Resource Base Assessment of *Acacia Seyal* in Eastern Amhara Region

Andualem Ayalew[1*], Derbie Wudu[2], Gezahagn Getachew[3], Tegabu Redae[4], Hoaddis kasshun[5]

Sirinka agricultural research center, P.O.Box 74, Woldiya, North Wollo, Ethiopia

Corresponding author: andualemayalew2010@gmail.com

Abstract

The study was conducted in north wollo, south wollo and orimiya zone, in Eastern Amhara with an aim to assess the resource potential of *Acacia seyal* in the selected sites. The data from the selected sites were collected using point center quarter method. A total of 90 quadrates from nine study areas with plot size 50m*50m, (22.5ha) were systematically located along each transect, 100 m apart, and was spatially captured with the aid of GPS. At every sampling point, four quadrants (90 degrees) were created, using the transect line and a line perpendicular to it. Species composition *Acacia seyal* structure and its regeneration status, at points along transects were taken to analyze diversity and target species structure of the sites. The highest and least density of *Acacia seyal* ha^{-1} were attained by Mehale mecharie (148) and Alene sefer (52). The highest shannon weiner diversity and species richness was observed in Alene sefer(Kemessie). *Acacia seyal* structure in all study sites showed an inverted J shape except lastie gerdao (Gubalafeto). Therefore, *Acacia seyal* deserves immediate conservation and appropriate management measures in order to get sustainable product and services from the species. Based on the results, awareness creation on the values and management of *Acacia seyal*, study on the management options of *Acacia seyal* for firewood, fuel wood, charcoal production and also investigation of gum production techniques of *Acacia seyal* for the sustainable use of the resource are recommended.

Keywords: resource potential; point center quarter methods; *Acacia seyal* structure; species composition; diversity

Introduction

Acacia species are important in a forestation programs and for producing non-timber forest products in arid and semiarid zones (Amelework *et al.*, 2010).

A. seyal belongs to the genus *Acacia* Mill., which is one the largest genera within the family *Mimosaceae*. The genus *Acacia* includes about 1200 species widely distributed in the dry land all over the world (Bakri, 1989). *Acacia seyal* is one of the strongly gregarious sub sharain tree species with major role of fuel wood and fodder production. According to (Thirakul, 1984; Badi *al et al*.,1989) indicates that *Acacia Seyal* is medium size tree up to 17 meters high, but 9-10 m is regarded as full-sized over most of its range with diameter 25-30 cm.

 doi:10.20944/preprints201908.0025.v1

Acacia seyal found in elevated areas up to 2100 m in tropical regions with soil pH 6-8 and *grows in a* mean annual rainfall of about 500- 1200 mm and high temperature of 39-42º C (NFTA, 1994).

In Ethiopia, it has good vegetation coverage around Woldia, Guba lafeto and Habru in north wello,kalu and Kombelecha south wello and Kemissie in Oromia zone of Easterm Amhara.

In Sudan and chad, Acacia seyal used for firewood ,fuel wood and charcoal. Trees managed on a 10-15 years rotation yield 10-35 cubic m/ha of fuel wood a year.

In Ethiopia, *Acacia seyal* mostly known by its charcoal, fire wood use and branches used for fences. When investigating the trend of neighboring countries like Sudan, it exports gum to India and Europe, therefore to earn income from Gum sale,to satisfy the demand of fire wood, fuel wood and charcoal production as well as to conserve and use *Acacia seyal* sustainably.

It is relevant to assess the distribution of species in Eastern Amhara to supply enough fuel wood, firewood and charcoal sustainably and hence to contribute as income source for the country.

2. MATERIALS AND METHODS

2.1. Description of the study area

The study area (Figure 1) is located in Gubalafeto,Habru and Woldia District, North Wollo Zone,Kalu and Combelacha south Wollo zone and also Kemssie in Oromia zone in Amahra Region at the distance of 520 km,466 and 450 km far from Addis Ababa. In addition,all the study areas are located at UTM zone 37N between 56°00'00"-59°50'00"E longitude and 11°90'.00"to 13°12'.50"N latitude. Acaci seyal as observed during the resource assessment, it prefers best kola agro climate with an altitude range from 1394m a.s.l up to1473m a.s.l, temperature of 25-30^{O}c, rainfall from 300-1400mm annually as well as weyna dega agro climate with an altitude range from 1605-1876 m a.s.l. temperature from18-25^{o}c and rainfall from300-1400mm annually.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

