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Research Article

Distribution and Regeneration Status of *Albizia gummifera* and *Prunus africana* along Agroecology in Agroforestry: The Case of Gombora District, Southern Ethiopia

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Empirical evidence on the patterns of the multipurpose trees distribution and regeneration status, which are under threats pressure is necessary for the proper management and conservation of the species. *Prunus africana* is listed as vulnerable while *Albizia gummifera* is listed as least concern amongst the multipurpose trees. This study was aimed to investigate the distribution, abundance, density, and regeneration status of *Prunus africana* and *Albizia gummifera* along agroecology and farmers' wealth status in agroforestry. Stratification sampling and equal sampling techniques were employed. A total of 162 quadrats were laid within the randomly selected 54 households' farms. A nested quadrat size was 20 m × 20 m for enset tree-based homegarden and parklands. For live fencing, a quadrat size was 4 m × 10 m. Abundance, diameter (cm), height (m), and growth habits of both trees were recorded. Density (stems per ha), diameter class (cm), height (m) class of both trees, and mean of growth habit were analyzed and considered. One-way ANOVA analysis and independent *t*-test were employed for means comparison by using SPSS V. 23.0. A total of 132 individual *A. gummifera* was recorded along agroecology while a total of 55 individual *P. africana* was recorded along agroecology. Mean density (stem/ha) of *A. gummifera* and *P. africana* showed significant difference between agroecology and farmers' wealth groups ($P < 0.05$). *A. gummifera* and *P. africana* were sparsely distributed in the enset tree-based homegarden, parklands, and live fencing along agroecology. The overall diameter (cm) class and height (m) class distribution pattern of these tree species were observed as a J-shaped curve. The regeneration status of *A. gummifera* and *P. africana* was poor. In conclusion, distribution, abundance, and regeneration status of *A. gummifera* and *P. africana* were influenced by agroecology and farmers' wealth status needing appropriate conservation measures.

1. Introduction

Prunus africana (Hook.f.) kalm from the Rosaceae family and *Albizia gummifera (J.F.Gmel.) C.A. Sm.* from the Fabaceae family are the multipurpose tree species, which are native to Africa in the Afromontane forests [1, 2]. *Prunus africana (Hook.f.) kalm* and *Albizia gummifera (J.F.Gmel.) C.A. Sm.* are the most important multipurpose tree species found in agroforestry practices [3], remnant natural forests, and forests [4]. Nowadays, *Prunus africana,* and *Albizia gummifera* are being under threats pressure [4]. For instance, *P. africana* was one of the IUCN Red List of Threatened species in 2021 [5]. Currently, *P. africana* is listed as vulnerable tree species https://www.iucnredlist.org/, while *Albizia gummifera* is listed as least concern tree species [6] accessed on 06 December 2023. Understanding the current regeneration status of *P. africana* and *A. gummifera* along agroecology in agroforestry is very important to introduce a sound management practice and conservation approaches.

The multiple benefits obtained from *P. africana* include traditional medicine from its bark and leaf parts [7], fuelwood, timber, construction materials, and soil and water conservation [8]. The benefits obtained from *A. gummifera* include gum/resin, tannin, medicine [9], apiculture, timber, ornamental, and soil fertility improvement through nitrogen fixation [10, 11].

Agroforestry is a collective name for land-use systems where trees, shrubs, palms, bamboos, vines, etc. are deliberately grown on the same land-management units, i.e., field or plot as agricultural crops and/or animals, in some form of spatial mixtures or temporal sequence [12]. Farmers have been planting and retaining the multipurpose tree species on their agroforestry land-uses for their benefits [3]. Agroforestry provides habitats for the forest-dependent species including the threatened native as well as exotic tree species [13]. However, the multipurpose tree species are being threatened due to the anthropogenic factors such as logging, selective removal of tree species from the farmlands, overexploitation of tree species, unwise utilization of plant parts [14, 15], agricultural expansion, the socioeconomic factors [16], deforestation [13], and environmental factors including altitude, soil type, and agroclimatic conditions [17, 18]. Hence, generating information about multipurpose woody species distribution patterns and also the population structure along agroclimatic conditions in agroforestry could be helpful for the effective management and implementing conservation strategies of the species [3].

