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Original Research

Vegetation Structure and regeneration status of Guard Dry Afromontane Forests in North Western Ethiopia

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Abstract

The study was conducted in Guard forest in Dejen district, East Gojam zone, North West Ethiopia, to determine the vegetation structure and regeneration status of Guard Dry Afromontane forests. A systematic sampling technique was used for vegetation data collection. 58 plots each with 400 m² (20 m X 20 m) for trees and shrubs. From each main plot, five subplots 4 m^2 and 1 m^2 were laid at the four corners and center of the main sample plot to count saplings and seedlings of woody plant species of the forest. The total species richness was 77 woody species belonging to 60 genera and 36 families. The total basal area of woody species is 20m^2 ha^{-1}. Tree species such as *Ficus vasta* had 3.5(18%), *Millettia ferruginea* 2.52(13%), *Ficus sycomorus* 1.63(8%), *Stereospermum kunthianum* 1.14(6%), *Croton macrostachyus* 0.68 (4%), *Ekebergia capensis* 0.25(2%) contribute the largest basal area and the remaining species contributed 49% of the total basal area. A total of 805 individuals were counted with a DBH class greater than 2.5 cm within the sampled plots, the highest DBH-class mostly recorded in DBH-Class 1(147.4ha^{-1} (48%) then declined towards the end of DBH-Class-8(5.6 ha^{-1} (2%). The upper story was represented by a height greater than 17m, which accounts for about 20% frequency of the woody species, whereas the middle story ranges from 7 m to 17 m (46.8%) and < 7m (32.8 %%) were constituted by the lower story. The total seedling, sapling, and mature tree densities of the 20 selected plant species were about 47.41 ha^{-1}, 92.2 ha^{-1}, and 279.31 individuals per hectare respectively, that shows the regeneration status of the forest is poor because the mature trees are greater than saplings and greater than seedlings.

Keywords: Seedling, Vegetation, Regeneration status, DBH.

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1. INTRODUCTION

Ethiopia is a biodiversity-rich country, harboring a wide diversity of most of the world's species and a large number of endemic species (Bajigo et al., 2022). Currently, there are about 6027 species of higher plants out of the total of these higher plant species, about 10% of the higher plants are endemic to Ethiopia and not found in other parts of the world (Kelbessa and Demissew, 2014).

The natural forest cover of Ethiopia decreases from time to time due to various natural and man-made factors. In 1900, Ethiopia's naturally abundant forest comprised between 35 and 40% of the country's total area (Mucheye and Yemata, 2020). However, these forest resources have decreased dramatically in size and quality, in the early 1950s Ethiopia's high forest resources were reduced to 16%; by the early 1980s, forest cover had declined to 3.6%; In 1989 it was reduced to around 2.7%. Between 1990 and 2000, the annual deforestation rate was 0.93%, and from 2000 to 2005, the deforestation rate increased to 1.03% per year (Shiferaw *et al*., 2019); since 2010, Ethiopia's annual deforestation rate has increased to 1.25% per year (JICA, 2020). Recent reports show that Ethiopia's natural forest cover is increasing in size and is estimated to cover about 15.7% of the country's total area (FAO, 2020). Today, Ethiopia has initiated reforestation to plant 20 billion seedlings in just four years (2019-2022). About 15 billion seedlings have been planted in the last three years. Reforestation of degraded uplands has been included in relevant national policies as a long-term objective of the forest sector. If the seedlings are protected, this will lead to an increase in the country's forest cover to 30% of the country's area in the long term (Moges et al., 2021).

In Amhara National Regional State, about 2% is covered by forest, 27% by shrubland, and 6% by forest. Most areas of the region have Afromontane vegetation, the majority of which is dry Afromontane forest (Getnet, 2018), and the residual forest is in protected forests or Ethiopian Orthodox Church forests (Wassie, 2017). In the East Gojjam Zone, there is no large patch of preserved natural forest, but there are the smallest patches of forest that can be found scattered, which is an indicator of the presence of forests in the past.

Guard Forest is a dry Afromontane area that is highly valued for its high economic and other ecological services for the community (personal observation and communication). However, the forest area is severely depleted from time to time. Therefore, detailed ecological studies are needed to understand the vegetation structure and regeneration status of the forest to take appropriate conservation measures.

2. MATERIALS AND METHODS

2.1.Description of the study area

Guard Forest is located in Kokuha kosekos kebele of Dejen district, East Gojjam Zone, Amhara National Regional State, which is situated between 10° 17'N to 10° 19'N and 38°14'E to 38°15'E with the altitudinal range between 2019 and 2230m a.s.l (Figure 1). It's approximately 40 km northeast of the district town and the total area of forest covers 28 ha.

Guard forest has an altitudinal range from 2019 m a.s.l. to 2230m a.s.l and its plant composition is a mixture of *Carissa spinarum*, *Grewia ferruginea, Olea europea* subsp. *cuspidata, Rosa abyssinica*, *Acacia abyssinica, Calpurena aurea, Croton macrostachyus, Milletea fergunea, Clutia abyssinica.* This is a good indication that Guard forest vegetation type belongs to the dry evergreen Afromontane Forest (Friis et al., 2010).