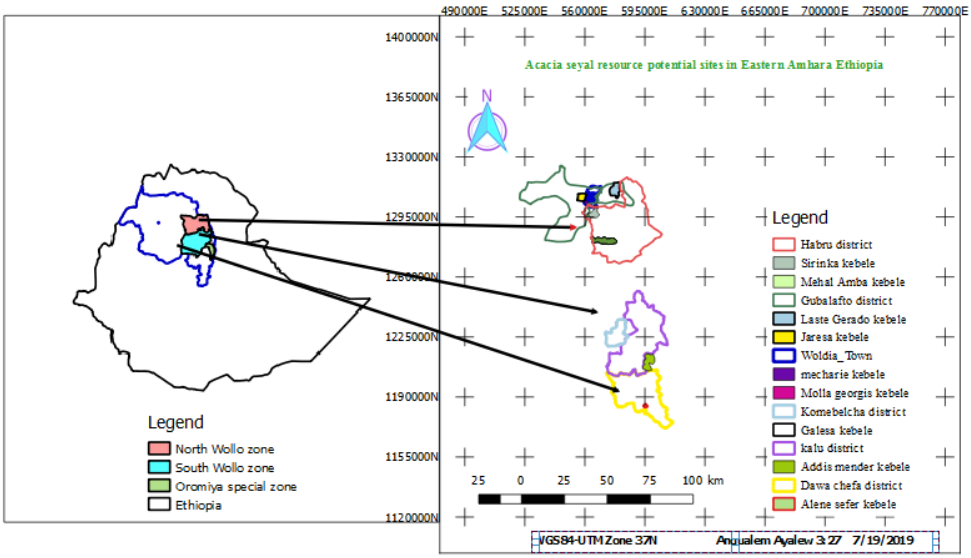

Figure 1.Map of the study areas

2.2. Sampling design

For resource base assessments, representative sites were selected and quadrants measuring 50m*50m (2500m^2) and in each quadrate, the total individuals counted and recorded. In addition, the height and DBH of Acacia seyal were measured using hypsometers and diameter tape, respectively. For individuals having height of less than 1.5m.their basal diameter and height was measured using caliper and calibrated sticks (rods), respectively.

Trees were considered with height >2m and DBH >2cm, sapling with height 1-2m and DBH<2cm and seedling with less than 1m height and no DBH.

Point center quarter was applied for the purpose of data collection on vegetation on farmland. The species composition, density, and size structure, at points along transects was assessed. The transect direction were determined randomly by selecting a bearing from the center of a farmland or village, with another transect perpendicular to the first transect (i.e. two cross cutting transects at 90). A series of points were systematically located along each transect, 100 m apart, and was spatially captured with the aid of GPS. There were 10 Point center quarters points in transects which normally become one kilo meter in length. At every sampling point, four quadrants (90 degrees) were created, using the transect line and a line perpendicular to it.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

2.3. Data collection method

Measurements and recording of species in each quadrant were done by selecting the *Acacia seyal* and sampled with all sizes that were closest to the sampling point in each of the four quadrants and then measuring its distance from the central point. Tree diameters were also be measured. This first part of assessment was made to measure our target trees in all sizes classes including seedlings, saplings and mature trees.

Materials required to conduct the assessment were caliper, meter, hypsometers, diameter tape, GPS and graduating ruler.

2.4. Data analysis

Species diversity and evenness are often calculated using shannon-wiener diversity index (Kent ,M. and P. Coker ,1992).

$$H' = -\sum \frac{ni}{N} \times ln \frac{ni}{N} — (1)$$

Where H' is Shannon diversity index, ni is the total number of individuals of species i and N is the total number of individuals of all species in that stand& Ln=natural logarithm. Possible values of the H′ range between 1.5 and 3.5 and only rarely exceed 4.5, where high values indicate high diversity

Species evenness was calculated as the: $J = \frac{H'}{Hmax} = \frac{H' = -\sum \frac{ni}{N} \times ln \frac{ni}{N}}{\ln s} - - - - - (2)$

Where J=species evenness H' = observed Shannon diversity index; S = the number of species. H max is the maximum level of diversity.

Species richness is defined as the number of species per unit area.

Stand characteristics of the scattered trees on farm lands

To describe the horizontal stand structure of tree species in the crop lands, basal area, density, frequency, height, Diameter at Breast Height (DBH),importance value index and basal area were calculated using the formuals used below;

Basal Area

It is the cross-sectional area of all of the stems in a stand at breast height (1.3m above ground level).This basal area per unit area is used to explain the crowdedness of a stand of forests. It is expressed in square meter/hectare (Jim and B. Becky2012).

