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VEGETATION STATUS AND SOCIO-ECONOMIC IMPORTANCE OF GUM- AND RESIN-BEARING SPECIES IN WESTERN BORENA, SOUTH WOLLO ZONE

Gashaw Desalew [1] and Berhanu Abraha [2,*]

ABSTRACT: Study on population status, socio-economic importance and threats of gum- and resin-producing plant species was made in Borena, South Wollo, (Ethiopia). After reconnaissance survey of the area, three kebeles were selected and studied. For each site, transect lines were systematically laid down in North-South compass direction. Along each transect line quadrates having a size of 20 m x 20 m (400 m^2) were laid at 400 m distance. From all study sites, a total of 60 quadrates were sampled. A total of 14 gum- and resin-bearing plant species representing seven families were recorded. Five of them were known to produce currently traded gum and incense. Diversity study showed the existence of more representative stands (species) at Mendeyu (H'= 2.58) than Beta Menedega (H'=2.38) and Wobo (H'= 2.17). To assess the socio-economic importance and threats encountered by the species, a total of 40 households were selected and interviewed. The survey revealed strong attachment of the local community to the gum- and resin-producing plant species. The community used the plants for construction, fodder preparation, fuel wood, charcoal, making household furniture, farm tools, fumigation, body lotion and medicine. The awareness for commercial use, however, was very low, which means the income generated from these species by the local households is very minimal. Hence, encouraging the local community to collect gum and resin for commercial purpose is necessary. Also such encouragement should be integrated with other activities such as livestock rearing and crop farming.

Key words/phrases: District, Gum, Importance, Population status, Resin, Socio-economic.

INTRODUCTION

Ethiopia is endowed with great biological and ecological diversity. It is one of the few countries in the world with relatively high level of endemic fauna and flora (Tewoldebirhan Gebre-Egziabhere, 1989). The wide altitudinal variation that range from about 120 meters below sea level to 4600 meters above sea level provides the country with a wide range of ecological conditions that are homes for large number of flora and fauna. Large

[1]Department of Biology, Semera University, P.O. Box 132, Semera, Ethiopia.
[2] Department of Biology, Bahir Dar University, P.O. Box 79, Bahir Dar, Ethiopia..
Email: berhanu.tsegay@yahoo.com
*Author to whom all correspondence should be addressed.

number of species of trees, shrubs, herbs, cultivated plants and their wild relatives are found in different climatic zones (Tadese Woldemariam, 2003; Alemayehu Wassie *et al.,* 2005). Among the different climatic zones of the country the dry lands (arid, semi-arid and dry sub-humid) cover the largest proportion which is estimated at about 860,000 km^2 (71.5 %) (Tamrie Hawando, 1997). This part of the country is habitat for vegetation with high economic and ecological roles such as those in genera *Acacia, Commiphora*, *Boswellia,* and *Sterculia* (Kindeya Gebrehiwot, 2003; Abeje Eshete *et al*., 2005). These genera mainly include the gum- and resin-bearing species that are important for the production of oleo-gum resins: gum Arabic, gum talha, frankincense/gum olibanum, myrrh and gum karrya (EFAP, 1994; Karamalla *et al.*, 1997; Mulugeta Lemenih *et al.,* 2003).

The oleo-gum resins have actual and potential uses as important raw materials in many modern industries such as drugs, food, beverage, liqueurs, cosmetics, detergents, creams and perfumery, paints, adhesives and dyes (Mulugeta Lemenih and Demel Teketay, 2003). The species are also valuable to the rural communities as sources of wood for fuel, farm implements and construction, fodder, as medicines and for various environmental services such as soil and water conservation (Chikamai, 1996).

Despite all these facts, very little attention has been given to the woodland vegetation harboring gum- and resin-bearing species as compared to the forests of humid and sub-humid areas in the country (Kindeya Gebrehiwot, 2003; Mulugeta Lemenih and Demel Teketay, 2004). This has resulted in rapid decline of the vegetation resource. The spread of sedentary farming, increased number of pastoralist population and their livestock, the increasing urban demand for fuel wood and charcoal and excessive deforestation for agricultural lands are factors facilitating the rapid decline of the vegetation.

