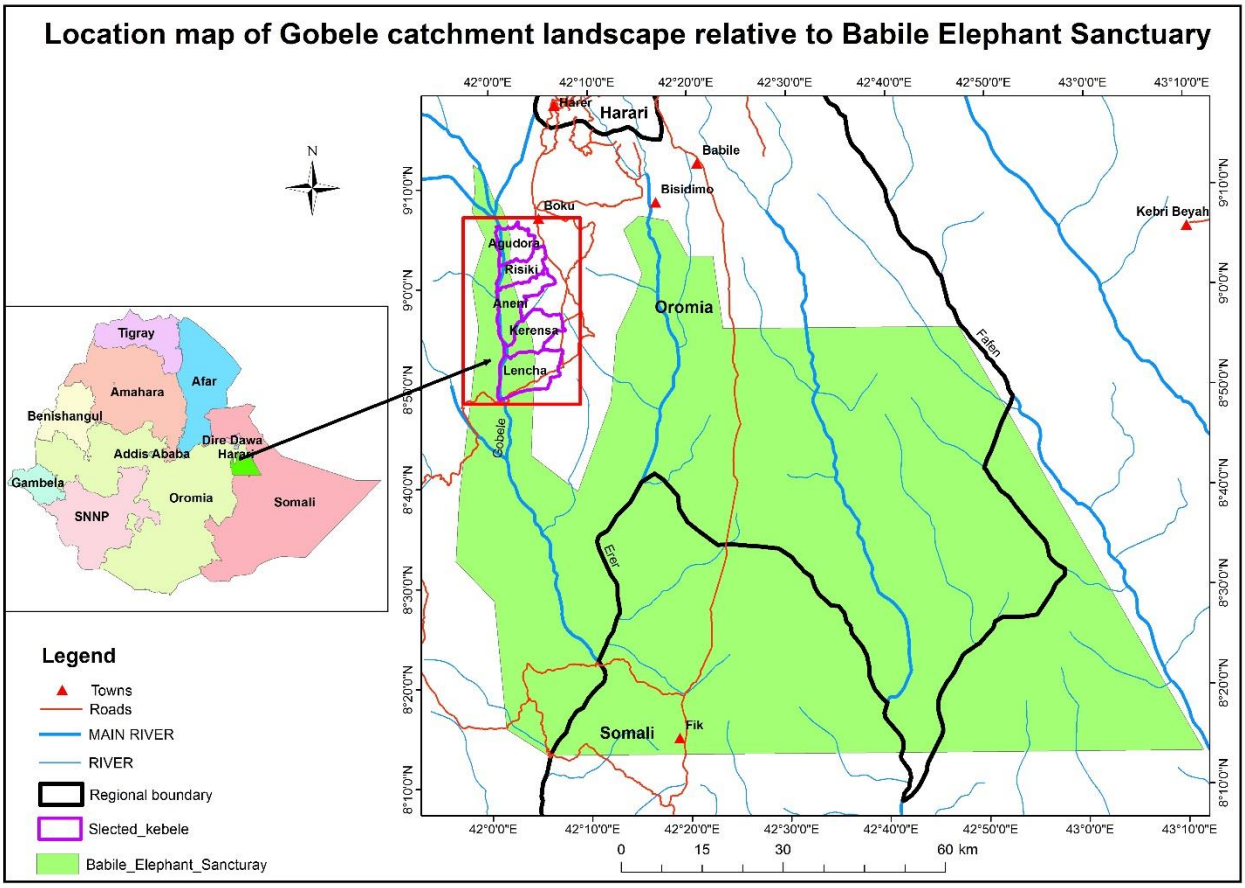
Gobele Catchment Integrated Landscape Management Plan in Babile Elephant Sanctuary



Prepared

as part of the

"Enhanced Management and Enforcement of Ethiopia's Protected Area Estate Project"

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1. Introduction and Background

1.1. Protected Area management and biodiversity conservation in Ethiopia

Ethiopia has great ecological and cultural diversity, which provides immense social and economic developmental potential to its people. Ethiopia encompasses major part of two biodiversity hotspots of global importance (the Eastern Afromontane and the Horn of Africa) ranking 7th in Africa in the Global Biodiversity Index (GBI). Moreover, Ethiopia is part of the eight most important development centers for crop plants in the world. This includes coffee (*Coffee arabica*), Teff (*Eragrostis tef*), Enset (*Ensete ventricosum*), sorghum (*Sorghum bicolor*) and others, which have their origin mainly in the Ethiopian highlands. Loss of biodiversity affects the poor, particularly women because of their role in the management, usage of natural resources mainly in agriculture and forestry.

Ethiopia has about 72 protected areas occupying about 16.4% of the total land area. With the inclusion of the National Forest Priority Areas (about 48000 Km^2), the total PA cover is estimated to reach about 22 %. The PAs in this report include 27 National Parks, 6 wildlife reserves, 32 controlled hunting areas, 2 sanctuaries and 5 community conservation areas (EBI, 2012; Solomon Abate, 2014). This study was focused on one of the protected areas known as the Babile Elephant Sanctuary (BES). In an effort to reduce the loss of biodiversity, the government declared about 187,000 km^2 area to be designated as protected areas (PAs) (EBI, 2012). The existing PAs, however, are facing serious management challenges from the local to policy levels. For instance, frequent restructuring and reform in the sector has increased vulnerability of the PAs to human impact, loss of institutional memory and trained manpower. At the local level, illegal hunting, land clearing for agriculture, extraction of forest products are very common. There are human-wildlife conflicts, competition for resources (water and pasture for wildlife and livestock) in areas where there is shortage of grazing land (e.g., Awash National Park).

In the last few years, the shift to community-based PA management approach, nevertheless, resulted in positive impacts. This approach has been initiated in Ethiopia in the early 1990s to enhance community participation in natural resources conservation. Co-management and benefit sharing were implemented by granting partial ownership rights to local communities (Tessema et al., 2007). The actions reduced human impacts and protected wildlife populations. The Semien Mountains National Park is a good example for successful results of the initiative.

The landscape management approach is relatively new and currently promoted by the IUCN and others for its conceptual strength with promising results. This approach considers PA management and biodiversity conservation not in isolation from the broader

geographical scale in which the PA is situated. Rather, the PA management is inclusive of the broader geographical unit in which the PA and other socioeconomic components are situated. The purpose is to ensure a sustainable landscape that meets multiple economic, social and environmental demands.

1.2. Brief Description of the Babile Elephant Sanctuary

Babile Elephant Sanctuary (BES) has been established in 1970, mainly to protect the ecologically isolated and distinct population of the African Elephant (*Loxodonta africana*) found in the Horn of Africa. The area supports an estimated number of over 340 Elephants, which makes the sanctuary the only remnant protected area in the Horn of Africa region with viable number of elephant population (Yirmed Demeke, 2009). It is believed that the sanctuary has already lost over 65 % of its area cover since its establishment, mainly accounted to human pressure coming in large number of farmers and domestic animals from the eastern and northern parts of the area (Yirmed Demeke *et al*., 2006). The Elephant population has also been declining due to severe poaching of the animals for ivory and unmanaged human-wildlife conflict.

BES is situated in the semi-arid trans-boundary region between the Oromia (22.3 %) and Somali (77.7 %) regions of Ethiopia, at a distance of 560 km southeast of Addis Ababa and 30 km from Harar Town (Yihew Biru and Afework Bekele, 2012). The total estimated area cover is about 7000 Km^2. The geographical location lies between 08° 22' 30" - 09° 00' 30" N latitudes and 42^0 01' 10" - 43° 05' 50" E longitudes (Fig. 1). The altitude ranges between 850 to 1785 m.a.s.l. The agro-climatic region is semi-arid, characterized by mean monthly minimum and maximum temperatures of 13°C and 26°C, respectively. The mean annual rainfall is 517 mm, with high variation from year to year, ranging from 452 mm to 1,275 mm. The BES is drained and dissected by four major river valleys such as Fafem, Daketa, Erer and Gobelle originating from the Garamuleta-Harar- Gursum Highlands and extend southwards through the sanctuary ending at the Wabi Shebelle River Basin.

The BES is known for its diversity and high endemicity of various plants and fauna. Although elephant is the key species, there are about 30 species of mammals and about 190 species of birds. Among the large mammals, black manned lion (African lion), Leopard, Hamadryas baboon and Menelik's Bushbuck are the few to mention (Yirmed Demeke et al. 2006). The vegetation of the Sanctuary is represented by small leaved deciduous species of Acacia and Commiphora woodland, desert and semi desert scrubland and evergreen scrub. The dense vegetation stand is found in the eastern parts of the sanctuary, in the Erer Valley, where extensive human pressure is exerted in the form of settlements and livestock grazing. The main species found in the Erer valley vegetation include *Capparis tomentosa, Acokanthera schimperi, Tamarindus indica, Acacia robusta* and *Oncoba spinosa.*

The purpose of this management plan is to achieve improved conservation of forestry and agrobiodiversity resources through an **integrated landscape management** approach by promoting community-based natural resource management.

1.3. Integrated landscape management approach

Integrated landscape management (ILM) has emerged as an innovative approach to land management that reduces land use conflicts, empowers communities, and achieves development objectives at the landscape scale. ILM is built on the principles of participation, negotiation and cooperation. It requires long-term collaboration among diverse stakeholders to achieve sustainable utilization of landscape resources (Thaxton, 2017). The landscape resources include agricultural production, ecosystem services, cultural heritage and values and livelihoods (Scherr et al., 2014). Effective management and sustainable utilization is ensured through integration of sectors at scales and increased coordination. Besides, ILM ensures the harmonization of planning, implementation and monitoring processes at the landscape as well as national and sub-national levels. ILM is adaptive and iterative process that enables adjustments to reduce unintended outcomes. A coordinated multi-sectoral integration can be realized through rights disposition process to determine what rights may be disposed over the landscape, how collective rights of user groups could be managed to ensure sustainability. In ILM collective decision-making process, the social, economic, cultural and ecological balances are taken into consideration for successful management.

1.4. Selection of the Gobele catchment landscape for the ILM intervention

The consulting firm, Green MEMIs, developed the selection criteria for conservation priority area and provided the same to the EBI (Annex 1). A systematic scoring and ranking method (Margules et al., 2002) was proposed by the firm for the prioritization and selection process. The procedure allows to compare potentially suitable biodiversity conservation sites based on multiple ecological, environmental and socioeconomic criteria (Bonn and Gaston, 2005). The proposed potential sites were evaluated by experts using the criteria. The expert team was formed from the EBI project office and the composition included the Harar Biodiversity Center and Woreda agriculture offices in the respective proposed priority areas.

The expert team visited and conducted series of discussions with stakeholders in the respective administrative and sectoral offices in Eastern Hararghe Zone. The Babile, Fedis and Midaga Tola Woredas were consulted in the Eastern Hararghe zone of Oromia region and the Ethiosomali regions. In Ethiosomali region, the Babile Woreda was consulted. Accordingly, Erer Ebada and Fedis-Midaga were proposed as potential sites in the Oromia region side of the Babile Elephant Sanctuary. In the Ethiosomali region side of the BES, Dandama was proposed as potential priority site for conservation (Table 1).

Using the various criteria and scoring procedures, the expert team members objectively evaluated the three sites and summarized the scores as shown in Table 2.

Table 1. Location and description of the proposed priority sites and demonstration site

No.	Proposed priority site (15,000 ha)			Name of demonstration farm site (20 ha) and Geographic coordinate		
	Zone/ District	District Name	Village / PA	Demonstration farm site	Coordinate of demonstration site)	
1	Eastern Hararghe (Oromia)	**Erere-Ebada** (Babile-Oromia)	Erere-Ebada Ebada-Gemachu Gemachu	Ganda Negaya	Lat.	$9^0$16'92''
					Long.	$42^0$25'55''
2	Eastern Hararghe (Oromia)	**Fedis-Midaga**	Anani, Riski, Agudora, Umar Kule, Lencha, Nagaya Midaga, Keransa, Barzala, Mudi Tola, Mudi Bali	Keberota Lule	Lat.	$9^0$07'34''
					Long.	$42^0$03'69''
3	Fiq (Ethiosomali)	**Dandama** (Babile-Ethiosomali)	Dandama, Dawareyu Burka, Al Ethiopia, Beka, Erere Yere, Kereyer	Gelo	Lat.	$8^0$92'18''
					Long.	$42^0$39'47''

While applying the criteria, the expert team used interviews with local experts, elders and also visited the suggested sites (selected Kebeles) before rating the prioritization criteria. The results of the scoring matrix (Annex 2), as reported by the expert team, are summarized in Table 2 below. Hence, the Fedis-Midaga site (Gobele catchment) in Fedis Woreda was selected for the implementation of integrated landscape management intervention for its economic, social and ecological significance compared to the other proposed sites. However, the total area of the Gobele Catchment landscape exceeds the proposed 15,000 ha due to the interconnectivity of the micro-watersheds draining to the Gobele river. It is agreed with EBI that the landscape management plan be prepared for the entire catchment encompassing the selected Kebeles in the Fedis Woreda of the priority site and some Kebeles in the Midaga Tola side.

Table 2. Summary of the evaluation score points of the proposed priority sites

Proposed Priority Site	Zone/ District	Presence of Demonstration Site	Mean Score (Out of 42)	Mean Weight (Out of 285)	Rank
Fedis-Midaga	Eastern Hararghe	**Yes**	**35.17**	**255.9**	**1st**
Erer Ebada	Eastern Hararghe	Yes	34.01	245.05	2nd
Dandama	Fiq	Yes	31.33	227.45	3rd

2. Existing Situation of the Gobele Catchment landscape

2.1. Location and description of the landscape

The Gobele catchment landscape is located largely in the Fedis Woreda encompassing three Kebeles (Adugora, Risiki and Aneni) and Partly in the Midaga Tola Woreda encompassing parts of two Kebeles (Kerensa and Lencha) within and outside of the boundary of the BES (Table 3, Fig. 1). Fedis Woreda is 25 Km from Harar city and the capital town is Boko; While Midaga Tolla Woreda is located at about 55 Km from Harar and 30 Km from Boko towards the east. The capital town is Midega. The geographical location of the catchment landscape is situated in the North latitude of $9^0$07'34'' and in the East longitude of $42^0$03'69'' E.

Table 3. Kebeles and their area coverage within the Gobele catchment landscape in the Fedis and Midega Tola Woredas

Kebele	Woreda	Area (ha)
Agudora	Fedis	4020
Risiki	Fedis	3759
Aneni	Fedis	5837
Kerensa	Midega Tola	5415
Lencha	Midega Tola	7630
Total		**26661**

About 14073 ha of the land or 39.6 % of the total area of the catchment is found within the BES boundary (green shaded) while the rest (60 %) of the land area is outside and adjacent to the BES boundary (Fig. 1).

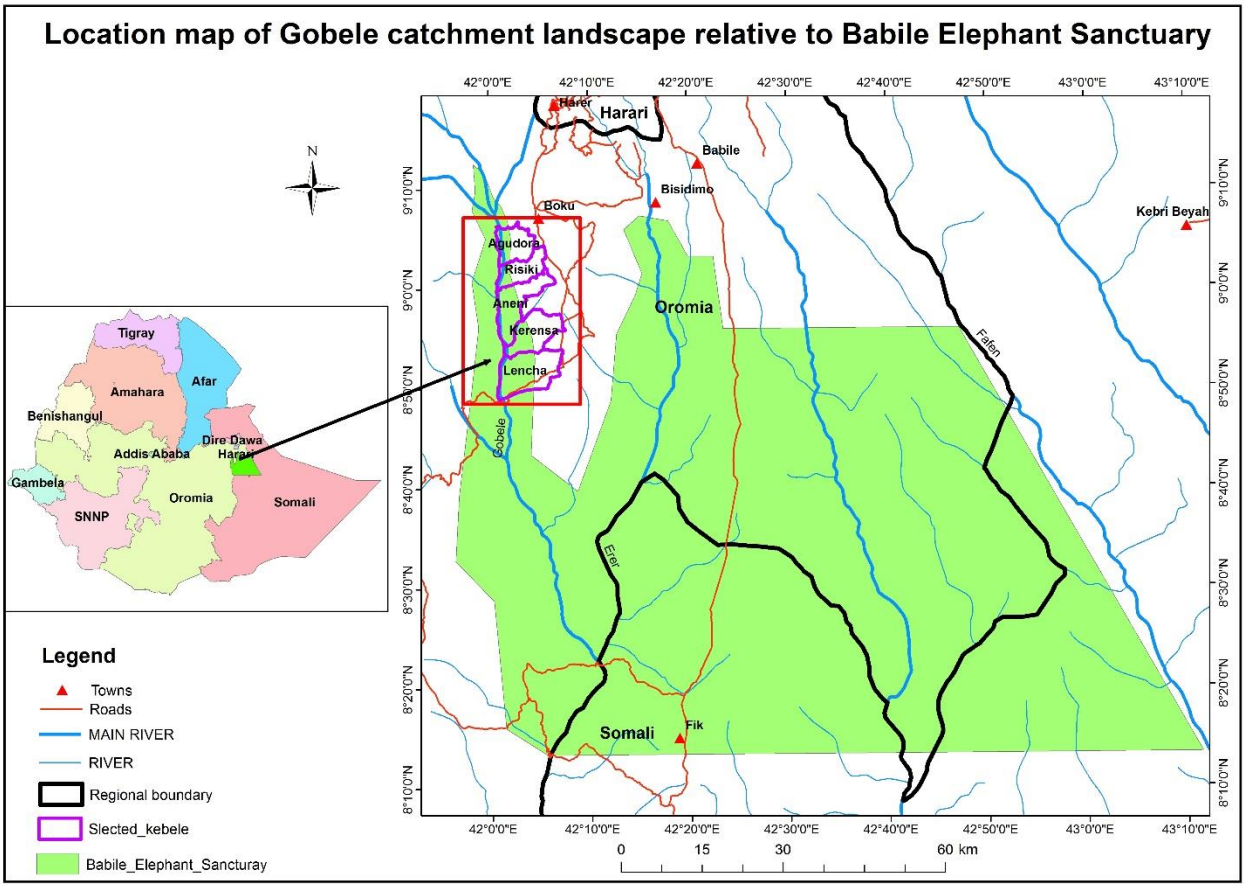


Figure 1. Relative location map of the Gobele catchment landscape (Marked in red)

2.2. Land use land cover

The total area of the catchment is 35546 ha. The land use land cover is categorized into five main classes (Table 4, Fig.2). About 37% of the land is covered by natural vegetation including grasslands. The single dominant natural vegetation type is *Acacia-Commiphora Woodland and bushland proper* (ACB). Agricultural land, which is composed of Khat-based intercropping system and cereal crop cultivation covers about 61 % of the land use, the former being the largest form of cultivation covering 47 % of the agricultural land (Table 4). However, cereal crop faming is expanding to the lowlands and towards the sanctuary.