Ethiopia is characterized by the enriched endemic flora and fauna with highly diversified agroecological zones [19]. Farmers are maintaining and retaining the multipurpose woody species on their farmlands in order to get the multiple benefits from them for decades in Ethiopia [20]. For instance, *A. gummifera* and *P. africana* are grown by the farmers in agroforestry land-uses of Lemo district, Southern Ethiopia [3]. Farmers have been planting and retaining these tree species in order to satisfy the ever increasing demand for the forest products [8, 21, 22]. In addition, *Albizia gummifera* and *Prunus africana* have been scattered in the montane forests, orthodox churches, protected areas, and groves [8, 23, 24]. In general, the integration of forest tree species in the farming systems is an alternative option in order to mitigate deforestation [2, 25, 26].

P. africana and *A. gummifera* tree species are under the threats pressure in Ethiopia [13], particularly in Southern Ethiopia [27–29] and in the study district of Southern Ethiopia. Having the scientific empirical evidence on the regeneration status of the forest tree species by comparing their seedlings, saplings, and adult trees in agroforestry systems can be necessary for proposing and also applying the various conservation approaches [30, 31]. However, from literature review, we observed that there has been a very limited information on the distribution and regeneration status of vulnerable tree species and least concern tree species by the IUCN Red List of Threatened species along agroecology and farmers' wealth status in agroforestry. Farmers have been retaining *P. africana* and *A. gummifera* tree species on their farms in Gombora district of Southern Ethiopia. But, no previous studies have been done on investigating the patterns of both tree species distribution and regeneration status along agroecology in agroforestry in the Gombora district of Southern Ethiopia. We hypothesized that the distribution, density, and regeneration of *A. gummifera* and *P. africana* differ among agroecology, agroforestry practices, and farmers' wealth status. This research was aimed to analyze and document the distribution, abundance, density, and regeneration status of *A. gummifera* and *P. africana* along agroecology, and farmers' wealth status in agroforestry in the study areas of Southern Ethiopia.

2. Materials and Methods

2.1. Descriptions of the Study Area. The present study was conducted in the Gombora district of Southern Ethiopia. The map of the study district is presented in Figure 1. The district comprised of the highland, midland, and lowland agroecological zones. The soil types of the district are Nitosols and Eutric nitosols. According to the district's agricultural organization, the land-uses are the enset tree-based homegarden agroforestry, live fencing, woodlots, parkland agroforestry practice, grazing lands, plantation forest, and natural forest.

2.2. Sampling Strategy

2.2.1. The Study Site Selection. The study district encompassed a total of 23 kebeles (kebele is the lowest administration unit in Ethiopia). All of 23 kebeles that are found in Gombora district were stratified into the highland (2300–3200 m.a.s.l), the midland (1500–2500 m.a.s.l), and the lowland (500–1500 m.a.s.l) according to Zemede [32], in order to have a representative sample. Subsequently, each stratum kebele was categorized into the two groups as kebeles with the absence of *Albizia gummifera* and *Prunus africana* trees in the existing agroforestry practices, and kebeles with the presence of *Albizia gummifera* and *Prunus africana* trees in the existing agroforestry practices. Finally, the two kebeles, namely, Gorta kebele from the midland agroecology and Adeana kebele from the lowland agroecology were randomly selected based on the presence of these tree species in order to have a representative sample of the whole population. The existing agroforestry practices of each randomly selected kebele were characterized as the enset (*Ensete ventricosum*) tree-based homegarden agroforestry, parkland agroforestry practice, and live fencing for inventory.

2.2.2. Tree Inventory. The investigation unit for the purpose of this study was the household's farms, i.e., the existing agroforestry practices (the enset (*Ensete ventricosum*) tree-based homegarden agroforestry practice, parkland agroforestry practice, and live fencing) in each randomly selected kebele. In order to have a representative sample and analyze the impact of farmers' wealth status on the patterns of *Albizia gummifera* and *Prunus africana* trees distribution and regeneration status across the existing agroforestry practices, the households' wealth stratification was done. Accordingly, all the households that are found in Gorta kebele from the midland and Adeana kebele from the lowland were stratified into the wealthy, medium, and poor households based on the local wealth stratification criteria

