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Resource Base Assessment of Acacia seyal in Eastern Amhara Region

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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 50 m × 50 m, (22.5 ha) 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°) 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, study on the management options 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 for Acacia seyal composition; Diversity

Introduction

Acacia species are important in a forestation programs and for producing non-timber forest products in arid and semiarid zones [1].*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 [2]. *Acacia seyal* is one of the strongly gregarious sub sharain tree species with major role of fuel wood and fodder production. According to [3,4] 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. *Acacia seyal* is found in elevated areas up to 2100 m in tropical regions with soil pH of 6-8 and grows in a mean annual rainfall of about 500- 1200 mm and high temperature of 39-42°C [5].

Acacia seyal native ranges include Egypt, Eritrea, Ethiopia, Ghana, Iran, Israel, Kenya, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Saudi Arabia, Senegal, Sudan, Syrian Arab Republic, Tanzania, Uganda, Yemen, Republic of, Zambia, Zimbabwe. The species is used to make syrup mixed with *Balanites aegyptiaca*, fodder, Apiculture, fuel, fiber, timber, gum or resin, tannin or dyestuff and medicinal values as well as shelter and shade [6].

A study reported by [7,8] showed that, *Acacia seyal* is one of best important species based on the importance value index in Borana Lowlands, southern Ethiopia and Awash Melka Kunture Prehistoric Archaeological Site, Ethiopia. Trees of *A. seyal* usually grow under different stand densities.Two types of *Acacia seyal*(*A. seyal var. seyal* and *A. seyal var. fistula*)found in Ethiopia in the natural stands study by [9] cited in Chikamai, 1999.

According to Getachew [10] showed that, the occurrence of seedling to a limited number, and low species diversity are indicators for the presence of the degradation of the species. However, many findings documented that farmers manage woody species within their home gardens and on their farms to derive a range of benefits [11,12].

Bender as cited by Zemede, farm woodlots have often been promoted to provide firewood, either for domestic consumption or for sale.

Resource assessment of *Acacia seyal* can be used as a base line to study management aspects, regeneration status, utilization of the resource for different purposes as well as to know the status of this species in order to provide the conservation measures on sustainable basis and also to make significant contribution to the economy of Eastern Amhara.

Materials and Methods

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 respectively. In addition, all the study areas are located at UTM zone 3 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 1,394-1,473m a.s.l, temperature of 25-30°C, rainfall from 300-1400mm annually as well as weyna dega agro climate with an altitude range from 1,605-1,876 m

a.s.l. temperature from18-25°C and rainfall from 300-1400 mm annually.

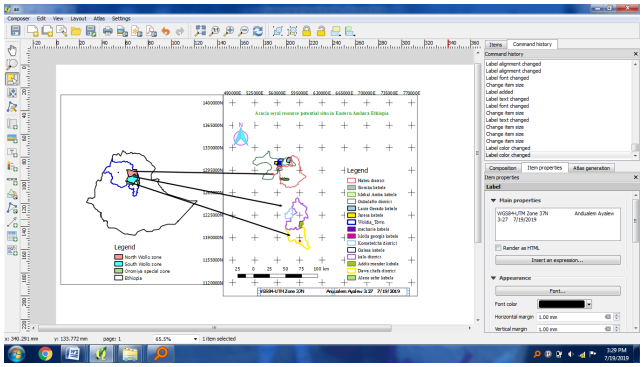

Figure 1: Map of the study areas

Sampling design

For resource base assessments, representative sites were selected and ten quadrants from each site measuring 50m*50m (2,500m^2), and in each quadrate, the total individuals counted and recorded. The total distance of the transect line is 1000m.The distance between quadrate and transact line was 100m and 1000m respectively. In addition, the height and DBH of *A.seyal* were measured using hypsometers and diameter tape, respectively. For individuals having height of less than 1.5m, their basal diameter and height were 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.

According to Ruch et al.[13] showed that, point center quarter was applied for the purpose of the vegetation data collection in farm lands. The species composition, density, and size structure, at points along transects were assessed. The transect direction was 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°) were created, using the transect line and a line perpendicular to it.