The basal area was computed as: $BA = \sum \frac{3.14 * DBH2}{4} - - - - - - - (4)$

Where, BA= basal area, DBH= average diameter at breast height.

Therefore, Relative basal area (RBA) was computed as

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

$$RBA = \frac{Total\ basal\ area\ of\ Acacia\ seyal}{Total\ basal\ area\ of\ all\ species} \times 100 - - - - - - - - - (5)$$

Density is defined as the number of plants of a certain species per unit area.

$$Density = \frac{total\ number\ of\ Acacia\ seyal}{n \times plot\ area} - - - - - - - - - - (6)$$

For density/ha calculation, the sum of individuals per species were calculated and analyzed following methods (Muellerand H.Ellenberge, 1974).

Relative density (RD) is the study of the numerical strength of a species in relation to the total number ***of*** individuals of all the species.

$$RD = \frac{Density\ of\ Acacia\ seyal}{Total\ density\ of\ all\ species} \times 100 - - - - - - - - - - - (7)$$

Frequency is defined as the chance of finding a plant species in a given sample area or quadrat (Kent and Coker ,1992). It is calculated with the formula:

$$Frequency = \frac{Total\ number\ of\ quadrats\ in\ which\ the\ species\ occur}{Total\ number\ of\ quadrats\ studies} \times 100 - - - - (7)$$

Relative frequency (RF) is the degree of dispersion of individual species in relation to the number of all the species occurred. It was computed;

$$Relative\ frequnecy = \frac{Frequnecy\ of\ Acacia\ seyal}{Sum\ of\ frequnecy\ of\ all\ species} \times 100 - - - - - - - - (8)$$

Importance value index (IVI) was computed using(Mueller- Dombois and Ellenberge, 1974):

$$IVI = RD + RF + RBA - - - - - - - - - - - - - - - - - - - (9)$$

The data collected were analyzed using descriptive statistics and presented using tables and graphs.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

3. Result

The resource assessment of A.seyal as conducted in North wello Zone (woldia,Guba lafato,Habru), south wello Zone (Kalu and Komblecha district) and Oromiya zone(kemessie district) revealed in following table below

Table 1.comparing A.seyal densities from Resource potential areas of Eastern Amhara

Parameters from Point center quarter methods	In Mehale Mechari kebele(woldia)	In molla Georgis Kebele(woldia)	Jaresa kebele(Gubalafeto)	Lastie gerado Kebele(Gubalafeto)	Mehale amba(Habru)	sirinka Kebele(Habru)	Addis mender kebele (Kalu)	Galesa o11 Kebele(Combelecha)	Alene sefer Kebele(Kemissie)
Average distance b/n trees & sampling point(m)	21.6	17.9	16.7	10.0	36.5	34.2	34.3	22	22.1
Absolute frequency of Acacia seyal	1	1	1	1	0.9	0.8	1	0.4	1
Relative frequency of Acacia seyal (%)	93	77.8	95	95	43	70	79	77.8	50
Relative density of Acacia seyal (%)	8	15	8	5	20	10	13	15	31
Density of A.seyal Stems ha^{-1}	148	84	152	144	68	112	124	84	52

As shown above in the table 1, the highest average distance between Acacia seyal trees and sampling point was observed in Mehale Ameba(36.5m).While ,the least average distance between Acacia seyal and sampling point was occurred in Lastie Gerado(10 m).This result implies the distances between the target species and sampling point increases, the distribution of *Acacia seyal* on Mehale Ambea farm lands is less dispersed compared to lastie gerado.

In other words,Acacia seyal distribution in more close relative to the studies sites in increasing order; Mehale Ameba, Addis mender, sirinka, Galesa, Alensefer, Mehale mecharie, Molla georgis, Jaresa and Lastie gerdao.

Absolute frequency of Acacia seyal is found the same for all studies sites except Galesa.

Relative frequency of Acacia seyal was highest in both Jaresa and lastie gerado(95%).While,the least was found in mehale Ameba. The relative density of Acacia seyal was highest in Alenesfer (31%).but the least one was Lastie gerado(5%).The highest density of *Acacia seyal* was found in mehale mecahrie(148trees/ha).Whereas, the least density of Acacia seyal was occurred in Alensefer(52 tree/ha).

Generally, comparing the resource potential of A.seyal assessed areas in terms of the density of *A.seyal* in from the smallest to the largest order are Alene sefer kebele(Kemissie district), Mehale amba kebele

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

(Habru district), Molla Georgis kebele (Woldia district) & Galesa kebele (Komblecha district) equally, sirinka kebele (Habru district), Addis mender kebele (Kalu district), Lastie gerado kebele (Guba lafeto district), Jaresa kebele (Guba lafeto district) and mehale mecahri kebele (Woldia district).