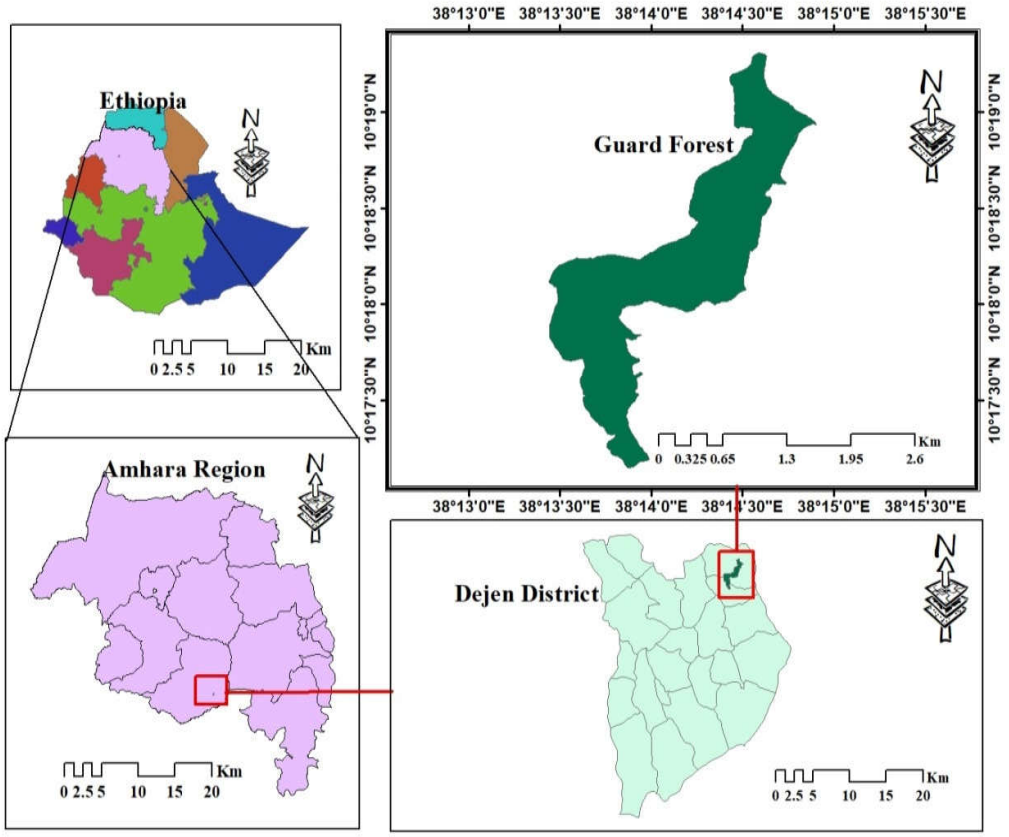


Figure 1. Map of Guard Forest

2.2.Climate

Rainfall and temperature data for the study area were obtained from National Meteorology Service Center Bahir Dar for twelve years (2010 – 2021). The analysis of obtained data shows that the mean minimum temperature is 4.7^{0}C and the mean maximum temperature is 25.9 ^{0}C,

while the mean annual temperature of the study area is 15.7^{0}C (Figure 2). The hottest month is March With a mean maximum temperature of 25.9◦c and the coldest month is December with a minimum mean temperature of 4.7^{0}C. The mean annual rainfall value for the study area was 98.74mm which varied greatly from season to season. Generally, the study area has low rainfall from December to February and the main rainy season is June to August (Figure 2).

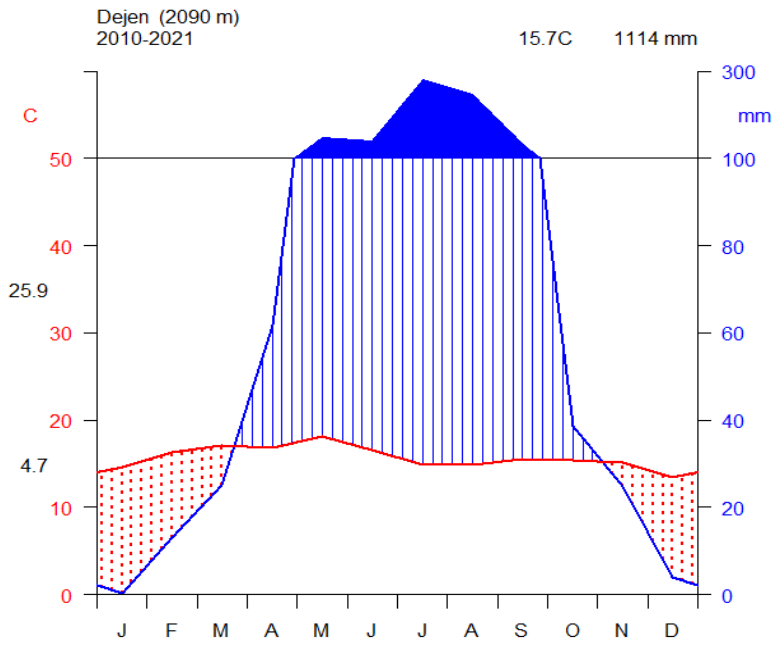


Figure 2. Climadiagram of Dejen (Data source: National Meteorological Agency).

