</i>	4.52	3.81	4.05	12.38
21	<i>Capparis micrautha</i>	0.65	0.85	0.22	1.72
22	<i>Sypypium puineense</i>	0.13	0.42	0.12	0.67
23	<i>Cossipoulea species</i>	1.22	2.12	1.17	4.51
24	<i>LN. Afarfatu</i>	0.58	0.85	0.60	2.03
25	<i>Moesa lanceolata</i>	0.52	0.85	0.50	1.87
26	<i>LN. Chalalaka</i>	0.29	0.85	0.18	1.32
27	<i>Ekeberpia capeusis</i>	0.39	1.27	0.51	2.17
28	<i>Olea Africana</i>	0.68	1.69	0.46	2.83
29	<i>LN. Hanku</i>	0.45	0.85	0.16	1.46
30	<i>Teclea nobilis</i>	0.02	0.42	0.01	0.45

3.2. Woody Species Diversity and Density Across the Site

The result of the study indicates that the species identified in the study area is assumed to be a total of 32 woody species. There was higher species richness (31) apart from the town than 22 in the area closer to town. There is a significant difference between site categories in terms of species richness (Table 2). Shannon's diversity index shows that there is a significant difference between land categories for woody species diversity (Table 2). Accordingly, the site considered to be apart from town has higher diversity than the one closer to town. This figure indicates that the site closing to town exposed to intensified human interference; following this damage, the regeneration of emerging seedlings decreases. The Highness of the seedling diversity in the area apart from the town is not surprising since human and human-related factors always negatively affect the regeneration potential of the plant. In a line with this, the regeneration potential of woody species in the area where humans are intact is very minimal is supposed to be higher. Therefore, different activities threaten the closer area to the city by grazing livestock, stone mining, construction wood, fuel wood, etc. The density of the site considered to be apart from the town has a higher density than the one closer to town [13]. The mean difference is significant between site

categories in terms of woody species density (Table 2).

The assessed study assumed that the density figure shows that as the site is nearer to town the intensity of human interference raise. In the line with this, emerging seedling damage increases as well. The highness of seedling density in the area far from the town is not surprising since anthropogenic and human-related factors always adversely affect the regeneration. In a line with this, the regeneration of woody species-area where humans intact very minimal is by far preferential [14].

The species evenness index indicated that there is an even distribution in both site categories (table 2). That means, there is a fair distribution between the site closer to the town and apart from the town. Since the forest is the natural forest in nature, the natural forest is heterogeneous, areas indicate has species richness due to conducive physical and edaphic factors of the study area.

The Jaccards coefficient (J') depicts that the similarity of woody species between the sites of closer town via apart from the town was almost similar [15]. The reason is that the species under the category of closer to town area almost all included under the site far apart from the area. i.e. the species recorded as common species for both categories almost all found under the category of woody species closer to town site category.

Table 2. Woody Species diversity and density across the site.

Site Category	Species richness (s)		Shannon's diversity index (H')		Species evenness (J')		Density	
	Mean \bar{x}	St. deviation (σ)	Mean \bar{x}	St. deviation (σ)	Mean \bar{x}	St. deviation (σ)	Mean \bar{x}	St. deviation (σ)
Near town	9.5	± 3.85	1.94	± 0.45	0.89	± 0.11	567	± 369.22
Apart town	15.7	± 2.71	2.38	± 32	0.87	0.12	1466	± 312.52
F	17.42		6.34		0.14		34.59	
P	0.001		0.021		0.713		0.000	

Means were computed at 0.05 level of significance vertically down wards

4. Conclusion

Natural forest regeneration through natural conditions is very important to the germination of forest seed banks that have critical environmental and economic value. Area closure action carried out on the deforested area to promote natural regeneration to afforest the area with native plant species is low cost but much needed to further regenerate.

From the study, the regeneration status of forests apart from the municipality town has significantly different from the site closer to town. There is high woody species density apart from the town than closer to the municipality town. Similarly, there is high species richness in the site apart from the town than closer to town which describes there is a highly significant difference between site categories. The woody species distribution of the two categories is almost fairly distributed.

The site was dominated by woody species like *Calputiana qurea*, *Carissa edulis*, *Croton macrostachyus*, and *Rubus steudneri* when they are considered from the value of IVI in

decreasing orders.

