MADDA WALABU UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF ECOTOURISM AND BIODIVERSITY CONSERVATION

DIVERSITY OF WOODY PLANT SPECIES AND CAUSES FOR THE DEGRADATION OF WOODLAND IN SAWENA PASTORAL DISTRICT OF EAST BALE ZONE,SOUTHEAST OROMIA,ETHIOPIA

BY

HAILU DEBELE FIRISA

July, 2021

Bale Robe, Ethiopia

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HAILU DEBELE FIRISA

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This thesis has been submitted for examination with my approval as University advisor

Habte Telila (PhD) _____ _____ _____

Major advisor Signature Date

DEDICATION

This thesis is dedicated to my lovely children, Sena and Bonsa, whom I was not able to stay with them at a very vulnerable stage of their lives. May this bring them the best possible future?

STATEMENT OF THE AUTHORS

First, I declare that this thesis is my genuine work and that all sources of materials used for this Thesis have been duly acknowledged. This Thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Madda Walabu University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this Thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Place: Madda Walabu University, Robe

Date of Submission: ----------

BIOGRAPHICAL SKETCH

The author was born in June 1984 in the Bale the Oromia regional state, Ginnir district Ebisa Kebele. He started his education at Ebisa elementary school, junior school and completed his senior secondary education at the same place Ginnir Mokuria Tessema and Ginnir Secondary School respectively.

Upon successful completion of his high school studies, he joined the then Mekellee University of Dry land Agriculture and Natural Resources in October 2003 and graduated with a B.Sc. degree in

Department of Land Resources Management and Environmental Protection (Soil and Water Conservation stream) in July 2006. Thereafter, he was employed at Sawena district Pastoral Development Office, Water, mining and Energy office, Irrigation Development Authority office as Irrigation process owner and expert. The author served there for 11 years working experience in the district. Finally, after serving eleven years in Sawena Irrigation Development Authority office, as Irrigation scheme and design team Leader, he joined the School of Graduate Studies of the then Madda Walabu University in 2019. He is married and father of two sons.

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LIST OF ABBREVIATION AND ACRONYM

CSA _____Central Statistical Agency

EFAP _____Ethiopian Forestry Action Program**.**

EPA _____Environmental Protection Agency**Error! Bookmark not defined.Error! Bookmark not defined.**

EDRI _____Ethiopian Development Research Institute

FDRE_____Federal Democratic Republic of Ethiopia

IBC _____Institute of Biodiversity Conservation

MoFED _____Ministry of Finance and Economic Development

NMA _____National Meteorological Agency

NTFPs _____Non-Timber Forests Products

OoARD _____Office of Agriculture and Rural Development (Sawena)

PA_____Pastoral Association**.Error! Bookmark not defined.**

SPDW _____Sawena Pastoral District Woodland

UNEP_____United Nation Environmental Program

WBISPP_____Woody Biomass Inventory and Strategic Planning Project

ABSTRACT

We collected data on Woody plant species richness, frequency, density, diversity and structure with in total 60 sample plots, 15 plots by 20m X20m in each study. PAs plot sampled and a semi-structured questionnaire (100 households) was used to gather socio-economic data. A total of 58 woody species were identified in the woodland that belongs to 37 genera and 23 families were identified, of which 62.1% were trees and 37.9% were shrubs. The density of woody plant species (969/ha), frequency of all species of woody species (256/ha) and then among the woody plants with the most ecologically important species were Acacia bussie, Acacia mellifera, Acacia tortilis, Acacia robusta, Commiphora erythraea and Boscia mossambicensis species are the major dominating plant species in the woodland. The result of Shannon-wiener diversity and evenness indices showed that Adele PAs woodland was the most diverse and had the highest species richness. In comparison to the other PAs woodlands, Chopi PAs woodland had the least diversity and number of species, as well as the least even distribution. Use woody plant species for multipurpose services. The main uses are construction (61.2%), followed by browsing (50.2%), medicinal purposes (43.3%) and household equipment (41.8%). However, similar to the other areas of the woodland ecosystem of Ethiopia, this woodland is also under population pressure largely because of the pastoral farming system exercised in the area. Both the household and field woodland plant species studies confirm that the factors causing woodland plant species degradation are charcoal production, agricultural land expansion, overgrazing, and invasive species expansion, according to the study's findings. Consequently, this leads to degradation of the woodlands through reduction in tree species richness, diversity, density and structure. The IVI analysis determined that Rhamnus staddo, Commiphora boranesis, Dichrostachys cinerea, Dobera glabra, Cordia gharaf, Olea europaea subspp cuspidate, Filicium decipiens, Berchemia discolor, and Acacia species were the least ecologically important. The woody plant species population structure showed different dynamics. From the viewpoint of population structure analysis, most woody species were in a good state of reproduction and recruitment, but some species, like Commiphora erythraea, Balanites aegyptica and Pistacia aethiopica species with high IVIs, were also among those species that exhibited poor regeneration and abnormal recruitment. Therefore, setting a high priority is needed to conserve these endangered woody plant species. The other remaining species require monitoring and management efforts in a sustainable way and all concerned bodies, especially local agricultural offices, Climate change office, security or police office departments have to work in collaboration to patrol woodland degradation. Finally, further research into the sustainable use of grazing woodland vegetation and you have to future, necessitating the need for improved overall woodland resources by controlling human activities within the woodland.