2.3. Sampling Technique

A reconnaissance survey was made in and around the forest patches to obtain the vegetation patterns of the study area, vegetation distribution, determine the sampling technique, and how transect lines were laid across the forest. A systematic sampling technique was used for vegetation data collection. Eleven line transects were laid vertically with a distance of 200 m between each line transect and the distance between each plot is 100 m distance. The number of plots per transect varies depending on the length of each transect and a total of 58 plots were collected from the forest. Each plot has 20 m × 20 m (400 m^2) for trees and shrubs and from the four corners and the center of the main sample plot subplots which have 4 m^2 and 1 m^2 were laid for counting saplings and seedlings respectively (Kent, 2012). A complete list of woody species, trees, and shrubs, including woody epiphytes, was taken from systematically selected plots along each transect.

In each plot, the diameter and height of all woody tree species were recorded. Diameters were measured for all individual trees having a DBH greater than 2.5 cm and diameters at the stump height (DSH) for shrubs were measured using a diameter tape. When the tree branched at breast height or below, the diameter was measured separately for the branches and the average was recorded. Trees with DBH/ DSH less than 2.5 cm were counted but not measured for DBH.

The Height was measured for all individual trees and shrubs which have a height greater than 2 m using a calibrated stick. To determine the stratification of the forest, the height was classified into 3 strata based on the differences of height less than 7 meters, height 7-17 meters, and greater than 17 meters.

To determine the regeneration status, the density of seedlings, saplings, and mature tree species of the forest was recorded from each plot. The height less than 1.5 m and DBH/ DSH less than 2.5 cm were considered seedlings, a height greater than 2 m and DBH/ DSH greater than 2.5 cm were considered trees, and those of seedlings and trees with DBH/DSH less than 2. 5 cm and heights of 1.5–2 m were considered as saplings (Temesgen and Warkineh, 2020).

The local names of all species were recorded during fieldwork and included in the list of taxa and specimens of all plant taxa were collected, pressed, dried, and brought to Debre Markos University herbarium room for identification. Their family, genera, and scientific names were identified using the published Flora of Ethiopia and Eritrea.

2.4. Data analysis

The structure of vegetation was analyzed for density, Diameter at Breast Height (DBH), frequency, dominance, basal area, and importance value using the following formula (Kent, 2012).

$$\text{Basal area (BA)} = \frac{C^2}{4\pi}$$

$$\text{Density (D)} = \frac{\text{Number of individuals of species A counted}}{\text{Area sampled in meter square}}$$

$$\text{Frequency (F)} = \frac{\text{Number of quadrats in which species A occurs}}{\text{The total number of quadrats sampled}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency value for species A}}{\text{Total of all frequency values for all species}} * 100$$

The importance value index of each species was also computed as a sum of relative density, relative dominance, and relative frequency.

$$\text{IVI} = \text{RDo} + \text{RD} + \text{RF}$$

The regeneration status of the forest was analyzed by comparing the density ratios between seedlings and mature individuals, seedlings and saplings, and saplings and mature individuals. When seedlings are greater than saplings and saplings greater than adults, the status has fair regeneration, whereas seedlings are greater than or less than saplings and saplings less than adults; the status is poor regeneration, and the species survives only in the sapling stage (saplings may be less than or greater than adults), and a species is present only in adult form it considered as not regenerating (Dhaulkhandi et al., 2008).

3. RESULTS

3.1.Woody plant species richness

A total of 77 woody plant species belonging to 60 genera and 36 families were recorded from Guard Forest (**Appendix 1**). Trees are the dominant growth form containing 41 (53%) followed by shrubs 32 (42%) and lianas 4(5%). The most dominant families of the study area were Fabaceae, which are represented by 16 Species (21 %) and followed by Euphorbiaceae and Moraceae which contain 4 species (5%).

3.2.Vegetation Structure

3.2.1. Basal area

The total basal area of woody plant species whose DBH is greater than 2.5cm was 20.11 m^2 per ha. The basal area of individual plant species was increased when their DBH class increased but their number decreased. *Ficus vasta* has 3.5(18%), *Millettia ferruginea* 2.52(13%), *Ficus sycomorus* 1.63(8%), *Stereospermum kunthianum* 1.14(6%), *Croton macrostachyus* 0.68 (4%), *Ekebergia capensis* 0.25(2%) contribute the largest basal area and the remaining species contributed 49% of the total basal area (**Table 1**).

3.2.2. Tree Diameter at Breast Height (DBH) Distribution

The pattern of the DBH class distribution of woody species was calculated on the sampled area. A total of 805 individuals were counted with a DBH class greater than 2.5 cm within the sampled plots. The highest DBH recorded from Guard Forest was 99.05 cm for *Ficus vasta* followed by *Acacia sieberiana* 85.99 cm and *Stereospermum kunthianum* 59.87 cm. The DBH class was traditionally grouped into 8 classes. Class1=2.5-10cm, 2=10-18 cm, 3=18-26 cm, 4=26-34 cm, 5=34 -42 cm, 6=42-50 cm, 7=50-58 cm, and 8>58cm. The total density of woody species and their DBH distribution between 2.5 and 10 is 147.4(48%), between 10-18 cm is 76.3(25%),18-26 cm is 34.9(12%), 26-34 cm is 13.4 (4%), 34-42 cm is 17.2(6%), 42-50 cm is 6.03(2%), 50-58 cm is 3.02 (1%), and greater than 58 is 5.6(2%) (Figure 3).