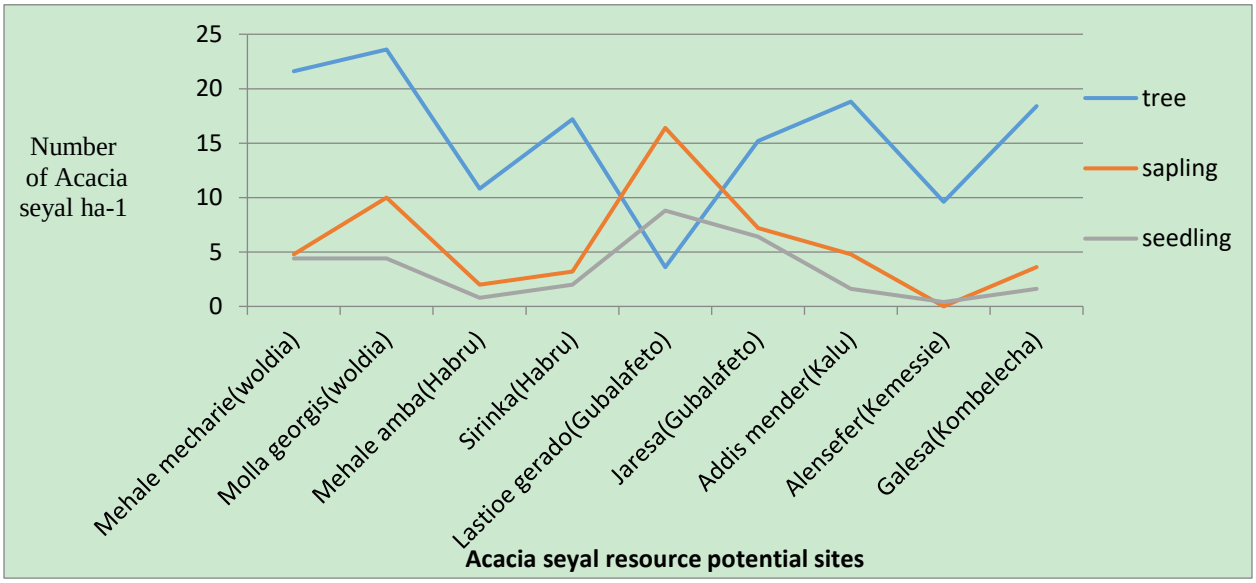

Figure 2.Acacia seyal resource potential sites in Eastern Amahra, Ethiopia

As indicated in Figure 2,the highest number of Acacia seyal in tree life form per ha^{-1} was found in Molla Georgis(woldia) followed by Mehale Mecharie(woldia).while,the largest number of sapling and seedlings were found in lastie gerdao(Gubalafeto) and the least one were Alene sefer(Kemessie).

Table 3.Shannon weiner diversity index(s), species richness(R) and evenness (E) for the different resource potential areas of Acacia seyal in Eastern Amhara

Index	Mehale mecahrie (woldia)	Molla georgis (Woldia)	Jaresa (Gubalafeto)	Lastie Gerdao (Gubalafeto)	Mehale Ameba (Habru)	Sirinka (Habru)	Addis mender (Kalu)	Alene sefer (Kemessie)	Galesa (Kombelecha)
Shannon weiner diversity	0.34	0.05	0.24	0.21	1.44	0.78	0.64	1.46	0.57
Species evenness	0.28	0	0.22	0.3	0.67	0.56	0.39	0.61	0.41
Species richness	3	1	3	2	8	4	5	10	4

As shown in the table 3 above, the highest shannon weiner diversity, species richness and species evenness was observed in Alene sefer(Kemessie) followed by Mehale Ambeba (Habru).While,the least shannon weiner diversity, species richness and species evenness was found by molla Georgis(Woldia).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

