



A Participatory Assessment of Forest Biodiversity Resources and Level of Threat in Hararge Area, Eastern Ethiopia

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Abstract: Ethiopia was endowed with abundant and diversified flora and fauna. Especially, forest ecosystem is one the important habitats which provide as home of variety of life. Thus, wood vegetation that covered almost all of the area is reduced due to miss management, limited awareness of forest value and high population pressure. Particularly, the forest resources of Harari region, eastern and west Hararge zone has been degraded dramatically. The study was conducted in eastern part of Ethiopia in both east and west Hararge zones. The aim of the study was to collect and document threatened forest Biodiversity species found in the study area for conservation priority. Data were collected community based participatory using single visit transect walk, informal interviews of elder community and review other literature. The collected data was summarized by table, percent and figure. A total of 112 forest species were recorded. Out of them 34.8% plant species were highly threatened, 22.3% species near threatened and 42.9% were least threatened plant species. Hence, it is recommended to establish legal basis for the in situ and ex situ conservation sites for the conservation of the priority species. In addition, there is an urgent need to apply biotechnology to propagate some of the priority species and raise public awareness on the value of forest genetic resources.

Keywords: Ethiopia, Forest Genetic Resource, Hararge, Threatened, Indigenous Knowledge

1. Introduction

Ethiopia is one of the top 25 biodiversity-rich countries in the world [1], and hosts two of the world's 34 biodiversity hotspots, namely the Eastern Afromontane and the Horn of Africa hotspots. It is also among the countries in the Horn of Africa regarded as major centre of diversity and endemism for several plant species. The Ethiopian flora is estimated to about 6000 species of higher plants of which 10% are considered to be endemic [2]. Woody plants constitute about 1000 species out of which 300 are trees.

Forests form the major constituents of vegetation resources and thus conservation of forest genetic resources (FGRs) is among the priority areas of biodiversity conservation in Ethiopia. Efforts have been made to conserve and sustainably utilize FGRs in the country. Notable examples of such efforts are floristic, structure and socio-economic studies of woody plant species in Afromotane

forests of the country; FGR conservation strategies and establishment of in situ and ex situ conservation sites.

Studies have shown that tropical forests are being destroyed at an alarming rate [3, 4, 5, 6]. Deforestation has been contributing to a decline in forest cover, loss of biodiversity both at global and national levels [7, 8]. Expansion of agricultural land as a result of over-increasing population growth, increase demand for fuel wood and construction material, illegal settlements within forests, logging and illegal trade were considered as major contributing factors to the loss of forest resources. Moreover, poverty and lack of alternative livelihoods have been driving forces of forest destruction [9, 10]. The annual rate of deforestation in Ethiopia was found to be extremely high [11, 12].

Particularly, the forest resource of Harari region eastern and west Hararge zone has been dramatically degraded due to limited agricultural land, over grazing, limited awareness of

forest value, due to high population pressure, mismanagement and recurrent drought. Moreover, absence forest protected areas and weak law enforcement, limited floristic document on forest diversity and conservation status are tackle for future conservation and research in the region. These situations are urgently called for forest data collection and writing forest biodiversity resource document in this region. Therefore, the objective of this study was to collect and document tree and shrub species found in Harari, eastern and west Hararge; to identify threatened species for priority conservation.

2. Methodology

2.1. Description of the Study Area

The study was conducted in the eastern part of Ethiopia at

West and East, Hararge zones of Oromyia region and Harari region. The study area is situated approximately 400 km east of the capital, Addis Ababa. It is bordered by east Showa zone in the west, Arsi zone in south west, Bale zone in the south, Somali National Regional State in the east and south-east, and Dire Dawa Administrative Council in the north. The study area has 541 kebeles from east Hararge, 449 from west Hararge and 36 from Harari which have totally 1026 kebele (the lowest administrative structure in Ethiopia). The study area has the total area of approximately 4 million square kilometer. The physiographic condition of the study area is characterized by plateaus, rugged dissected mountains, deep valleys, gorges and plains. There are various prominent mountains and peaks in the area; Kundudo and Gara Mullata mountain chain are the major ones.