Table 4. Land use land cover types in the Gobele Catchment landscape

LULC	Area (ha)	%
Khat-based intercropping	16939	47.09
Cereal crop	5173	14.38
***Acacia-Commiphora* woodland and bushland proper (ACB)**	13345	37.10
Settlement	310	0.86
Degraded land	205	0.57
Total	35546	100

The dominant land use land cover within the BES boundary in the catchment landscape is the Acacia-commiphora woodland and bushland proper (ACB), which accounts 75 % of the land area (Table 5). The rest is covered by cultivated lands (both by cereal and khat-based intercropping system). There is a growing tendency of expansion of cultivate land towards the natural vegetation in the protected area.

Table 5. Land use land cover types in the Gobele Catchment landscape within the BES

LULC	Area	%
Khat-based inter-cropping	1657	11.77
Cereal crop	1814	12.89
Acacia-Commiphora woodland and bushland proper (ACB)	10602	75.34
Total	14073	100

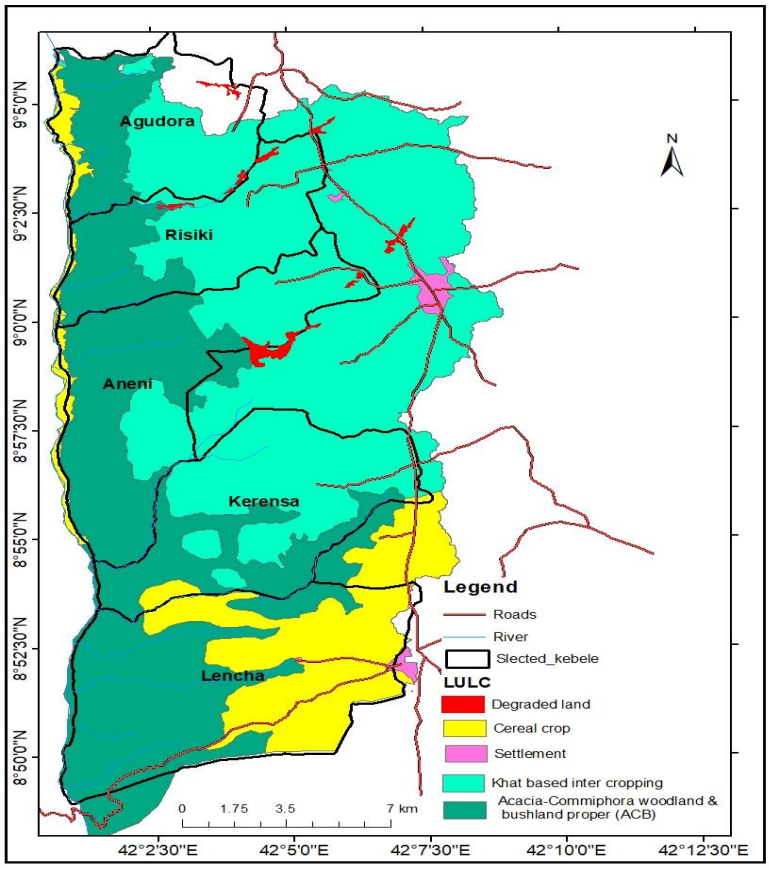


Figure 2. Land use land cover map of the Gobele catchment landscape

2.3. Topography and agro-climatic zones

The topography is rugged with a very deep gorge towards the Gobele river valley and extending upward to the banks with undulating and scenic features of deep gorges, steep hills and upland plains. The altitude ranges from 1021 to 1808 m.a.s.l (Fig. 3, Table 6), resulting in two distinct agro-climatic zones: lowland (<1500 m.a.s.l) and mid-highland

(1500 – 1808 m.a.s.l.). About 47 % of the land is in the lowlands and 53 % is in the mid-highland agro-climatic zones. Much of the lowland is occupied by the Acacia-commiphora woodland and bushland proper vegetation types, while the mid-highlands are mainly covered by agricultural land.

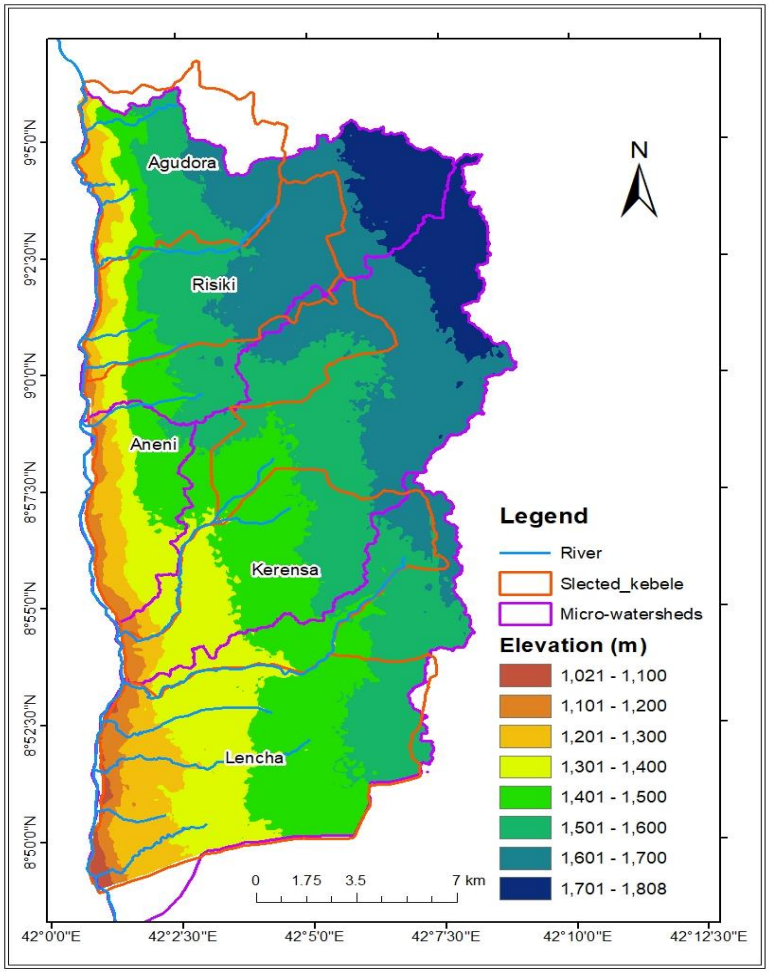


Figure 3. Elevation map of the Gobele catchment landscape

Table 6. Altitude range of the Gobele catchment landscape

Elevation (m)	Area (ha)	%
1021-1100	223	0.63
1101-1200	1049	2.95
1201-1300	2623	7.38
1301-1400	5270	14.83
1401-1500	7507	21.12
1501-1600	8909	25.06
1601-1700	7379	20.76
1701-1808	2586	7.28

Large part of (i.e., about 59 %) the high-altitude areas in the mid-highlands are characterized by flat to plain topography with slope ranging from 0-5 %. Generally, these areas are cultivated lands with slope less than 10 %, which is less exposed for erosion if supported with reasonable measures of soil and water conservation. Whereas the gorges towards the valley bottom are steeper in slope reaching up to 30 % (Fig. 4, Table 7). In general, 79% of the landscape has a slope of less than 9%, about 17% of the area has 9-16% slope and the remaining 4% area has a slope of up to 32%.

Table 7. Slope characteristics of the Gobele catchment landscape

Slope class	Area (ha)	%
0-3	11516	32.40
4--5	9267	26.07
6--8	7544	21.22
9--16	5934	16.69
17--32	1263	3.55
33--43	20	0.06

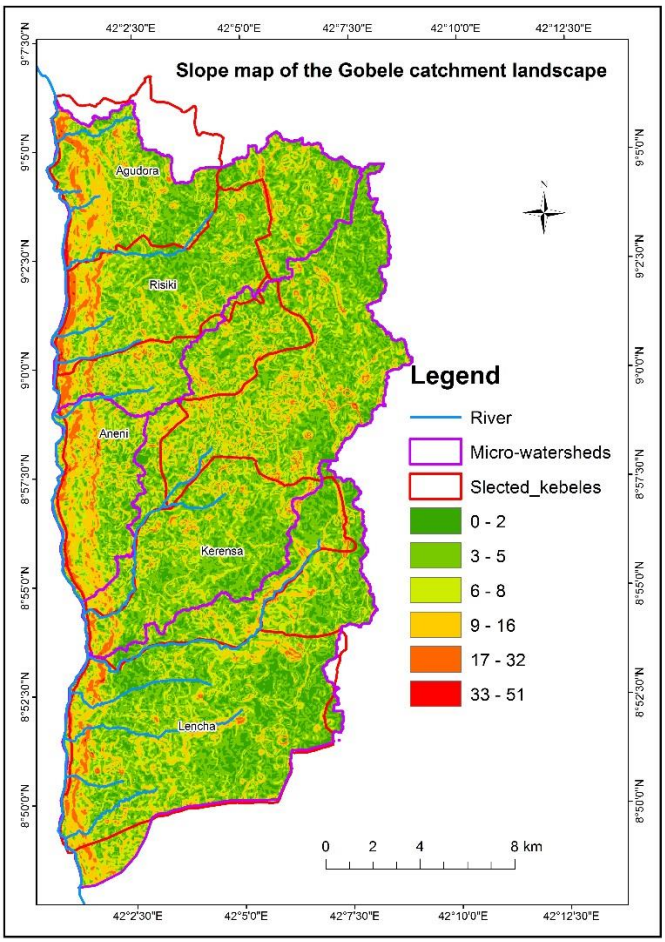


Figure 4. Slope map of the Gobele catchment landscape

2.4. Geology and Soils

The geological formations in the BES are characterized by pre-Cambrian rocks dominated by igneous (granite) and sandstone layers. Soils are sandy and shallow. However, deep soils are also found in the low-lying valley bottoms formed from sedimentary deposits in the past several years. The agricultural soil in the plains are Nitisols, which are deep and well drained. Whereas the soils along the valley banks are shallow sandy soils with highly eroded top surface and minimum organic matter cover.

2.5. Climate and Surface hydrology

The climate of the BES is categorized as semi-arid climate. The low-lying valleys are warmer than the mid-highland plains. The mean annual temperature is about 19.6 ^{0}C, ranging from a mean minimum of 11.9 ^{0}C to mean maximum of 27.2 ^{0}C. The hottest period is between April to June, in which case the temperature reaches to a maximum of 29 ^{0}C. and the coldest period is between October to December with a minimum temperature of 7.8^{0}C. Although the annual variability of the rainfall is very high, the mean annual rainfall is 703 mm year^{-1}. The minimum rainfall in the low-lying areas is a low as 452 mm and the maximum reaches up to 1,116 mm in the highland areas. The distribution is bimodal with two picks occurring between March to April (Belg season) and June to September (Meher season).

The Gobele river is the main channel draining the surface hydrology of the catchment of the landscape. It originates from mount Gara Muleta. Smaller streams such as Ije Kersa and Hermata formed the micro-watersheds draining the upper catchments to the Gobele river (Fig. 5).

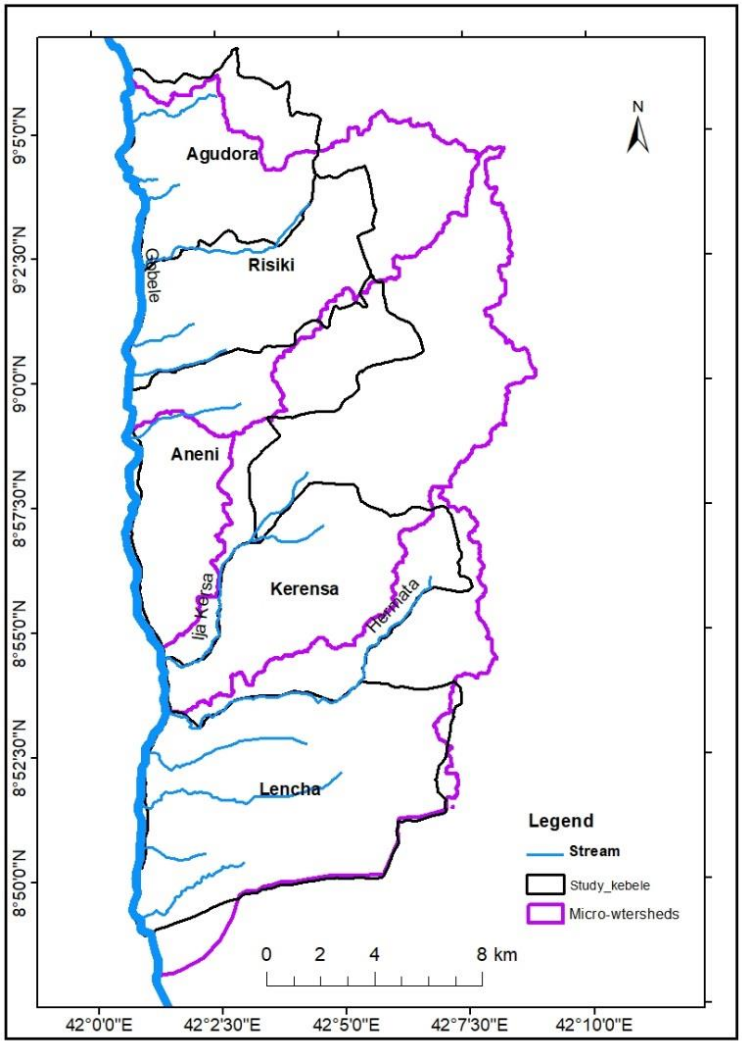
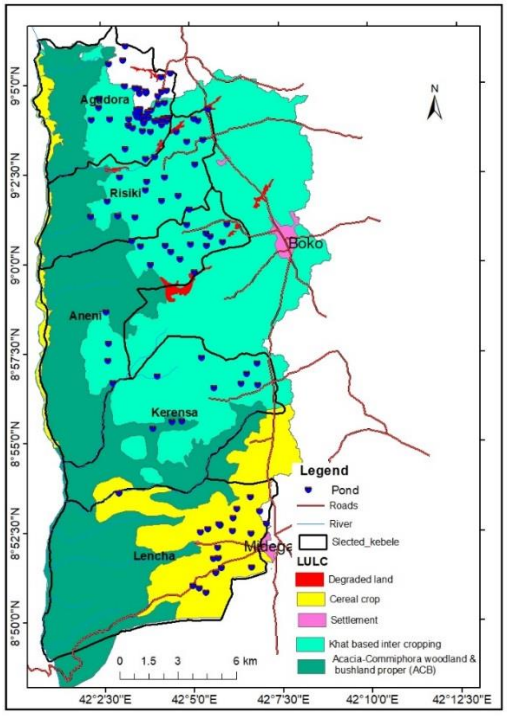


Figure 5. Drainage map of the Gobele catchment landscape

The main source of water for the local communities (for livestock and people) are ponds dug in the different Kebeles. As shown in Table 8 and Figure 6 below, there are quite large numbers of ponds in each Kebele. Most of the ponds are in the agricultural landscapes where the slope is gentler. The ponds serve as main source of water for livestock watering.

Table 8. Distribution and number of ponds in the Gobele catchment landscape

Kebele	Number of ponds
Agudora	51
Risiki	20
Aneni	17
Kerensa	10
Lencha	21
Total	119



a) Pond distribution

b) picture of a pond used by villagers

Figure 6. Location and distribution map of ponds in the Gobele catchment landscape

2.6. Natural Vegetation Types and Diversity

According to the potential vegetation types of Ethiopia (Friis *et al*., 2010), one major natural vegetation type has dominated the Gobele catchment landscape. This vegetation type is the ***Acacia-Commiphora Woodland and bushland proper (ACB)*** (Fig. 7). With a slight difference in composition (mainly because of the distribution of the *Commiphora* species), the upper plain parts are dominated by a mix of *Acacia* spp., *Terminalia brownii* and *Combretum* spp while the lower valley banks are dominated by variety of *Commiphora* species (personal observations, August, 2019).

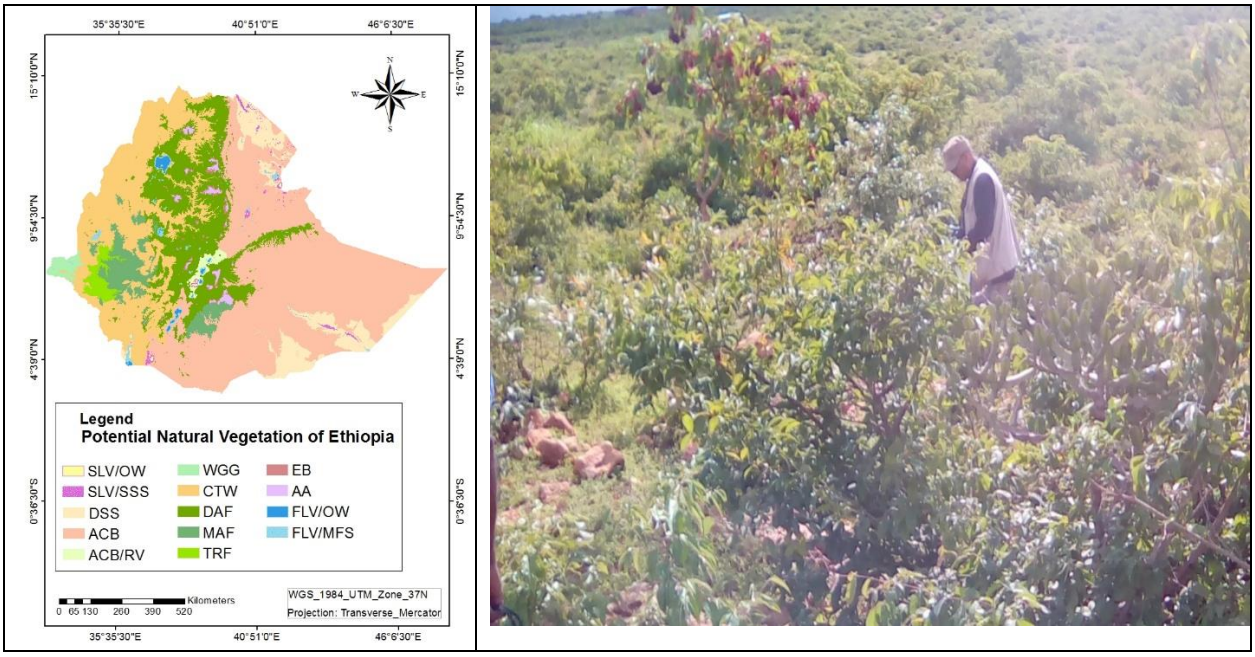


Figure 7. Potential vegetation types map of Ethiopia and partial view of the ACB. The ACB is dominant vegetation in the eastern and south eastern parts of the country. BES is located in this vegetation zone (Friis et al. 2010).