Although there is no full national inventory on the resource base, Ethiopia is believed to have large gum- and resin-yielding woodland vegetation (Wubalem Tadesse *et al*., 2002). According to Volleson (1989) there are about six species of *Boswellia*, 52 species of *Commiphora* and many species of *Acacia* in Ethiopia. In the Amhara Regional State, an estimated area of 680,000 ha is covered by woodlands in which gum- and resin-bearing species of the genera *Boswellia*, *Commiphora*, *Acacia* and *Sterculia* predominate (Girmay Fitwii, 2000). In the western part of Borena District (former Debresina District) near the Abay River, these gum- and resin-

producing plants are abundant (personal observation). But, to our knowledge, the distribution, diversity, socio-economic potential and the associated threats to these plant species has not been studied and documented. As a result, there is no information on the population status, socio-economic potential and threats associated with utilization, development and conservation. Therefore, this study intends to provide quantitative information on the current population status and socio-economic potential of the plants and the prevailing threats to their survival in Borena District. Such information could enable the local community specifically and the environmental protection sector at large to sustainably use the resource.

MATERIALS AND METHODS

Study site

The study was carried out in three kebeles (villages) of Borena District, South Wollo, Ethiopia. The three kebeles are Beta Menedega, Mendeyu and Wobo Mikael (Fig. 1). Borena District is one of the 106 administrative districts in Amhara region of Ethiopia and is located in South Wollo zone. It covers an area of 97, 688 ha and the capital town, Mekane Selam, is 580 kms north of Addis Ababa. Its altitude ranges from 500 m asl at the bottom of canyon of Abay to 3600 m asl in the north east corner of the District. The District hosts 1% Wurch (cool, 3200-3600 masl), 20% Dega (humid, 2300-3200 masl), 47% Weyna Dega (dry sub-humid, 1500-2300 masl) and 32% Kolla (arid to semi-arid, 500-1500 masl) agro climatic zones (South Wollo Department of Agriculture, Land use and Environmental Protection Section (S.W.D.A.L.E.P.S), 1990). Beta Menedega, Mendeyu and Wobo Mikael are found in western parts of Borena District, and 42, 36 and 31 km far from the administrative center of the District (Mekane Selam), respectively. All of the tree kebeles are under Kolla agro-climatic zone of the District (S.W.D.A.L.E.P.S, 1990). In Beta Menedega kebele, Hanka and Abajema Debay were selected as study sites, while Wase and Lege Worke were selected in Mendeyu kebele. In Wobo Mikael, only Tame Debay was selected. These five sites were purposely selected because they have relatively dense vegetation cover and good representation of the study species in the District.

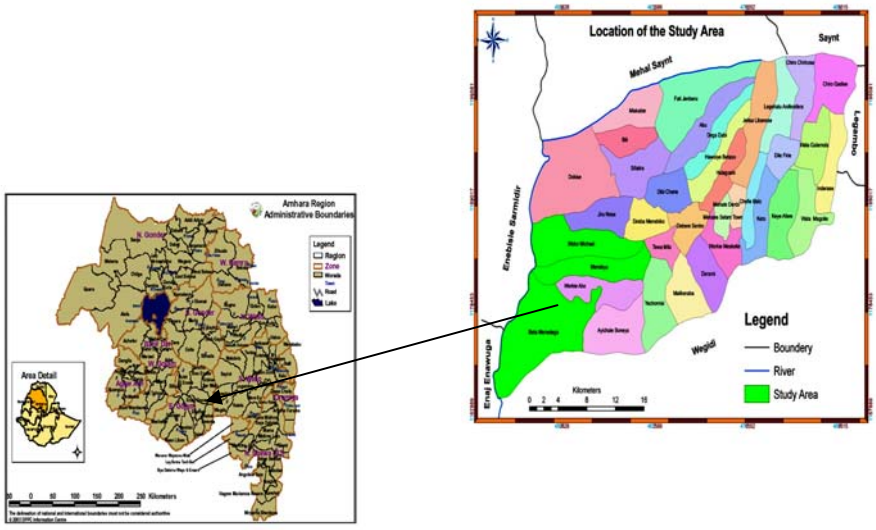

Fig. 1. Map of Borena District (study area), South Wollo.

Vegetation survey

In order to survey the vegetation (composition and abundance) of gum- and resin-bearing species, a transect-quadrate method was applied. At each study site, transect lines were systematically laid down in North-South compass direction. They were laid at 300 m distance apart. Along each transect line quadrates having a size of 20 m x 20 m (400 m^2) were systematically laid at 400 m apart. From all study sites a total of 60 quadrates (20 quadrates from each of the three sites) were used to collect the data.