5. Recommendations

1. Assisted plantation with desirable plant species is needed on both sides of the boundary to avoid illegal encroachment (expansion of agricultural land) by some farmers who have the land nearby natural forest.
2. Legal actions which protect charcoal making should be taken in the forest area. These actions cause a fire hazard to the natural forest.
3. Government and concerned stakeholders should be creating other alternative means of income generation to the local community to reduce forest dependency livelihood.
4. Soil and water conservation should be done to stabilize gully in the forest.
5. Further research should be conducted to identify the management aspect of forests and for restoration forests.
6. Area closure with reforestation action silviculture measures should be applied.

7. Control inappropriate uses of resources such as illegal mining of stone in the forest.

Conflict of Interest

All the authors do not have any possible conflicts of interest.

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Appendix

Table A1. Type and number of plant species at seedling stage.

Transect and plot	Local name	Scientific name	Family	Abundance of seedling
				Count/plot
T1P1	Ceka	<i>Calputiana qurea</i>		14
	Lolchisa	<i>Bersama abyssinica</i>		3
	Qomonyo	<i>Brucea antiaysenterica</i>		10
	Reejii	<i>Vernonia uriculifera</i>		8
	Birbirs	<i>Afrocrapus falctus</i>		15
	Uleefoonii	<i>Hypericum revoletum</i>		4
	Ceeka	<i>Calputiana qurea</i>		97
	Agamsa	<i>Carisse edulis</i>	Bursaceae	46
	Muka Arba	<i>Albizia gumifera</i>		6
	Itacha	<i>Dodenea viscosa</i>		64
	Anfare	<i>Buddleja polystachya</i>		17
T1P2	Lafto	<i>Acacia abyssinica</i>	Fabaceae	4
	Bakkanisa	<i>Croton macrostachyus</i>		9
	Reejii	<i>Vernonia uriculifera</i>		6
	Qadida	<i>Allophyllus macrobotrys</i>		17
	Kombolcha	<i>Duranta erecta</i>		33
	Soollee	<i>Pittosporum species</i>		42
	Ulee foonii	<i>Hypericum revoletum</i>		8
	Bite	<i>Dracaena ellaubedna</i>		27
	Arangama	<i>Capparis micrantha</i>		24
	Ulumaaye	<i>Clausena anisata</i>		11
	T1P3	Ceka	<i>Calputrana qurea</i>	
Agamsa		<i>Carries edulis</i>		49
Muka Arba		<i>Albizia gumifera</i>		18
Itacha		<i>Dodenea viscosa</i>		65
Reji		<i>Vernonia uriculifera</i>		15
Bakanisa		<i>Croton macrostachyus</i>		47
Sole		<i>Pittosporum species</i>		84
Birbirs		<i>Afrocrapus falctus</i>		18
Lolchisa		<i>Bersama abyssinica</i>		61
Gora		<i>Rubus steudneri</i>		48
Qomanyo		<i>Brucea antidysenterica</i>		19
T1P4	Qacama	<i>Myrine Africana</i>		41
	Bite	<i>Dracaena ellaubedna</i>		57
	Kombolcha	<i>Duranta erecta</i>	Varbenaceae	12
	Qadida	<i>Allophyllus macrobotrys</i>		29
	Ceka	<i>Calputiana qurea</i>		116
	Birbirs	<i>Afrocrapus falactus</i>		16
	Lafto	<i>Acacia abyssinica</i>		44
	Ulefone	<i>Hypericum revoletum</i>		10
	Sole	<i>Pottosporum species</i>		66
	Muka Arba	<i>Albizia gumifera</i>		11
	Hadhesa	<i>Teclea nobilis</i>		2
T1P4	Bite	<i>Dracaena ellaubedna</i>		21
	Kombolcha	<i>Duranta erecta</i>		31
	Gatama	<i>Olea capensis</i>	Olea ceae	-
	Lolchisa	<i>Bersama abyssinica</i>		26
	Qomanyo	<i>Brucea antidysenterica</i>		33