The population structure of individual trees *Celtic africana* has an inverted J-shaped distribution pattern; *Croton macrostachyus* has an inverted J-shaped distribution pattern but is absent in the last three consecutive DBH classes; *Millettia ferruginea* has bell-shaped distribution with high number of individuals in the middle of DBH class, and *Ficus vasta* had the highest number of individuals in the lower DBH class followed by an irregular decrease and increase (Figure 4).

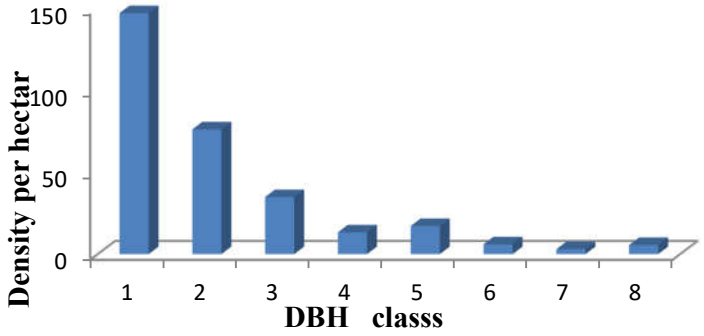


Figure 3. DBH class distribution of woody plant species in Guard Forest

DBH-class 1=2.5-10cm, 2=10-18 cm, 3=18-26 cm, 4=26-34 cm, 5=34-42 cm, 6=42-50 cm, 7=50-58 cm, 8=>58cm.

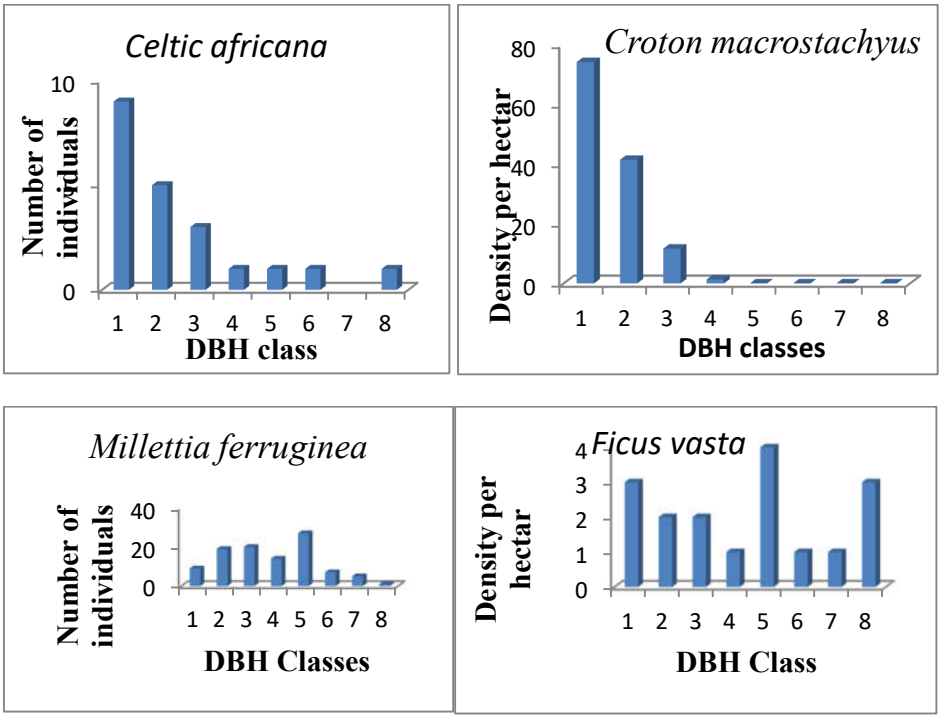


Figure 4. Population structure of six representative woody species of Guard Forest patch. DBH-class 1=2.5-10cm, 2=10-18 cm, 3=18-26 cm, 4=26-34 cm, 5=34-42 cm, 6=42-50 cm, 7=50-58 cm, 8=>58cm.

3.2.3. Height class distribution

The highest height of the tree was recorded for *Millettia ferruginea* (38 m) followed by *Acacia polyacantha* (32 m) and *Albizia schimperiana* (28 m) (Figure 5). The density of tree height decreases when height classes increase, this indicates that there are a higher number of individuals in the lower class and a gradual decrease in the medium and large-sized trees, but there is a continuous representation of individuals in all height classes but their number is lower in a large-sized tree. More than 65% of the density of the woody species is distributed in the first two lowest height classes.