Data on type of species, density, frequency and diameter at breast height were recorded for all of gum- and resin-producing plant species. Species identification was done using flora texts such as Flora of Ethiopia and Eritrea (Edwards, *et al.*, 1995; 2000; Hedberg, *et al.*, 2003).

Socio-economic survey

To study the socio economic importance and threats of the study species, a semi-structured questionnaire survey was conducted. Interview was made using local language (Amharic). A total of four villages (two from Wobo

Mikael and one from each of the other two study kebeles) were systematically selected. From each village a total of 10 households (about a tenth from each village) were randomly selected and interviewed. In addition, discussion with agriculture workers (both extension agents and officers at the bureau) of the District was made. The focus of the interview was on issues like species from which gum and resin are collected, season of collection, purposes of collection, status of the forest and efforts made so far to conserve the species.

Data analysis

The population status of gum- and resin-bearing species were examined by computing abundance, density, frequency, dominance, importance value and by constructing population structure. Density was calculated by suming up all the stems across all sample quadrates (abundance) and translated to hectare base for all the species encountered in the study quadrates and it provided a quantitative estimate of the stocking of the species in the area (Kent and Coker, 1992). Importance value index (IV) was used to explain the relative ecological importance of each study species in the wood land. Importance value index was calculated as the sum of relative abundance (%), relative dominance (%), and relative frequency (%) of the species, following Kent and Coker (1992). To detemine population structure, individuals of each species encountered were grouped into seven diameter classes at breast height (0-5 cm, 6-10 cm, 11-15 cm, … and 31-35 cm). It was depcted using frequancy histogram of diameter class distribution. Diversity (heterogeneity) of the study species were also determined using Shannon-Weiner diversity and evenness indices (Shannon and Wiener, 1949).

RESULTS AND DISCUSSIONS

Floristic composition

A total of 14 gum- and resin-bearing plant species (12 at Beta Menedega, 14 at Mendeyu and 10 at Wobo Mikael) representing seven families were recorded from all sample quadrates (Table 1). Fabaceae was the most diverse family with 5 species and 35.7% cover abundance in the study area (Table 1). The second diverse family was Burseraceae which was represented by 3 species or 21% of the study species. The family Combretaceae, Anacardiaceae, Mimosoideae and Sterculiaceae were represented each by one species. From all of the species recorded in the study area, only *Boswellia pirotte* was endemic.

From all the species recorded, five of them (*B. pirotte, C. habessinica, C. africana, A. seyal* and *A. polycantha*) produce commercial gum- and incense. The woodland of the study area was rich in commercial gum- and resin-producing plant species as compared to the study made in the northern dry land and upper rift valley areas of the country. For example, the study conducted by Abeje Eshete *et al.* (2005) and Kindeya Gebrehiwot (2003) at North Gondar and Tigray regions, respectively, identified *B. papyrifera* to be the major incense bearing species. Similarly, *A. seyal* and *A. senegal* were the two known gum-producing plants in the upper rift valley zone of the country (Getachew Eshete, 1999). But comparing the study conducted at Liben zone, Somalia region, and Borena zone of Oromia region, the study area had low number of commercial gum and incense producing plant species. For instance, Mulugeta Lemenih *et al.* (2003) reported seven commercial gum and incense producing species at Liben zone while Adefris Worku (2006) reported 15 species at Borena zone of Oromia Region.

Table 1. List of gum- and resin-bearing plant species encountered in Western Borena.

No	Scientific Name	Family	BM	Me	WM	Product
1	*Boswellia pirottae*	Burseraceae	✓	✓	✓	Incense
2	*Commiphora habessinica*	Burseraceae	✓	✓	X	Incense
3	*Commiphora africana*	Burseraceae	✓	✓	✓	Incense
4	*Combretum aculeatum*	Combretaceae	X	✓	✓	Gum
5	*Albizia lophantha*	Mimosoideae	✓	✓	✓	Gum
6	*Lannea spp.*	Anacardiaceae	✓	✓	X	Gum
7	*Ficus sycomorus*	Moraceae	✓	✓	✓	Gum
8	*Ficus ovata*	Moraceae	✓	✓	✓	Gum
9	*Sterculia africana*	Sterculiaceae	✓	✓	X	Gum
10	*Acacia nilotica*	Fabaceae	✓	✓	✓	Gum
11	*Acacia tortilis*	Fabaceae	✓	✓	✓	Gum
12	*Acacia seyal*	Fabaceae	✓	✓	✓	Gum
13	*Acacia lahal*	Fabaceae	X	✓	X	Gum
14	*Acacia polyacantha*	Fabaceae	✓	✓	✓	Gum

In this table, BM = Beta Menedega, Me = Mendeyu and WM= Wobo Mikael. And the sign "✓" indicate the presence of the species while "X" shows absence.