Data collection method

Measurements and recording of species in each quadrant were done by selecting the *A. 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 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, hypsometers, diameter tape, GPS and graduating ruler.

Data analysis

Species diversity and evenness are often calculated using Shannon-Wiener diversity index [14].

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

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 and 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:

$$J = \frac{H'}{Hmax} = \frac{H' = -\sum \frac{ni}{N} \times ln\frac{ni}{N}}{\ln s} \quad ----- (2)$$

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 in 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 formulas 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 [15].

The basal area was computed as:

$$BA = \sum \frac{3.14 * DBH2}{4} \quad -------- (4)$$

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

Therefore, Relative basal area (RBA) was computed as

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

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

$$Density = \frac{Total\ number\ of\ A.seyal}{n \times plot\ area} \quad --------- (6)$$

For density/ha calculation, the sum of individuals per species were calculated and analyzed following methods [15].

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

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

Frequency is defined as the chance of finding a plant species in a given sample area or quadrat [14].

$$Frequency = \frac{Total\ number\ of\ quadrats\ in\ which\ the\ species\ occur}{Total\ number\ of\ quadrats\ studies} \times 100 \quad ----(8)$$

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

$$Relative\ frequnecy = \frac{Frequnecy\ of\ Acacia\ seyal}{Sum\ of\ frequnecy\ of\ all\ species} \times 100 \quad -------(9)$$

Importance value index (IVI) was computed using the formula of Mueller- Dombois and Ellenberge, [15]:

$$IVI = RD + RF + RBA \quad ----------(10)$$

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

Ethical consideration

The study was conducted after getting accepted the proposal for resource assessment of *Acacia seyal* in Eastern Amhara in collaboration with Ethiopia Agricultural research institute of forest research center at Addis Ababa and Sirinka Agricultural Research Center (SARC). The vegetation survey using point center quarter method and GPS from ground truth was used to capture the scattered distribution of *Acacia seyal* found in farmer's farm land from North Wollo, South wollo and Oromiya Zone selected sites.

The collected data would be remained anonymously and confidentially.

Results

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) is revealed in Table 1. The highest average distance between *A.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* in Mehale Ambea farm lands is less dispersed compared to that of Lastie gerado.

In other words,*A.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.

Relative frequency of *A.seyal* was highest in both Jaresa and Lastie Gerado (95%)while, the least was found in Mehale Ameba. The relative density of *A.seyal* was highest in Alenesfer (31%).but the least one was Lastie gerado(5%).The highest density of *A.seyal* was found in Mehale mecahrie (148trees ha-1).Whereas, the least density of *Acacia seyal* was occurred in Alensefer(52 tree ha-1).

Generally, comparing the resource potential of *A.seyal* assessed areas in terms of the density from the smallest to the largest order was Alene sefer kebele(Kemissie District), Mehale Amba kebele (Habru District), Molla Georgis kebele (Woldia District) and 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).

As indicated in Table 1, showed, the highest number of *A,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).

Parameters from Point center quarter methods	In Mehale Mechari kebele(woldia)	In molla Georgis Kebele(woldia)	Jaresa kebele (Gubalafeto)	Lastie gerado Kebele(Gubala feto)	Mehale amba(Ha bru)	sirinka Kebele(Ha bru)	Addis mender kebele (Kalu)	Galesa o11 Kebele(Comb elecha)	Alene sefer Kebele(Kemi ssie)
Average distance b/n trees and sampling point(m)	21.6	17.9	16.7	10	36.5	34.2	34.3	22	22.1
Absolute frequency	1	1	1	1	0.9	0.8	1	0.4	1
Relative frequency (%)	93	77.8	95	95	43	70	79	77.8	50
Relative density (%)	8	15	8	5	20	10	13	15	31
Density (Stems ha-1)	148	84	152	144	68	112	124	84	52

Table 1: Comparing *A.seyal* densities from resource potential areas of Eastern Amhara

As shown in Table 3,the higher species importance value observed for *A.seyal*(181%) was 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, *A.polyacantha* and *A.nilotica* dereves immedate conservation measures in the farm lands of Mehale Ameba and Sirinka respectively.