***Key Words**: Dry woodland, Pastoral district, woodland degradation, woody plant species*

1. INTRODUCTION

1.1. Back ground of the study

In Africa Woodland plays a great role in the livelihood of both rural households and urban dwellers, and they contribute significantly to the economic development of many countries, particularly in Western, Eastern and Central Africa, where there is considerable forest cover (UNEP, 2006; Lu et al, 2010; Elliot et al, 2013).The African savanna woodlands provide the habitat for a large number of endemic plant and animal species, and the home of Pastoral and agro-pastoral communities and their cattle. The trees are used for fuel wood and construction timber, and serve as valuable bee, human and animal fodder. Some species are used in traditional medicine, for tanning hides, and harvesting for gum and incense, thus providing an important source of income (Reusing, 2017). Hence, dry land woodlands are an important source of ecosystem services to the agro-pastoral and pastoral communities living within and around them (Sedano et al, 2017).

The dry forests and woodlands are the dominant vegetation type in sub-Saharan Africa, covering over 17.3 million km^2in a total of 31 countries (Chidumayo and Marunda, 2010). Beside their wide rage importance, dry land woodlands are degraded due to charcoal production for urban energy consumption is a main driver of forest degradation in sub-Saharan Africa (Ndegwa et al., 2016).

Dry woodlands are vegetation formations, which comprise of scrubs, bush lands, thickets, wooded grasslands and dense woodlands (Chidumayo, 2010; Antoine Van,.and Alparsian, 2007). They occur in climates with annual rainfall of 300 to 1200 mm and a dry period of five to ten months (FAO, 2000). These woodlands are an important source of ecosystem services to the agro-pastoral and pastoral communities living within and around them (Maass et al., 2005).

About 75% of Ethiopia's landmass is categorized as dry land, experiencing moisture stress during most days of the year (Giorgis, 2014). The lowland woodlands are the largest remaining Woody plant species in Ethiopia, covering account for 55 % of the total land area (EPA, 2003;Biazin and Sterk, 2013; Worku et al., 2014). Here, the Acacia-Commiphora small leaved deciduous woodland is found mainly in southern and eastern parts of the country and the Rift Valley with altitudinal range lie between 900-1900 a.s.l. The characteristics of plant species in this vegetation type include drought tolerant trees and shrubs: *Acacia tortilis, A. nilotica, A. seyal, A. Senegal, A. etbaica, A. sibieriana,*

A. mellifera, A. brevispica, Commiphora africana, Solanum schimperianum, Acokanthera schimperi, Dichrostachys cinerea, Grewia vilosa, Rhus natatalensis etc.

The main causes of deforestation in tropical Africa are the expansion of subsistence agriculture, extraction of fuel wood, commercial crop cultivation, and poverty (Boahene, 1996; Appiah et al, 2009; Tegegne et al, 2016). Ethiopia lost over 2 million ha of her forests, with an annual average loss of 140 000 ha (FAO, 2010). The loss is attributed to low level of standard of living of farming community and their close dependency on forest and woodlands have led to clearing of trees for agricultural land expansion, fuel wood extraction, charcoal, constructional material and overgrazing (MNRCDEP, 1994; Reynolds, 2010). Woodland degradation in quality (species reduction) and quantity (shrinkage in volume/area) are threatening the biodiversity resources of the country. This reality is true in all highland and lowland ecological systems. In line with this, Woldu (1999), on which this technical report has focused, has reported that the *Acacia–Commiphora* (small-leaved) deciduous woodlands have been seriously depleted in recent years for wood and charcoal production.