The result of this study also showed that there were different numbers of species in the 3 neighboring study kebeles which are found in the same climatic zone. The reason for the low number of the species at Wobo Mikael might be its short distance (is accessible) to Mekdela village. The short distance to the village means high exposure of the woodland to many human induced factors such as cutting for fuel wood and charcoal, construction materials and for expansion of their farm lands. This destruction of the woodland may cause loss of the species in the area.

Abundance, density, frequency, dominance and important value of gum- and resin-bearing plant species

As shown in Tables 2, 3 and 4, the total density/ ha of gum- and resin-bearing species at Mendeyu was relatively higher than at Beta Menedega and Wobo Mikael. At Beta Menedega the 4 species with high density were, in descending order, *C. habessinica, Lannea spp. C. africana* and *A. polyacantha* (Table 2). These species constitute 42% of all stems in all sample quadrates of the kebele studied. At Mendeyu *C. africana, A. tortilis* and *A. lahal* were species with high density in descending rank (Table 3). These species constitute 41.46% of all stems in all quadrates of the kebele. As to Wobo Mikael, *B. pirotte, C. aculeatum* and *A. lahal* had the highest density (Table 4) and constitute almost half (50.54%) of all stems in all quadrates sampled. On the other hand, *A. seyal* and *F. ovata* at Beta Menedega, *S. africana* and *A. seyal* at Mendeyu and *F. ovata* and F. *sycommorus* at Wobo Mikael were species having lower density/ha. The study also revealed the existence of some commercial gum- and resin-bearing plants with high density/ha. For instance, *C. habessinica, C. africna* and *A. lophantha* at Beta Menedega, *C. africana* at Mendeyu and *B. pirotte* at Wobo Mikael were the commercial gum- and resin-producing plant species with high density/ ha. The presence of these species in high density creates good opportunity for the local community to plan for enhanced/intensive gum and resin production.

Information from the result of frequency is important to show uniformity (homogeneity) of the distribution of species in given vegetation or study area (Silvertown and Doust, 1993). The result on the frequency of the species in this study showed that the majority of the gum-/resin-producing species were registered in more than half of the quadrates laid (Tables 2, 3 and 4). These high occurrences across all quadrates revealed that most of gum- and resin-bearing species could be cultivated in vast area of the District. On the contrary, the low distribution of some of the species such as *B. pirottae* and A. *seyal* at Beta Menedega, *A. nilotica* and *C. habessinica* at Mendeyu and *C. africana* at Wobo Mikael may be due to human interference.

Table 2. List of gum- and resin-bearing species recorded in the study quadrants at Beta Menedega in descending rank of abundance.

Rank	Species name	N	D	% N	F	% RF	DO	% RDO	% IV
1	*Commiphora habessinica*	128	160	16.8	17	13.7	2.2	15.9	15.5
2	*Lannea spp.*	102	127	13.4	9	7.3	1.3	9.3	10
3	*Commiphora africana*	92	115	12.0	14	11.3	1.7	12.6	12
4	*Acacia polyacantha*	77	96.3	10.1	12	9.7	0.5	3.4	7.7
5	*Albizia lophantha*	76	95	10.0	8	6.5	1.3	9.6	8.7
6	*Acacia tortilis*	69	86.3	9.1	11	8.9	1.2	8.8	8.9
7	*Boswellia pirotte*	46	57.5	6.0	6	4.8	0.7	6.4	5.4
8	*Acacia nilotica*	43	53.8	5.6	9	7.3	0.8	5.9	6.2
9	*Ficus sycomorus*	38	45.5	5.0	11	8.9	1.5	8.3	7.4
10	*Sterculia africana*	34	42.5	4.5	12	9.7	1.1	8.3	7.5
11	*Ficus ovata*	30	37.5	3.9	8	6.5	1.4	10.2	6.9
12	*Acacia seyal*	28	35	3.7	7	5.6	0.3	2.2	3.8

In this table, N= abundance of species, %N = relative abundance D= density / ha F= absolute frequency, %RF= relative frequency, DO= dominance, %RDO= relative dominance and %IV= percent importance value.