Species name	North Wollo Zone																		South Wollo Zone						Oromiya		
	Woldia District						Gubalafeto District						Habru district						Kalu district			Kombelecha			Kemise District		
	Mehale Mecharie kebele			Molla george's kebele			Jaresa Kebele			Lastie Gerado Kebele			Mehale Ameba Kebele			Sirinka kebele			Addis mender kebele			Galesa kebele			Alene-sefer kebele		
	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF	RD	RBA	RF
Acacia abyssinica	-	-	-	-	-	-	-	-	-	-	-	-	3	11	4	-	-	-	-	-	-	-	-	-	2	3	7
Acacia polyacantha	-	-	-	-	-	-	-	-	-	-	-	-	2	3	4	3	7	4	11	10	13	-	-	-	5	16	7
Acacia seyal	76	83	93	100	100	100	3	82	95	95	6	9	43	4	38	70	58	53	83	4	67	84	32	71	65	8	40
Acacia tortilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	30	14	12	9	7
Cordia africana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	40	7	-	-	-	2	6	7
Acacia nilotica	-	-	-	-	-	-	-	-	-	-	-	-	5	9	8	3	2	7	-	-	-	-	-	-	-	-	-
Ziziphus mauritiana	10	8	5	-	-	-	96	9	3	-	-	-	35	6	29	25	36	33	-	-	-	-	-	-	5	6	13
Euphorbia tirucalli	-	-	-	-	-	-	-	-	-	-	-	-	3	40	4	-	-	-	-	-	-	-	-	-	-	-	-
Ehretia cymosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	42	7	-	-	-	-	-	-
Eucalyptus camaldulensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	34	7	2	3	7
Croton macrostachyus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	7	2	48	7
Leucaena leucocephala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	7	-	-	-	-	-	-
Pterolobium stellatum	14	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: The distribution of *Acacia seyal* in terms relative density (RD), relative basal area (RBA) and relative frequency (RF) in Eastern Amhara.

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.

As shown in the Table 2 above, the highest Shannon Weiner Diversity, species richness and species evenness was observed in AleneSefer (Kemessie) followed by Mehale Ambeba (Habru).while, the least Shannon Weiner Diversity, species richness and species evenness were found in Molla Georgis(Woldia).

As shown also in Table 3,the higher importance value for *A. seyal* is found in Galesa kebele(187%) than Addis Mender kebeble(154%).Leucaena leucophala and Croton macrostachyus showed the least importance value of 12% and 18% respectively.Thefore, *L. leucophala* and *C. macrostachyus* species needs immediate conservation measures.

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 wiener 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

Table 3: Shannon wiener diversity indexs, species richness(R) and evenness (E) for the different resource potential areas of *A. seyal* in Eastern Amhara

Generally, *A. seyal* exhibited the highest importance value compared to other species. The highest importance value of *A. seyal* is recorded in Molla George's (Wodia).

As shown in Table 3 showed, the higher importance value is attained by *A. seyal* (300%) in Molla georgis than Mehale mechari(252%) in case of Woldia. This implies *A.seyal* is a key stone species.

Discussion

The distribution of *A. seyal* in the resource potential areas in Eastern Amahara showed uneven status across the sites studied. In scattered trees on crop lands, Yemenzwork et al., [16] found that there were different tree species distributions across sites, low tree density and low regeneration. Feyissa [17] 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 that of Abreha we Atsebeha(15 species) in crop lands [18].

The average number of seedlings (98 ha-1) reported by Eshete [10] from Acacia woodlands of the Rift Valley of Ethiopia is higher than the number of seedlings (3 ha-1) found in this study (Figure 2). This could be expected due to the location of the trees are found in the farmers farm land and during ploughing the seedlings will be destroyed and hence their number declines compared to Acacia woodland.