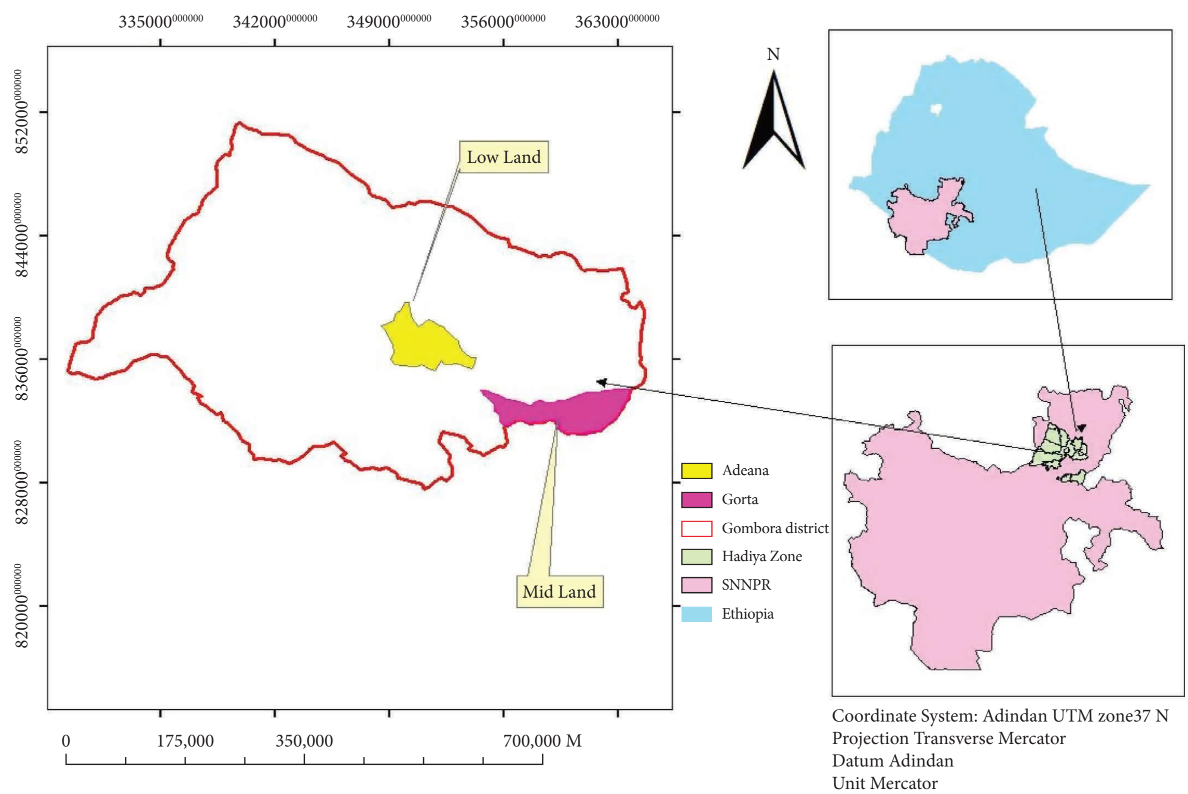

Figure 1: Map of the study area in Gombora district, Hadiya zone, Southern Nations' Nationalities and Peoples' Regional State.

such as tropical livestock unit (TLU), land size in hectare (ha), gross annual income, and income from off-farm activity in order to select the target household's farms for inventory. This was achieved with the help of elders, experts, and the managers of the two kebeles.

An equal sampling technique was employed in order to have a total of 54 households' farms from the two randomly selected kebeles for inventory. A big nested quadrat size was 20 m × 20 m with the four subplot size of 5 m × 5 m were set up at the four corners for the enset tree-based homegarden agroforestry practice and parkland agroforestry practice [33], and 100 m length of live fencing was divided into 10 sections at 10 m interval, and one section was randomly selected with the quadrat size of 4 m × 10 m with some modification of approach adopted from Lauriks et al. [34].

A total of $n = 162$ quadrats from the 54 households' farms were used for inventory as shown in Table 1.

Tree parameters such as abundance, diameter (cm), height (m), number of matured trees, saplings, and seedlings were recorded within each sampled quadrat. Mature trees were with a diameter of >25 cm, small poles were with the diameter >5–25 cm, saplings were the young trees with a diameter of 2–5 cm, and seedlings were with the diameter size of <2 cm [33]. Hypsometers and calipers were used to measure DBH (cm) and tree height (m), respectively.

2.3. Data Analysis. Before the collected data analysis, the histogram (visual) and skewness *Z*-values were used in order to ensure the normality test of the collected data, i.e., number of stems per plot/density, diameter class (cm) of individuals per plot, and height (m) of individuals per plot. The histogram of the collected data visually showed that data were normally distributed. In addition to this, text analysis outputs (skewness *Z*-values) for density, diameter class (cm), and height (m) of trees were 1.73, 1.26, and 0.95, which indicates that data were approximately normally distributed.