2.6.1. The *Acacia-Commiphora* Woodland and Bushland (ACB) proper vegetation

The *Acacia-Commiphora* woodland and bushland (ACB) occurs in wider areas of the dry lowlands in the rift valley and eastern and southern part of Ethiopia. This vegetation type is characterized by drought resistant trees and shrubs, either deciduous or with small, evergreen leaves, generally occurring in the altitude range of 400 – 1900 m a.s.l (Friis et al., 2010). The characteristic species of trees and shrubs that are found in this vegetation type includes *Acacia bussei, A. drepanolobium, A. hamulosa,, A. ogadensis, A. prasinata* (endemic), *A. reficiens, A. tortilis, A. zizyphispina* (all Fabaceae sub-family Mimosoideae), *Boswellia microphylla, B. neglecta, Commiphora alaticaulis, C. albiflora, C. ancistrophora, C. boiviniana, C. boranensis, C. campestris, C. ciliata, C. confusa, C. coronillifolia, C. corrugata, C. cyclophylla, C. ellenbeckii, C. gowello, C. hildebrandtii, C. mildbraedii, C. myrrha, C. obovata, C. quadricincta, C. rostrata, C. serrulata, C. sphaerophylla, C. truncata* (all Burseraceae), and others.

Among the succulents, those prominent found in such vegetation type include *Euphorbia awashensis*, *E. monacantha*, *E. burgeri*, *E. cryptocaulis*, *E. dalettiensis*, *E. gymnocalycioides*, *E. omariana*, *E. piscidermis*, *E. sebsebei*, *E. tescorum,* all are endemic

and belong to Euphorbiaceae family. There are also several endemic species of Aloaceae family including, *A. friisii*, *A. gilbertii*, *A. otallensis*, *A. mcloughlinii*, *A. pirottae*, and others. Unique species of the area such as shown in Figure 8 (b,c) are recorded in the lower part (Midaga Tola Woreda) of the Catchment.

a) *Acacia etbaica (left and middle); Euphorbia aff. adjurana (right)* at Gobele catchment landscape

Aloe megalacantha (Aloaceae) c)

b) Caralluma acutangula (Asclepiadaceae)

Figure 8. Pictures of some Characteristic species of the ACB in Gobele catchment

Over 60 types of species have been recorded in the natural vegetation of the ACB, in the khat-based agro-forestry system and in the riverine vegetation visited during the field survey of the catchment (Table 9). Fabaceae, Burseraceae and Tiliaceae families are the dominant types in the ACB.

Table 9. List of species recorded in the ACB in Gobele catchment landscape

No.	Species list	Family	Habit	Vernacular Name (Or)
1	*Acacia albida*	Fabaceae	Tree	Gerbi
2	*Acacia bussei*	Fabaceae	Tree	Hallo
3	*Acacia etbaica*			Dodota
4	*Acacia mellifera*	Fabaceae	Shrub	Korsa
5	*Acacia senegal*	Fabaceae	Shrub	Korsa
6	*Acacia seyal*	Fabaceae	Tree	Wacho
7	*Acacia tortilis*	Fabaceae	Tree	Dhadhecha
8	*Aloe pirottae*	Aloaceae/ Asphodelaceae	Shrub	Argesaa
9	*Aloe megalacantha*	Aloaceae/ Asphodelaceae	Shrub	Argesaa
10	*Balanites aegyptiaca*	Balanitaceae	Tree	Badano
11	*Berchemia discolor*	Rhamnaceae	Tree	Jejeba
12	*Calpurnia aurea*	Fabaceae	Tree/shrub	Cheka
13	*Calotropis procera*	Asclepiadaceae	Shrub	
14	*Caralluma acutangula*	Asclepiadaceae	Shrub/succulent	
15	*Cissus quadrangularis*	Vitaceae	Perennial climber	
16	*Combretum collinum*	Combretaceae	Tree	Rukello
17	*Combretum molle*	Combretaceae	Tree	
18	*Commiphora africana*	Burseraceae	Tree	
19	*Commiphora boranensis*	Burseraceae	Tree	
20	*Commiphora holtziana*	Burseraceae	Tree	Agersu
21	*Commiphora kataf*	Burseraceae	Tree	Dhere-Kele
22	*Commiphora corrugata*	Burseraceae		Dhekero
23	*Cordia africana.*	Boraginaceae	Tree	
24	*Cychlocheilon kelleri*	Cyclocheilaceae	Shrub	Dimello
25	*Delonix elata*	Fabaceae	Tree	Ligaba
26	*Dichrostachys cinerea*	Fabaceae	Tree	Jisme
27	*Dobera glabra*	Salvadoraceae	Tree	
28	*Dodonaea angustifolia*		Shrub	Tedecha
29	*Dobera glabra*	Salvadoraceae	Tree	
30	*Drimia altissima*	Hyacinthaceae	Herb	
31	*Ehretia cymosa*	Boraginaceae	Shrub	Oulaga

32	*Euclea racemose*	Ebenaceae	Shrub	Dodoti
33	*Euphorbia aff. adjurana*	Euphorbiaceae	Tree	
34	*Euphorbia polyacantha*	Euphorbiaceae	Shrub	
35	*Euphorbia dichogama*	Euphorbiaceae	Shrub	
36	*Ficus* vasta.	Moraceae	Tree	
37	*Flugea virosa*	Euphorbicaeae	Shrub	
38	*Gardenia lutea*	Rubiaceae	Shrub	
39	*Grewia bicolor*	Tiliaceae	Shrub	
40	*Grewia pennicilata*	Tiliaceae	Shrub	Ogobdi
41	*Grewia schweinfurthii*	Tiliaceae	Shrub	
42	*Grewia tenax*	Tiliaceae	Shrub	Dheka
43	*Grewia trichocarpa*	Tiliaceae	Shrub	Metekoma/ Mudugure
44	*Ipomoea cicatricosa*	Convolvulaceae	Shrub	
45	*Ipomoea longituba*	Convolvulaceae	Woody climber	
46	*Jasminum abyssinicum*	Oleaceaea	Herb climber	
47	*Justicia flava*	Acanthaceae	Herb	
48	*Hypoestes forskaolii*	Acanthaceae	Herb	
49	*Lannea fruticosa*	Anacardiaceae	Tree	
50	*Lantana camara* L.	Verbenaceae	Shrub	Beke-Argete
51	*Melhania velutina*	Sterculiaceae	Herb/shrub	Dala
52	*Ochna inermis*	Ochnaceae	Tree	Rige-Lencha
53	*Premna resinosa*	Lamiaceae	Shrub	Ourgessa
54	*Pterolobium stellatum*	Fabaceae	Climbing shrub	Serkma
55	*Pyrenacantha malvifolia*	Icacinaceae	Tuberous climber	
56	*Rhus ruspolii*	Anacardiaceae	Shrub	Tatesa
57	*Seddera* sp.	Convolvulaceae	Shrub	
58	*Sesbania sesban*	Fabaceae	Tree	
59	*Tarchonamthus camphoratus*		Shrub	Geri-Adi
60	*Terminalia brownii*	Combretaceae	Tree	
61	*Terminalia spinosa*	Combretaceae	Tree	
62	*Ximenia americana*	Olacaceae	Shrub	Huda
63	*Ziziphus spina-christi*	Rhamnaceae	Tree	Kurkura

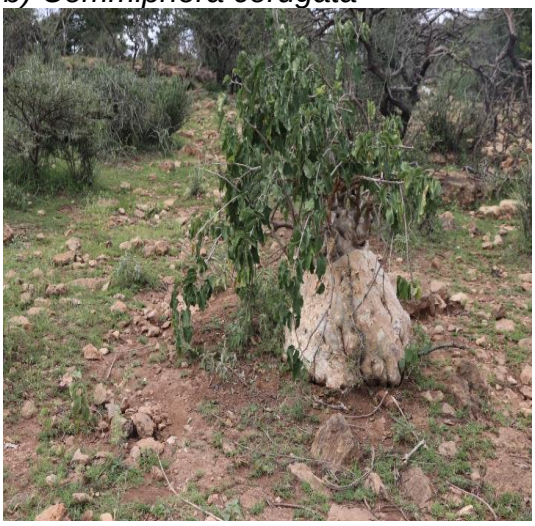
The vegetation type in lower part of the Gobele catchment landscape (Lencha and Kerensa Kebeles of the Midaga Wereda) is dominantly populated with varieties of Acacia, Combretum and Commiphora species in the *Acacia-Commiphora woodland and bushland proper (ACB). The Commiphora species include C. borenensis, C. holtziana,*

C. kataf, and others. The combretum pockets of species include *Combretum collinum and C. molle* (in the Family Combretaceae).

a) Commiphora boranensis

b) Commiphora corugata

b) Commiphora holtziana



c) Pyrenacantha malvifolia

Figure 9. Some unique representative species of *Commiphora* and others encountered in the lower Gobele catchment

As discussed above, most of the vegetation in the upper part of the Gobele catchment in the Babile Wereda is mixed with cultivated land and the riverine patches of the woody species are highly degraded. Besides, the *Commiphora* species are very rare in this part. On the contrary, in the lower part of the Gobele catchment within the Midaga Wereda has relatively intact woodlands wherein some parts are dominated by *Commiphora* species (Burseraceae). On top of these, there are rare species such as *Pyrenacantha malvifolia* (Icacinaceae) with a unique habit. There are also endemic Aloaceae family species such as *A*. *megalacantha and A. pirottae* which are endemic to the area and a near endemic *Euphorbia, E. adjurana* known only in Ethiopia and Kenya. Generally, this unique woodland habitat requires special attention for management intervention given its high level of species endemism.

2.7. Agrobiodiversity and ethnobiology

Agrobiodiversity, which is the variety and variability of life in food producing and agricultural systems, is the pillar and critical ingredient in food systems and livelihood activities of farming communities. The extent and values of agrobiodiversity in farming systems are best captured by employing the methods of ethnobiology and hence the present research capitalized on this approach. This comes up with a strong component of ethnobotany in particular when dealing with agricultural systems that depend on use and management of diverse plant species and their varieties. The farming communities of the study area manage and use many crops, crop varieties and different categories of wild useful plants. As part of their indigenous knowledge, farmers realize and express in various ways that a rich agrobiodiversity can enhance productivity, reduce the impact of pests and diseases, improve household food security and nutritional status, enhance critical ecosystem services, expand market opportunities, and facilitate adaptation to climate change (Hoffmann, 2011). Since diversity in crop species and varieties serves as insurance against future environmental changes by increasing the system's resilience through improvement of the soil organic matter derived from green manures; mulching and recycling of crop residues and animal manure, the water holding capacity of soils and their ability to absorb water during torrential rains can be improved (Hoffmann, 2011). Researchers in Kenya showed that agrobiodiversity conservation enhanced food security in subsistence farming systems (Mburu et al., 2016). Thus, continued increase of the agrobiodiversity of the study area has the potential to mitigate the water shortage and other problems that agriculture is facing in Midega and Fedis districts.

The Gobele Catchment landscape broadly comes under the semi-arid zone that includes, wetter and drier agroclimatic regions as given in the new agroecological classification of Ethiopia using data on thermal zones, moisture regimes and length of growing period (EIAR, 2011). The cultivated landscape of the Gobele River catchment area has been placed under the Low Potential Cereal Zone that experiences high rainfall variability, occasional drought with the length of the growing period ranging from 90-150 days (FAO,1986). In this type of agroecological zone, cultivation of lowland cereals and associated crops with the traditional ox-plough system and livestock rearing are the main livelihood systems.

With the broad aim of enhancing the management and enforcing protection of the BES, this study looked at the status of interface between the agricultural landscape and the protected area. The human-elephant conflict and the impact of these on the environment and biodiversity in and around the BES have been discussed by several authors (Zelalem Wodu, 2007; Anteneh Belayneh and Sebsebe Demissew, 2011) who among other things showed that the vegetation and the land are being affected due to charcoal production, wood collection, grazing by livestock leading to vegetation destruction and major land use

changes due to continued agricultural expansion. The analyzed the population structure of the woody species browsed by elephants and concluded that the BES needs immediate rehabilitation measures. Another paper (Anteneh Belayneh et al., 2012), underlined that the BES is an important reservoir of traditional medicinal plants further listing 51 species with the ailments that each has been claimed to treat. DAs informed the current research group that about 30% of the people are currently food insecure and face serious rainfall and potable water deficiency. Therefore, in order to ascertain sustainable use of the natural and cultivated landscapes, while taking into account peoples' livelihoods and wellbeing of the wildlife with the natural habitats, the agrobiodiversity elements and the indigenous local biological knowledge and practices of the local people need to be considered in informed decision making.

The main objective of the agrobiodiversity and ethnobiology component of the study was to document the agrobiodiversity resources by recording through observation, interview and discussion, further assessing the importance of the useful plant and animal species of the cultivated and natural landscapes along with their uses to the people and the country's economic resources and the ecological wellbeing of the area. Besides, the examined and proposed interventions for agrobiodiversity enhancement fair sharing of the resources between people and wildlife under sustainable management ensuring that the ecosystem of the Gobele catchment and the agroecosystem of the cultivated land remain well protected with optimal productivity and continue supplying ecosystem and agroecosystem services.

Standard ethnobiological research methods were applied to understand the agrobiodiversity wealth of the study area. The main methods and techniques included interviewing, free listing exercises, guided field walk and guided farm tour along with motivating formal and informal discussions plus ranking exercises as deemed necessary. Data collection formats that can capture information on crops and livestock of the agricultural landscape and useful plants and animals sourced from outside the farms were included in the open-ended data collection procedure. The sampling frame was restricted to two target districts (Fedis and Midega) from which the key informants were purposively identified from among the male and female household heads. Individual interviews were held with each informant in and around their respective field farms and/or home-gardens.

2.7.1. Agroforestry Practices and Agrobiodiversity in the Gobele catchment landscape

Crop associations in farms and home-gardens showed the agrobiodiversity richness maintained and used by the community of farming households. It also shows the nutritional complements that each household prepares for the family members being described as farmers' nutritional formulation (Marten, 1990; Zemede Asfaw and Zerihun Woldu, 1997). The spatial structure of the agricultural landscape in Fedis and Midega

Tola Woredas in general and in the Gobele catchment landscape in particular can be described under different categories and each is elaborated below.

2.7.1.1. Parkland Agroforestry System (Open traditional agro-forestry)

The parkland agroforestry system in this type of landscape is marked by scattered wild trees that are left in the farm fields, around homes and on fence lines are sometimes reinforced by domesticated tree crops including the fruit crops such as Mango, Guava, Casmir and others. The main wild trees are *Cordia africana, Ehretia cymosa, Ziziphus spina-christi, Terminalia brownii* and many *Acacia* spp. The frequency of trees in the farm fields increases moving from Fedis to the valley bottom as could be observed across the Fedis-Midega road (Figure 12).

Figure 10. Partial view of the Parkland agroforestry system in the Gobele Catchment landscape

The farmlands were established by clearing the acacia trees and bushes. Looking deeper into the density and types of trees left on the farms, one does not get an encouraging impression because not many acacia trees that could have been utilized not only as sources for wood and feed but also as soil fertilizers because of their nitrogen fixation ability. This might have been driven by traditional practices of total clearing for fear of bird attack on sorghum crop, dependence on inorganic chemical fertilizers and the desire to plant Khat (*Catha edulis*). Very limited in-situ trees are left on the farm missing the opportunity for promotion of legume trees-based agroforestry. In view of this, the development agents would need to discuss and convince farmers to let seedlings of *Acacia* spp. that germinate from the soil seed bank to grow to full maturity within their farmlands by selecting the most suitable ones like *Acacia albida* and *Acacia tortilis*.

2.7.1.2. Alley Cropping or Strip Cropping Agroforestry System

This system is very common in the Fedis Woreda Kebeles (Agudora, Aneni and Riski) of the Gobele Catchment. This is where a domesticated woody crop species called *Khat* (*Catha edulis*) is intercropped with staple cereals (mainly sorghum and maize) and the associated companion crops. This type of agroforestry is called alley cropping system (Figure 13) also known as strip cropping. The farmers have developed an ingenious way of managing this *Khat crop* in the field farm integrated with the staples in sharp contrast with what is usually observed in the highlands of central Ethiopia. Alley cropping with *Khat* as the woody species is widely practiced in Fedis District where out of all farmers (30) interviewed and observed in Fedis District, about 82% reported cultivating *Khat* while the number is much less in Midega where most of the fields are covered by cereals (sorghum and maize) intercropped with groundnut, sweet potato and sometimes common bean. Visual observation also shows that Fedis farms had higher frequency of alley cropped *Khat* as seen in Figure 13. However, there appears to be modifications with regard to intercropping of the staple cereals with *Khat (Catha edulis)* and other crops (groundnut and common bean) perhaps mainly triggered by the growing market values of this crops. Development agents and farmers explained that the *Khat* shrub *is* annuall*y pruned* from the ground level to encourage sprouting of more harvestable young shoots for the lucrative domestic and external markets and to provide more space between the rows of this widely planted shrub species for sorghum and other crops. Maximizing yields of grains as well as cash income from commercializing Khat have been the major driving forces that transformed the agricultural landscape into a complex of traditional agroforestry system with a major alley/strip cropping component.

Figure 11. Partial view of the Alley cropping agroforestry system in Gobele catchment

2.7.1.3. Grain Crop-intercropping with root and cash crops (home-garden) Agroforestry Systems

The main crop in the intercropped farms is sorghum. All interviewed farmers had sorghum and 93% of them had maize among the list of crops they cultivated. The crop

production system can be described as sorghum-maize culture with maize being more affected by the dry climate and shortage of rain. Hence, sorghum is the main crop with large area coverage, and being cultivated by all farmers and with more varieties such as *Wegere*, *Muyra* and *Red* types among others. Intercropping is done with groundnut, sweet potato, common bean and other minor crops and sometimes with.

Figure 12. Grain-intercropping with root crops and cash crops in backyard gardens (home-gardens) in the agricultural landscape of the Gobele catchment (Aneni Kebele)

2.7.2. Plant Agrobiodiversity in Gobele Catchment Landscape

2.7.2.1. Plant Species Richness in the Agricultural Landscape

Farmers in the Gobele catchment landscape cultivate many domesticated plants and use products from these and from many non-domesticated plants accessed from the surrounding environment. People in the study area use many species of plants in their food systems that include human food, livestock feed and products that are used for production, transport, storage, processing and preparation of food. A total of 73 useful plant species (see Annex 1), have been recorded from the study area through interviewing, discussion complemented with direct field observation.

Cultivated plants diversity

The cultivated plants that consisted of 30 species and distributed in 18 families are presented in Table 10 along with their frequencies of occurrence. The taxonomic diversity is presented in Figure 15. About 70 % (21 species) are herbs and most of the remaining species (trees and shrubs) are not only few but they are either minor fence species or scattered fruit crops. With respect to crop functional categories, two major cereals (sorghum and maize) with several farmer-recognized varieties, several legumes, root/tubers, oil, fodder, fruits, vegetables and other categories complementing the taxonomic richness have been recovered.