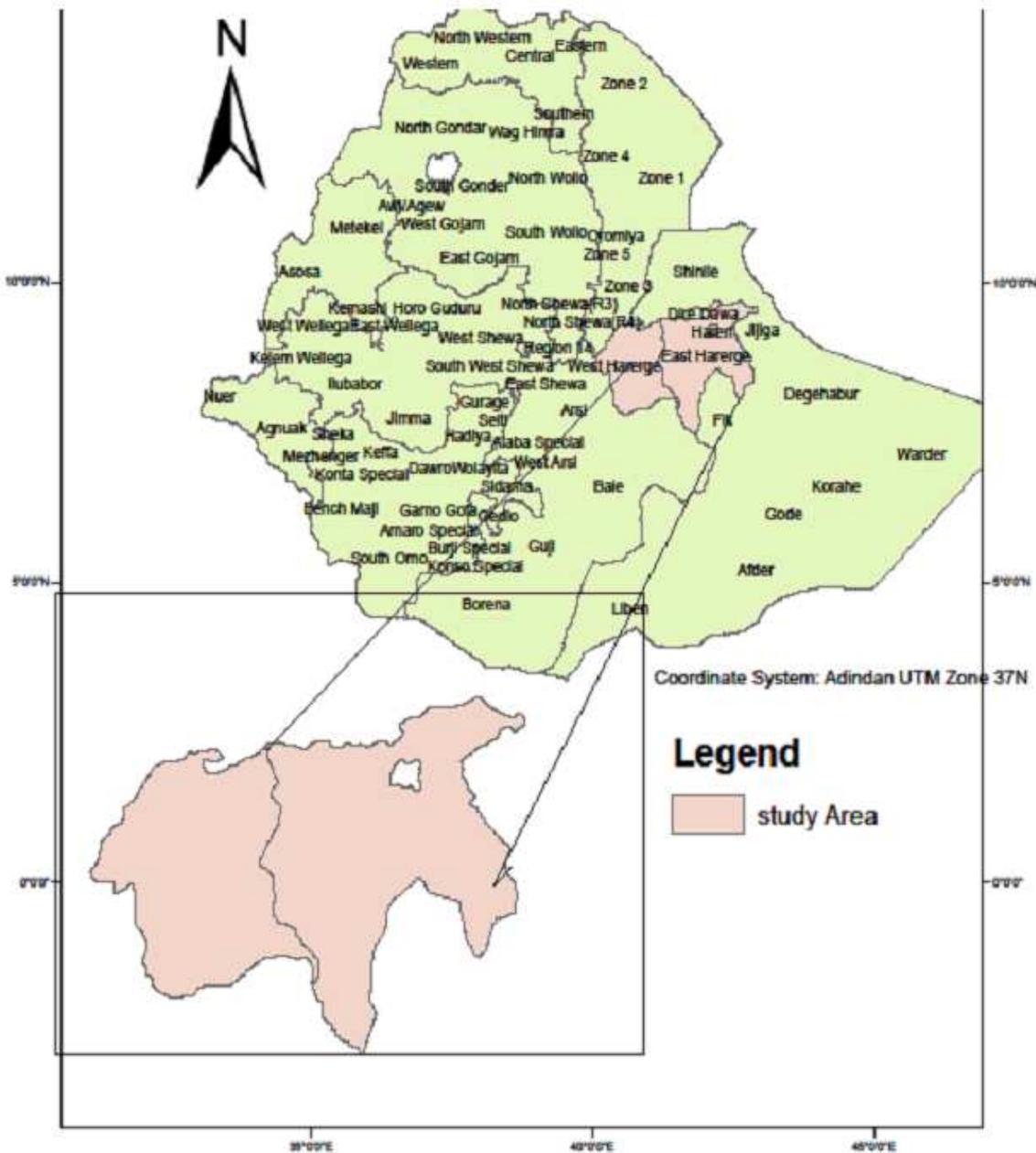


Figure 1. Map of the study area.