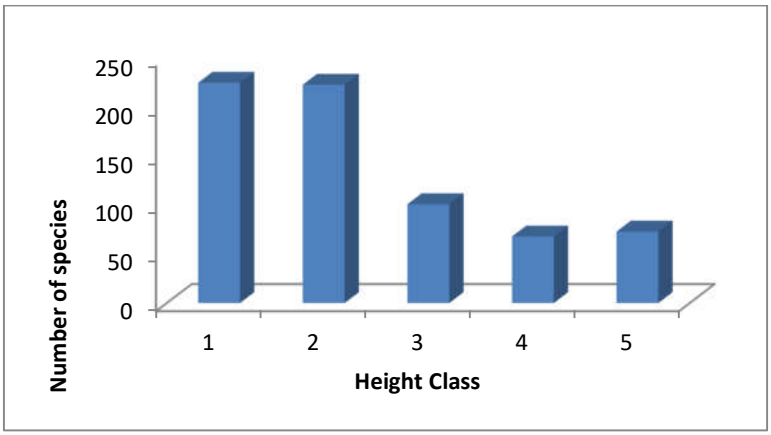


Figure 5: Height classes: 1= 2–7 m, 2= 7 m – 12 m, 3= 12 m – 17 m, 4= 17 m – 22 m, and 5= greater than 22 m

3.2.4. Density

The Density of woody species in Guard forest was 1759 individuals per hectare. The highest density of individuals in the forest was recorded by *Croton macrostachyus (*180 individuals per hectare) followed by *Euclea racemosa (*103 individuals per hectare) and *Premna schimperi (*97 individuals per hectare) respectively. Tree and shrub density with DBH greater than 2.5 were 704 individuals per hectare, individuals with DBH greater than 15 cm were 403 individuals per hectare, and DBH greater than 25 cm were 144 individuals per hectare. The overall tree and shrub densities with DBH greater than 2.5 cm were grouped into 3 DBH classes greater than 2.5, greater than 15, and greater than 25cm.

3.2.5. Frequency

Frequency reflects the pattern of distribution and gives an approximate indication of the heterogeneity of a stand. The highest relative frequency was scored by *Croton macrostachyus* This may be because these species might have a wide range of seed dispersal mechanisms by wind, livestock, or adaptability of the species to a wide range of habitats and *Combretum*

collinum has relatively low frequency than other woody species and this might be due to high human pressure by cutting the tree for firewood, Charcoal production, and timber production.

3.2.6. The Importance value index

The IVI of woody species in Guard forest ranged from 1.54 to 19.8. The highest IVI was documented for *Croton macrostachyus* (19.8), followed by *Ficus vasta*, *Combretum collinum*, and *Acacia polyacantha,* 18.9, 9.29, and 9.25 respectively (Table 1).

Table 1: Basal area, Density, IVI, and Frequency of Commonly existing species

No	Scientific name	N	F	P	RF	D	RD	BA	DO	RDO	IVI
1	*Acacia polyacantha*	8	0.07	4	0.6	3.45	0.2	1.68	1.68	8.32	9.12
2	*Albizia schimperiana*	27	0.12	7	1.06	11.6	0.66	0.71	0.71	3.51	5.23
3	*Celtis africana*	54	0.16	9	1.36	23.3	1.32	0.61	0.61	3.04	5.73
4	*Cordia africana*	22	0.12	7	1.06	9.48	0.54	0.93	0.93	4.63	6.23
5	*Croton macrostachyus*	417	0.71	41	6.19	180	10.2	0.68	0.68	3.38	19.8
6	*Ficus sur*	13	0.1	6	0.91	5.6	0.32	0.3	0.3	1.47	2.7
7	*Ficus thonningii*	44	0.07	4	0.6	19	1.08	0.17	0.17	0.86	2.54
8	*Ficus vasta* Forssk	17	0.1	6	0.91	7.33	0.42	3.5	3.5	17.3	18.7
9	*Grewia bicolor*	71	0.17	10	1.51	30.6	1.74	0.41	0.41	2.05	5.3
10	*Grewia ferruginea*	66	0.12	7	1.06	28.4	1.62	0.03	0.03	0.17	2.85
11	*Millettia ferruginea*	126	0.16	9	1.36	54.3	3.09	2.52	2.52	12.5	16.9
12	*Combretum collinum*	4	0.05	3	0.45	1.72	0.1	1.74	1.74	8.61	9.16

3.3. Regeneration Status

The regeneration status of selected woody plant species of Guard forest patch was determined to predict the future fate of the forest. 20 selected plant species were used for determining the regeneration status of the forest from selected plant species, 6 were not represented by both seedling and sapling stages, and these species were *Acacia polyacantha , Acacia sieberiana, Ficus sur, Ficus sycomorus, Ficus vasta,* and *Albizia amara,* and 3 species such as *Erythrina abyssinica, Ekebergia capensis, and, Euphorbium candelabrum* has sapling and mature tree but not seedling on the other hand 11 species has seedling, sapling, and mature tree species. The total seedling, sapling, and mature tree densities of 20 selected plant species were about

47.41, 92.2, and 279.31 individuals per hectare, respectively (Figure 6). The regeneration status of Guard forest was considered as poor regeneration; since seedling (47.4 1individual/ha) < sapling (92.21individual/ha) <mature tree (279.311 individuals/ha); showing J– shape pattern indicating that the selected woody species of the forest has a small number of seedlings than saplings and mature trees species.