Data on importance value index (IV) permits a comparison of ecological significance of a species in a given forest type and depicts the sociological structure of population in its totality in the community (Lamprecht, 1989; Kenet and Coker, 1992). It reflects all variations in basal area and abundance (Kenet and Coker, 1992). Therefore it is good index for summarizing vegetation characteristics and ranking of species. The result of the present study depicted variation in their IV among species recorded in the three kebeles studied. This showed differences in ecological importance of each species. For instance, *C. habessinca, C. africana* and *Lannea spp.* at Beta Menedega, *A. lahal, A. tortilis, C. africana* and *F. ovata* at Mendeyu and *B. pirottae, C. aculeatum* and *A. lahal* at Wobo Mikael were highly important gum- and resin-bearing species in decreasing order (Tables 2, 3 and 4). On the other hand, the least important species were *A. seyal, S. africana* and *C. africana* at Beta Menedega, Mendeyu and Wobo Michael, respectively (Tables 2, 3 and 4), which might be due to human intervention and they need conservation measures.

The result of analysis of dominance (as calculated from basal area) revealed that *C. habessinica, C. africana* and *F. sycomorus* were the three top species in descending order at Beta Menedga (Table 2) while *A. lahal, F. ovata* and *A. tortilis* were at Mendeyu and *B. pirotte,* C. *aculeatum, A. lahal* and *A. lophantha* at Wobo Mikael (Table 3 and 4). *A. seyal, A. nilotica* and *C. africana* were the least dominant species at Beta Menedega, Mendeyu and Wobo Mikael, respectively. The existence of such dominant commercial resin-producing plant species in the areas could create good possibility for bulk production of incense.

Table 3. List of gum- and resin-bearing species recorded in the study quadrants at Mendeyu in descending rank of abundance.

Rank	Species name	N	D	% N	F	% RF	DO	% RDO	% IV
1	*Commiphora africana*	93	116	11.6	16	9.8	1.8	9.5	10.3
2	*Acacia tortilis*	92	115	11.5	14	8.8	2.1	10.8	10.4
3	*Acacia lahal*	83	104	10.1	18	11.3	3.1	15.8	12.4
4	*Acacia polyacantha*	68	85	8.4	18	11.3	0.7	3.7	7.8
5	*Lannea spp.*	64	80	8.0	9	5.7	0.8	4.1	5.9
6	*Boswellia pirotte*	58	73	7.2	9	5.7	1.0	5.1	5.9
7	*Ficus ovata*	53	66	6.6	15	9.3	2.9	14.9	10.2
8	*Albizia lophantha*	52	65	6.4	8	4.6	0.9	4.9	5.3
9	*Acacia nilotica*	52	65	6.4	6	3.6	0.4	2.1	4.5
10	*Combretum aculeatum*	51	64	6.3	11	6.7	0.6	3.2	5.4
11	*Ficus sycomorus*	48	60	6.0	13	7.7	2.6	13.4	9.0
12	*Commiphora habessinica*	47	59	5.8	5	3.1	1.2	3.2	4.9
13	*Acacia seyal*	26	33	3.2	9	5.7	0.6	3.2	4.0
14	*Sterculia africana*	21	26	2.6	11	6.7	0.7	3.4	4.0

In this table, N= abundance of species, % N = relative abundance, D= density / ha, F= absolute frequency, % RF= relative frequency, DO= dominance, % RDO= relative dominance and % IV= percent important value.

Table 4. List of gum- and resin-bearing species recorded in the study quadrants at Wobo Mikael in descending rank of abundance.

Rank	Species name	N	D	% N	F	% RF	DO	% RDO	% IV
1	*Boswellia pirotte*	170	212.5	23.6	20	16.2	1.7	16.4	18.7
2	*Combretum aculeatum*	120	150	16.2	16	13.1	1.5	14.7	14.7
3	*Acacia lahal*	82	102.5	11.1	11	9.1	1.2	11.3	10.5
4	*Acacia tortilis*	75	93.7	10.1	9	7.1	1.1	10.5	9.2
5	*Acacia polyacantha*	67	83.8	9.1	11	9.1	0.6	5.5	7.9
6	*Albizia lophantha*	66	82.5	8.9	9	7.1	1.2	10.9	8.9
7	*Commiphora africana*	56	70	7.6	6	5.1	0.5	4.7	5.8
8	*Sterculia africana*	36	45	4.8	14	11.1	0.7	6.5	7.5
9	*Ficus sycomorus*	35	43.8	4.7	14	11.1	1.0	9.2	8.4
10	*Ficus ovata*	29	36.3	3.8	14	11.1	1.1	10.3	8.5

In this table, N= abundance of species, % N = relative abundance, D= density / ha, F= absolute frequency, % RF= relative frequency, DO= dominance, % RDO= relative dominance and % IV= percent important value.