2.2. Methods of Data Collection

The data were collected through community based participatory approach using reconnaissance survey of single field visit; transect walk and informal interviewing with farmers and elder of local community. The survey covered Harari region, Babile, Jarso, Gara Mullata, Meta, Qarsa, Fadis and KurfaChale woredas in East Haragehe zone of Oromiya regional state and also Habro, Asbot, Dindin and Ades Forest of West Hararge. During informal interview respondent was requested to categorize level threat for all of the forest species into three categories: High, Medium and low. Where 'High' represent highly threatened plant species, when the population of the plant is rare and declining in the study area. Where 'medium' represent near threatened plant species, when the population of plant species some was present but, not much abundant generation. Where 'low' represent least threatened plant species, when the population of plant species has good regeneration. To help the respondents to categorize the species key questions like trends of plant species, the origin of plant species and importance of individual species were asked.

2.2. Species Identification

Most plant species were identified in the field by the help of the book called flora of Ethiopia and Eritrea. Few species which couldn't be identified at the field were identified at the herbarium of Addis Ababa University through collection of specimen.

3. Data Analysis

The collected data were mostly analyzed and summarized by table. The data on level of plant threat, local name, family and scientific name was analysed by descriptive statics such as, tables and percentages.

4. Results and Discussions

The study of the vegetation data revealed that a total of

116 plant species were registered from study area. This all were belong to 42 families and 86 genera. Fabaceae was the most dominant family which comprise 24 species. Euphorbiaceae was the second family comprising 7 species. Moraceae and Rosaceae are both the third most abundant families by holding 6 species each. Asteraceae is the fourth family with 5 species while Anacardiaceae, Lamiaceae, Rhamnaceae, Tiliaceae are together ranking fifth by holding 4 Species each. Boraginaceae, Rubiaceae, Spotaceae, and Flacourtiaceae are the sixth altogether by holding 3 species each. The families Acanthaceae, Apocynaceae, Burseraceae, Myrtaceae, Oleaceae, and Simaroubaceae were represented by 2 species while the rest of the families were represented by a single species. The genus Acacia was represented by 10 species, Ficus by 4 species, Grewia and Euphorbia were represented by 3 species each, Cordia, Combretum, Grewia, Prunus, Ziziphus, Acanthus, Rhoicissus, Commiphora, Boswelia and Albizia by 2 species each. The rest of the genera of the survey area contained a single species each (Table 1).

Out of the 116 plant species 53 (45.7%) were categorized as highly threatened, 26 (22.4%) as medially threatened, and 37 (31.9%) as least threatened by the local community. Out of the 53 plant species categorized as highly threatened 22 were tree, 24 were Shrub, 6 species were exhibiting tree or shrub life-forms, and 1 species was herbaceous.

Among the recorded woody plant species, there was a number of plant species that are already nationally red listed (following the IUCN threat categories) as threatened species. These include *Acacia negrii*, *Acanthus sennii*, *Cadaba divaricata*, *Euphorbia burger*, *Euphorbia dalettiensis*, *Hagenia abyssinica*, *Juniperous procera*, *Prunusa fricana* and *Podocarpus falcatus* [22]. On the other hand out of the plants collected from the study area, 16 (13.8 %) were endemic to Ethiopia, calling immediate conservation measures. The endemic plant species in the study area are listed in Table 3.

Table 1. List of Forest Species and Levels of Threat Based the Indigenous Knowledge.