Among the 30 cultivated species, 27 of them or 90% were recorded from the Kebeles in Fedis Woreda while 20 of the crop species or 67 % were recorded in Midaga Tola Kebeles. The frequencies of each crop species were generally higher in Fedis than in Midega. Considering individual crops, the occurrence of *Khat* was more in Fedis while in Midega more sesame and sweet potato were observed both from interview results and visual observation during the guided field tour. Further analysis of the collected data showed that the crop species have a few major landraces of sorghum, maize, common bean and kale. The frequently encountered species were *Sorghum bicolor*, *Zea mays*, *Arachis hypogea* and *Catha edulis* with respective relative occurrences of 93, 83, 80 and 60 percent in the entire study area.

Khat or Catha edulis is popularly grown as it is a cash crop for export to the neighboring countries. For this reason, significant amount of the farm fields are allocated for *Khat* production than food crops. This might have contributed to food insecurity and production insufficiency in the area, which might have contributed to the permanent food aid during the shortfalls. According to the Development agents, about 75% of the cultivated land is devoted to long season traditional varieties of sorghum (*Muyra, Wegere* and others) intercropped with groundnut. The former is the main staple food and the latter is a cash crop along with *Khat*. The remaining 25% of the cultivable land is annually planted with early maturing maize (*Shote*) and upon its harvest in June or July of each year, the same farm plot is planted to common bean, early maturing sorghum varieties and chickpea during the same cropping season. The long season sorghum is preferred by farmers over the short season high-grain-yielding improved varieties because it provides reasonable grain yield, best feed quality and has superior values for construction purposes.

Despite repeated efforts to promote very high yielding improved sorghum varieties, farmers preferred to continue cultivating their traditional varieties. While further research may show if there are additional attributes of the improved varieties such as grain qualities, there appears to be enough reason already to guide the research towards breeding of farmer preferred sorghum varieties that may combine the good qualities of the new varieties and the farmer-preferred attributes of the traditional varieties. This observation calls for motivating participatory sorghum variety selection and participatory breeding where farmers take part in the entire process.

Table 10. Cultivated plant species, frequency in farms and habit (H = herb, T = Tree, S = Shrub)

No	Scientific Name of Plant	Family Name	Growth Habit	Local Name	Frequency	Relative Percentage
1	*Sorghum bicolor*	Poaceae	H	*Mishinga*	28	93
2	*Zea mays*	Poaceae	H	*Bokolo*	25	83
3	*Arachis hypogea*	Fabaceae	H	*Lozi*	24	80
4	*Catha edulis*	Celastraceae	S	*Jima*	18	60
5	*Linum usitatissimum*	Linaceae	H	*Qonxir*	10	33
6	*Phaseolos vulgaris*	Fabaceae	H	*Atara*	8	27
7	*Psidium guajava*	Myrtaceae	T	*Zeytuna*	7	23
8	*Cucurbita pepo*	Cucurbitaceae	H	*Bakil/duba*	6	20
9	*Ipomoea batatas*	Convolvulaceae	H	*Mitatisa*	6	20
10	*Sesamum orientale*	Pedaliaceae	H	*Salixa*	6	20
11	*Jatropha curcas*	Euphorbiaceae	S	*Abata muluk*	5	17
12	*Mangifera indica*	Anacardiaceae	T	*Hanbe/mango*	5	17
13	*Phaseolus vulgaris*	Fabaceae	H	*Atara baqula*	5	17
14	*Brassica carinata*	Brassicaceae	H	*Rafu*	4	13
15	*Capsicum annuum*	Solanaceae	H	*Quache*	4	13
16	*Citrullus lanatus*	Cucurbitaceae	H	*Habhab*	4	13
17	*Coffea arabica*	Rubiaceae	S	*Buna*	3	10
18	*Ricinus communis*	Euphorbiaceae	H	*Qobo*	3	10
19	*Vigna radiata*	Fabaceae	H	*Masho*	3	10
20	*Allium cepa*	Alliaceae	H	*Shinkurta*	2	7
21	*Brassica sp.*	Brassicaceae	H	*Rafu-hulo*	2	7
22	*Hyparrhenta sp.*	Poaceae	H	*Chita*	2	7
23	*Lycopersicon esculenta*	Solanaceae	H	*Timatima*	2	7
24	*Solanum tuberosum*	Solanaceae	H	*Dinicha*	2	7

25	*Allium sativum*	Alliaceae	H	*Qulubi*	1	3
26	*Annona reticulata*	Annonaceae	T	*Hambeshok*	1	3
27	*Citrus sinensis*	Rutaceae	T	*Burtukana*	1	3
28	*Euphorbia tirucalli*	Euphorbiaceae	S	*Qinchiba*	1	3
29	*Lantana camara*	Verbenaceae	S	*Bekergeta*	1	3
30	*Terminalia brownii*	Combretaceae	H	*Biresa*	1	3

Among the total families and species, the Fabaceae, Poaceae and Solanaceae yielded 3 species each while Alliaceae, Brassicaceae and Cucurbitacee yielded 2 species each. About 11 families are represented only by a single cultivated species (Fig.13). The Euphorbiaceae has three species but all are found along fence lines and are not considered proper crops by the farmers though concerned about their presence for uses as fence and for some other uses.

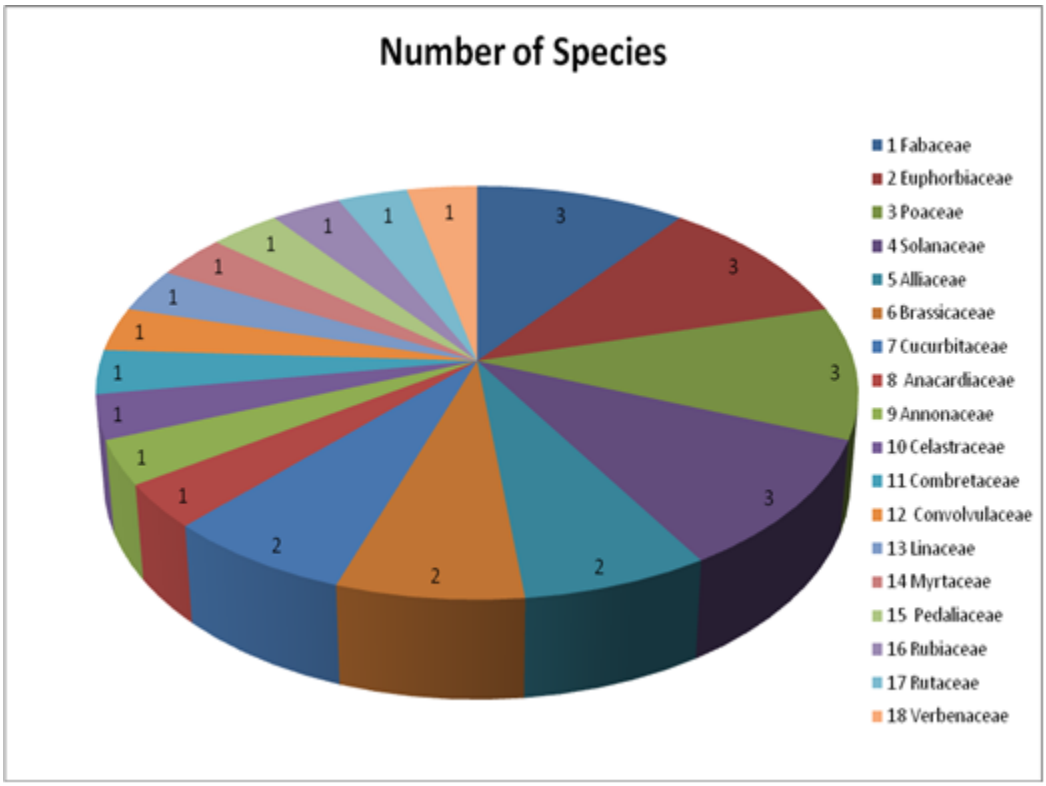


Figure 13. The total number and occurrence of plant agro-biodiversity species in the agricultural landscape

Most of the plants in the agrobiodiversity system have multiple uses. These include edible fruits, medicine, food, feed and wood with higher frequency of responses than the others. However, edible fruits, edible oils, vegetables and spice are also sub-categories of food. Furthermore, plants used in the local food system belong to different categories (all those related to human food including edible fruits, edible oils, vegetables and spice and those that support the food system including farm implements, wood, fiber/cordage, feed, fencing and others that are used in food production preparation, transport, storage and processing). Figure 14 below shows responses of farmers on plant uses.

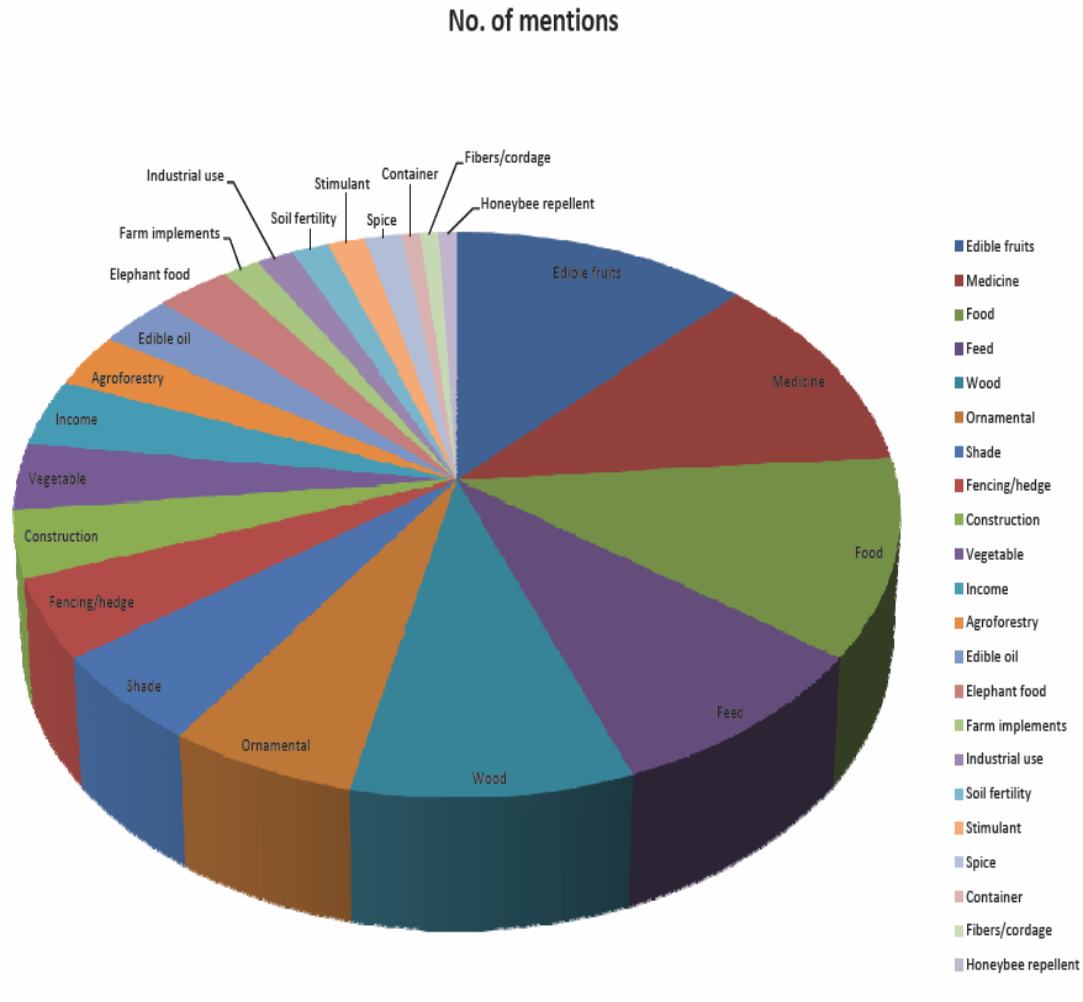


Figure 14. Plant use diversity as reported by the local farmers in the Gobele catchment

The food crop agrobiodiversity in the Gobele catchment is highly diverse considering the species and varieties recorded during the field observations. However, paradoxically the

area is grouped among the food insecure areas. Part of the reason could be that a large area of the land space is allocated to a commercial non-food crop, *Khat*. Among the crops cultivated, *Khat*, groundnut, onion (*Allium cepa*), mung-bean (Vigna radiata) and common bean are good sources of cash income. Also included are some high value crops such as flax and sesame provided the amount of production is increased above home consumption. Crops and varieties that are more suitable for the area as they are known to survive drought periods are given in Table 11. These crops and varieties are very important in the area particularly for the drier conditions of Midega Woreda. Emphasis needs to be given to these crops in future in view of promoting climate smart options in order to prepare for coping with the anticipated climate variability.

Table 11. Early maturing crops (local and improved varieties) that are adapted to drought situations in the Gobele catchment landscape

No	Crops and crop varieties	Days for maturity
1	Local variety of maize (*Zea mays*) called *Buquri* or *Shote*	90
	Improved variety of maize (*Zea mays*) called *Melkasa-4*	90
2	Improved varieties of sorghum (*Sorghum bicolor*) called *Gubiye, Abshire, Teshale, Berhane, Meko, Gedo, Melkam (*all from Prof. Gebisa Ejeta's research)*	90
3	Mungbean *(Vigna radiata)*	*60*
4	Local variety of *Catha edulis* called *Amercot*	*90*
5	Common bean *(Phaseolus vulgaris)*	*90*
6	Sweet potato *(Arachis hypogeal)*	*90*

*Explanation by the DAs

As reported by the DAs, farmers apply the blended type of fertilizer to most crops. While this is better than using full packages of inorganic fertilizers, it needs to be gradually replaced by agroecologically intensive farming system to reduce the cost of fertilizer input and enhance agroecosystem restoration. There is an international move to shift to eco-agriculture for food security and ecosystem stability (van Tol, 2016). The Gobele catchment landscape is suitable for many leguminous crops and trees to allow this and there is already an established practice, which may require enhancement and intensification.

Wild useful plants diversity

Of the 73 plant species (Annex 1) recorded as the useful components of the plant agrobiodiversity in the Gobele catchment, about 59% are wild useful plants. Most of these plants are found in the natural vegetation and sometimes in the agricultural landscape as weeds and those remaining behind when the natural vegetation is replaced by crops. Some of the more promising useful wild plant species are listed categorically in Table 12 under wild edibles, medicinal, shade, ornamental, feed and industrial use, some multipurpose species appearing in multiple categories. In each case, the more promising species are included. These species are selections from a long list and further selections

of the best of the best can be considered to recommend them for priority intervention. Some species appear in multiple categories and this testifies their multipurpose nature. Given the limited land space of the farmers, multipurpose species will be much desired for benefitting from a few species without taking much space.

Table 12. List of Wild useful plants and their multiple uses in the order of development priority in the Gobele catchment landscape

A. Wild plants reported to be eaten		**Uses and promises for development**
1	*Ximenia americana*	Commercializing fruits as it happens traditionally, processing as jams, soft drinks, fruit juice and fruit salads.
2	*Oncoba spinosa*	
3	*Ziziphus spina-christi*	
4	*Opuntia ficus-indica*	
5	*Carissa spinarum*	
6	*Tamarindus indica*	
7	*Berchemia discolor*	
8	*Cordia africana*	
9	*Grewia tricocarpa*	
10	*Grewia tenax*	
11	*Lantana camara*	
B. Wild plants suitable for fence lines		**Uses and promises for development**
12	*Jatropha curcas*	These are prioritized based on suitability as live fence species and use of products for food, medicine, hone production and commercialization in various forms.
13	*Ximenia americana*	
14	*Ziziphus spina-christi*	
15	*Oncoba spinosa*	
16	*Ehretia cymosa*	
17	*Euphorbia abyssinica*	
18	*Euphorbia aff. adjurana*	
19	*Calpurnea aurea*	
20	*Commiphora* cataf	
21	*Ricinus communis*	
C. Wild plants said to be used in traditional herbal medicine		**Uses and promises for development**
22	*Dodonaea angustifolia*	These are useful in traditional medicine, for honey production as honeybee forage, agroforestry trees, promising for developing modern pharmaceuticals and cosmetics
23	*Acokanthera schimperi*	
24	*Ehretia cymosa*	
25	*Ximenia Americana*	
26	*Aloe pirotae*	
27	*Aloe megalacantha? (giant aloe)*	
28	*Berchemia discolor*	
29	*Calpurnea aurea*	
30	*Carissa spinarum*	
31	*Cordia africana*	

D. Wild plants with livestock feed quality		**Uses and promises for development**
32	*Sesbania sesban*	Livestock feed, browse, honeybee forage, agroforestry trees, soil fertility
33	*Terminalia brownii*	
34	*Acacia albida*	
35	*Acacia tortilis*	
36	*Grewia ferruginea*	
37	*Grewia tenax*	
38	*Grewia tricocarpa*	
39	*Different grasses (e.g. Hyparrhenta* sp.) *and many herbs*	
E. Woody species (shade, wood, implements, construction)		**Uses and promises for development**
42	*Acacia albida*	Shade, wood, multiple functions as livestock feed, honeybee forage, agroforestry trees, soil fertility
43	*Acacia tortilis*	
44	*Ficus vasta*	
45	*Terminalia brownie*	
46	*Acokanthera schimperi*	
47	*Combretum* sp.	
48	*Euphorbia abyssinica*	
F. Wild plant species for possible use as ornamental plants		**Uses and promises for development**
49	*Pyrenacantha malvifolia*	These can be developed as ornamentals for the urban markets
50	*Plumeria rubra?*	
51	*Drimia sp.*	
52	*Caralluma speciosa?*	
53	*Aloe megalacantha? (*giant aloe*)*	
54	*Aloe pirotae*	
55	*Euphorbia abyssinica*	
56	*Euphorbia adjuranta*	
G. Wild plants that could be considered for possible industrial applications		**Uses and promises for development**
57	*Aloe megalacantha* (giant aloe)	These could be experimentally tested, the last two have already been tested in the study area itself. Re-instating the Jatropha company that is closed would be helpful for prospecting new potential species.
58	*Aloe pirottae*	
59	*Commiphora spp.*	
60	*Jatropha curcas*	
61	*Ricinus communis*	

2.7.3. Livestock diversity in the Gobele catchment landscape

Livestock is an important component of the farming system. Households keep reasonable number and different types of livestock as integral part of their livelihoods. They are

sources of mainly income, protein (milk and meat), and skin and hides. The farmers reported about seven different livestock species as shown in Table 13. Only less than 50% of the informants reported having any type of livestock. The most frequent is donkey. In the area, the donkey is a very important transport animal for grain, fire wood and other products to markets. Given that the area is an agropastoral community, the proportion of households, i.e., 47%, who reported owning livestock, is lower than expected despite the fact that people frequently mentioned that the key role of the donkey to their life and that in some parts of the study area many households are engaged in market-oriented ox fattening. DAs explained that households fatten their oxen during the rainy season and sell them on the onset of the dry season and buy smaller oxen/bulls for fattening and selling. Thus, they keep less oxen during the dry season as a copping strategy not to expose their animals to the dry, feed and water deficit period of the year. Farmers reported that the crop residue is a very important livestock feed listing some 11 species used for this purpose. Of these, by far the most important species are sorghum reported by 93% of the informants and maize reported by 83% of the informants. Farmers noted that, when hungry animals eat almost any plant and this indicates how feed becomes very scarce in some seasons.