Similarly, forest and woodland resources are continuously diminishing in Ethiopia year by year as a consequence of increasing population and an associated increasing demand for agricultural and pastoral land (Reusing, 2017). Ethiopia's natural high forests and woodlands are already under severe pressure, and may be lost within the next decades.

Federal Government of Ethiopia has identified deforestation as one of the major problems to be tackled by the conservation strategy of the country (Wood et al, 2001; Gebresilasie, 2014; Birhanu, 2014). To achieve this in a sustainable way, setting priorities for the threatened species in each vegetation types is indispensable (Lemessa, 2009; Tasfaye et al, 2009).

1.2. Statement of the Problem

In Ethiopia people particularly in the rural areas of the country, are highly dependent on forest resources to full fill their basic needs such as fuel wood for cooking and heating, fodder for livestock, for timber and non-timber products and as source of medicine (EFAP, 1994; Wickens, 1995; Price et al, 2011). Woody plant species of the Sawena pastoral district is one of the remnants natural woodland in the southeastern lowland of Ethiopian. However the pastoralists because of agricultural land expansion, fire wood collection, charcoal production, overgrazing and tree cutting for house construction have continuously exploited the woodland. If appropriate and immediate measures were

not being taken for the pressure exerted on this woodland resources it may lead to the loss of woodland resources after a few years.

Therefore the assessment of woodland plant species degradation in dry land pastoral district are important elements of biodiversity to conserving apply proper management and reduce *unwise* utilization of the woodland resources (Gebremedin and Belayhun, 2018). Therefore, the present study focused on the assessment of the diversity of woody species in the woodlands and factors for their degradation in Sawena Pastoral district.

1.3. Objectives of the study

1.3.1. General objective

The overall objective of the study was to assess the diversity of woody plant species and factors for degradation of the woodland in Sawena Pastoral District, East Bale Zone.

1.3.2 Specific objectives

The specific objectives of the study were to**:**

1. Investigate the woody plant species richness, diversity and structure in Sawena Pastoral District;
2. Assess the causes for the degradation of the woodland in Sawena Pastoral District, and
3. Examine the use values of the woody plant species in Sawena Pastoral Districts

1.4. Research Question

In order to address the above issues the study attempted to answer the following questions

1. What are the status of woody species richness, diversity and structure in the study site?
2. What are the causes for the degradation of Woodland in Sawena Pastoral District?
3. What are the main uses of the woody plant species in Sawena Pastoral District?

1.5. Significance of the Study

At present, one of the challenges facing Sawena Pastoral District is the alarming rate of degradation of woodland plant species being experienced in the study area. The rates and cause of the problem are still debatable due to paucity of reliable data and the processes involved are not clearly understood. This study is considered to be an important step towards bridging this information gap. The findings of the study are expected to contribute towards an understanding of the dynamics of degradation of woodland in Sawena Pastoral District. The result of this research provides important information

regarding the status of woody plant species richness, diversity, and structure. Thus, the knowledge gained can be used by forest policy makers and woodland development and utilization experts for sustainable forest and woodland conservation and utilization. The study serves as a document for other researchers who may have strong desire to carry out a research on this or related topics in this district or elsewhere.

2. LITERATURE REVIEW

2.1. Dry forests, woodland, Coverage and their importance

Woodlands are classified as tropical dry forests because they are dominated by woody plants, primarily trees, whose canopy covers more than 10% of the ground surface in combination with shrubs, grass, thickets, and bushes (FAO, 2005).Dry forests share the largest part of the forest resources of Ethiopia and cover an area of about 55 million ha (WBISPP, 2004; Lemenih and Bongers, 2011). Woodland is predominately found in the Southern, Southeastern and Central Rift Valley (low lying areas within the altitude of 900-1900m a.s.l, dominated by small-leaved deciduous trees and shrubs of the family Fabaceae and Burseraceae (Yebeyen and Worku, 2006). Woody plant species play a critical role in the livelihoods of Ethiopia, in particular pastoral and Agro-pastoral communities because they provide social, economic and environmental benefits such as firewood, charcoal production, gum and resin, timber, medicinal plants, livestock production, household utensil and farm implements, wild edible fruit and catchment protection (Gemado et al, 2005; Mamo et al, 2007; Babulo et al, 2008; Abate et al, 2012; Abtew et al, 2014; Yemiru et al, 2014).