NO.	Scientific name	Local name	Family	Level of threat	Habit
1	<i>Acacia albida</i>	Garbi	Fabaceae	Medium	T
2	<i>Acacia brevispice</i>	Hamareessa	Fabaceae	High	T
3	<i>Acacia bussei</i>	Hallo	Fabaceae	High	T
4	<i>Acacia etabaica</i>	Doddoti	Fabaceae	High	T
5	<i>Acacia lahai</i>	Laftoo	Fabaceae	Medium	T
6	<i>Acacia negrii</i>	Dhedacha	Fabaceae	High	T
7	<i>Acacia nilotica</i>	Serkama	Fabaceae	Medium	T
8	<i>Acacia senegal</i>	Sopheensadiima	Fabaceae	Low	T
9	<i>Acacia seyal</i>	Wacuudiima	Fabaceae	Medium	T
10	<i>Acacia tortilis</i>	Dhadacha	Fabaceae	High	T
11	<i>Acanthus sennii</i>	Kosorruu	Acanthaceae	High	S
12	<i>Acokanthera schimperi</i>	Qaraaru	Apocynaceae	Medium	T
13	<i>Albizia lebbek</i>	Lebbek	Fabaceae	Low	T
14	<i>Albizia lophantha</i>	Shifire	Fabaceae	Low	T
15	<i>Allophylus abyssinicus</i>	Duruba	Sapindaceae	Low	T/S
16	<i>Aloe trichosantha</i>	Hargiissa	Aloaceae	High	S
17	<i>Aningeria altissima</i>	Kuraro/quduba	Sapotaceae	High	T
18	<i>Arundinaria alpina</i>	Karkaa	Poaceae	Medium	S