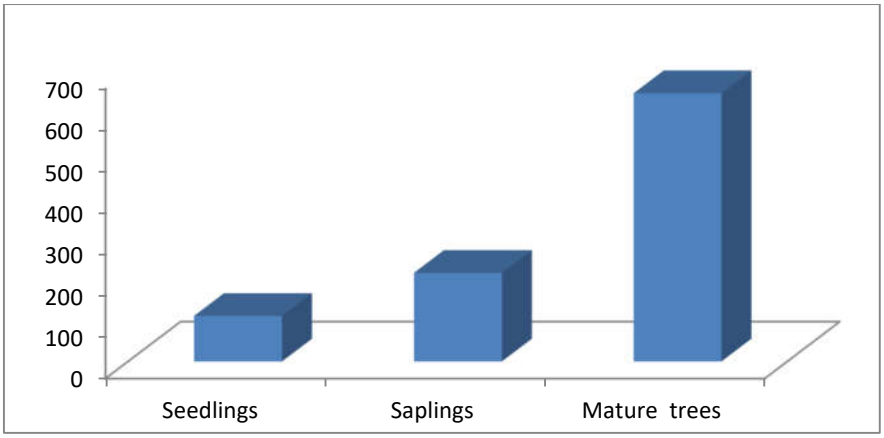


Figure 6. Regeneration status of Guard forest patch.

3.4.Vertical stratification of Guard Dry Afromontane forest

According to the tree/shrub structures, Guard forest was categorized into three vertical stories: upper story (tree height >17m), middle story (tree height between 7-17m), and lower story (tree height <7m). The dominant height in the forest patch was *Millettia ferruginea* with a height of 38m. As a result, the upper story was represented by a height greater than 17m, which accounts for about 20% frequency of the woody species whereas the middle story ranges from 7-17m and the lower story less than <7m (32.8%) in the forest vertical layer as shown on (Table 2; Appendix 2).

Table 2. Frequency, percentage, and species richness in the lower, middle, and upper strata of Guard Forest.

Strata	Height class	Frequency	Richness	Percentage
Lower story	<7m	227	25	32.8%
Middle story	7-17m	324	18	46.8%
Upper story	>17m	141	14	20%

4. Discussion

4.1. Woody species richness

Dry Afromontane forests of Ethiopia are the home for supporting a wide range of plant species and different studies are conducted on dry Afromontane forests of Ethiopia to determine the species richness of particular area. The species richness of Guard forest contains 77 species that can compare with other dry afromontane forests of Ethiopia For instance from Gelawoldie community forest, Mucheye and Yemata (2020) identify 59 woody plant species and from Debark District, Tefera et al. (2014) identified 55 woody species. This shows that the Guard forest has relatively good species richness.

From plant families recorded in the study area family Fabaceae is the dominant family that record from Guard dry afromontane forest compared to other families in the study areas this Family also identified as the top dominant plant family in the Flora of Ethiopia and Eritrea (Kelbessa and Demissew, 2014). The dominance of Fabaceae might be due to their efficient pollination and successful seed dispersal mechanisms that might help them to adopt a wide range of ecological conditions (Kelbessa and Soromessa, 2008).

The vegetation structure of Forest can be described in terms of tree density, basal area, height and DBH size class distribution. The total density of all woody species in Guard forest contains 1759 individuals per ha, but the density of woody species with DBH greater than 2.5 were 704 individuals per hectare. This is lower than the result reported by Sebsibe (2018) from Doshke Forest with 1288 individuals per hectare.

The density of tree height decreases when height classes increase, this indicates that there are a higher number of individuals in the lower class and a gradual decrease in the medium and large-sized trees, but there is a continuous representation of individuals in all height classes but their number is lower in a large-sized tree. This indicates that the forest is dominated by small size and medium-sized trees. The existence of this pattern might be an indication of selective cutting of large size trees for different purposes and the presence of anthropogenic influences.

DBH density of individuals of woody species decreased from DBH-class 1 to DBH-class 8. When the DBH class size increases, the number of individuals gradually decreases, beginning from 147.4 individuals per hectare in the first class and decreasing to 5.6 individuals per hectare in the eighth DBH class. The result of this study shows that about 48% of the individuals per hectare have DBH between 2.5-10 cm (DBH class 1) and the last class DBH greater than 58cm contains 2% when viewed from the whole set of population structures. Similar results were reported by (Burju et al., 2013; Berhanu et al., 2017; and Sebsibe et al., 2018)DBH class

distribution showing an inverted J– shape pattern, indicating that the forest is dominated by small or medium DBH size trees than large-size trees this Might be due to the consumption of those woody species at the middle and higher DBH classes by local communities for various purposes.

4.2. Basal Area

The total basal area of Guard forest is 20.11m^2/ha and the basal area of individual plant species was increased when their DBH class increased but their number decreased. The study area had relatively less total basal area than some dry Afromontane forests in Ethiopia, for instance, Boda Forest (Erenso et al., 2014), Gelawoldie forest (Mucheye and Yemata, 2020) contain better basal area than Guard forest but the study areas contained better basal area than Abune Yosef Mountain Range (Gebrehiwot, 2020). This indicates that the diameter at breast height and the number of individuals were lower in the forest, and that implies that the forest was under severe disturbance and cutting of forest by humans for different purposes.

Frequency reflects the pattern of distribution and gives an approximate indication of the heterogeneity of a stand. The highest relative frequency was scored by *Croton macrostachyus* This may be because these species might have a wide range of seed dispersal mechanisms by wind, livestock, or adaptability of the species to a wide range of habitats and *Combretum collinum* has relatively low frequency than other woody species and this might be due to high human pressure by cutting the tree for firewood, Charcoal production, and timber production.

The important value index of a given species indicates its level of importance in the given vegetation, where species with the highest IVI value reflects the degree of abundance, dominance and occurrence of a given species in relation to the other associated species in the area. The highest IVI was documented for *Croton macrostachyus* (19.8), followed by *Ficus vasta*, *Combretum collinum*, and *Acacia polyacantha,* 18.9, 9.29, and 9.25 respectively.