Table 13. Types and frequency of livestock reported by respondents in the Gobele catchment landscape

No	Scientific Name of Domestic Animal	Common English Name	Local Name	Present	% of Total
1	*Equus africanus asinus*	Donkey	Hare	14	47
2	*Capra aegagrus hircus*	Goat	Re'ae	13	43
3	*Bos Taurus*	Cattle	Lon	10	33
4	*Gallus gallus domesticus*	Chicken	Lukkuu	9	30
5	*Ovis aries*	Sheep	Hola	8	27
6	*Camelus dromedarius*	Camel	Gala	6	20
7	*Apis mellifera*	Honeybee colony	Kenisa/Gagura	2	7

2.8. Wildlife (Wild animal) resources

The BES is known to have several wildlife species such as Black-manned Lion (*Panthera leo*), Cheetah (*Acinonyxju batus),* Leopard (*Panthera pardus*), African Elephant (*Loxodonta africana*), antelopes such as Lesser Kudu and Greater Kudus (*Tragelaphus sciptus),* (Minilik bushbuck and common bushbuck), Hamadryas baboon (*Papio anubis*), hyena (*Crocuta crocuta*) and Vervet monkeys. However, poaching, charcoal production, extensive deforestation for fire wood collection and agricultural expansion are series threats to the Sanctuary. In the Gobele catchment landscape, farmers reported the presence of many of the above listed wild animals, especially in the natural vegetation part of the Gobele river valley.

From the discussion with local communities, it was obvious that some of the local people may have some interests on some wild animal products and some community members may commit illegal hunting of at least small herbivores. Thus, some incidences of hunting of wild animals like antelopes (bushbuck, dik-dik) may take place in the protected area. Local community members also hunt some primates to protect crop attack, domestic animals and water points. Thus, as commented by farmers, the human-wildlife conflict is more of prevention of attacks or defense (human, livestock, crops) rather than for product use in the Gobele Catchment. In such situations, conflicts are inevitable and it is necessary to consider the right conflict resolution options. This conflict can best be handled by protecting the natural vegetation from human destruction, thus containing the wild animals in the natural vegetation as they get sufficient resources without having to cross to the human territory. The domestic animals should also be kept around the villages and farms by growing fodder species as observed in many families and optimizing the use of crop residue through enhancement of the traditional practices. In case conflicts between animals (elephants and others) and people continue to be problems, traditional conflict resolution strategies like discussion between senior members of the local community or the entire community on the one hand and professional working in the area and local administrators must sit around the table and design ways of overcoming the problem and be committed to enforce such jointly agreed upon rules/bylaws and guidelines. The EBI must spearhead the development of such community bylaws with the experience it already had in other parts of the country.

2.9. Socioeconomic conditions

2.9.1. Land holding

Landholding is among the top productive assets that rural smallholders consider a greater potential to lift themselves out of poverty, ensure food security and promote rural development (According to (Barrett et. al., 2001). Landholding is, hence, very important to the households in the rural Kebeles at Fedis and Midega Tolla Woredas. The average landholding size of a household in the Gobele catchment is 1 hectare at Fedis Woreda and 1.5 hectare at Midega Tolla. The overall average is 1.25 hectare. This figure is larger than the national average of landholding of households, which is 1.17 hectare (CSA, 2014). FAO (2012) defines smallholder farmers as those who own land size of less than 10 hectare and hence the farmers in the Gobele catchment are smallholders. The minimum landholding size is as small as 0.25 hectare.

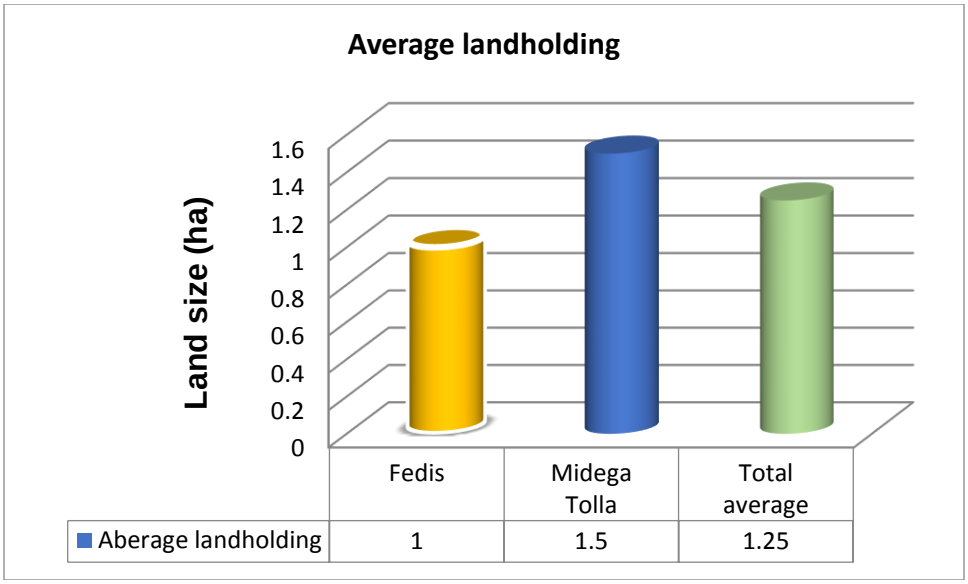


Figure 15. Landholding size of households in the Gobele catchment landscape of the respective woredas

Even though the land size is small, farmers use their plots for multiple crops production through intercropping and relay cropping of Sorghum, Maize, Beans, Groundnut, *Khat* and vegetables (mainly Potato, Sugar beet, and Chilli pepper) (Table 14).

Table 14. Allocation and use of land for different crop production by households in the Gobele catchment landscape

Crop Types	% of Usage	Remark
Cropping sorghum, maize, groundnut and others	75.2	Intercropped with the others, the farmers estimate that **groundnut** covers up to 25% of their land.
Khat	24.4	
Vegetables	0.4	

2.9.2. Agricultural production and products by households

The major agricultural products by households in Gobele catchment (in both Fedis and Midaga Tola woreda Kebeles) include livestock (goats, cattle, sheep, camels, donkey, chicken), cereals (sorghum, maize and rarely wheat), vegetables (Chilli pepper and rarely cabbage and onion) and pulses (haricot bean and chick pea) (Fig. 16). They also produce oilseeds (mainly groundnut), cash crop *Khat*, fruit (slighly mango at Fedis) and honey. The communities produce most of the agricultural products primarily for subsistence (home-consumption). *Khat* and groundnut are mostly, about 90-95%, for commercial.

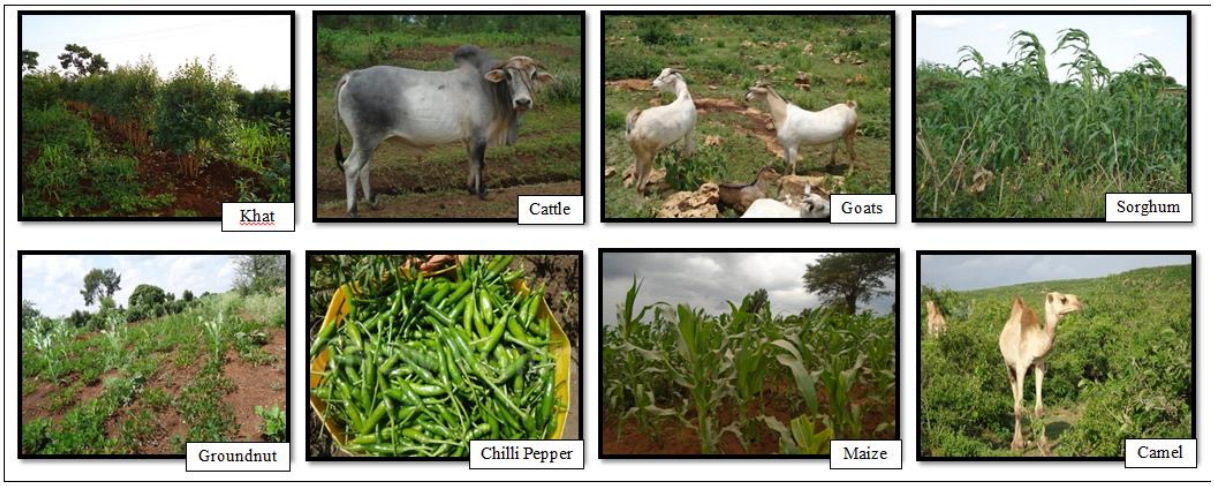


Figure 16. Some examples Types of agricultural products in the Gobele catchment

2.9.3. Livelihoods and major sources of income

The main livelihood sources (income sources) are ranked by surveyed households. the majority of the households in Gobele catchment (Fedis and Midaga Tolla) indicated that crop production is the main source of livelihood followed by mixed crop and livestock (Fig. 16). The next three important sources of livelihood are livestock alone (semi pastorals), selling firewood and charcoal, selling of timber and employment as forest guards. The rest are off-farm causal jobs (labor), remittance and petty trade. This shows that crop and livestock are the main sources of living for households. Firewood collection and charcoal making (cutting of trees from the sanctuary) is most severe in the Midaga Tola part of the catchment as the remaining natural vegetation is largely found there and crop cultivation is not effective because of drier climate.

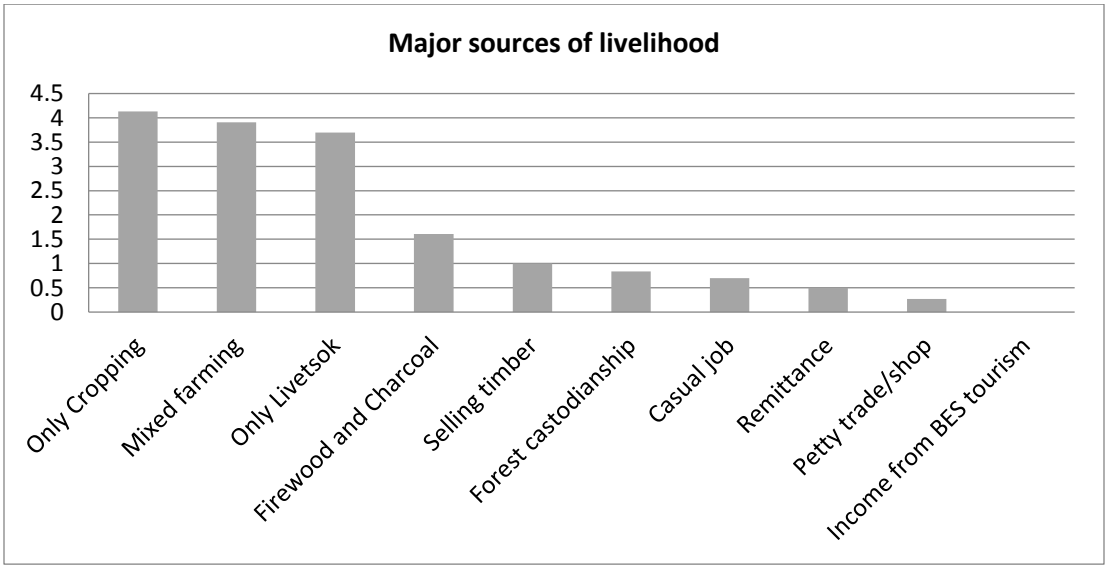


Figure 17. Sources of livelihoods as reported by farmers in the Gobele catchment landscape

The survey on most frequently marketed products suggest that almost all farmers sell chicken and egg more frequently as means of small income than other products. Although *Khat* and groundnut are specifically produced for cash income, they are marketed seasonally when harvest is possible. As shown in Figure 18 below, the next most marketed products are *Khat* and groundnut. The marketable products such as groundnut, *Khat*, goats and oxen suggest the potential to engage the households in promising business opportunities essential to improve their livelihoods.

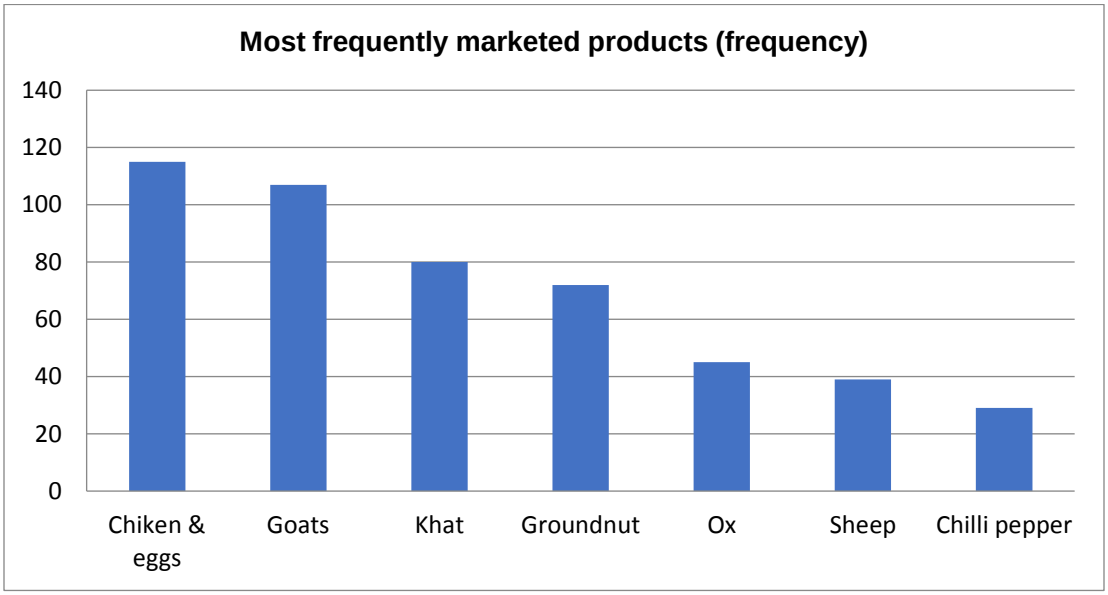


Figure 18. Most marketed products as reported by households in the Gobele catchment

2.9.4. Sources of energy for households

The main source of energy for domestic use (cooking and heating) in the Gobele catchment is biomass and solar (Fig. 19). Small proportion of the farmers use charcoal and electricity. Those who have access to electricity are those in the nearby vicinity of the capital town Boko in Fedis woreda. The firewood is collected mainly from the natural vegetation in the Sanctuary. This has put a lot of pressure on the vegetation resources as matured trees are largely removed from the stand. Firewood is a good source of income not only for local communities but also for people coming from distant Kebeles to collect firewood in the protected area.

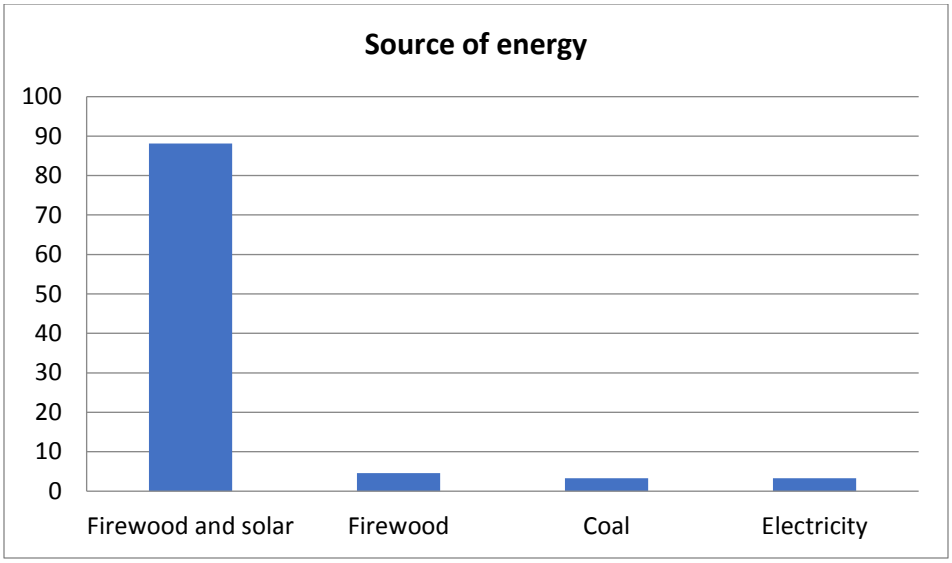


Figure 19. Sources of household energy in the Gobele catchment

2.9.5. Access to finance and microcredit schemes

Access to financial institutions is very limited in the study catchment. As indicated in Table 15 below, 70% of the respondents reported that access finance is through informal sources such as loans from friends and relatives. Almost all respondents (98 %) reported that accessing finance from community funds is rare and limited. There are no social mechanisms such as Equb, or formal sources like microfinance and banks. Although some formal institutions such as banks are available in towns, the interest is the deterring factor for not using banks for loans and saving as well.

Table 15. State of access to financial sources to local farmers

Access to	**Very difficult (%)**	**Difficult (%)**	**Moderate (%)**	**Easy (%)**	**Very easy (%)**
Friends and relatives	2.7	4.6	22.7	28	42
Rich households	22.7	23.3	38	10	6
Community-based (endowment/rolling) funds	98	2	0	0	0
Applied for loan to (%)				**Yes**	**No**
Rich households				50.7	49.3
Microfinance				7.3	92.7
Community-based fund				1	99
Commercial banks				2	98

Over 50 % of the households indicated that they deposit their savings at home followed by no saving at all. Most often, saving is not the cultural norm and incomes are spent and

not often portioned for saving. Very few of the households indicated that they have saving with commercial bans and Oromia micro finance institution (Fig. 20).