NO.	Scientific name	Local name	Family	Level of threat	Habit
19	<i>Balanites aegyptiaca</i>	Baddanoo	Balanitaceae	High	T
20	<i>Berchemia discolor</i>	Jajebe	Rhamnaceae	Low	T
21	<i>Cadaba divaricata</i>	Qalqalcha	Capparidaceae	High	S
22	<i>Caesalpinia decapetala</i>	Qajii maaraba	Fabaceae	Low	S
23	<i>Calpurnea aurea</i>	Ceekaa	Fabaceae	Medium	S
24	<i>Capparis tomentosa</i>	Gamooraa	Capparidaceae	Low	C
25	<i>Carissa edulis</i>	Agamsa	Apocynaceae	Medium	S
26	<i>Celtis africana</i>	Mataqooma	Ulmaceae	Low	T
27	<i>Combretum aculeatum</i>	Totaf	Combretaceae	Low	T
28	<i>Combretum molle</i>	Bikaa/Rukeesa	Combretaceae	Medium	T
29	<i>Commiphora africana</i>	Anqa	Burseraceae	High	T/S
30	<i>Commiphora erythraea</i>	Hagar	Burseraceae	High	T
31	<i>Cordia africana</i>	Wodeesa	Boraginaceae	High	T
32	<i>Cordia monoica</i>	Medhero	Boraginaceae	Medium	T/S
33	<i>Croton macrostachyus</i>	Mekenisaa	Euphorbiaceae	High	T/S
34	<i>Cussonia holstii</i>	Harfattuu	Araliaceae	Low	T
35	<i>Dichrostachys cherea</i>	Jirime/adesa	Fabaceae	Low	T/S
36	<i>Dodenaea angustifolia</i>	Kitkita/dhadacha	Sapindaceae	Low	S
37	<i>Dovyalis abyssinica</i>	Koshumoo	Flacourtiaceae	Low	S
38	<i>Dracaena afromontana</i>	Alghee	Dracaenaceae	Low	S
39	<i>Ehretia cymosa</i>	Huulaga	Boraginaceae	High	T/S
40	<i>Ekebergia capensis</i>	Somboo	Meliaceae	Low	T
41	<i>Entada abyssinica</i>	Kentafa	Fabaceae	Low	T
42	<i>Eriobotrya japonica</i>	Woshmella	Rosaceae	High	T/S
43	<i>Erythrina brucei</i>	Walensuu	Fabaceae	High	T
44	<i>Euclea schimperi</i>	Mi, eesa	Ebenaceae	Low	T/S
45	<i>Euphorbia burgeri</i>	Qancaree	Euphorbiaceae	High	S
46	<i>Euphorbia dalettiensis</i>	Adamii	Euphorbiaceae	High	S
47	<i>Euphorbia tirucalli</i>	Qinciiba	Euphorbiaceae	Low	T
48	<i>Ficus carica</i>	Beles	Moraceae	Low	T
49	<i>Ficus sur</i>	Qilxuu	Moraceae	Medium	T
50	<i>Ficus sycomorus</i>	Lugoo	Moraceae	Low	T
51	<i>Ficus vasta</i>	Odaa	Moraceae	High	T
52	<i>Ficus thonningii</i>	Dambii	Moraceae	Medium	T
53	<i>Flacourtia indica</i>	Hudhaa	Flacourtiaceae	High	T
54	<i>Flueggea virosa</i>	Qacacilee	Euphorbiaceae	Medium	T/S
55	<i>Gardenia terminifolia</i>	Gambeloo	Rubiaceae	High	T/S
56	<i>Grewia bicolor</i>	Horeresa	Tiliaceae	Medium	T
57	<i>Grewia tembensis</i>	Dheekkaa	Tiliaceae	Medium	T/S
58	<i>Grewia villosa</i>	Ogomoodi	Tiliaceae	Low	S
59	<i>Hagenia abyssinica</i>	Kosso	Rosaceae	High	S
60	<i>Hildebrandtia diredawaensis</i>	Dhacd hale	Convolvulaceae	High	S
61	<i>Indigofera rothii</i>	Khoshi	Fabaceae	High	S
62	<i>Indigofera ellenbeckii</i>	Khoshi	Fabaceae	High	S
63	<i>Jasminum abyssinicum</i>	Biluu	Oleaceae	Low	C
64	<i>Juniperus procera</i>	Gatiraa	Cupressaceae	High	T
65	<i>Justicia schimperiana</i>	Dhumugaa	Acanthaceae	High	S
66	<i>Kalanchoe lanceolata</i>	Kontoma	Crossulaceae	Low	H
67	<i>Kirkia burgeri</i>	Hudhaa Sawwa	Simaroubaceae	High	T
68	<i>Kirkia tenuifolia</i>	Hudhaa Sawwa	Simaroubaceae	High	S
69	<i>Kotschya recurvifolia</i>	Henna	Leguminosae	High	S
70	<i>Lannea schimperi</i>	Handarakkuu	Anacardiaceae	Low	T/S
71	<i>Maesa lanceolata</i>	Abbayyii	Myrsinaceae	Medium	S
72	<i>Maytenus undata</i>	Kombolcha	Celastraceae	High	T/S
73	<i>Millettia ferruginea</i>	Dedatu, Sotellu	Fabaceae	High	T
74	<i>Mimusops kummel</i>	Buriri	Sapotaceae	Low	T
75	<i>Moringa oleifera</i>	Shefera	Moringaceae	High	T
76	<i>Myricasa licifolia</i>	Abay, kataba	Myricaceae	Low	T
77	<i>Myrtus communis</i>	Ades	Myrtaceae	Low	S
78	<i>Ocimum lamiiifolium</i>	Damacasee	Lamiaceae	Medium	S
79	<i>Ocimum jamesii</i>	Qayyadurbaa	Lamiaceae	Medium	S
80	<i>Olea europaea</i>	Ijersa	Oleaceae	High	T
81	<i>Oncoba spinosa</i>	Jilboo	Flacourtiaceae	High	S
82	<i>Pappea capensis</i>	Biiqqaa	Sapindaceae	Medium	T
83	<i>Phytolacca dodecandra</i>	Handode	Phytolacaceae	High	S
84	<i>Plectranthus barbatus</i>	Barbarusha	Lamiaceae	Low	H
85	<i>Podocarpus falcatus</i>	Birbirsaa	Podocarpaceae	High	T