Transect and plot	Local name	Scientific name	Family	Abundance of seedling Count/plot	
T2P1	Itacha	<i>Dodonea viscosa</i>		94	
	Agamsa	<i>Carisse edulis</i>		84	
	Qadida	<i>Allophyllus macrobotrys</i>		18	
	Ulumaye	<i>Clausena anisata</i>		40	
	Gora	<i>Rubus steudneri</i>		65	
	Arangama	<i>Capparis micrantha</i>		32	
	Reeji	<i>Vernonia uriculifera</i>		16	
	Anfare	<i>Buddleja palystachya</i>		17	
	Bakanisa	<i>Croton macrostachyus</i>		46	
	Reji	<i>Vernonia uriculifera</i>		25	
	Qomanyo	<i>Brucea antidysenterica</i>		19	
	Ulefoni	<i>Hypericum revoletum</i>		12	
	Ceka	<i>Calputiana qurea</i>		12	
	Lafto	<i>Acacia abyssinica</i>		1	
	Bakanisa	<i>Croton macrostachyus</i>		8	
	Bakanisa	<i>Croton macrostachyus</i>		16	
	T2P2	Ceka	<i>Calputiana qurea</i>		45
Ulefoni		<i>Hypericum revoletum</i>		4	
Qomanyo		<i>Brucea antidysenterica</i>		15	
Gora		<i>Rubus steudneri</i>		32	
Lolchisa		<i>Bersama abyssinica</i>		4	
Dodota		-		16	
Agamsa		<i>Carisse edulis</i>		46	
Qachama		<i>Myrine Africana</i>		5	
Ceka		<i>Calputiana qurea</i>		127	
Sole		<i>Pottos porum species</i>		51	
Bakanisa		<i>Croton macrostachyus</i>		58	
Agamsa		<i>Carisse edulis</i>		77	
Lafto		<i>Acacia abyssinica</i>		5	
Muka Arba		<i>Albizia gumifera</i>		24	
Reji		<i>Vernonia uriculifera</i>		19	
T2P3		Qomanyo	<i>Brucea antidysenterica</i>		4
		Dodota	-		8
	Qachama	<i>Myrine Africana</i>		17	
	Kombolcha	<i>Duranta erecta</i>		44	
	Lolchisa	<i>Bersama abyssinica</i>		13	
	Ulumaye	<i>Clausena anisata</i>		14	
	Birbirs	<i>Afrocrapus falctus</i>		6	
	Lolchisa	<i>Bersama abyssinica</i>		40	
	Ceka	<i>Calputiana qurea</i>		71	
	Agamsa	<i>Carisse edulis</i>		21	
	Reji	<i>Vernonia uriculifera</i>		56	
	Ulefoni	<i>Hypericum revoletum</i>		28	
	Gora	<i>Rubus steudneri</i>		25	
	Bakanisa	<i>Croton macrostachyus</i>		15	
	Birbirs	<i>Afrocrapus falctus</i>		13	
	Qomanyo	<i>Brucea antidysenterica</i>		14	
	T3P1	Birbirs	<i>Afrocrapus falctus</i>		14
Muka Arba		<i>Albizia gumifera</i>		19	
Sole		<i>Pottos porum species</i>		21	
Gagama		<i>Olea capensis</i>		-	
Agamsa		<i>Carisse edulis</i>		31	
Itacha		<i>Dodonea viscosa</i>		56	
Kombolcha		<i>Duranta erecta</i>		19	
Qachama		<i>Myrine Africana</i>		31	
Lolchisa		<i>Bersama abyssinica</i>		49	
Bite		<i>Dracaena ellaubedna</i>		40	
Lafto		<i>Acacia abyssinica</i>		19	
Ejersa		<i>Olea Africana</i>		10	
Wato		<i>Teclea nobilis</i>		10	
Ceka		<i>Calputiana qurea</i>		88	
Gora		<i>Rubus steudneri</i>		61	
Reji		<i>Vernonia uriculifera</i>		10	
T3P3		Bakanisa	<i>Croton macrostachyus</i>		44
	Birbirs	<i>Afrocrapus falctus</i>		45	
	Muka Arba	<i>Albizia gumifera</i>		44	