2.3.1. Density. The density of woody species was the mostly considered one to estimate structural parameters during the data analysis [3]. Density can be calculated by summing up all stems across all plots, land-uses, and converting into a hectare basis as follows:

$$\text{Density} = \frac{\text{Total number of individuals of species}}{\text{Sample area (ha)}}. \quad (1)$$

2.3.2. Diameter Class Distribution (cm) and Height (m) Distribution Analysis. Diameter class (cm) and height (m) of woody species were among the commonly used structural parameters to be considered during the data analysis. Diameter class (cm) and height (m) of both tree species were categorized into the seven diameter classes as DBH (cm): 1 = 0–15.9, 2 = 16–30.9, 3 = 31–45.9, 4 = 46–60.9, 5 = 61–75.9, 6 = 76–90.9, and 7 = ≥ 91. The height (m) classes are as follows: 1 = <1.3 m, 2 = >1.3 m–5 m, 3 = >5 m–10 m, 4 = >10 m–15 m, 5 = >15 m–20 m, 6 = >20 m–25 m, and 6 = ≥25 m.

Table 1: Equal sample size taken from each agroforestry practice along agroecology and farmers' wealth group.

Agroecology	Agroforestry practices	Wealth group and number of plots			Total
		Poor	Medium	Rich	
Midland	Enset-based agroforestry practice	9	9	9	27
	Parkland agroforestry practice	9	9	9	27
	Live fencing	9	9	9	27
Lowland	Enset-based agroforestry practice	9	9	9	27
	Parkland agroforestry practice	9	9	9	27
	Live fencing	9	9	9	27
Total		54	54	54	**162**

Density (stem per plot and per hectare) of *P. africana* and *A. gummifera* was calculated in order to investigate the distribution patterns and was subjected to one-way ANOVA least significant difference (LSD) test at $P < 0.05$ across the enset-based homegarden agroforestry practice, parkland agroforestry practice, and live fencing, and the farmers' wealth status for comparison. In addition, the independent *t*-test was used in order to investigate the effect of agroecology on the distribution of *P. africana* and *A. gummifera* in the study sites at $P < 0.05$ level using SPSS V. 23.0.

Regeneration status of trees was evaluated in the two agroecological zones by counting the total number of individual stems, and by comparing seedlings and saplings with the matured trees according to Tiwari et al. [35]; Farwig et al. [36]; and diameter class (cm) and height class (m) distribution [3]. Good regeneration, if seedlings > saplings > mature; fair regeneration, if seedlings > or ≤ saplings ≤ mature; poor regeneration, if the species survives only in the sapling stage but no seedlings (saplings may be <, >, or = mature); and if a species is present only in a mature form, it is considered as not regenerating [35].

3. Results

3.1. Abundance of A. gummifera and P. africana along Agroecology. A total of 132 individuals of *Albizia gummifera* were recorded in 72 quadrats out of 162 quadrats, while a total of 55 individuals of *Prunus africana* were recorded in 36 quadrats out of 162 quadrats in the study areas. Of 132 trees, 48 individuals of *A. gummifera* were recorded on the midland while 84 individuals of *A. gummifera* were recorded on the lowland agroecology. Of 55 individuals of *P. africana*, 19 individuals of *P. africana* were recorded on the midland while 36 individuals of *P. africana* were recorded on the lowland agroecology. The lower number of individuals of both tree species was observed along agroecology indicating poorly regenerated stands in the study areas.

3.2. Distribution of Albizia gummifera and Prunus africana Trees

3.2.1. Distribution of A. gummifera and P. africana Trees across Agroforestry Practices and Farmers' Wealth Status. In the study areas, *Albizia gummifera* and *Prunus africana* were recorded in the enset tree-based homegarden agroforestry practice and live fencing in a smaller density (per hectare (ha)), while parklands composed of the higher mean number of density (stems/ha) of both tree species (Tables 2 and 3). Mean density of *A. gummifera* and *P. africana* trees showed a significant difference across the three agroforestry practices at $P < 0.05$ (Tables 2 and 4).

The rich farmers had the higher mean number of density (stems per hectare (ha)) of *A. gummifera* and *P. africana* trees within their agroforestry practices than the medium and poor farmers in the study areas (Table 2). Similarly, the higher mean number of density of *P. africana* tree was recorded on the rich farmers' agroforestry practices than medium and poor farmers (Table 4). This implies that there were variations of densities of both tree species across farmers' wealth groups at $P < 0.05$ (Tables 2 and 4).