NO.	Scientific name	Local name	Family	Level of threat	Habit
86	<i>Polygala obtusissima</i>	Harmal	Polygalaceae	High	S
87	<i>Pouteria adolfi-friederici</i>	Mandhisaa	Sapotaceae	Medium	T
88	<i>Premna schimperii</i>	Urgeessaa	Lamiaceae	Medium	S
89	<i>Prunus africana</i>	Hadheessaa	Rosaceae	High	T
90	<i>Prunus persica</i>	Kuki	Rosaceae	High	T
91	<i>Psyrax schimperiana</i>	Galo	Rubiaceae	Low	T
92	<i>Pterolobium stellatum</i>	Qajimaa	Fabaceae	Low	S
93	<i>Rhamnus prinoides</i>	Geshoo	Rhamnaceae	High	S
94	<i>Rhoicissus revoilii</i>	Dagachebsa	Vitaceae	Low	C
95	<i>Rhus glutinosa</i>	Tatessa	Anacardiaceae	High	S
96	<i>Rhus retinorrhoea</i>	Debeluca	Anacardiaceae	Low	S
97	<i>Rhus vulgaris</i>	Rigaawaraabo	Anacardiaceae	Medium	T/S
98	<i>Rhynchosia erlangeri</i>	Soor-mudu	Fabaceae	High	S
99	<i>Ricinus communis</i>	Qoboo	Euphorbiaceae	Medium	S
100	<i>Rosa abyssinica</i>	Enqoto, Goro	Rosaceae	High	S
101	<i>Rothmannia urcelliformis</i>	Buruurii	Rubiaceae	Low	S
102	<i>Rubus apetalus</i>	Goraa/Altufa	Rosaceae	High	S
103	<i>Senecio myriocephalus</i>	Ingeshu	Asteraceae	High	S
104	<i>Sterculia africana</i>	Geri	Sterculiaceae	Low	T
105	<i>Solanecio angulatus</i>	Jinraas	Asteraceae	High	H
106	<i>Sparmannia macrocarpa</i>	Wulkifa	Tiliaceae	High	S
107	<i>Suregada procera</i>	Xillo	Euphorbiaceae	Medium	S
108	<i>Syzygium guineense</i>	Baddeessaa	Myrtaceae	High	T
109	<i>Tamarindus indica</i>	Roka	Fabaceae	High	T
110	<i>Terminia liabrownii</i>	Birensaa	Combretaceae	Low	T
111	<i>Vernonia amygdalina</i>	Grawa/Ebicha	Asteraceae	Medium	S
112	<i>Vernonia leopoldi</i>	Qaxxee korma	Asteraceae	High	S
113	<i>Vernonia rueppellii</i>	Reejjii	Asteraceae	High	S
114	<i>Woodfordia uniflora</i>	Marmarte	Lythraceae	Low	S
115	<i>Ziziphus mauritiana</i>	Kurkura	Rhamnaceae	Medium	T/S
116	<i>Ziziphus mucronata</i>	Kurkuragabroo	Rhamnaceae	Low	T/S

Key: *: Local name is unknown, T: tree, S: shrub, T/S: tree/shrub, H: herbs, C: climber

Table 2. Plant Families and number of highly threatened species they contained.

Families	Number of highly Threatened Species	Percentage
Fabaceae	11	20.7
Rosaceae	6	11.3
Asteraceae	4	7.5
Euphorbiaceae	3	5.6
Acanthaceae	2	3.8
Boraginaceae	2	3.8
Burseraceae	2	3.8
Flacourtiaceae	2	3.8
Simaroubaceae	2	3.8
Others in lump sum	1	35.9

Table 3. Endemic plant species collected from the study area.

NO.	Scientific name	Local name	Family
1	<i>Acacia negrii</i>	Dhedeca	Fabaceae
2	<i>Acanthus sennii</i>	Kosorruu	Acanthaceae
3	<i>Aloe trichosantha</i>	Hargiissa	Aloaceae
4	<i>Berchemia discolor</i>	Jajeba	Rhamnaceae
5	<i>Cadaba divaricata</i>	Qalqalcha	Capparidaceae
6	<i>Euphorbia burgeri</i>	Qancaree	Euphorbiaceae
7	<i>Erythrina brucei</i>	Fabaceae	Tree
8	<i>Euphorbia dalettiensis</i>	hadaamii	Euphorbiaceae
9	<i>Hagenia abyssinica</i>	Kosso	Rosaceae
10	<i>Hildebrandtia diredawaensis</i>	Dhacd hale	Convolvulaceae
11	<i>Indigofera ellenbeckii</i>	Khoshi	Fabaceae
12	<i>Indigofera rothii</i>	Khoshi	Fabaceae
13	<i>Kirkia burgeri</i>	Hudhaa Sawwaa	Simaroubaceae
14	<i>Maytemus undata</i>	Kombolcha	Celastraceae
15	<i>Millettia ferruginea</i>	Dedatu, Sotellu	Fabaceae
16	<i>Moringa oleifera</i>	Shefera	Moringaceae
17	<i>Vernonia rueppellii</i>	Reejjii	Asteraceae