Transect and plot	Local name	Scientific name	Family	Abundance of seedling Count/plot
T3P4	Lafto	<i>Acacia abyssinica</i>		36
	Lolchisa	<i>Bersama abyssinica</i>		48
	Qadida	<i>Allophyllus macrobotrys</i>		15
	Reji	<i>Vernonia uriculifera</i>		14
	Ulumaye	<i>Clausena anisata</i>		16
	Sole	<i>Pottos porum species</i>		19
	Qachama	<i>Myrine Africana</i>		14
	Ejersa	<i>Olea Africana</i>		24
	Bite	<i>Dracaena ellaubedna</i>		44
	Ceka	<i>Calputiana qurea</i>		4
	Itacha	<i>Dodonea viscosa</i>		48
	Gora	<i>Rubus steudneri</i>		144
	Gora	<i>Rubus steudneri</i>		41
	Muka Arba	<i>Albizia gumifera</i>		28
	Ceka	<i>Calputiana qurea</i>		124
	Agamsa	<i>Carisse edulis</i>		41
	Wato	<i>Teclea nobilis</i>		12
	Bakanisa	<i>Croton macrostachyus</i>		41
	Qadida	<i>Allophyllus macrobotrys</i>		100
	Bite	<i>Dracaena ellaubedna</i>		41
	Birbisa	<i>Afrocrapus falctus</i>		46
	Kombolcha	<i>Duranta erecta</i>		28
	Ejersa	<i>Olea Africana</i>		10
	Lafto	<i>Acacia abyssinica</i>		18
	Somboo	<i>Ekeberjia Capensis</i>		4
	Afarfaatu	<i>LN. Afarfatu</i>		11
	Abayyi	<i>Maesa Lanceolata</i>		15
	Calalaqaa	<i>LN. Calalaka</i>		5
	Ulee foonii	<i>Hypericum revoletum</i>		10
	Ceka	<i>Calputiana qurea</i>		45
	Bakanisa	<i>Croton macrostachyus</i>		21
	Agamsa	<i>Carisse edulis</i>		20
Bite	<i>Dracaena ellaubedna</i>		18	
Lolchisa	<i>Bersama abyssinica</i>		28	
Qachama	<i>Myrine Africana</i>		29	
Qomanyo	<i>Brucea antidysenterica</i>		41	
Ceka	<i>Calputiana qurea</i>		49	
Bakanisa	<i>Croton macrostachyus</i>		14	
Agamsa	<i>Carisse edulis</i>		23	
Gora	<i>Rubus steudneri</i>		41	
Qomanyo	<i>Brucea antidysenterica</i>		18	
Birbisa	<i>Afrocrapus falctus</i>		15	
Kombolcha	<i>Duranta erecta</i>		21	
Baddesa	<i>Syzygium guineense</i>		11	
Bite	<i>Dracaena ellaubedna</i>		41	
Reji	<i>Vernonia uriculifera</i>		11	
Wato	<i>Teclea nobilis</i>		11	
Itacha	<i>Dodonea viscosa</i>		57	
Sole	<i>Pottos porum species</i>		22	
Muka Arba	<i>Albizia gumifera</i>		18	
Ceka	<i>Calputiana qurea</i>		53	
Bakanisa	<i>Croton macrostachyus</i>		48	
Bite	<i>Dracaena ellaubedna</i>		41	
Agamsa	<i>Carisse edulis</i>		33	
Kombolcha	<i>Duranta erecta</i>		18	
Wato	<i>Teclea nobilis</i>		10	
Reji	<i>Vernonia uriculifera</i>		38	
Gora	<i>Rubus steudneri</i>		48	
Itacha	<i>Dodonea viscosa</i>		55	
Sole	<i>Pottos porum species</i>		31	
Muka Arba	<i>Albizia gumifera</i>		19	
Gagama	<i>Olea capensis</i>		11	
Lolchisa	<i>Bersama abyssinica</i>		41	
Birbisa	<i>Afrocrapus falctus</i>		13	
Muka Arba	<i>Albizia gumifera</i>		29	
Bakanisa	<i>Croton macrostachyus</i>		37	