3.2.2. Distribution of Albizia gummifera and Prunus africana Trees along Agroecology. Density (stems per plot and hectare (ha) of *A. gummifera* and *P. africana* across the agroecological zones showed a significant difference at $P < 0.05$ (Tables 3 and 5).

The higher mean density of *A. gummifera* was observed on the lowland agroecology than the midland agroecology (Table 3). Similarly, the higher mean density of *P. africana* on the lowland agroecology was recorded when compared to the midland agroecology (Table 5). *A. gummifera* and *P. africana* trees were distributed sparsely and showed J shape along agroecology.

3.3. Regeneration Pattern of Albizia gummifera and Prunus africana Trees

3.3.1. Diameter Classes Distribution and Height Classes' Distribution of Trees along Agroecology. In the present study, the abundance of *A. gummifera* trees were presented up to as high as 76–98 cm diameter class, and 7 m and above height class on the midland and lowland agroecology. The overall diameter distribution pattern of *A. gummifera* was J-shaped curve on the midland and lowland agroecology (Figures 2 and 3). Similarly, the abundance of *P. africana* trees was found as higher as 76–98 cm diameter class, and 7 m and above height class on the midland and lowland agroecology. The general diameter and height distribution patterns of *P. africana* were J-shaped curves in two agroecologies (Figures 2 and 3).

Table 2: Mean density (stems per hectare (ha)) of *Albizia gummifera* across the three agroforestry practices and farmers' wealth groups.

Agroecology	Kebele	N	Agroforestry practices	Number of stems (ha) Mean		SE	Wealth groups	Number of stem (ha) Mean		SE
Midland	Gorta	27	Enset tree-based	5.56^{b}	±	2.03	Rich	29.63^{c}	±	7.4
		27	Live fencing	4.63^{a}	±	2.32	Medium	11.11^{b}	±	3.08
		27	Parkland	34.26^{c}	±	7.08	Poor	3.70^{a}	±	1.74
		81	Overall mean	14.81	±	2.97	Overall mean	14.81	±	2.97
Lowland	Adeana	27	Enset tree-based	2.78^{a}	±	1.54	Rich	42.59^{c}	±	9.78
		27	Live fencing	12.04^{b}	±	2.45	Medium	19.44^{b}	±	4.68
		27	Parkland	62.96^{c}	±	7.82	Poor	15.74^{a}	±	4.03
		81	Overall mean	25.93	±	4.036	Overall mean	25.9	±	4.036

Different superscript letters within column indicates significantly different at $P < 0.05$.

Table 3: Mean density (stems per hectare (ha)) of *Albizia gummifera* along agroecology.

Agroecology	N	Number of stems per plot Mean		SE	Number of stems per ha Mean		SE
Midland	81	0.59^{a}	±	0.11	14.81^{a}	±	2.97
Lowland	81	1.04^{b}	±	0.16	25.93^{b}	±	4.03
Overall mean	162	0.81	±	0.10	20.37	±	2.53

Different superscript letters within column indicate significant difference at $P < 0.05$.

Table 4: Mean density (stems per hectare (ha)) of *Prunus africana* across the three agroforestry practices and farmers' wealth groups.

Agroecology	Kebele	N	Agroforestry practices	Number of stems (ha) Mean		SE	Wealth groups	Number of stem (ha) Mean		SE
Midland	Gorta	27	Enset tree-based	4.63^{b}	±	2.32	Rich	11.11^{c}	±	3.85
		27	Live fencing	1.85^{a}	±	1.28	Medium	5.56^{b}	±	2.77
		27	Parkland	11.11^{c}	±	4.07	Poor	0.93^{a}	±	0.92
		81	Overall mean	5.86	±	1.65	Overall mean	5.86	±	1.66
Lowland	Adeana	27	Enset tree-based	4.63^{b}	±	2.32	Rich	19.44^{c}	±	4.69
		27	Live fencing	1.85^{a}	±	1.28	Medium	12.04^{b}	±	3.86
		27	Parkland	26.85^{c}	±	4.98	Poor	1.85^{a}	±	1.85
		81	Overall mean	11.11	±	2.24	Overall mean	11.11	±	2.24

Different superscript letters within column indicate significant difference at $P < 0.05$.

Table 5: Mean density (stems per hectare (ha)) of *Prunus africana* along agroecology.