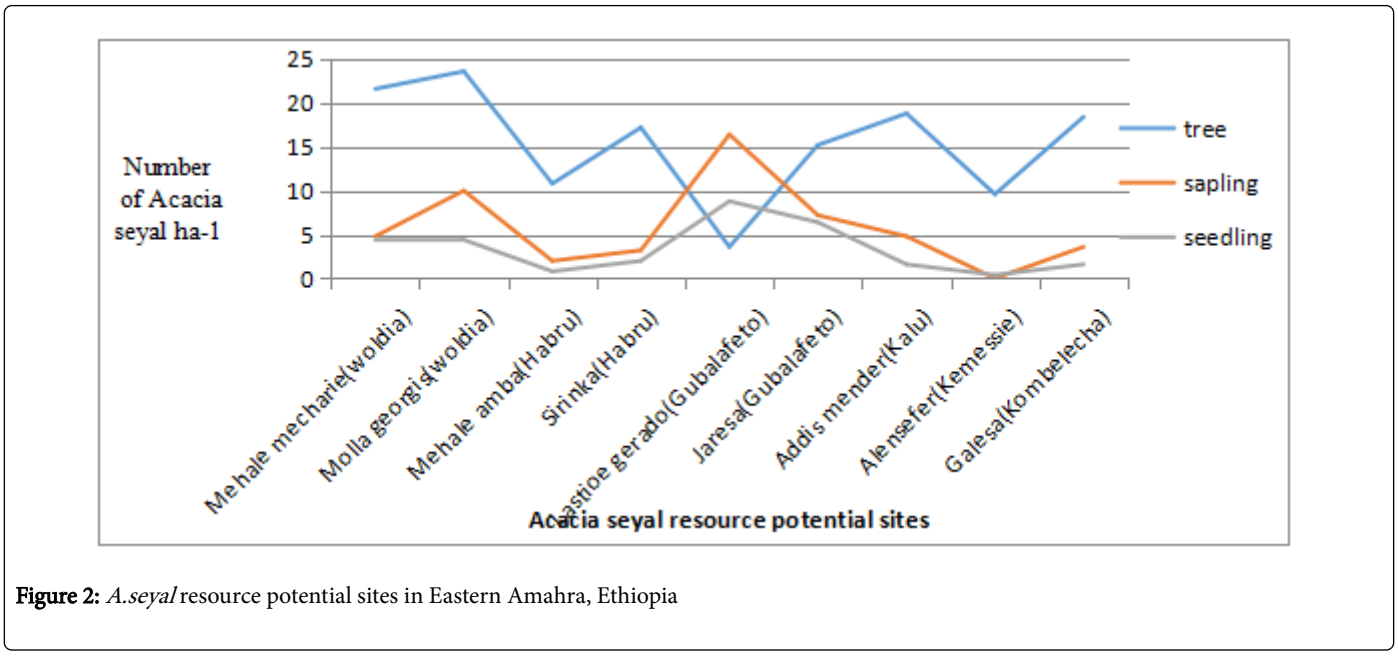

Figure 2: *A.seyal* resource potential sites in Eastern Amahra, Ethiopia

Garrity [19] 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 farmers subsistence and contributes 25–50% to their annual food requirements [20,].According to Grubb et al. [21] 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.

Conclusion and Recommendations

The highest and lowest density of *Acacia seyal* ha-1 were attained by Mehale Mecharie kebele from Woldia District (148) and Alene Sefer kebele from kemessie District (52) respectively.

seyal structure in all study sites showed an invertedJ shape except Lastie gerdao(Gubalafeto). Therefore, *A. 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 were observed in Alene Sefer(Kemessie)and Molla georgis(Woldia) respectively.

IVI values of *A. seyal* ranged from 84.3 to 300%, and the importance of *A.seyal* is higher than other species which were found in farmland of the study areas of Eastern Amhara.

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

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

Mehale Mecahrie, Molla george's and sirinka were selected as the best *A. seyal* resource potential sites.

- 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 A.seyal for sustainable use of the resources are suggested, and
- Study on the management options for sustainable fuel wood and charcoal production

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Conflict of Interest

No conflict of interest in the authorship

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