Transect and plot	Local name	Scientific name	Family	Abundance of seedling Count/plot
	Sole	<i>Pottos porum species</i>		77
	Kombolcha	<i>Duranta erecta</i>		18
	Bite	<i>Dracaena ellaubedna</i>		38
	Arfātu	-		36
	Abayi	<i>Maesa lanceolata</i>		27
	Lolchisa	<i>Bersama abyssinica</i>		41
	Itacha	<i>Dodonea viscosa</i>		59
	Ulee foonii	<i>Hypericum revoletum</i>		46
	Chalaka	-		19
	Lafto	<i>Acacia abyssinica</i>		29
	Sombo	<i>Ekebergia capensis</i>		24
	Ejersa	<i>Olea Africana</i>		13
	Qadida	<i>Allophyllus macrobotrys</i>		14
	Gora	<i>Rubus steudneri</i>		61
	Qomanyo	<i>Brucea antidysenterica</i>		41
	Hanqu	-		10
	Ceka	<i>Calputiana qurea</i>		178
	Sole	<i>Pottos porum species</i>		73
	Bakanisa	<i>Croton macrostachyus</i>		62
	Agamsa	<i>Carisse edulis</i>		103
	Muka Arba	<i>Albizia gumifera</i>		42
	Qachama	<i>Myrine Africana</i>		18
	Kombolcha	<i>Duranta erecta</i>		41
	Reji	<i>Vernonia uriculifera</i>		29
	Gora	<i>Rubus steudneri</i>		41
	Birbirs	<i>Afrocrapus falctus</i>		7
	Lolchisa	<i>Bersama abyssinica</i>		18
	Sombo	<i>Ekebergia capensis</i>		4
	Wato	<i>Teclea nobilis</i>		35
	Ulumaye	<i>Clausena anisata</i>		8
	Ulee foonii	<i>Hypericum revoletum</i>		14
	Kombolcha	<i>Duranta erecta</i>		13
	Reji	<i>Vernonia uriculifera</i>		10
T5P1	Qomanyo	<i>Brucea antidysenterica</i>		7
	Ceka	<i>Calputiana qurea</i>		8
	Agamsa	<i>Carisse edulis</i>		6
	Ceka	<i>Calputiana qurea</i>		22
	Lolchisa	<i>Bersama abyssinica</i>		17
	Birbirs	<i>Afrocrapus falctus</i>		15
	Agamsa	<i>Carisse edulis</i>		10
T5P2	Kombolcha	<i>Duranta erecta</i>		21
	Qachama	<i>Myrine Africana</i>		9
	Bakanisa	<i>Croton macrostachyus</i>		10
	Muka Arba	<i>Albizia gumifera</i>		8
	Qomanyo	<i>Brucea antidysenterica</i>		13
	Bakanisa	<i>Croton macrostachyus</i>		6
	Agamsa	<i>Carisse edulis</i>		12
	Muka Arba	<i>Albizia gumifera</i>		21
	Sole	<i>Pottos porum species</i>		7
	Ceka	<i>Calputiana qurea</i>		4
T5P3	Birbirs	<i>Afrocrapus falctus</i>		3
	Kombolcha	<i>Duranta erecta</i>		2
	Qachama	<i>Myrine Africana</i>		8
	Ulumaye	<i>Clausena anisata</i>		2
	Lolchisa	<i>Bersama abyssinica</i>		2
	Qomanyo	<i>Brucea antidysenterica</i>		3
	Wato	<i>Teclea nobilis</i>		1
	Sole	<i>Pottos porum species</i>		21
	Bakanisa	<i>Croton macrostachyus</i>		22
	Agamsa	<i>Carisse edulis</i>		48
	Muka Arba	<i>Albizia gumifera</i>		27
T5P4	Gora	<i>Rubus steudneri</i>		17
	Reji	<i>Vernonia uriculifera</i>		8
	Ceka	<i>Calputiana qurea</i>		12
	Birbirs	<i>Afrocrapus falctus</i>		12
	Kombolcha	<i>Duranta erecta</i>		8

Transect and plot	Local name	Scientific name	Family	Abundance of seedling Count/plot
	Qomanyo	<i>Brucea antidysenterica</i>		2
	Qachama	<i>Myrine Africana</i>		23
	Lolchisa	<i>Bersama abyssinica</i>		6
	Lafto	<i>Acacia abyssinica</i>		1
	Hanqu	<i>LN Hanku</i>		11
	Ulumaye	<i>Clausena anisata</i>		4
	Wato	<i>Teclea nobilis</i>		4

Table A2. IVI-Value of the kata forest.