Agroecology	N	Number of stems per plot Mean		SE	Number of stems per ha Mean		SE	P value
Midland	81	0.23^{a}	±	0.06	5.86^{a}	±	1.65	0.001
Lowland	81	0.44^{b}	±	0.09	11.11^{b}	±	2.24	
Overall mean	162	0.34	±	0.05	8.49	±	1.40	

Different superscript letters within column indicate significant difference at $P < 0.05$.

3.3.2. Regeneration Pattern of Albizia gummifera and Prunus africana Trees along Agroecology. The mean age-classes distribution were seedlings (<2 cm), saplings (>2-5 cm diameter), small poles (>5–25 cm), and mature trees (>25 cm) diameter classes. This is important to understand the mean of age-class distribution to determine the regeneration distribution along agroecology. *A. gummifera* and *Prunus africana* both had a low mean density (stems per hectare (ha)) of seedlings, saplings, and small poles, while had a high mean density (stem/ha) of mature individuals (Figures 4 and 5). This implies that regeneration population of both native trees showed J-shaped curve which indicate the abundance of seedlings and saplings are a smaller comparatively to mature trees (saplings and adults) on both studied agroecological areas.

4. Discussion

4.1. Distribution of A. gummifera and P. africana in Agroforestry Practices, Farmers' Wealth Groups, and Agroecology. Understanding the patterns of the threatened tree species distribution, the regeneration status along agroecology, and the farmers' wealth groups could be very essential to determine the composition of an agroforestry, and implementing appropriate conservation approaches of the species. The regeneration status of the threatened multipurpose woody species can be affected by environmental factors, and the household's wealth groups in homegarden agroforestry, life fencing, and parkland agroforestry practice of Lemo district, Southern Ethiopia [3].

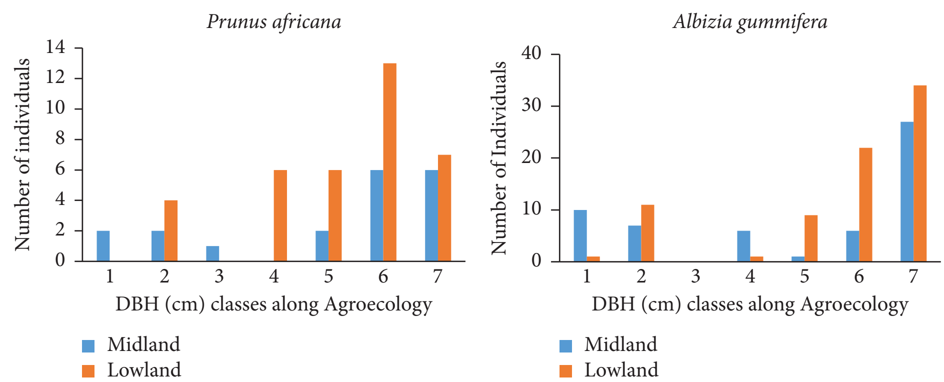

Figure 2: Diameter classes' distribution of *Albizia gummifera* and *Prunus africana* in two agroecological settings. DBH (cm): 1 = 0–15.9, 2 = 16–30.9, 3 = 31–45.9, 4 = 46–60.9, 5 = 61–75.9, 6 = 76–90.9, and 7 = ≥91.

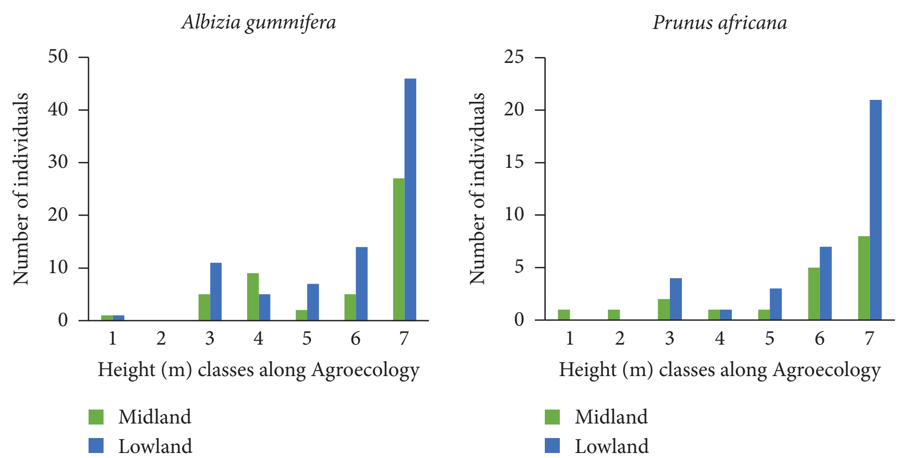

Figure 3: Height (m) class distribution of *A. gummifera*, and *P. africana* along agroecology.