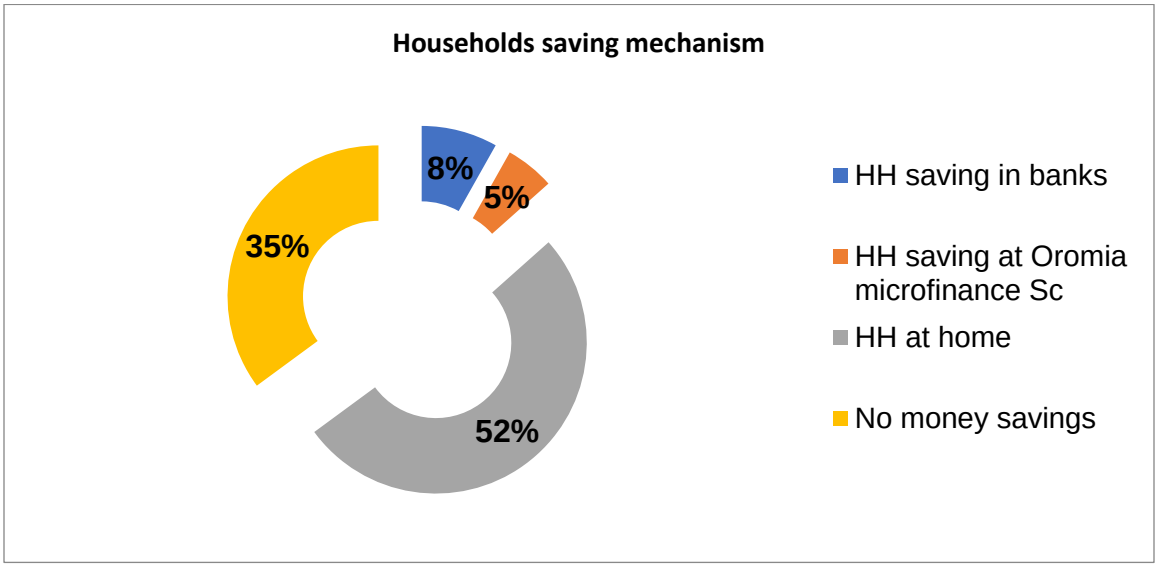


Figure 20. Modes of saving by households in the Gobele catchment landscape

Access to finance are limited for a number of reasons. As shown in Figure 20 below, physical inaccessibility and absence of interest free packages are major reasons. In addition, limited outreach by formal institutions, limited options in the financial packages and lack of interest free financial options by the existing financial institutions are also major constrains. Responses suggest that only 51 % of the households applied for loan from rich households and only 7 % applied to microfinance institutions (Table 15). Almost all the respondents (99%) have not applied to borrow from community-based funds as it is not available for households not registered as safety net beneficiaries. About 98% neither applied nor borrowed from commercial banks mainly because they do not need to borrow from the banks (because of interest) and/or the options are not available in their vicinity.

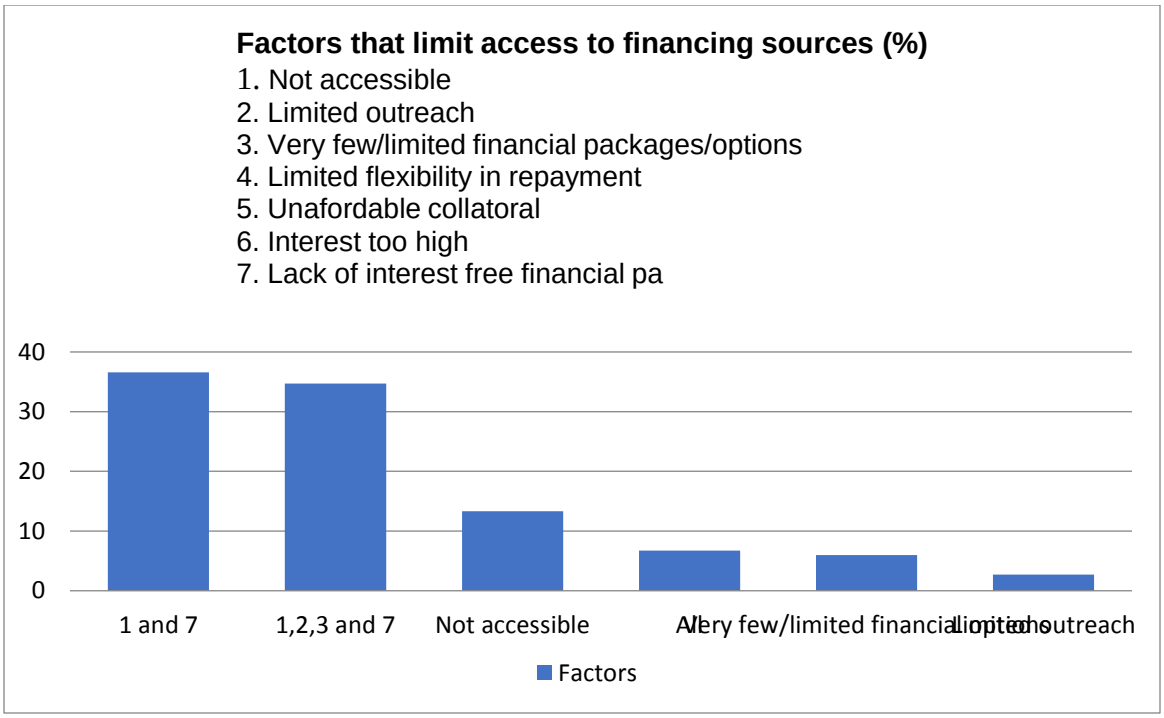


Figure 21. Factors limiting access to financial sources as reported by households in Gobele catchment

3. Major problems of natural resources management in the landscape

3.1. Vegetation clearing for agriculture

The woodland vegetation is being extensively cleared along the buffer areas of the boundary to the sanctuary. Cultivation is expanding towards the valley. This trend is observed in Fedis and Midaga tola Kebeles. In the Fedis Kebeles, especially in the Aneni and Agudora Kebeles, the parkland agroforestry is expanding followed by fully cleared Khat-based intercropping is developing into the sanctuary. In the Midaga Tola Kebeles, a more extensive land clearing, supported by machinery is taking place. This is a serious threat to the Sanctuary and the wildlife therein. The expansion of cultivation and settlement is also taking place in the valley bottom.

Figure 22. Partial view of the land clearing for cultivation expansion in the Midaga Tola Woreda (Kerensa Kebele)

3.2. Wood extraction and charcoal making

Firewood and charcoal selling is one major source of income for the local communities. Most of the tree species such as *Acacia tortilits, Combretum collinum* and *Terminalia brownii* are preferred for firewood and charcoal. Hence, the mature trees are selectively removed in the vegetation stand. There are lots of old and fresh stumps clearly observed in the vegetation. Besides, biomass is the main source of energy to the local communities and also to the majority in the nearby towns. Thus, the local communities are using the natural vegetation as source of income from the sale of firewood and charcoal. Wood extraction is very high in the lower part of the Gobele catchment in the Midaga Tola woreda Kebeles.

Figure 23. Some examples of wood and charcoal extraction in the Lencha Kebele

3.3. Livestock grazing and competition with wildlife

One of the main interferences of the local communities is grazing of their livestock inside the Sanctuary. Not only communities residing in close proximity to the protected area but also from surrounding Kebeles use the Sanctuary as an open grazing area. The reasons mentioned by farmers are shortage of grazing land, absence of supplemental feed and critical shortage during the dry season. Although bull fattening is traditionally practiced in the area, feed shortage is a limiting factor. Tie-and-feed is a well-established practice in the area and farmers use cut-and-carry methods for harvesting crop residues. Stall feeding is not practiced for lack of feed sources, especially during the dry season. There is no delineated buffer zone as such but the transition to the natural vegetation of the Sanctuary is fluid. There is no well-defined hard boundary that people respect. As reported by local farmers, crop attack by wildlife is very common. Especially by Elephants, Baboons and Warthogs.

Figure 24. Some evidences of grazing of livestock and small ruminants in the sanctuary

3.4. Illegal hunting and wildlife-people conflict

Illegal hunting is generally a common problem in the BES. However, farmers reported that it is not severe in the Gobele catchment landscape. Incidental hunting of antelopes takes place for bush meat. Killing of Baboons and Warthogs during crop raid is also common. Elephants occupy the valley bottom and hunting for ivory is not common in the study landscape. However, poachers are reported to have killed several Elephants in the lower parts of the Sanctuary towards the Somali region. The conflict is during crop raids and attack to small ruminants in the Sanctuary and around settlements.

3.5. Soil degradation

In the alley cropping and Khat-based intercropping systems, soil erosion is minimum. Whereas in the parkland agroforestry system, physical structures are rarely implemented and top soil erosion is a common feature. Small stream banks are visibly filled with sediment deposits. In the inter-cropping system, nutrient cycle is well maintained with reasonable return of biomass residues to the system. Whereas in the parkland system, farmers use mineral fertilizers to compensate for lost nutrients by erosion and removal. Generally, physical structures to prevent soil and water are missing.

3.6. Limited access to water

There is critical shortage of water in the Gobele Catchment landscape. The primary source of water for humans and livestock is earthen ponds that capture runoff during the rainy season. There is no access to running pipe water. The Gobele river is quite far from settlements and not readily accessible to people and livestock. During the dry season, ponds dry and communities face serious shortage of water both for humans and livestock.

3.7. Habitat destruction and biodiversity loss

The BES in general and the Gobele catchment in particular is rich in plant diversity, hosting several endemic plant species. In the agricultural landscape as well, there are varieties of crops cultivated by farmers as discussed in the previous sections. The natural vegetation is part of the large woodland vegetation type that is covering the entire eastern and south eastern lowlands, which is well known as part of the Horn of Africa biodiversity hotspot. It is known for its avifauna diversity and also mammals that are unique and endemic to the ecology. However, there is a continued expansion of cultivation by clearing the natural vegetation and degradation due to selective cutting for charcoal and fuelwood. Grazing and pockets of settlements are also widespread in the lowlands and valley bottoms. Although Commiphora species should have been well represented in the vegetation belt, it was found restricted only to the lowlands and valley banks. Hence, habitat degradation is risking biodiversity loss.

4. Management Actions for intervention

4.1. Management objectives

4.1.1. Overarching goal

The overall goal of the integrated landscape management plan is to guide management actions in the priority landscape to achieve the conservation and sustainable utilization of biodiversity and agrobiodiversity resources by involving key stakeholders, ensuring the active participation and ownership of the management actions by the local communities. Successful achievements in the priority landscape will eventually serve as a learning model for the sustainable management of the BES in harmony with the surrounding agricultural landscapes.

4.1.2. Specific objectives

The landscape approach to forest and agrobiodiversity conservation is a new concept and being popularly promoted in protected area management. The approach integrates conservation and management of natural ecosystems along with agricultural landscapes in a continuum of a large landscape unit. The focus is on understanding the value of agrobiodiversity by the local communities living in the surroundings of protected areas targeted in PA management and biodiversity conservation.

- Effectively protect the vegetation cover of BES and the natural scenic beauty of the area with its rich biodiversity as a sustainable major tourist attraction site that can continuously generate income
- Effectively protect the wildlife resources of the BES as a sustainable major tourist attraction site that can continuously generate income
- Develop elements of cultural and historical tourism in the surroundings of the BES to be attraction factors for tourism and generate income
- Promote/improve the production, sustainable utilization and conservation of agrobiodiversity resources in the landscape
- Improve access to finance and suitable credit facilities for local communities to diversify their livelihoods and reduce the dependence on natural resources exploitation
- Improve agricultural productivity and reduce or avoid expansion of cultivation towards marginal and forest lands
- Establish micro-credit scheme in the form of a revolving and community managed fund so as to improve access for credit to low income farmers who could not meet the criteria prescribed by the formal institutions
- Promote the value chain for high value marketable products
- Maximize the opportunity to augment household income by promoting and increasing production of marketable non-forest products such as frankincense

- Introduce and implement land management technologies to reduce the risk of soil erosion and soil fertility decline in the agricultural landscape
- Develop tourism infrastructure and promote tourism economy to benefit local communities and to sustainably manage the biodiversity resources in the national park

4.2. Identified major management interventions

As briefly described below, ten major categories of management interventions are identified along with specific actions. The details of activities under each category are provided in Table 15. The interventions were identified based on the analysis of existing problems in both the natural and agricultural landscapes and the social dimensions. The interventions will address the existing problems as well as achieve effective conservation and sustainable utilization of agrobiodiversity and biodiversity resources in the natural and agricultural landscapes, in the BES in general and in the Gobele catchment in particular.

4.2.1. Production and promotion of high-value and marketable agro-products

4.2.1.1. Improving the production of Organic Honey and developing the value chain

Honey is locally produced both in the natural vegetation and in traditional forms around homesteads. It is purely organic and can fetch high market price. Honey is among the least marketed product in the area because of very small volume of production. However, considering the high diversity of vegetation in the natural ecosystem (in Sanctuary), there is a high potential to improve yield and engage more number of farmers in the business. It is feasible to introduce more productive modern beehives to be placed in backyards or in margins of the protected area. Production volume can be increased and quality can also be improved if the necessary technical and material support is provided. The organic honey can be eco-labeled and linked to the central market. Producers can form associations and can benefit better from their honey production.

4.2.1.2. Increase the production of groundnut and develop the value chain

Groundnut is produced in intercropping with Sorghum and Maize. Farmers traditionally produce the crop for cash income. Despite the experience, the high market value and the need for the product in the central market (as an input for industrial production), the production per household is very small. The volume of production is very much limited due to land shortage and also the view of farmers that it is a sideline cash income crop rather than a major income earner like *Khat*. Hence, the production can be increased and expanded to larger areas. The main bottleneck is the market linkage. The local prices are low compared to the central market. For example, a Kilo of groundnut is sold for 6 Birr at

the local market while it is tenfold in the central market. Thus, increasing production volume and developing the market linkages improved the income from the crop.

4.2.1.3. Increase production of marketable agricultural crop products

In the home-garden agroforestry systems, there are important agricultural products that are marketable and can generate significant income for local livelihoods. These products include Chilli pepper, sweet potato, Linseed, Mung bean and other pulses such as Haricot bean. Although not tested, it is also possible to introduce cassava, is suitable for inter-cropping in the local climate. These products are cash crops and can be promoted in the production system. They contribute to food security and supplement the nutritional needs. are produced as supplements to the household food security. However, the volume of production can be increased by engaging more farmers and allocating more land for such products. Those products are good sources of household nutrition and income.

4.2.1.4. Increase incense and gum production and create market linkages, develop value chain

The commiphora species and Acacia species are suitable for producing incense and gum arabic for market. Several studies have been conducted on the potential of production and market values. Promoting the production of this product will significantly support the livelihoods of the local communities and reduce the pressure on the natural vegetation. The current production at local level is very limited by the proper collection methods, restrictions, poor management and promotion of the activity as a viable income source and also poor market linkage. Farmers are interested to be engaged in the business with proper support on training, technical skills and market access.

4.2.1.5. Increase fruit production and marketing, and develop the value chain

Harar is well known for its fruit varieties and production. The Fedis and Midaga Tolla Woredas are suitable for lowland fruit production. There are different varieties of fruits grown in the agricultural landscape. The most common is mango (*Mangifera indica*) followed by Water Melon. The production of mango is very limited to few stands of scattered individual trees around homesteads. However, the climate and soil is suitable for variety of lowland fruits such as Guava (*Psidium guajava*), Casmir (*Casimiroa edulis*), Citrus fruit *(Citrus sinensis)*, avocado (*Persea americana*), Banana (*Musa paradisiaca*), Papaya (*Carica papaya)*, and *Annona squamosa* (*Sweetsop, or Ambeshock or Gishta).* These are not introduced to the area but have immense potential to be integrated into the farming system in the agricultural landscape with additional roles in protecting the land from soil erosion, contributing to fodder availability and optimizing organic honey production.

There is a great market potential and opportunity to engage more farmers in the production of fruits. In addition, linking the production with the central market will bring more benefits to farmers. Hence, increasing the production, creating market linkage and developing the value chain will contribute to agrobiodiversity conservation, nutrition diversification and livelihood improvement in the landscape.

4.2.1.6. Promote and improve bull and small ruminant fattening and develop the value chain

Fattening is a well-established practice in the area. Harar beef bulls are very popular. There is already this business by a number of households. Although small ruminants (shots) are common in the area, market-oriented fattening is not promoted. However, there is a great potential to promote and improve the practice to an organized business level. In the lower Kebeles (Kerensa and Lencha), small ruminant fattening is more suitable because of the availability of relatively better access to forage sources. In the upper Kebeles of Fedis, bull fattening is more suitable because of the availability of better feed source in the farm fields (divers and integrated crop production providing biomass). There is also a possibility that forage species (legumes) can be supplied as feed source in the farming system. Hence, if linked to micro-credit access, farmers can be engaged in this activity to ensure improved income an dfood security.

4.2.2. Establishment of community managed micro-credit Scheme

4.2.2.1. Improve access for credit and saving that can meet the needs of low-income farmers

The majority of the local communities, particularly low-income households do not have access to financial services. The formal financial institutions such as banks are not physically accessible and their loan requirements cannot be met by low income farmers. Besides, interest free services are not readily available for some farmers who do not accept the formal banking service. The Oromia microfinance is not actively present in the area. Hence, a community managed saving and credit scheme with a revolving fund can provide access for credit service and farmers can get loans without any stringent requirements. This will improve local entrepreneurship and create job opportunities for the youth and women. They can involve in small businesses and improve their income.

4.2.3. Introduction and implementation of Soil and Water Conservation technologies in the parkland agroforestry system

In the agricultural landscape, the parkland agro-forestry system is affected by soil erosion, especially in the lower parts of the Gobele catchment (in kerensa and Lencha) Kebeles. Cultivation is expanding towards the natural vegetation in the sanctuary. There are very little evidences of efforts to prevent crop fields from soil erosion. Physical structures are missing. Along stream banks and steeper areas of the fields, evidences of sediment

deposits and minor rill formations were observed. Trees are very sparse and perennial crops are kept to the minimum. This is exposing the soil for erosion. Loss of productivity will result in expansion of cultivation to marginal areas. Hence, Soil and Water Conservation technologies need to be introduced.

4.2.4. Introduction and provision of energy efficient technologies and planting of forage species in homesteads and farm boundaries

4.2.4.1. Provide energy efficient technologies and renewable household energy sources

Biomass is the largest single source of energy for households. There are little efforts to introduce solar lighting systems for individual homes. However, the most serious problem is energy fo r cooking and hence fuel saving stoves are needed to reduce the consumption of wood. Therefore, women groups will be organized to form improved stove producers' association and will produce and distribute two types of fuel saving stoves (Mirt and Tikikil). Besides, solar home light systems will reduce fuel wood consumption for lighting. The farmers are already familiar with the technology and access to fiancé and technology will be crated.

4.2.4.2. Integrate variety of forage species in home-gardens and farm boundaries

Grazing in the natural vegetation is very common. Farmers stated shortage of grazing land in the visited villages. However, the number of livestock per household is quite large and this has to be reduced. Stall feeding and using supplemental feed need to be introduced to farmers so that the dependence on free grazing will be reduced. The feed from leguminous trees is naturally rich in nutrients and increases milk yield. Hence, it is not only reducing the grazing pressure but also the productivity of livestock will increase. In addition, more trees in the farming system will help reduce land degradation and improve soil fertility on top of providing fuel wood.