No	Species name	Relative density (%)	Relative Frequency (%)	Relative dominance (%)	IVI
1	<i>Venonia uriculifera</i>	3.55	5.93	4.64	14.12
2	<i>Brucea antdysenferica</i>	3.24	5.93	3.57	12.74
3	<i>Hypericum revoletum</i>	1.67	3.39	0.92	5.98
4	<i>Calputiana qurea</i>	16.94	3.47	16.31	41.72
5	<i>Acacia abyssinica</i>	1.98	2.12	2.04	6.14
6	<i>Croton macrostachyus</i>	6.9	7.20	9.50	23.60
7	<i>Rubus steudneri</i>	7.67	5.08	5.28	18.03
8	<i>Bersama abyssinica</i>	5.33	6.35	6.24	17.92
9	<i>LN. Dodota</i>	0.29	0.42	0.85	1.56
10	<i>Carisse edulis</i>	10.84	6.35	10.44	27.63
11	<i>Myrine africana</i>	3.24	4.24	3.12	10.60
12	<i>Pittosporum species</i>	5.94	4.24	4.90	13.30
13	<i>Albizia gumifera</i>	4.33	5.08	5.06	14.17
14	<i>Duranta erecta</i>	4.62	5.50	5.40	15.52
15	<i>Clousena anisata</i>	1.47	2.96	0.81	5.24
16	<i>Afro crapus falctus</i>	3.59	5.50	4.20	13.29
17	<i>Dodenea viscose</i>	6.12	3.39	5.89	15.40
18	<i>Buddesia polystachya</i>	0.42	1.69	0.37	2.48
19	<i>Allophylus macrpbotrys</i>	2.37	2.52	2.45	6.94
20	<i>Dracaena ellaubeclna</i>	4.52	3.81	4.05	12.38
21	<i>Capparis micrantha</i>	0.65	0.85	0.22	1.72
22	<i>Sygygium guineense</i>	0.13	0.42	0.12	0.67
23	<i>Cassipoulea species</i>	1.22	2.12	1.17	4.51
24	<i>LN. Afarfatu</i>	0.58	0.85	0.60	2.03
25	<i>Maesa Lanceolata</i>	0.52	0.85	0.50	1.87
26	<i>LN. chaleka</i>	0.28	0.85	0.18	1.32
27	<i>Ekebergia capensis sparm</i>	0.39	1.27	0.51	2.17
28	<i>Olea Africana</i>	0.68	1.69	0.46	2.83
29	<i>LN. Hanku</i>	0.45	0.85	0.16	1.46
30	<i>Teclea inbilis</i>	0.02	0.42	0.01	0.45
	Total	100	100	100	298.09

Table A3. Diversity and similarity of forest across the site.

TRANSECT, PLOT	CATEGORY	DENSITY OF SEEDLING	SHANNON DIVERSITY INDEX (H') $H' = -\sum p_i \ln p_i$	SPECIES RICHNESS (S)	SPECIES EVENNESS (J') $J' = \frac{H'}{\ln S}$
T1P1	1	285	1.06	6	0.59
T2P2	1	1022.5	2.35	15	0.93
T2P1	1	195	1.55	6	0.87
T2P2	1	457.5	1.89	9	0.86
T3P1	1	707.5	2.04	9	0.93
T3P2	1	1195	2.45	15	0.90
T4P1	1	505	1.89	7	0.97
T4P2	1	880	2.49	14	0.94
T5P1	1	110	1.56	5	0.97
T5P2	1	312.5	2.13	9	0.97
T1P3	2	1697.5	2.56	15	0.95
T1P4	2	1970	1.63	21	0.54
T2P3	2	1167.5	2.17	14	0.82
T2P4	2	1682.5	2.40	15	0.88
T3P3	2	1322.5	2.49	15	0.92
T3P4	2	1437.5	2.53	17	0.89
T4P3	2	1115	2.47	13	0.96
T4P4	2	1590	2.87	19	0.97
T5P3	2	992.5	2.26	12	0.91
T5P4	2	1692.5	2.47	16	0.89

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