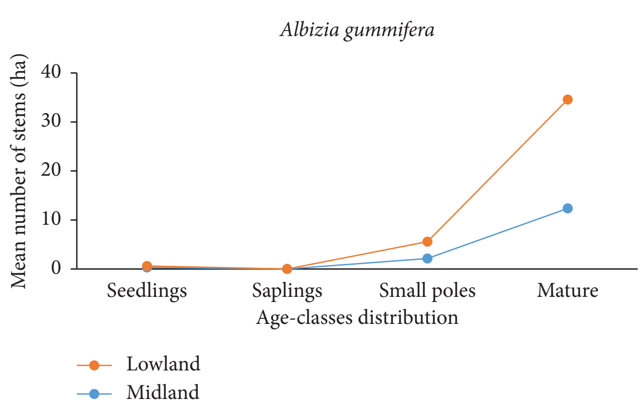

Figure 4: Mean age—classes (stems/ha) distribution of *A. gummifera* along agroecology.

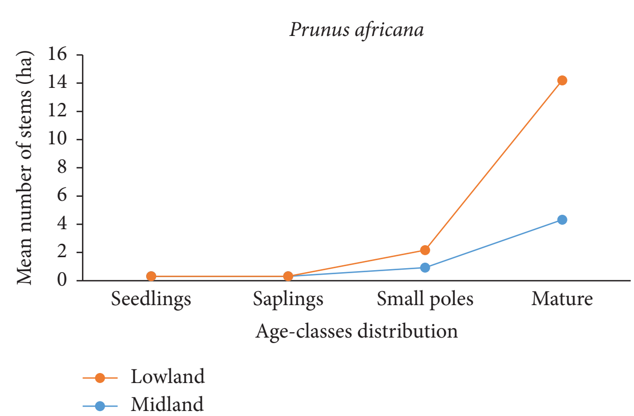

Figure 5: Mean age—classes (stems/ha) distribution of *P. africana* along agroecology.

A. gummifera and *P. africana* trees have a wide distribution in Afromontane regions where they provide multiple uses for the people. *P. africana* is one of the IUCN Red List of Threatened species in 2021 [5], and it is listed as vulnerable tree species currently https://www.iucnredlist.org/. *A. gummifera* is categorized as least concern [6]. *P. africana* and *A. gummifera* have been sparsely scattered across the enset tree-based homegarden agroforestry practice, parkland agroforestry practice, and live fencing along agroecology in the study area. The lower abundance of *P. africana* and *A. gummifera* was observed along agroecology. This might be due to selective removal of these trees from the farms. This agrees with studies by Yakob et al. [8] and Muluneh et al. [22] who revealed that *A. gummifera* and *P. africana* were threatened due to overexploitation and trees removal from homegarden agroforestry practice.

The patterns of *Albizia gummifera* and *Prunus africana* distribution across the existing agroforestry practices, i.e., the enset tree-based homegarden agroforestry, parkland agroforestry practice, and live fencing were influenced by agroecology, and the farmers' wealth groups in the study areas. The mean density of *A. gummifera* and *P. africana* trees showed a J-shaped curve indicating poorly regenerated stands of the enset tree-based homegarden agroforestry, parkland agroforestry practice, and live fencing in the study areas. This might be due to the selective cutting of these trees, inclusion of exotic tree species (for instance, inclusion of *Grevillea robusta* in the enset tree-based homegarden agroforestry, inclusion of *Cupressuss lusitanica* in the live fencing, and inclusion of *Eucalyptus globulus* and *Eucalyptus camaldulensis* in parkland agroforestry practice), overexploitation, improper management, the ecological conditions, and the requirement of the farmers in the study areas. This is supported by Bijalwan and Dobriyal [30] and Tefera et al. [18] who revealed that selective removal of tree species, farmers' selection criteria for maintaining trees on their farms, and the ecological variations can be the reasons for poorly regenerated population of the tree species in agroforestry practices.

Parkland agroforestry practice had higher mean of densities distribution (stems/ha) of *A. gummifera* and *P. africana* than enset tree-based homegarden agroforestry practice and live fencing. This variation could be that farmers are selective, and they control trees densities on the farms based on the species uses. For example, enset tree-based homegarden agroforestry practices composed of a smaller density of *A. gummifera* and *P. africana*, indicating that farmers mainly cultivate enset crop and other food crops as a source of food in the tree-based homegarden agroforestry. This is in agreement with the finding of Tefera et al. [18] who reported that the lower densities of tree species were recorded in enset tree-based homegarden agroforestry practices because farmers mainly grow enset (*Enset ventricosum*) as a source of food, and farmers are selective to retain trees on their farms [8, 30].