Table 4. List of the top 22 highly threatened shrub and tree species as their population is highly decreasing.

No.	Top Threatened species	Habitat
1	<i>Acacia brevispice</i>	Tree
2	<i>Acacia bussei</i>	Tree
3	<i>Acacia etabaica</i>	Tree
4	<i>Acacia tortilis</i>	Tree
5	<i>Aloe trichosantha</i>	Shrub
6	<i>Commiphora africana</i>	Tree
7	<i>Commiphora erythraea</i>	Tree
8	<i>Croton macrostachyus</i>	Tree
9	<i>Delonix rega</i>	Tree
10	<i>Ehretia cymosa</i>	Tree /shrub
11	<i>Eriobotrya japonica</i>	Shrub
12	<i>Flacourtia indica</i>	Shrub
13	<i>Justicia schimperiana</i>	Shrub
14	<i>Rosa abyssinica</i>	Shrub
15	<i>Maytenus undata</i>	Shrub
16	<i>Moringa oleifera</i>	Shrub
17	<i>Oncoba spinosa</i>	Shrub
18	<i>Prunus persica</i>	Tree
19	<i>Polygala obtusissima</i> Chod	Shrub
20	<i>Rhammus prinoides</i>	Shrub
21	<i>Solanecio angulatus</i>	Herbs
22	<i>Tamarindus indica</i>	Tree

5. Conclusion and Recommendation

The objective of this community based participatory survey was to identify the threatened forest genetic resource in Hararge area, eastern Ethiopia and to recommend appropriate genetic conservation approaches in the area. The study has revealed 44% of the forest plant species in the study area were categorized as highly threatened by the local community. Among those species some like *Cordia africana*, *Erythrina burci*, *Hagenia abyssinica*, *Juniperous procera*, *Prunus africana* and *Podocarpus falcatus* were already incorporated in the IUCN red data list as vulnerable species [22]. Moreover, the record of population structure showed that 100% tree species listed in IUCN red data list have abnormal population structures with no or few individual's distribution in study area. Therefore, these species need urgent conservation measures that will facilitate healthy regeneration and guarantee sustainable use of the species. In addition, the vegetation survey conducted in the same area in 1996 reported 361 vascular plants species [23] while only 116 species were recorded by the present study which indicates there is marked amount of biodiversity loss. Hence, the following recommendations were suggested:

- (1) Raise public awareness on the value of forest genetic resources and the problems related to loss of genetic information and devise a mechanism by which human impacts can be minimized through discussion and consultation with the local people.
- (2) Carry out further studies on the patterns of ecosystem functioning, biology and ecology of the key stone species to be able to restore the composition and structure of the forest.
- (3) Establish legal basis for the in-situ and ex-situ conservation sites for the conservation of the priority species.

- (4) Conduct research on storage behaviour (seed physiology) and reproduction biology of woody species that focus on threatened and economically important species.
- (5) There is an urgent need of application of tissue culture for the rapid and mass propagation of the threatened plant species to conserve the available genetic resource.
- (6) Increase traditional forest management like, home garden and on-farm conservation.
- (7) Implement participatory management of protected areas by insuring the benefit shared to the local people.

Conflict of Interests

The authors declare that they have no conflict of interests.

Authors' Contribution

Tahir Abdala collected the field data by consulting the local people in the study area and prepared the first draft of the manuscript, Girma Eshetu initiated the idea of the research and designed the methodology, and Abebe Worku identified the plant species both in the field and in the herbarium.

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