4.2.5. Develop tourism infrastructure and promote tourism

4.2.5.1. Improve access roads and other tourist infrastructure in the landscape

Access to the Park and mobility within the Park is very much limited. In the Gobele catchment landscape, the access road from Harar is very poor and takes longer time to reach to the Sanctuary. There is a need to upgrade and maintain the road for tourist access. This is very crucial to promote the BES for local and international tourism market. In addition, there are no tourist reception centers at Fedis and Midaga Woredas. This needs to be improved if tourism is seriously taken as one source of livelihood for the local communities.

4.2.5.2. Conduct regular census of wildlife and map their seasonal movement pattern

Currently, there are no clear records of the types, numbers and distribution of the wildlife in the Park. Particularly, the population of keystone species such as the African elephant, lions, etc… is not clearly known. The habitats are also not mapped. Therefore, this is essential for the proper management, utilization and conservation of the Park resources.

4.2.5.3. Clear indication of the boundaries of the BES

The boundary of the BES is not clearly demarcated and the buffer area is not properly managed. The intrusion or in-ward expansion of cultivation is due to the absence of this clearly demarcated boundary of the Sanctuary. Therefore, land mark features have to be put in place to demarcate the boundary and any illegal activity beyond the boundary can be controlled by not only law enforcement bodies but also by local communities. The absence of such boundary resulted in shrinkage of the habitat range for the wildlife.

4.2.6. Restriction of NTFP collection only to the buffer zone vegetation

The local farmers use the natural vegetation as source of bee forage and they hung bee hives within the vegetation. They also try to collect in few areas of the sanctuary incense and gum Arabic. Besides, farmers also indicated that some medicinal herbs ae collected from the natural vegetation. These activities are often associated with firewood extraction and charcoal production. Some settlements have also taken place in the valley bottoms, where the natural vegetation is cleared for crop production. Thus, once the boundary is restricted, the extraction of NTFPs have to be restricted to the buffer zone. If allowed towards the core zone, then there should be strict control and supervision.

4.2.7. Control and stop illegal hunting in the Park

Hunting of small antelopes and other wild animals takes place in the Sanctuary illegally. Some farmers in Kerens and Lencha Kebeles reported that hunting of Kudus for meat, and hunting of primates for preventing crops from attack, takes place in the Gobele catchment. This is quite damaging to the biodiversity conservation role and a risk to its potential as tourist attraction site.

Table 16. Major categories of proposed management interventions with specific activities in the agricultural and natural vegetation landscape

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
Production and promotion of high-value and marketable agro-products	Improve production of **organic honey** and develop the value chain	• Provide modern beehives • Provide training on beekeeping and honey production • Reduce the dependence on wild honey production moving towards eco-honey production in home-gardens and nearby secondary vegetation • Increase the volume of production • Organize farmers into honey producer's associations • Create market linkage to central market • Introduce packaging, eco-labeling, quality labeling and control, develop the value chain	• Improved agrobiodiversity conservation • Improved household income • Diversified livelihoods and reduced pressure on the sanctuary • Improved forest biodiversity conservation	In the agricultural landscape, and in the Khat-based agroforestry system, In the natural vegetation, especially in the Fedis Kebeles

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
	Increase production of **groundnut** and develop value chain	• Engage more number of individual farmers to specialize in the production of groundnut • Allocate more land/plot for groundnut production • Provide technical training on production and management of the crop to improve productivity • Provide inputs (improved seeds) • Organize farmers into producers' association • Develop the value chain for peanut butter processors, create market linkage with the central markets	• Improved agrobiodiversity conservation, • Livelihoods diversified • Household income increased • Land productivity improved • Reduced human pressure on the sanctuary	In the Khat-based agroforestry of the agricultural landscape in Fedis and expand to the cereal based forming in Midaga

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
	Increase **incense and gum arabic** production and create market linkages, develop value chain	• Engage more farmers in incense and gum arabic production (from the natural vegetation) • Promote the protection and management of tree species that produce incense and gum arabic resins in the natural vegetation (Acacia senegal, Commiphora sp) • Provide technical training and support on propagation and management of incense trees • Create market linkage with export and central market • Organize farmers into producers' associations • Provide skill development training to farmers, youth and women on incense harvesting and handling	• Income increased • Landscape protected from degradation • Livelihood diversified • Effective utilization of the natural landscape achieved • Incense and gum resin availability increased • Pressure on natural vegetation reduced • Biodiversity conservation improved	In the natural vegetation landscape, mainly in Midaga Tolla Kebeles along the river valley

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
	Promote and improve **bull and small ruminant** fattening, and develop the value chain	• Engage more number of farmers in the bull fattening and small ruminant fattening • Train and engage youth and women in this business as it requires less space • Provide training on animal management for meat production, tie-and-feed system, management and marketing • Provide alternative options for feed source through forage legume provision, concentrate feed preparation • Organize farmers into fattening group and create access to finance • Create marketing linkage to export market and central market	• Grazing pressure in the natural vegetation reduced • Employment opportunity created • Household income improved • Livelihood diversified	In the agricultural landscape (in the Khat-based agroforestry system and in the cereal-based system) more in Fedis and less in Midaga Tola Kebeles

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
	Increase **fruit** production and marketing, and develop the value chain (avocado, mango, Banana, Citrus, Guava, Casmir, sweetsop or Gishta, Papaya, etc…)	• Engage more number of farmers in fruit production • Provide technical training on fruit production and handling • Integrate fruit production within the home-gardens and marginal spaces around farm fields (boundaries) • Provide planting materials (seedlings) • Create market linkage and develop the value chain • Organize farmers into fruit producers associations	• Livelihood diversified • Agrobiodiversity conservation improved • Income of households increased • Household nutrition supply improved • Pressure on the park reduced • Effective utilization of land achieved • Land management improved	Agricultural landscape (Khat based agroforestry and creal-based production system) in Fedis and Midaga Tola Kebeles
	Increase production of **marketable agricultural crop** products (Linseed, sweet potato, Mung bean, Haricot bean, Chiilli pepper)	• Improve productivity and increase volume of production by engaging more number of farmers • Establish links with research institutes and provide improved varieties of planting materials • Provide technical training on management of the crops • Integrate the production of these crops in the agroforestry systems, home-gardens	• Household income increased • Agrobiodiversity conservation improved • Household food and nutrition security improved • Livelihood diversified	Agricultural landscape Promote such intervention in the Khat-based agroforestry system and Cereal crop-based system in both Fedis and Midaga Kebeles
Introduction and implementation of Soil and Water	Introduce **physical and biological soil**	• Implement physical soil erosion prevention structures in crop fields that have slope more than 5 %	• Soil erosion will be controlled/reduced	Agricultural landscape

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
Conservation technologies	**conservation** measures in crop fields	• Integrate biological measures on physical structures	• Vegetation cover will increase • Biomass availability will be improved • Ground and surface water well managed	Especially in the Midaga Tolla Kebeles, in the Parkland agroforestry system,
Introduction and integration of variety of forage species in alleys, homesteads and farm boundaries	Plant **alternative source of feed for livestock** through forage plants establishment along farm boundaries and homesteads	• Engage farmers to establish forage stands along alleys, farm boundaries, backyards, front yards, etc… for feed and fire • Provide fast growing legume species (e.g., *Acacia albida, Sesbania sesban*, and other fast growing indigenous species) for forage • Provide technical training and seedlings production to farmers • Engage farmers to plant forage species (e.g., *Sesbania sesban*, *Milletia ferruginea*, Leucaena leucosephala, etc…)	• Alternative biomass source provided • Pressure on natural vegetation reduced • Increased supply of feed to livestock • Productivity of livestock improved • Income of households improved	Agricultural landscape, Khat-based agroforestry system, Cereal based agroforestry, parkland agroforestry (Fedis and Midaga Tolla Kebeles)
Providing **energy efficient technologies and alternative renewable energy sources**	Avail energy efficient and fuel saving technologies Avail solar home systems for lighting and small electrical appliances	• Introduce energy efficient cook stoves • Provide training on production of cook stoves • Organize youth and women on cook stove producers' association • Link the business with micro-credit schemes	• Household fuel wood use improved • Energy cost reduced • Deforestation reduced	Agricultural landscape, in Fedis and Midaga Tolla Kebeles

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
		• Introduce solar home systems • Provide access to credit for renewable energy sources • Organize farmers in users and producers' association	• Alternative renewable energy source provided • Supply of energy efficient cook stoves improved • Employment for women and youth created	
Establishment of community managed micro-credit Scheme	Improve **access for credit** and saving that can meet the needs of low-income farmers	• Implement the micro-credit scheme establishment proposal • Organize farmers into associations • Legalize and register the association • Provide revolving seed fund • Provide credit as per the bylaw	• Access to finance and credit improved • The poor, women and youth benefited from the credit services • Livelihood diversified	Agricultural landscape, Fedis and Midaga Kebeles

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
Develop tourism infrastructure and promote tourism	Improve **access roads** and other tourist infrastructure in the landscape to promote eco-tourism	• Upgrade and improve the access road to the Park (from Harar to Fedis, Midaga Tolla) for eco-tourism • Identify and establish touristic trek routes within the Park (to the river valleys, wildlife view spots, etc…) • Establish scenic view sites and tourist spots • Establish Tourist Service Center (information Center) in Harar for BES, in Fedis and Midaga Tola • Establish tourist facilities such as lodges, hotels at BES (Gobele Valley)	• Tourist flow to the sanctuary in creased • Local economy improved from tourism income • Community attitude on the sanctuary positively changed • Country benefited from hard currency earned from tourists • Local youth benefited from jobs created	Natural vegetation landscape and agricultural landscape (Fedis and Midaga Tola)
	Conduct **regular census** of wildlife and map their seasonal movement pattern	• Monitor population of wildlife and their seasonal movement for tourist information	• Wildlife population controlled and managed • Information on wildlife distribution and movement made available	Natural vegetation landscape In Fedis and Midaga Tola Kebele
	Clearly demarcate the BES boundary with landmark features so that communities easily identify and respect it	• Conduct community **consultations** and discussions with respective administration hierarchies for clear demarcation on the ground • Enact bylaw to deter trespassing and violation of the boundary	• Expansion of agriculture reduced • Deforestation reduced • Human-wildlife conflict reduced	In the natural and agricultural landscape (Fedis and Midaga Tola)

Categories of major landscape management interventions	Specific management actions	List of activities to be implemented in the landscape	Benefits and expected Outcomes	Landscape component and Location
Restriction of NTFP collection to the buffer zone vegetation	Restrict access to the natural vegetation for NTFP collection to the buffer zone (transition zone)	• Implement strict regulatory measures (bylaws, formal and informal laws) • Enforce laws with local law enforcement bodies • Capacitate rangers through training and material provision	• Biodiversity better conserved • Forest disturbance and illegal activities reduced	Natural vegetation landscape, transition zone
Control and stop illegal hunting in the sanctuary with informed consent	Stop illegal hunting of wild animals in the sanctuary	• Strictly monitor illegal activities in the sanctuary	• Wildlife conservation improved	Natural Vegetation landscape, in the ACB

5. Implementation, Monitoring and Evaluation

5.1. Implementation

5.1.1. Stakeholders identification and analysis

Integrated landscape management is a multi-stakeholder action that requires the involvement and contribution of all parties with direct and/or indirect influence on the management of the landscape. Integration takes place in the vertical hierarchies and horizonal structures in decision making, which is guided by policy and planning stages. Integration cultivates coordination among multi-stakeholders. Stakeholder involvement and contribution is critical for the successful implementation and sustaining positive outcomes. For the Gobele catchment landscape management, there are several stakeholders with different interests, functional roles and degree of influence. These stakeholders are from different administrative levels of government (federal to Kebele levels), academic, non-governmental organizations and private sectors. Some of them may have a direct role in the implementation and could play a key role in the process. Others may be indirectly linked and may have primary contributions to make in the implementation. Hence, functionally, stakeholders are identified as **implementers**, if they are involved or responsible for the implementation of actions; as **contributors** if they are directly contributing financially or by providing expertise support, and as **beneficiaries** those who directly or indirectly benefit from the implementation of the interventions (Table 17).

Table 17. Description of stakeholders and their roles in the implementation of management actions

Type	Hierarchy/ Level	Stakeholders	Functional Role (Implementor, Contributor, Beneficiary)	Category (Key, Primary, Secondary)
Government	Federal	Ethiopian Biodiversity Institute	Contributor	Primary
		Ethiopian Wildlife Conservation Authority	Implementor and Contributor	Key
		Ministry of Culture and Tourism	Implementor and Contributor	Primary
		Commission for Environment, Forest and Climate Change	Contributor	Secondary
	Regional	Regional Biodiversity Office (Oromia, Somali)	Implementor and contributor	Key

		Regional Culture and Tourism Bureau (Oromia, Somali)	Implementor and contributor	Key
		Regional Environment and Forest Bureau	Contributor	Secondary
		Regional Road Construction Bureau	Implementor	Secondary
	Zonal	East Hararghe Zone Agriculture Department	Contributor	Secondary
		East Hararghe Zone Culture and Tourism Department	Implementor	Primary
		Investment office	Contributor	Primary
	Woreda	Fedis and Midaga Woredas administration	Contributor and Beneficiary	Key
		Fedis and Midaga Woredas agriculture office	Implementor	Key
		Fedis and Midaga Woredas Cooperatives office	Contributor	Secondary
		Fedis and Midaga Woredas Trade and Industry office	Contributor	Secondary
		Woreda culture and tourism office	Contributor	Primary
	Kebele	Agudora/Risiki/Aneni/Kerensa Lencha Kebele administration	Implementor	Key
		Nada Sefera Kebele administration	Implementor	Key
	BES Management Office, Harar	Harar office	Implementor	Key
Academic	Regional	Haramaya University	Contributor	Primary
	Regional	Jigjiga University	Contributor	Primary
Non-government (NGOs)	GIZ Federal	BFP project: biodiversity and forest conservation project	Contributor	Primary
WFP	WFP federal	Food aid provider	Contributor	Primary
Private	Federal and regional	Investors	Contributor and beneficiary	Secondary
	Federal and regional	Tour operators	Contributor and beneficiary	Secondary
Communities	Local	Organized community groups and individuals	Implementor and beneficiaries	Key

5.1.2. Stakeholders consultation on prioritization of management actions

Stakeholder consultation is a key step in the planning and implementation process. It is an iterative process conducted by implementing bodies. The consultation of stakeholders can be conducted according to their functional roles together or individually at the different levels of hierarchy. The key stakeholders and those who are significant contributors and direct beneficiaries need to be given the necessary attention. Among them, some should be included as part of the implementing bodies (as members of a committee or any form of decision-making role in the process). What is most important in this step is that all actions and expected outcomes need to be transparently discussed and all interests or concerns of stakeholders need to be addressed. The ultimate result should be a common consensus on the actions, roles and responsibilities during implementation, monitoring and evaluations of actions. During the consultations, as proposed in Table 17, the management interventions need to be prioritized in terms of the planning horizons and phases of implementation by the implementing bodies.

Table 18. Proposed planning horizons and implementation phases for management interventions

No.	Major Management interventions	Planning horizon	Implementing body	Implementation Phase
1	Production and promotion of high-value and marketable agro-products	Short term (1-2 years)	Fedis and Midaga Woredas agriculture office, Regional biodiversity bureau, Local communities	Phase I
2	Introduction and implementation of Soil and Water Conservation technologies	Medium term (1-5 years)	Woreda Agriculture office, local communities	Phase 2
3	Introduction of energy efficient and alternative energy technology, planting of forage species in homesteads and farm boundaries	Medium term (1-5 years)	BES office, Woreda agriculture office (NRM desk), NGOs	Phase 2
4	Establishment of community managed micro-credit Scheme	Short term (1-2 years)	Woreda agriculture office, Cooperatives	Phase 1

			office,Kebele administration	
5	Developing tourism infrastructure and promote tourism	Long term (5-10 years)	Regional road authority, BES management, Culture and tourism office, EWCA, investors	Phase 3
6	Demarcation of the BES boundary with land mark features	Long term (5-10 years)	Harar BES office, Woreda administration, Regional Wildlife bureau, Kebele administrations	Phase 3
7	Restriction of NTFP collection only to the buffer zone vegetation	Medium term (1-5 years)	Harar BES office, Fedsi and Midaga Weredas agriculture office, local communities	Phase 2
8	Control and stope illegal hunting in the Sanctuary	Short term (1-2 years)	Harar BES office, Kebele administration, Woreda administration	Phase 1

5.1.3. Process of sectoral coordination and Integration

A multi-stakeholder platform needs to be formed in order to coordinate and effectively integrate sectoral management actions. The platform can be formed by the key stakeholders and a steering committee under the leadership of the Woreda administration office should be established. The key stakeholders must include woreda sector offices, BES Management office, non-governmental organizations and the Kebele administrations. The steering committee provides guidance on joint planning of management actions, pooling of resources, joint implementation and monitoring of activities. In the process, the roles and responsibilities of each of the stakeholders will be clearly defined. For instance, activities to be implemented in the agricultural landscape will be spearheaded by the agriculture office. The same applies to the other sectors. The BES office plays the coordination role and should take the lead in steering the implementation process. Joint annual plans should be appraised by the steering committee before implementation. Modalities of the steering committee meeting can be defined as per agreed terms among the key stakeholders. At least, the steering committee should appraise annual plans, review quarterly progress and conduct biannual monitoring of activities on the ground.

5.2. Monitoring and evaluation

5.2.1. Monitoring

Monitoring and evaluation mechanisms will be put in place before implementation. For each of the management actions, baseline survey will be conducted in the intervention areas. The baseline data will be useful to measure impacts and changes as a result of the interventions. The steering committee ensures baseline surveys are conducted before implementation. For each activity, target indicators will be clearly identified and progress will be measured against target indicators (Table 19). The monitoring tools include quarterly and annual progress reports, field observations and stakeholder consultations. Key stakeholders will participate during the monitoring and evaluation activities. Field observations should at least be done biannually.