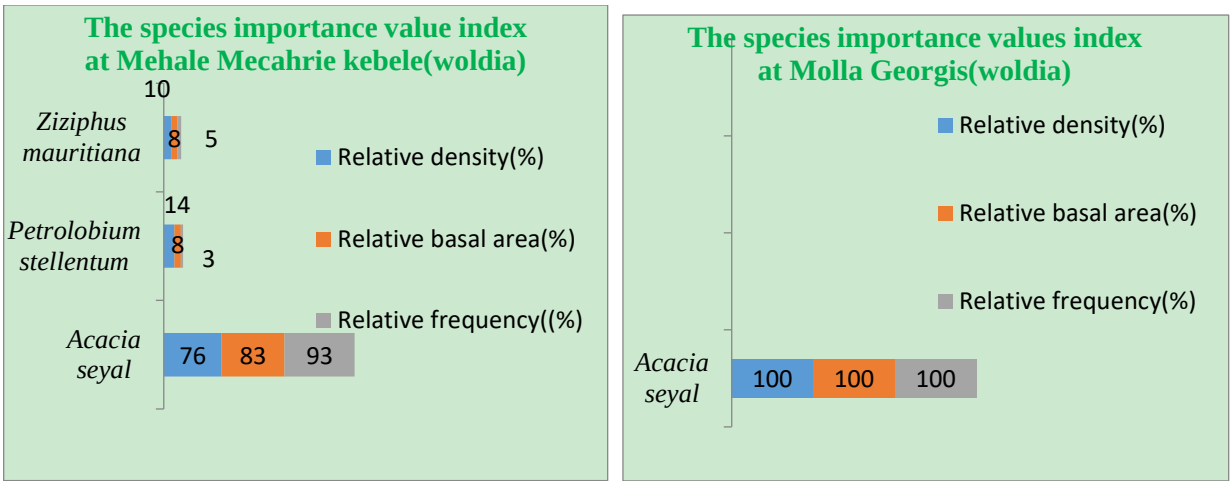

Figure 3.The relative frequency (Rf), relative basal area (RBA) and relative density (RD) of tree species found in farm lands of Mehale Ameba and Molla georgis of Woldia district, north wollo,Ethiopia

As shown in figure 3, the higher importance value is attained by Acacia seyal (300%) in Molla georgis than Mehale mechari(252%) incase of woldia. This implies Acacia seyal is a key stone species.

Ziziphus mauritiana has showed the least in importance values of 23% compared to tree species retained in the farm lands of Mecharie .Therefore, Ziziphus mauritiana species requires immediate conservation measures to sustain it.

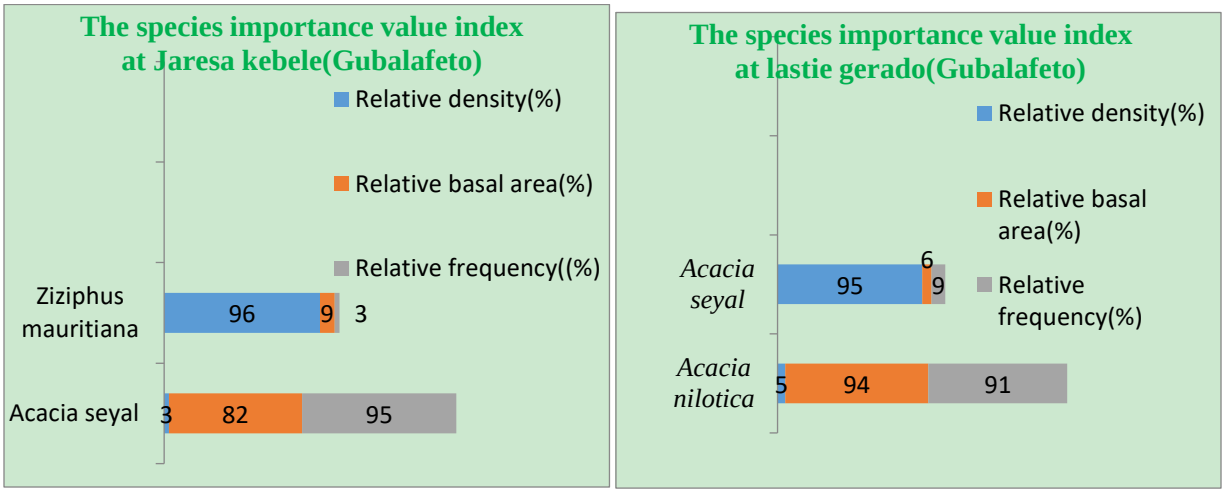

Figure 4.The relative frequency (Rf), relative basal area (RBA) and relative density (RD) of tree species found in farm lands of Guablafeto

As indicated in figure 4 above, Acacia seyal is the higher importance value in Jaresa compared to *Ziziphus mauritiana*. This is due to the presence of Acacia seyal in relative frequency and relative basal area.Whereas,*Acacia nilotica* is the higher in importance value index in lastie gerado compared to Acacia seyal.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