Population structure of gum- and resin-producing plants at Beta Menedega, Mendeyu and Wobo Mikael

Population structure, defined as the distribution of individuals of each species in arbitrary diameter, height and size class (Kenet and Coker, 1992) was determined to provide the overall regeneration profile of the gum- and resin-producing plants following Abeje Eshete *et al.* (2005) and Kindeya Gebrehiwot (2003). Information on the population structure of a tree species indicate the history of past disturbance to that species and environment and hence is used to forecast the future trends of population of a particular species (Peters, 1996). According to Peters, analysis of population structure

is a basic tool for orienting management activity. The population structure of this study was interpreted following Abeje Eshete *et al.* (2005) (Fig. 2). Tree species with population structures Skewed to an inverted 'J' or 'L'-shaped distribution i.e. with many small individuals and few large once, are considered to have favorable status of regeneration and hence stable population (Silvertown, 1982). In other words, the presence of small-sized individuals in abundance in a given forest will be seen as reserve for replacing cut, large-sized and old individuals. On the other hand, tree species with population structure of a bell-shaped, miss-shaped (sort of binomial distribution) and J-shaped exhibits serious problems of regeneration and, therefore, are unstable populations.

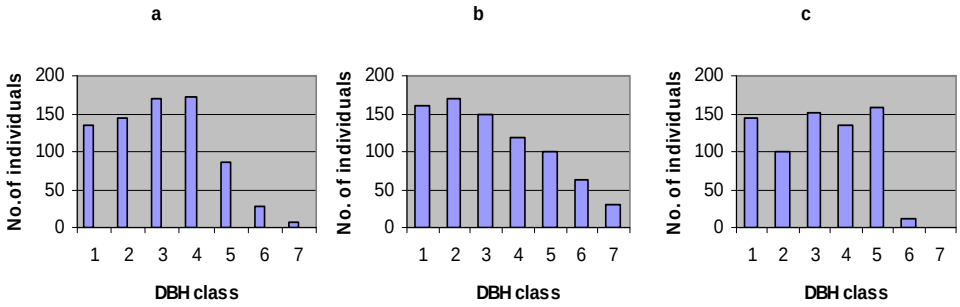

Fig. 2. Diameter size class distribution of gum- and resin-producing vegetation at Beta Menedega (a), Mendeyu (b) and Wobo Mikael (c), Borana, South Wollo. (Diameter at the Brest Height Class (DBH) in cm: 1= 0 - 5cm, 2 = 6 -10, 3 = 11 - 15... 7 = 31<35).

In this study, the result of population structure of gum- and resin-bearing plants species at Mendeyu showed L'-shaped. This indicates that the species have good regeneration potential and healthy population status. On the contrary, those species which showed miss-shaped at Beta Menedega and Wobo Mikael (Fig. 2) did not have healthy populations. Therefore, they need an orientation of management activity to have good regeneration potential and healthy population status.

Diversity, evenness and similarity of gum- and resin-producing species

Diversity in abundance (individual plants), richness (number of species), evenness (distribution) and similarity of gum- and resin-bearing plants were recorded for the three kebeles. Diversity (H') is calculated to interpret the difference in relative abundance of a species. Diversity (H'=2.58) at Mendeyu is higher than at Beta Menedega and Wobo Mikael (with values at H'=2.38 and H'= 2.17, respectively) High diversity at Mendeyu shows the

existence of high representative stands of gum- and resin-bearing plants than at the other two. It also showed the difference in the relative abundance of species (Table 5). Low Shannon evenness is an indication of the existence of unbalanced distribution of individuals of the species encountered at a given study area (Kent and Coker, 1992). In the present study the evenness in Mendeyu (H'/H'max = 0.9) is higher than the evenness at Beta Menedega (H'/H'max = 0.88) and Wobo Mikael (H'/H'max = 0.86). This indicates that distributions of plants per species were uneven in Beta Menedega and Wobo Mikael, which means that the species at Mendeyu have relatively similar abundance than the species at the other study kebeles.

Table 5. Diversity and evenness of gum- and resin-producing species in Beta Menedega, Mendeyu and Wobo Michael (Borena District).