4.3.Regeneration Status

When the regeneration status of the natural vegetation is considered poor regeneration if seedlings are greater than or less than saplings and saplings are less than adults (Dhaulkhandi et al., 2008*).* Therefore, the regeneration status of Guard forest was considered as poor regeneration since seedling (47.41 individual/ha) < sapling (92.21 individual/ha) <mature tree (279.311 individual/ha); showing J– shape pattern indicating that selected woody species of the forest has a small number of seedling than sapling and mature trees species. From the selected species, *Celtis africana* has good regeneration status and the species of *Acacia*

polyacantha, Acacia sieberiana, Ficus sur, Ficus sycomorus, Ficus vasta, and *Albizia amara* are not represented by seedlings. The Possible reasons for the existence of poor regeneration status in the forest might be grazing intensity, cutting of young plants for different purposes before maturation, temperature effect, and soil nutrient deficiencies (Getie and Yemata, 2020). The result of this study also agrees with a similar study (Alemayehu, 2016; Berhanu et al., 2017) which has poor regeneration status.

4.4. Vertical stratification

Millettia ferruginea, *Ficus vasta, Acacia polyacantha, Acacia seyal, Albizia amara* sub sp *amara*, *Albizia schimperiana, Celtis africana, Cordia africana, Croton macrostachyus*, *Ficus sur, Ficus sycomorus* are some of woody species on upper story contribute 14 species(20%), *Ekebergia capensis, Erythrina abyssinica*, *Ficus thonningii, Maesa lanceolata, Maytenus arbutifolia, Maytenus senegalensis, Mimusops kummel, Schefflera abyssinica, Grewia bicolor Grewia ferruginea* are the representative of middle story incorporates 18 species and *Osyris quadripartite, Otostegia integrifolia, Euclea racemosa, Justicia schimperiana, Lippia adoensis Senna didymobotrya, Senna singueana, Acanthus polystachyous* and *Acokanthera schimperi* are lower story of the forest contain 25 species. This result is better than the result of shiferaw *et al* (2019). On its upper and middle story but lower in lower story that might be due to weather condition, soil fertility, and selective cutting of small size tree species.

5. CONCLUSIONS

The study provides valuable information about the present conditions of woody plant structure and the regeneration status of Guard Dry Afromontane forest. The study showed that much of the individual woody species frequencies of the study area were in the lower height class, which had implications of selective cutting and grazing intensity that inhibits the growth of species in upper diameter classes. The presence of some large trees and the prevalence of small to medium-sized individuals in this forest showed that the forest was exposed to infrequent human interference in the conservation of the forest. The overall stand densities expressed as DBH and height classes showed an inverse J-shaped distribution pattern and the number of seedlings, saplings, and matured plants showed J-shaped distribution pattern, which indicates the presence of disturbances on the population structure of the forest and other important and indicator species were poorly represented or missed either in the lower or higher DBH and height classes, Therefore, evidence-based and well-planned long-term conservation measures are recommended in the study area.

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Appendix 1: List of woody plant species in the study area