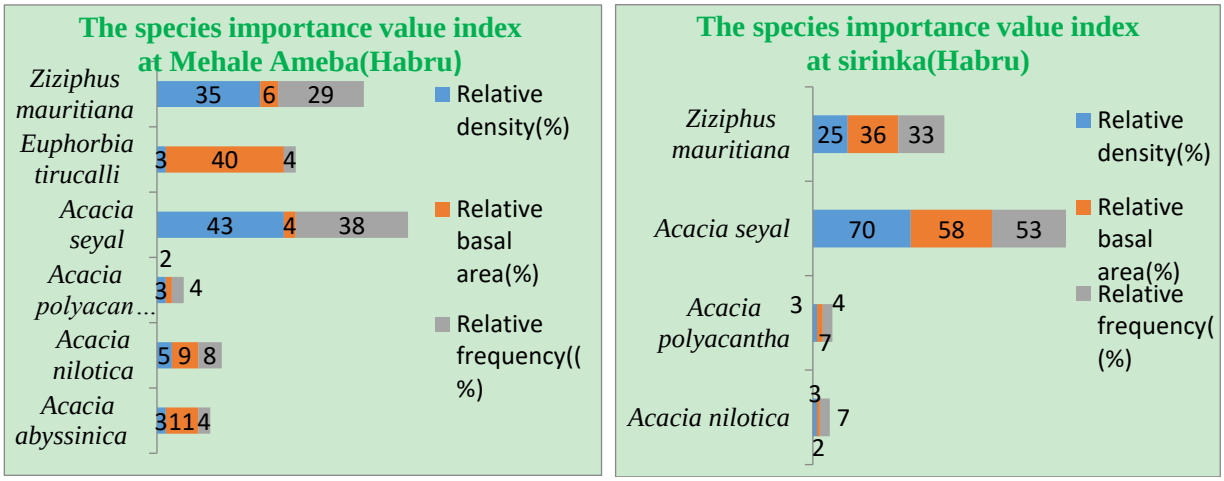

Figure 5.The relative frequency (Rf),relative basal area(RBA) and relative density(RD) of tree species found in farm lands of Habru district, North wollo,Ethiopia

As shown in figure 5,the higher species importance value is observed for Acacia seyal(181%) found in sirinka than Mehale Ameba(67%).Acacia polyacantha and Acacia nilotica were the least in importance value index of 9% and 12% respectively.Hence, Acacia polyacantha and Acacia nilotica dereves immedate conservation measures in the farm lands of Mehale Ameba and Sirinka respectively.

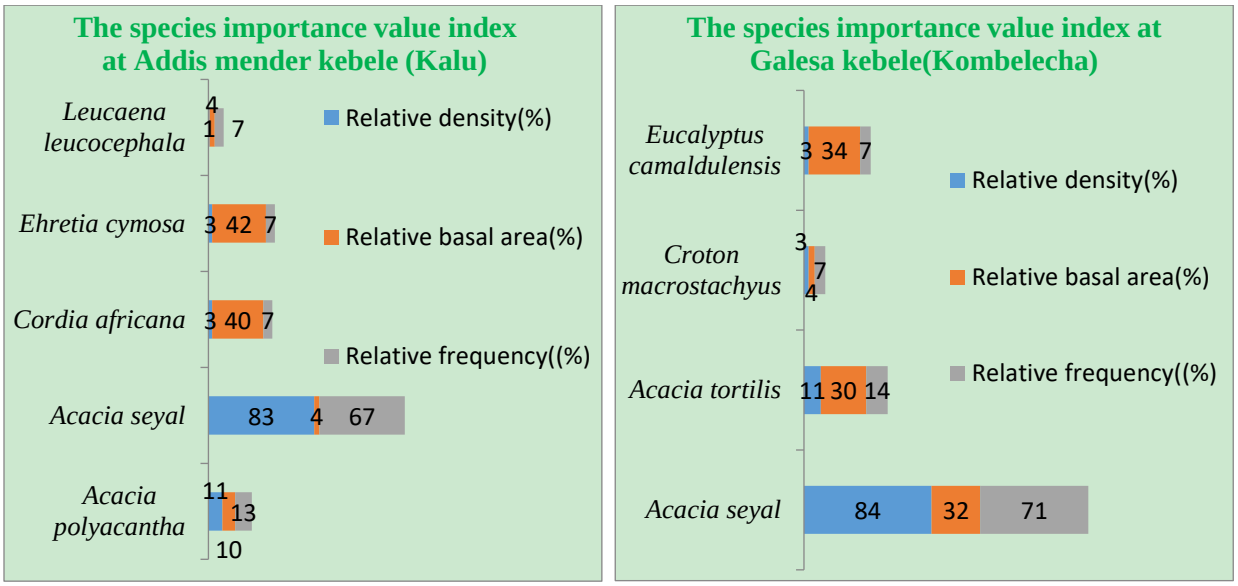

Figure 6.The relative frequency(Rf),relative basal area(RBA) and relative density(RD) of tree species found in farm lands of Addis mender(kalu District)(A) and Galesa(komebelcha district)(B),South wollo,Ethiopia