Study kebele	Species richness	Total abundance /0.8 ha	H'	H'max	Evenness H'/H'max
Beta Menedega	12	763	2.38	2.68	0.88
Mendeyu	14	808	2.58	2.87	0.90
Wobo Mikael	10	736	2.17	2.51	0.86

To see the similarity in gum- and resin-bearing plant species between the three kebeles, Serenson's similarity coefficient (index) (Ks = 2C /A+B) was used (Table 6). Coefficient (index) was used to quantify richness similarity of two sampling locations. The most similar two places in species will have an index of 1 or 100% and those with no similarity have an index of zero. Greater than 60% index indicates that they are more or less similar (Qiming *et al.*, 1999; Stefan, 2005). The gum- and resin-producing vegetation of the three study sites was more or less similar as they have more than 60% similarity index (Table 6).

Table 6. Gum- and resin-producing vegetation similarity between Beta Mendega, Mendeyu and Wobo Michael kebeles in Borena District (as calculated by Sorensen's similarity coefficient (Ks)).

Study kebeles	Beta Menedega	Mendeyu	Wobo Mikael
Beta Menedega	------	(12) 0.9231=92.31%	(8) 0.7273 =72.73%
Mendeyu	------	------	(10) 0.8330 =83.3%
Wobo Mikael	------	------	------

Socio-economics of gum- and resin-producing plants in Borena District

The household resource base in the study area was typical of subsistence agro-pastoralist nature. Majority of the respondents (93 %) were engaged in crop farming and livestock rearing (Table 7). This showed that the local community generates its income mainly by selling crops and livestock. Few households, in addition to crop farming and livestock rearing, were dependent on trading of herds and cereal crops and also in collection of gum and resin. None of the households in the three kebeles were totally dependent on gum and resin-collection and sale. The major reasons for this are low market price which is not comparable to the time and energy they expend, prevalence of malaria and the absence of any natural gum-processing and marketing enterprise in the area.

Table 7. Major occupation and source of income of the community in the study area.

Household occupation	CF	LS	GR	OR
Beta Menedega	1	2	3	3
Mendeyu	1	2	4	3
Wobo Mikael	1	2	3	4

(CF= crop farming, LS= livestock rearing, GR=gum and resin collection and sale, OR= other activity. Number shows the rank, 1 means main, 4 means least source of income.)

Knowledge (awareness) of the population to gum and resin production

More than ninety per cent (90.4 %) of the respondents had good knowledge about the existence of gum- and resin-bearing plant species in their area. They were able to identify the species, season of collection and factors affecting the quality and the quantity of the products. In addition, they knew the traditional (local) importance and the major causes for decline of the population of the gum- and resin-producing species. But, their awareness about the importance of gum and resin at a larger market was very little.

Collection, trading and season of collection of gum and resin by the local community

Although the use of natural gum and resin for commercial purpose in Ethiopia has very old history (Wubalem Tadese *et al.*, 2002; Mulugeta Lemenih and Demel Teketay, 2003), collection of gum and resin for commercial purpose in the study area started a few years ago. Before commerce started, local people were using the products only for local purposes. The incense from *C. habessinica, C. africana* and *B. pirotte* were collected and sold by few members of the community. Gum Arabic from *A.*

seyal was important for increasing trade volume by mixing it with the incense of *C. habessinica* and *C. africana*. Collection is traditional and done from natural exudates (ooze from the tree trunk) or by cutting the tree trunk. No training was given on collection and taping techniques. The main collectors are the herdsmen, locally known as 'derebtegna' but farmers also collect side by side with their herding and farming activity. The products are collected in the area from January to May. The collectors of the area use local collection materials such as sack for temporary storage, axes and knife for bleeding and detaching from the tree trunk and branches. In general, the production of gum and resin in the study area differ from those in North Gondar (Abeje Ehete *et al.*, 2005) where artificial tapping is used for gum collection and also there are organized collectors' association, relatively good market price, presence of Natural Gum Processing and Marketing Enterprises (NGPME) and access of infrastructure (Abeje Ehete *et al.*, 2005). All these are absent in Borena.

When asked about their future career, 87% of respondents had indicated interest to make the gum and resin collection as one of their future activity beside their farming and livestock rearing, and they are in favor of the establishment of collectors' association. The main reason for the non-interested group (13%) was their belief that the sector is the activity of the poor. They also believe that it is tedious work, and does not last long due to the increased deforestation and they are convinced that it is not as sustainable as crop farming and livestock production.