Table 19. Target indicators for monitoring of management interventions

No.	Major Management interventions	Examples of target indicators	Means of verification (Monitoring tools)
1	Production and promotion of high-value and marketable agro-products	• No of farmers engaged in the activities • Volume of production • Magnitude of annual income increased • Number of low income farmers, women and youth involved	Progress reports (monthly, quarterly, annual) Field observations Stakeholder consultations
2	Introduction and implementation of Soil and Water Conservation technologies	• Total land area covered with SWC • Areas prevented from erosion • Types of technologies introduced • Quantity of biological and physical measures implemented	Progress reports Field observations Beneficiary consultations
3	Introduction of energy efficient and alternative energy sources, planting of forage species in homesteads and farm boundaries	• No of stoves and solar systems distributed • Number of women and households benefited • Number of farmers involved • Number of planting materials distributed • Types and number of forage species planted	Progress reports Field observations Beneficiary consultations
4	Establishment of community managed micro-credit Scheme	• No of credit schemes established and number of farmers benefited • Magnitude of income generated from the credit	Progress reports Field observations Beneficiary consultations

		services, jobs created and livelihood improvement • Number of low-income farmers, women and youth benefited from the scheme	
5	Develop tourism infrastructure and promote tourism	• Roads constructed • Degree of improvement of access to the Sanctuary • Number of service provision centers established • Number of tourists visited the Sanctuary	Progress reports Field observations Beneficiary consultations
6	Demarcation of the boundary of BES	• Total area of the Sanctuary • Boundary marks • Map of the sanctuary	Reports, minutes, agreements, maps, field observation
7	Restriction of NTFP collection only to the buffer vegetation	• Incidences of trespassing caused NTFP collectors • Disturbance indicators	Reports, field observations
8	Control and stope illegal hunting in the BES	• Number of incidences of hunting • Trade in wildlife products in local market	Reports, field observation, community discussion

5.2.2. Evaluation and feedback mechanisms

The implemented management interventions have to be evaluated by independent party with the participation of stakeholders. An interim evaluation should be conducted mainly to assess the progress of activities and outputs delivered as per the plan. Performance indicators such as milestones and target outputs will be used to measure progress. A final evaluation should be conducted at end of the implementation period for each of the planned activities. The focus of the final evaluation will be mainly on impacts and changes brought as a result of the interventions on the conservation and sustainable utilization of the agrobiodiversity and natural landscape, which the snactuary resources. The lessons (positive impacts and gaps) will then be compiled and communicated to stakeholders for plan review and adjustments to fill gaps in planning and reduce unintended and unwanted impacts. During evaluations, the full participation of local stakeholders and beneficiaries is very essential.

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Annexes

Annex 1: Priority site Selection Criteria

Type	Criteria	Weight Value	Description of the criteria	Expert*** evaluation of the site (Score: 1,2,3)
Ecological	Keystone, flagship species (fauna and flora)	5	Presence of Plant and animal species (taxa) of high interest for conservation (endemic, rare, threatened, endangered)	
	Habitat	10	Habitats of special interest and of special importance (habitats of avifauna, games, large mammals and carnivores, herbivores)	
	Vegetation/ Ecosystem	5	Representation of diverse ecosystems/ uniqueness (Moist, riverine, grassland, wooded grass land)	
Environmental	Physiography and topography	5	Representation of spectacular physiographic features (valleys/gorges, mountains/hills, plains/plateau, water body, waterfalls)	
	Critical position in the watershed	5	Significance of site for hydrological management of the landscape (headwaters, mid-catchment, lower catchment)	
	Access	5	Accessible or inaccessible. Accessibility is positive or negative for the site conservation. Accessible sites are better managed.	
	Condition (state of degradation)	10	Degree of disturbance, severity of soil degradation, fragility/sensitivity, potential threats and vulnerability, edge effect, pressure from local communities, pressure	

			from settlements, fire threats, etc…	
Socioeconomic	Agro-biodiversity, Ethnobotany	10	Areas of high agrobiodiversity, high interest for conservation	
	Livestock and human pressure on park	5	Areas of high extraction of forest products, expansion of cultivation and high deforestation, high grazing pressure	
	Dependence on natural resources	10	Livelihoods are highly dependent on park/forest resources, charcoal and wood extraction, NTFPs extraction, etc	
	Tourist rout/scenic spot	5	Area is important rout for visitors and tourists, high scenic value, needs protection and management	
	Wildlife-people conflict	5	High incidences of people-park or wildlife-people conflict	
	Limited access to finance and credit facility	10	Absence of access to finance and credit/loan facility for the community,	
	Unemployment and gender disparity	5	Limited access to jobs, alternative livelihoods for youth and women	

Type	Criteria	Weight Value	Description of the criteria	Expert evaluation of the site (Score: 1,2,3)
Ecological	Keystone, flagship species (fauna and flora)	10	Presence of Plant and animal species (taxa) of high interest for conservation (endemic, rare, threatened, endangered)	2.67
	Habitat	10	Habitats of special interest and of special importance (habitats of avifauna, games, large mammals and carnivores, herbivores)	2.83
	Vegetation/ Ecosystem	5	Representation of diverse ecosystems/uniqueness (Moist, riverine, grassland, wooded grass land)	2.0
Environmental	Physiography and topography	5	Representation of spectacular physiographic features (valleys/gorges, mountains/hills, plains/plateau, water body, waterfalls)	2.67
	Critical position in the watershed	5	Significance of site for hydrological management of the landscape (headwaters, mid-catchment, lower catchment)	2.5
	Access	5	Accessible or inaccessible. Accessibility is positive or negative for the site conservation. Accessible sites are better managed.	2.17
	Condition (state of degradation)	10	Degree of disturbance, severity of soil degradation, fragility/sensitivity, potential threats and vulnerability, edge effect, pressure from local communities, pressure from settlements, fire threats, etc…	2.0
Socioeconomic	Agro-biodiversity, Ethnobotany	10	Areas of high agrobiodiversity, high interest for conservation	2.67
	Livestock and human pressure on park	5	Areas of high extraction of forest products, expansion of cultivation and high deforestation, high grazing pressure	2.67
	Dependence on natural resources	10	Livelihoods are highly dependent on park/forest resources, charcoal and wood extraction, NTFPs extraction, etc	2.33

	Tourist rout/scenic spot	5	Area is important rout for visitors and tourists, high scenic value, needs protection and management	2.5
	Wildlife-people conflict	5	High incidences of people-park or wildlife-people conflict	2.33
	Limited access to finance and credit facility	10	Absence of access to finance and credit/loan facility for the community,	2.5
	Unemployment and gender disparity	5	Limited access to jobs, alternative livelihoods for youth and women	2.17

Annex 2. Erer Ebada Potential Project Site

Type	Criteria	Weight Value	Description of the criteria	Expert evaluation of the site (Score: 1,2,3)
Ecological	Keystone, flagship species (fauna and flora)	10	Presence of Plant and animal species (taxa) of high interest for conservation (endemic, rare, threatened, endangered)	2.67
	Habitat	10	Habitats of special interest and of special importance (habitats of avifauna, games, large mammals and carnivores, herbivores)	2.83
	Vegetation/ Ecosystem	5	Representation of diverse ecosystems/uniqueness (Moist, riverine, grassland, wooded grass land)	2.0
Environmental	Physiography and topography	5	Representation of spectacular physiographic features (valleys/gorges, mountains/hills, plains/plateau, water body, waterfalls)	2.67
	Critical position in the watershed	5	Significance of site for hydrological management of the landscape (headwaters, mid-catchment, lower catchment)	2.5
	Access	5	Accessible or inaccessible. Accessibility is positive or	2.17

			negative for the site conservation. Accessible sites are better managed.	
	Condition (state of degradation)	10	Degree of disturbance, severity of soil degradation, fragility/sensitivity, potential threats and vulnerability, edge effect, pressure from local communities, pressure from settlements, fire threats, etc…	2.0
Socioeconomic	Agro-biodiversity, Ethnobotany	10	Areas of high agrobiodiversity, high interest for conservation	2.67
	Livestock and human pressure on park	5	Areas of high extraction of forest products, expansion of cultivation and high deforestation, high grazing pressure	2.67
	Dependence on natural resources	10	Livelihoods are highly dependent on park/forest resources, charcoal and wood extraction, NTFPs extraction, etc	2.33
	Tourist rout/scenic spot	5	Area is important rout for visitors and tourists, high scenic value, needs protection and management	2.5
	Wildlife-people conflict	5	High incidences of people-park or wildlife-people conflict	2.33
	Limited access to finance and credit facility	10	Absence of access to finance and credit/loan facility for the community,	2.5
	Unemployment and gender disparity	5	Limited access to jobs, alternative livelihoods for youth and women	2.17

Annex 2. Fedis-Midaga Potential Project Site

Type	Criteria	Weight Value	Description of the criteria	Expert evaluation of the site (Score: 1,2,3)
Ecological	Keystone, flagship species (fauna and flora)	10	Presence of Plant and animal species (taxa) of high interest for conservation (endemic, rare, threatened, endangered)	2.67
	Habitat	10	Habitats of special interest and of special importance (habitats of avifauna, games, large mammals and carnivores, herbivores)	2.5
	Vegetation/ Ecosystem	5	Representation of diverse ecosystems/uniqueness (Moist, riverine, grassland, wooded grass land)	2.17
Environmental	Physiography and topography	5	Representation of spectacular physiographic features (valleys/gorges, mountains/hills, plains/plateau, water body, waterfalls)	2.33
	Critical position in the watershed	5	Significance of site for hydrological management of the landscape (headwaters, mid-catchment, lower catchment)	2.33
	Access	5	Accessible or inaccessible. Accessibility is positive or negative for the site conservation. Accessible sites are better managed.	1.83
	Condition (state of degradation)	10	Degree of disturbance, severity of soil degradation, fragility/sensitivity, potential threats and vulnerability, edge effect, pressure from local communities, pressure from settlements, fire threats, etc…	2.67
Socioeconomic	Agro-biodiversity, Ethnobotany	10	Areas of high agrobiodiversity, high interest for conservation	2.5
	Livestock and human	5	Areas of high extraction of forest products, expansion of cultivation and high	3.0

	pressure on park		deforestation, high grazing pressure	
	Dependence on natural resources	10	Livelihoods are highly dependent on park/forest resources, charcoal and wood extraction, NTFPs extraction, etc	3.0
	Tourist rout/scenic spot	5	Area is important rout for visitors and tourists, high scenic value, needs protection and management	2.17
	Wildlife-people conflict	5	High incidences of people-park or wildlife-people conflict	2.83
	Limited access to finance and credit facility	10	Absence of access to finance and credit/loan facility for the community,	2.67
	Unemployment and gender disparity	5	Limited access to jobs, alternative livelihoods for youth and women	2.5

Annex 2. Dandama (Ethio somali Babile) Potential Project Site

Type	Criteria	Weight Value	Description of the criteria	Expert evaluation of the site (Score: 1,2,3)
Ecological	Keystone, flagship species (fauna and flora)	10	Presence of Plant and animal species (taxa) of high interest for conservation (endemic, rare, threatened, endangered)	2.33
	Habitat	10	Habitats of special interest and of special importance (habitats of avifauna, games, large mammals and carnivores, herbivores)	2.33
	Vegetation/ Ecosystem	5	Representation of diverse ecosystems/uniqueness (Moist, riverine, grassland, wooded grass land)	1.67
Environmental	Physiography and topography	5	Representation of spectacular physiographic features (valleys/gorges, mountains/hills, plains/plateau, water body, waterfalls)	1.67
	Critical position in the watershed	5	Significance of site for hydrological management of the landscape (headwaters, mid-catchment, lower catchment)	1.83
	Access	5	Accessible or inaccessible. Accessibility is positive or negative for the site conservation. Accessible sites are better managed.	2.67
	Condition (state of degradation)	10	Degree of disturbance, severity of soil degradation, fragility/sensitivity, potential threats and vulnerability, edge effect, pressure from local communities, pressure from settlements, fire threats, etc…	2.33
Socioeconomic	Agro-biodiversity, Ethnobotany	10	Areas of high agrobiodiversity, high interest for conservation	2.17
	Livestock and human	5	Areas of high extraction of forest products, expansion of cultivation and high	3.0

	pressure on park		deforestation, high grazing pressure	
	Dependence on natural resources	10	Livelihoods are highly dependent on park/forest resources, charcoal and wood extraction, NTFPs extraction, etc	2.67
	Tourist rout/scenic spot	5	Area is important rout for visitors and tourists, high scenic value, needs protection and management	1.83
	Wildlife-people conflict	5	High incidences of people-park or wildlife-people conflict	2.5
	Limited access to finance and credit facility	10	Absence of access to finance and credit/loan facility for the community,	2.33
	Unemployment and gender disparity	5	Limited access to jobs, alternative livelihoods for youth and women	2.0

Annex 3: **List of species of plants recoded in the Gobele catchment landscape both from the natural and agricultural landscapes**

No	Scientific name	Local Oromo name	Family name	Uses in the study area
1	*Acacia albida*	GERBI	Fabaceae	Shade, soil fertility, wood, agf.
2	*Acacia etbaica*	DODOTI	Fabaceae	Wood
3	*Acacia lohai*	DODOTI	Fabaceae	Wood
4	*Acacia mellifera*	KERSA	Fabaceae	Shade, soil fertility, wood, agf.
5	*Acacia tortilis*	DIDECHA	Fabaceae	Elephant food, wood, shade, soil fertility, agf.
6	*Acokanthera schimperi*	QERARU	Apocynaceae	Medicine, wood, elephant food
7	*Agave americana*	QACHA	Agavaceae	Fencing, fibers for cordage
8	*Allium cepa*	SHINKURTA	Alliaceae	Spice, vegetable
9	*Aloe megalacantha? (giant aloe)*	HARGESSA	Aloaceae	Medicine, ornamental
10	*Aloe pirotae*	HARGESSA	Aloaceae	Medicine, ornamental

No	Scientific name	Local Oromo name	Family name	Uses in the study area
11	*Annona reticulate*	HAMBESHOK	annonaceae	Edible fruit
12	*Arachis hypogea*	LOOZI/OCHOLONI	Fabaceae	Food, edible oil, industrial, income
13	*Balanites aegyptiaca*	BEDENO	Balanitaceae	Elephant food
14	*Berchemia discolor*	JEJEBA	Rhamnaceae	Medicine, edible fruit, wood
15	*Brassica carinata*	RAFU/GOMEN/KALE	Brassicaceae	Vegetable food, edible oil
16	*Brassica* sp.	HULLOO	Brassicaceae	Root and leafy vegetable, HIDA NYAADHAMA
17	*Calpurnea aurea*	CHEKA	Fabaceae	Medicine, bee repellent, construction
18	*Capsicum annuum*	QUACEE	Solanaceae	Spice, vegetable
19	*Caralluma speciosa*	*YAIBERRA*	Asclepediaceae	Ornamental, flower beautiful (bad smell!)
20	*Carissa spinarum*	AGAMSA	Apocynaceae	Medicine, edible fruit, fencing
21	*Casimiroa edulis*	CASMIR	Rutaceae	Edible fruit
22	*Catha edulis*	JIMAA/CHAT	Celastraceae	Stimulant (narcotic), income
23	*Citrullus lanatus*	HABHAB/WATER MELON	Cucurbitaceae	Food, feed
24	*Citus sinensis*	BURTUKANA	Rutaceae	Edible fruit
25	*Coffea Arabica*	BUNA	Rubiaceae	Stimulant
26	*Combretum*	?	Combretaceae	Wood
27	*Commiphora* cataf	DHALL	Burseraceae	Elephant food
28	*Commiphora* spp.	RUKESA	Burseraceae	Gum
29	*Cordia africana*	WEDEYSA	Boraginaceae	Construction, medicine, edible fruit
31	*Cucurbita pepo*	BAQIL/DUBA/PUMPKIN	Cucurbitaceae	Food, feed
32	*Dobera glabra*	?	Salvadoraceae	Wood
33	*Dodonea angustifolia*	EDECHAA	Sapindaceae	Medicine, construction
34	*Drimia* sp.	SHINKURTI ARAGESA	Hyacinthaceae	Ornamental

No	Scientific name	Local Oromo name	Family name	Uses in the study area
34	*Ehretia cymosa*	RUKELO	Boraginaceae	Farm implements, medicine, wood
35	*Euclea racemosa*	MIESAA	Ebenaceae	Medicine, firewood
36	*Euphorbia abyssinica*	ADAMI	Euphorbiaceae	Shade, ornamental
37	*Euphorbia adjuranta* ~~cactus?~~	ADAMI	Euphorbiaceae	Dwarf tree euphorbia, ornamental
38	*Euphorbia tirucalli*	QINCHIBA	Euphorbiaceae	Fencing/hedge
40	*Ficus vasta*	KILTU	Moraceae	Shade
42	*Grewia bicolor*	HARORESA	Tiliaceae	Edible fruits, feed
43	*Grewia feruginea*	TATESA	Tiliaceae	Edible fruits, feed
44	*Grewia tenax*	*DHEKA*	Tiliaceae	Edible fruits, feed
45	*Grewia tricocarpa*	DIMELO	Tiliaceae	Edible fruits, feed
46	*Hyparrhenta* sp.	SANBALETA/CHITA	Poaceae	Construction, feed
47	*Ipomoea batatas*	MITATISH	Convolvulaceae	Food, income
48	*Ipomoea* sp.	BURI	Convolvulaceae	Fencing
49	*Jatropha curcas*	ABATA MULUK	Euphorbiaceae	Non-edible industrial oil, medicine
50	*Lagenaria cineraria*	BUQE	Cucurbitaceae	Container
51	*Lantana camara*	BEKERGETA	Verbenaceae	Fencing/hedge, edible fruits
52	*Linum usitatissimum*	QONTAR	Linaceae	Edible oil
53	*Lycopersicon esculenta*	TIMATIMI	Solanaceae	Food, fruit vegetable
54	*Mangifera indica*	MANGO	Anacardiaceae	Food, fruit
55	*Melhania* velutina	DICKETELE	Sterculaceae	Elephant food
56	*Moringa stenopetala*	MORINGA	Moringaceae	Shade
57	*Oncoba spinosa*	JILBO	Flacourtiaceae	Edible fruits, medicine
58	*Opuntia ficus-indica*	TINI	Cactaceae	Edible fruits
59	*Phaseolus vulgaris - bushy*	ATARA	Fabaceae	Food, feed
60	*Phaseolus vulgaris- climbing*	ATARA	Fabaceae	Food, feed
61	*Plumeria rubra*	?	Apocynaceae	Ornamental

No	Scientific name	Local Oromo name	Family name	Uses in the study area
62	*Psidium guajava*	ZEYTUNA, GUAVA	Myrtaceae	Food
63	*Pyrenacantha malvifolia*	MUNKUY	Icacinaceae	Ornamental
64	*Ricinus communis*	QOBO/GULO/CASTOR	Euphorbiaceae	Non-edible oil
65	*Sesamum orientale*	SELIXA	Pedalisaceae	Oil
66	*Sesbania sesban*	SEZBANIA	Fabaceae	Shade
67	*Solanum Tuberosum*	DINICHA	Solanaceae	Food, root/tuber
68	*Sorghum bicolor*	BISHINGA	Poaceae	Food, feed
69	*Tamarinduc indica*	ROQA	Fabaceae	Food, medicine
70	*Terminalia brownie*	BIRESA	Combretaceae	Wood, shade, feed, construction, agf.
71	*Ximenia americana*	HUDAA	Olacaceae	Edible fruits, medicine
72	*Zea mays*	BOQOLLOO	Poaceae	Food, feed
73	*Ziziphus spina-christi*	QURQURA	Rhamnaceae	Edible fruits, wood, fence, medicine, agf.