As shown in figure 6,the higher importance value is shown by Acacia seyal found in Galesa kebele(187%) than Addis mender kebeble(154%).*Leucaena leucophala* and *Croton macrostachyus* has

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2019 doi:10.20944/preprints201908.0025.v1

shown the least importance value of 12% and 18 % respectively.Thefore,the least importance valued species needs immediate conservation measures.

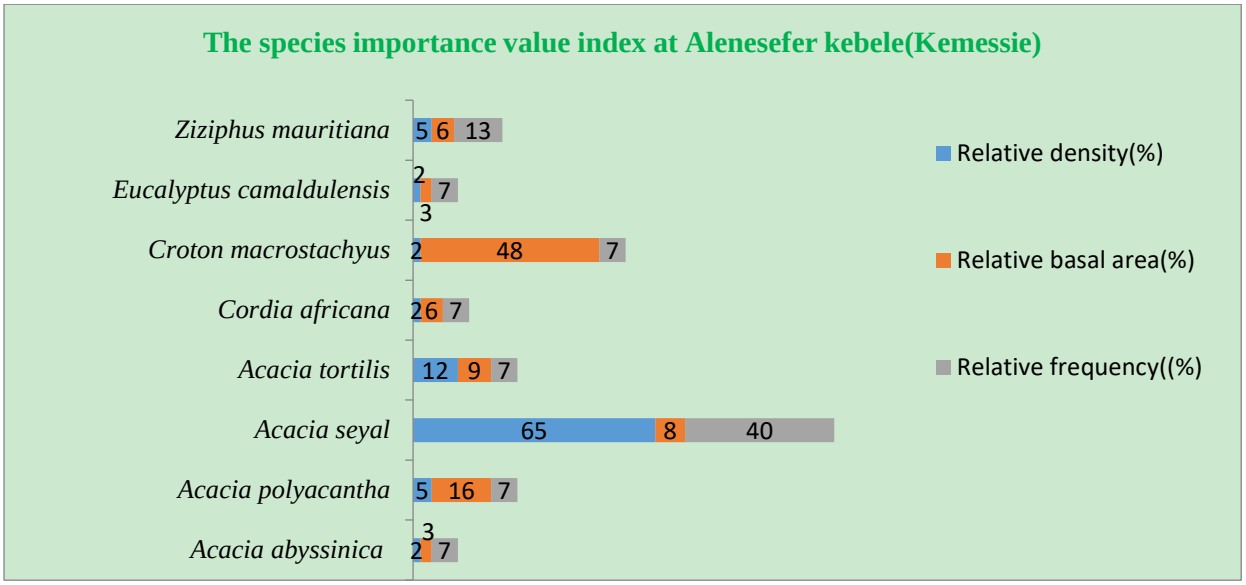

Figure 7.The relative frequency (Rf), relative basal area(RBA) and relative density(RD) of tree species found in farm lands of Alenesefer kebele(kemissie distrct),oromiya zone, Ethiopia

Acacia seyal has showed the highest importance value index compared to the species studied. *Acacia abyssinica* and *Eucalyptus camaldulensis*.

Generally, *Acacia seyal* has got the highest importance value compared to other species. The highest importance value of Acacia seyal is recorded in molla Georgis(Wodia).

Discussion

The distribution of Acacia seyal in the resource potential areas in Eastern Amahara shows different across the sites studied. In scattered trees on crop lands, Yemenzwork *et al*., 2016 found that there were different tree species distributions across sites and low tree density and low in regeneration. Feyissa, (2006) also indicated frequently varying agro-climatic conditions with diverse cultural and farming practices remain characteristics of agriculture in Ethiopia. The total number of species found on in the studied farm lands (14 species) is nearly similar to Abreha we Atsebeha(15 species) on crop lands(Etefa and Antony ,2013). Garrity,(2004) outlined the food security issues that can be addressed by adopting agro-forestry practices. Food from trees in agro forestry systems is of particular importance to subsistence farmers and contributes 25–50% to their annual food requirements (Magcale-Macandog *et al*.,2010).According to Grubb *et al*.1963, IVI is a good measure for summarizing vegetation characteristics of a given habitat and also useful to compare the ecological significance of species and for conservation practices.