Traditional importance of gum- and resin-producing plants in Borena District

Like other gum- and resin-producing areas of Ethiopia such as Metema and Kisha (Abeje Eshete *et al.*, 2005), Liben (Mulugeta Lemenih *et al.*, 2004) and Arero and Yabello (Adefris Worku, 2006), the gum- and resin-bearing species of Borena have traditional importance. The local communities use them for making farm equipments, door, fencing, veranda pole and household furniture. The leaf and the bark of *A. tortilis*, the leaf of *C. habessinica, A. seyal* and *A. nilotica* are used for preparing fodder while the fruit of *F. ovata, F. sycommorus* and the gum of *A. seyal* are edible by humans. Traditionally, the local community burnt the incense of *B. pirotte* to fume their house. Among all recorded gum- and resin-bearing species only *C. africana* has medicinal importance. The root of *C. africana* is used for snake bite while the resin is used for blood clotting and healing skin wound. In addition, the resin of *C. africana* is important particularly to the

herdsmen to paint their face and hands as a body lotion and brush their sticks (to make them shine).

Factors threatening population of species and efforts done to conserve gum- and resin-producing plant species

The vegetation harbouring the gum- and resin-bearing plants is rapidly declining by natural and human induced factors. The major human induced threats were browsing and trumping by livestock, conversion of the wood lands to farm land, inappropriate tapping and the high demand of charcoal and fuel woods by the local community and town dwellers of the District. Consequent drought in the area is also one of the main natural factors for the degradation of the forests.

I. Improper tapping

Tapping is done traditionally. The local community of the area had no training techniques of any sort. They use sharp axes and knives to make incisions (wounding) on the trunk of the trees. The depth, intensity and frequency of incisions of the area are different from the normal tapping techniques. This unskilled tapping resulted in improper peel of tree bark, insect attack, parasite infection and drying of the trees. According to Peters (1996), increasing the yield of exudates will almost certainly restrict the regenerative capacity of the population. Furthermore, Wubalem Tadese *et al.* (2002) pointed out that deep incision affects the inner bole (the sapwood) of the tree, which disturbs the physiology and causes death of the tree. This phenomenon could compromise the sustainability of the species.

II. Browsing and trampling by livestock

The local community of the study area uses the number of livestock per household to express their social status. They are highly interested to keep large number of livestock. Large numbers of animals are allowed to graze in all types of woodlands of the area without restriction in number and season. Consequently, the ecological disturbance and damage caused, particularly to the naturally regenerating vegetation, is immense.

III. Conversion of the woodlands to farm lands

Despite the harsh living condition, the study areas in which population of gum- and resin-bearing species occur naturally are potential areas for the production of cash and food crops. Hence, the local people clear the forest to get their own farmlands for crop production. In addition, the newly introduced irrigation scheme near Abay River to produce fruits also had an

impact. This rapid clearing of forests definitely leads to the shift of the woodlands to complete farmlands and needs appropriate resource management measure before the worst happens.

IV. Other factors

There were also other problems observed. For instance, intensive exploitation of the woodlands for construction, fuel wood and charcoal making are the main ones. This is aggravated due to the access created by the newly constructed road from Kombolcha to Gundewoine that cross the study area.

According to the respondents, efforts done to conserve the vegetation in general and gum- and resin plants in particular by the local community and government were very low. Low awareness of the community on future consequences, absence of financial support from any governmental and non-governmental organization and the high demand of farmlands by the local elders are the main reasons for the low efforts. Discussion with the chairman of agriculture office of the District revealed that trials are being made by preventing the charcoal merchants of the area, orienting the kebele leaders to teach the local community on the importance of the forest in collaboration with agriculture extension workers, distribution of seedlings to re-afforest the bare lands by local peoples, etc., for conserving the wood land area of the District.

CONCLUSIONS

A total of 14 gum- and resin-bearing plant species representing seven families were recorded in three kebeles of Borena district. Fabaceae was the most diverse family with 5 species and 35.7% cover abundance. From all of the species encountered, only *Boswellia pirotte* was endemic. The wood land was exposed to many human-induced factors such as cutting for fuel wood and charcoal, construction materials and for expansion of farm lands. Such negative intervention of the woodland may cause loss of the species in the area. However, some species showed inverted J shaped population structure, indicating possibility of regeneration if destructive interventions are minimized. This means that development of a management plan concerning the gum- and resin-bearing plant species by the District is necessary so that the local community could be introduced to the conservation, supervision and sustainable utilization of the natural resource.

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