The mean values of density (stems per plot, ha) of *P. africana* and *A. gummifera* was the higher on the rich farmers' agroforestry land-use when compared to the moderate and poor ones. The reasons can be the poorer and medium farmers only focusing on a few cash crops to supplement household income, food crops, and also selective removal of these trees from their farms. This agrees with the study of Crowley [16] and Ermias and Zebene [3] who revealed that wealthier farmers retained relatively more trees on their farms because rich farmers have more resources such as land and other assets to support households. Contradicted by Yakob et al. [8] and Bucagu et al. [10] who reported that more number of stems/ha was found on the poor farmers' farms indicating the ability of poor farmers to intensively utilize their smaller farms.

The largest number of *A. gummifera* trees per hectare and *P. africana* trees per hectare was found on the lowland agroecology comparatively on the midland agroecology. This might be associated with moist and warm climate, the ecological situations, soil type, trees attributes, and planting activities. This is supported by Getahun et al. [26] and Tefera et al. [18] who stressed that farmers accommodated higher number of trees planted on the limited area as ecological condition and favored to grow more number of tree species.

4.2. Regeneration Status of A. gummifera and P. africana Trees along Agroecology. The diameter class (cm) and height (m) distribution of *A. gummifera* and *P. africana* trees showed the high number of adult trees and the presence of the lower number of these species at the lower diameter and height classes. These results showed J-shape in studied areas which indicated unstable population structure because the higher presence of the upper diameter class and height class of these tree species were recorded on the midland and lowland in studied areas. The main reasons could be not overexploited by the farmers, retained for a long term, integrated exotic species, and grow crops instead of these trees. This is in agreement with the study by Balemlay and Siraj [31] who revealed that J-shape pattern indicates poor regeneration of trees due to not highly utilized by the local people for various benefits and selective logging of trees. Previous studies by Lejju [33] and Farwig et al. [36] also confirmed that the regeneration of native species under exotic farms was generally low.

Presence of a very few number of seedlings and saplings per hectare (ha) were found in two agroecological zones, while the higher number of adult trees were recorded in two studied agroecological zones indicating poor regeneration. This is consistent with the finding of Tiwari et al. [35] who reported that if seedlings < saplings < adults, there is a poor regeneration status.

5. Conclusions

The patterns of *Prunus africana* and *Albizia gummifera* distribution across the enset tree-based homegarden agroforestry practice, parkland agroforestry practice, and live fencing, abundance, and density (number of stems per hectare (ha)) along agroecology are very important information for proposing and implementing evidence-based conservation approaches and management strategies of the species. The regeneration status of *P. africana* and *A. gummifera* across the farmers' wealth groups and agroecological zones in the homegarden agroforestry practice, parkland agroforestry practice, and live fencing has not been promising in the study areas. The inclusion of some exotic tree species such as *Grevillea robusta* in the enset tree-based homegarden agroforestry practice, *E. globulus* and *E. camaldulensis* in parkland agroforestry practice, *C. lusitanica* in live fencing, the selective removal of both trees from the farms, overexploitation, improper tree management, the farmers' species selection, and the agroclimatic conditions could be the major causes for a rapid depletion of *A. gummifera* and *P. africana* tree species along an agroecology and the farmers' wealth groups in the study areas. As hypothesized, abundance and density (stems per hectare (ha)) of *A. gummifera* and *P. africana* did differ across the enset tree-based homegarden, parkland agroforestry practice, live fencing, and the farmers' wealth groups along an agroecology in the study areas. Diameter class (cm), height class (m), and regeneration status of *A. gummifera* and *P. africana* trees differed significantly along an agroecology. The population structure of *A. gummifera* and *P. africana* was characterized by high number of mature trees with a poor representation in lower diameter (cm) and height classes (m). This indicates unstable and intermittent population structure of both trees on the midland and lowland agroforestry. The results suggested that *A. gummifera* and *P. africana* trees need both ex situ and in situ conservation approaches along agroecology. Further research is required on the biomass, adaptability, and uses of *A. gummifera* and *P. africana* at large landscapes.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

All authors have read, revised, and approved the manuscript.

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