4. CONCLUSION AND RECOMMENDATION

The highest and least density of *Acacia seyal* ha^{-1} were attained by Mehale mecharie kebele from woldia district (148) and Alene sefer kebele from kemessie district (52).

Acacia seyal structure in all study sites showed an inverted J shape except lastie gerdao(Gubalafeto). Therefore, *Acacia seyal* deserves immediate conservation and appropriate management measures which showed abnormal population structure in order to get sustainable product and services from the species.

The highest and lowest shannon weiner diversity and species richness was observed in Alene sefer(Kemessie and Molla georgis(Woldia) respectively.

IVI values of *Acacia seyal* range from 84.3 to 300% showed, the importance of *Acacia seyal* is higher than other species which retain on farmland of the study areas of Eastern Amhara.

The use of *Acacia seyal* on sustainable base to satisfy the demand of famers for fuel wood, firewood and charcoal was the key to successful retaining *Acacia seyal* specie on farm lands of Eastern Amhara and there by improve the income as well as food self sufficient environment for the farmers.

Species which also showed least importance value in each selected sites deserves appropriate conservation measures to sustain the species retained on selected farm lands of Eastern Amhara Ethiopia.

Mehale mecahrie from woldia and Jaresa from Gubalafeto were the resource potential sites in terms of density ha^{-1}.While, Molla georgis was also included as the resource potential site due to its highest value of importance value index.

Based on the findings the following recommendation was forwarded:

- Raising awareness on the values and management of the *Acacia seyal* for the farmers.
- Investigating Gum production techniques of *Acacia seyal* for sustainable use of the resources are suggested.
- Study on the management options for sustainable fuel wood and charcoal production

Acknowledgments

We gratefully acknowledged the financial support provided by Ethiopia Agricultural research organization of forest research center (FRC) and the staff members providing technical backup to accomplish the project successfully from the vegetation resource assessment activity up to report for FRC and Sirinka Agricultural research center (SARC).

Reference

Amelework Kassa, Ricardo Alía, Wubalem Tadesse, Valentin Pando and Felipe Bravo (2010).Seed germination and viability in two African *Acacia* species growing under different water stress levels

Badi, K.H; ELHori, A. and Bayoumi, A.A.(1989).The Forests of the Sudan. Forest Department. Khartoum, Sudan

Bakri Mahmoud(1989). Effect of Type, Time of Tapping and Tree Size of *Acacia seyal* var. *seyal* on the Production of Gum Talha in Rawashda Forest, Gedarif State, Sudan

Etefa Guyassa and Antony Joseph Ra(2013). Assessment of biodiversity in cropland agroforestry and its role in livelihood development in dryland areas: A case study from Tigray region, Ethiopia, International Journal of Agricultural Technology 2013 Vol. 9(4): 829-844 Available online http://www.ijat-aatsea.com

Feyissa, R. (2006). Farmers' Rights in Ethiopia: A Case Study. Lysaker, Norway.:The Fridtj of Nansen Institute

Garrity, D. (2004). Agroforestry and the achievement of the millennium development goals. Agro forestry Syst, 5–17.

Grubb,P. J., J. R. Lloyd, T. D.Penigton and T. C. Whitmore,(1963).A Comparison of Montane and Lowland Rainforests in Ecuador. Journal of Ecology, 51, 567-601.https:/ /doi. org/ 10.2307/ 2257748

Jim, E.and B. Becky,(2012).Basal Area: A measure made for management, school of Forestry and Wildlife sciences, Auburn University, ANR-1371

Kent ,M. and P. Coker,(1992).Vegetation description and analysis a practical approach. John Wiley and Sons, New York Károly RÉDEI, Irina VEPERDI

Magcale-Macandog DB, Ran˜ola FM, Ran˜ola RF, Ani PAB, Vidal NB (2010) Enhancing the food security of upland farming households through agroforestry in Claveria, Misamis Oriental, Philippines. Agrofor Syst 79:327–342

Mueller- Dombois, D. and H.Ellenberge(1974). Aims and Methods of Vegetation Ecology (p. 304). New York, NY: John Wiley and Sons

NAFTA(1994).A quick quid to useful nitrogen fixing trees from around the world. Accessed at www.winrok.org in May 2007

Thirakul, Souane(1984).*Manual of Dendrology*.Canadian International Development Agency and Groupe Poulin, Theriault Lte'e Consultants. Quebec. Canada.

Yemenzwork Endale, Abayneh Derero, Mekuria Argaw & Catherine Muthuri(2016). Farmland tree species diversity and spatial distribution pattern in semi-arid East Shewa, Ethiopia