No	Scientific name	Family	Habit	Local name
1	*Acacia brevispica* Harms	Fabaceae	Shrub	Kentafa
2	*Acacia bussei* (Harms ex Y.Sjöstedt)	Fabaceae	Tree	Girare
3	*Acacia polyacantha* Hochst. ex A. Rich.	Fabaceae	Tree	Qento
4	*Acacia seyal* Del.	Fabaceae	Tree	Nech_Girar
5	*Acacia sieberiana* DC.	Fabaceae	Tree	Dera
6	*Acanthus polystachyous* Delile	Acanthaceae	Shrub	Kosheshila
7	*Acanthus sennii* Chiov.	Acanthaceae	Shrub	Kosheshila
8	*Acokanthera schimperi* (A.DC.)	Apocynaceae	Tree	Merth
9	*Agave sisalana* Perro exEng.	Agavaceae	Shrub	Cherat
10	*Albizia amara* sub sp *amara* (Roxb.)	Fabaceae	Tree	Shifere
11	*Albizia schimperiana* Oliv.	Fabaceae	Tree	Sesa
12	*Bersama abyssinica* Fresen.	Melianthaceae	Tree	Azamera
13	*Brucea antidysenterica* J.F. Mill.	Simaroubaceae	Shrub	Wagnos
14	*Buddleja polystachya* Fresen.	Loganiaceae	Tree	Anfar
15	*Caesalpina decapetala* (Roth) Alston.	Fabaceae	Climber	Konter
16	*Calpurnia aurea* (Ait.) Benth.	Fabaceae	Shrub	Digeta
17	*Capparis tomentosa* Lam.	Capparidaceae	Climber	Gumero
18	*Carissa spinarum* L.	Apocynaceae	Shrub	Agam
19	*Celtis africana* Burm. F	Ulmaceae	Tree	Kawoot
20	*Clerodendrum indicum* L.	Lamiaceae	Shrub	Misrch
21	*Clutia abyssinica* Jaub. & Spach.	Euphorbiaceae	Shrub	Fiyele-Fej
22	*Combretum collinum* Fres*en.*	Combretaceae	Tree	Zegudem
23	*Combretum molle* R. Br. ex G. Don.	Combretaceae	Tree	Abalo
24	*Commiphora africana* A. Rich	Burseraceae	Tree	Anqa
25	*Cordia africana* Lam.	Boraginaceae	Tree	Wanza
26	*Crateva adansonii* DC.	Capparidaceae	Tree	Dingay-Seber
27	*Croton macrostachyus* Del.	Euphorbiaceae	Tree	Bisana
28	*Dichrostachys cinerea* (L.) Wight &Arn	Fabaceae	Tree	Ader
29	*Dodonaea viscosa* L.	Sapindaceae	Tree	Kitketa
30	*Dombeya torrida* (J.F.Gmel.) P. Bamps	Sterculiaceae	Tree	Wolkefa
31	*Ekebergia capensis* Sparrm.	Meliaceae	Tree	Sembo
32	*Erythrina abyssinica* Lam. ex DC	Fabaceae	Tree	Bogert /Korch/
33	*Euclea racemosa (*A. DC.) White	Ebenaceae	Tree/shrub	Dedeho
34	*Euphorbia tirucalli* L.	Euphorbiaceae	Shrub	Kincheb
35	*Euphorbium candelabrum* Trem.ex Kotschy	Euphorbiaceae	Tree	Kulkual Adem
36	*Ficus sur* Forssk.	Moraceae	Tree	Shola
37	*Ficus sycomorus* L.	Moraceae	Tree	Abar_Worka
38	*Ficus thonningii* Blume.	Moraceae	Tree	Chebha
39	*Ficus vasta* Forssk.	Moraceae	Tree	Warka
40	*Gossypium hirsutum* L.	Malvaceae	Shrub	Tete
41	*Grewia bicolor* Juss.	Tiliaceae	Tree	Sofa
42	*Grewia ferruginea* Hochst. ex A.Rich.	Tiliaceae	Tree	Lenquata
43	*Justicia schimperiana* Hochst. ex Nees	Acanthaceae	Shrub	Sensel
44	*Lippia adoensis* Hochst. ex Walp.	Verbenaceae	Shrub	Kese
45	*Maesa lanceolata* Forssk.	Myrsinaceae	Tree	Ashkamo
46	*Maytenus arbutifolia* (A. Rich.) Wilczek	Celastraceae	Shrub	Atate
47	*Maytenus senegalensis* (Lam).	Celastraceae	Shrub	Nech Atate
48	*Millettia ferruginea* (H*ochst.)* Bak.	Fabaceae	Tree	Birbira
49	*Mimusops kummel* A. DC.	Sapotaceae	Tree	Shiye
50	*Ocimum lamiifolium* Hochst. ex Beth.	Lamiaceae	Shrub	Dama-Kese

51	*Opuntia ficus-indica* L.	Cactaceae	Tree	Kulkual
52	*Osyris quadripartite* Decn.	Santalaceae	Shrub	Keret
53	*Otostegia integrifolia* Benth.	Lamiaceae	Shrub	Tunjit
54	*Phragmanthera regularis* (Sprague).	Loranthaceae	Shrub	Tegadera
55	*Phytolacca dodecandra* L 'Herit.	Phytolaccaceae	Climber	Endode
56	*Plumbago zeylanica* L.	Plumbaceae	Shrub	Amera
57	*Premna schimperi* Engl.	Verbenaceae	Shrub	Checho
58	*Rhamnus staddo* A. Rich	Rhamnaceae	Shrub	Yedur Gesho
59	*Rhus glutinosa* A. *Rich.*	Anacardiaceae	Tree	Ambus
60	*Rhus retinorrhoea* Steud. ex Oliv.	Anacardiaceae	Tree	Telom
61	*Rhus vulgaris* Meikle	Anacardiaceae	Tree	Ashqamo
62	*Rosa abyssinica* Lindley	Rosaceae	Climber	Qega
63	*Salix mucronata* Thumb.	Salicaceae	Shrub	Kiya
64	*Schefflera abyssinica* (Hochst. ex A.Rich.)	Araliaceae	Tree	Getama
65	*Securidaca longepedunculata* Fresen	Polygalaceae	Shrub	Tsemnahe
66	*Senna didymobotrya* Fresen.	Fabaceae	Shrub	Gim Abeba
67	*Senna septemtrionalis* (Viv.) Irwin	Fabaceae	Shrub	Gufa mesel
68	*Senna singueana* (Del.) Lock	Fabaceae	Shrub	Gufa
69	*Sesbania sesban* (L.) Merr.	Fabaceae	Shrub	Sespania
70	*Solanecio gigas* (Vatke) C. Jeffrey	Asteraceae	Shrub	Boze
71	*Solanum indicum* L	Solanaceae	Shrub	Embuay
72	*Stereospermum kunthianum* Cham.	Bignoniaceae	Tree	Washte
73	*Vernonia leopoldii* Sch. Bip. ex Walp.	Asteraceae	Shrub	Chibo
74	*Vernonia amygdalina* Del.	Asteraceae	Tree	Girawa
75	*Withania somnifera* L.	Solanaceae	Shrub	Gizewa
76	*Ximenia Americana L.*	Oleaceae	Tree	Enkoy
77	*Zizyphus mucronata* Wild	Rhamnaceae	Tree	Foch