2.2. Dry forests and woodland challenges

There are a number of problems facing the dry land forest and woodland resources in Ethiopia. These include climatic, ecological, soil related, biological and socio-economic and institutional problems (Georgis et al, 2010)**.** They have received far less scientific attention than moist forests, despite their high ecological, environmental and economic importance, being situated in rather densely populated rural areas. The natural dry land forests of Ethiopia are threatened as a consequence of gradual degradation and deforestation. They are highly fragmented and the risk of extinction of the rich biodiversity they hold is increasing (Muys, 2006). The major disturbances affecting this dry forests and woodland are agricultural expansion, overgrazing, drought, fuel wood and charcoal trade (Lemenih and Woldemariam, 2010). Agricultural land expansion and high dependence on biomass energy are the two most important direct drivers of deforestation and forest degradation in Ethiopia (Reusing, 1998; WBISP, 2004; EDRI, 2010).

2.2.1. Agricultural land expansion

Clearance for subsistence Agriculture is the leading cause of deforestation in the dry forests of Ethiopia (Lemenih et al, 2008), causing the loss of 91,400ha of woodlands (deciduous forests) and 76,400ha of shrub land annually (WBISPP, 2004). With the geometric increase in population, from 12 million in 1900 to 85 million in 2010, the proportional impact of agricultural land expansion on forest cover in the country has been obvious and significant (Dessie, 2007; Lemenih *et al*, 2008). Unlike in many other parts of the world, the shift from area expansion towards agricultural intensification has not happened in Ethiopia, making deforestation not only a past process but also a likely phenomenon in the future. Between 2000 and 2008 alone, agricultural lands expanded by about 4 million ha.and 80% of these new agricultural lands came from conversion of forestlands, woodlands, and shrub lands (Federal Democratic Republic of Ethiopia, 2010; Brown et al, 2010). In a business-as-usual growth path, demand for agricultural land is expected to increase from 15 million ha in 2008 to 34 million ha by 2030, most of which is expected to come from forested landscapes (EDRI, 2010).

2.2.2. Charcoal production

In many African countries, charcoal making is among the primary drivers of deforestation and subsequent land degradation (Butz, 2013; Chidumayo and Gumbo, 2013; Ahrends et al, 2010). The *Acacia* species, among other hardwoods, are specifically targeted for charcoal production, while the *Commiphora* species and other softwoods are mostly left standing. This selective felling has in some areas resulted in a residual forest dominated by softwood tree species (Kiruki *et al.*, 2016). Ethiopian cities and towns burn over three million tons of charcoal each year. Dependency on charcoal is rather increasing as a result of rapid growth in the urban population. The majority of charcoal entering Ethiopian towns and cities is produced in the country's acacia-dominated dry-woodlands, which have been over-exploited for decades due to loosely established property rights on their resources and/or little control over the resource base. Charcoal production heavily depends on acacia species for the quality they constitute. Besides its convenience and accessibility at reasonable cost as a household energy source, the charcoal trade is also offering an important income generation opportunity. Hence, charcoal will expectedly remain the main cooking fuel for most people in the country’s towns and cities for the foreseeable future (Girmay, 2014).

In Ethiopia, the current charcoal production system does not take the tree resources into account; charcoal is illegally produced from free sources. Even though there is a lack of reliable information,

fuel wood extraction (firewood and charcoal) is often associated with the alarming rate of deforestation and environmental degradation (Girmay, 2015).

New threats to the forests of Ethiopia have also emerged, including land-grabbing, biological invasion and climate change. Large-scale land leases (land grabbing) to foreign and domestic investors in the agricultural sector, particularly for the production of export crops and befouls, are being promoted. Several recent policy frameworks, such as the Growth and Transformation Plan (MoFED, 2010), strongly advocate large-scale intensification and commercialization of agriculture (Lavers, 2012). The total amount of land leased to investors between 2004 and 2008 was about 1.2 million ha, and it will likely increase to nearly 7 million ha by 2015 (Stebek, 2011).

2.2.3. Invasive species

Invasive species are among the major threats of rangeland biodiversity. Bush encroachment has negatively affected the yield of grasses, which in turn suppress the productivity of livestock particularly grazers such as sheep and cattle (Gemado et al, 2006; Dessalegn et al, 2013). Some of the plant species introduced to the country have become invasive, taking over large areas of woodlands. Total of 12 invasive plant species were recorded, and of which herbaceous or semi-woody rangeland invader are *Parthenium hysterophorus*, were highly distributed invasive species in Southeastern Ethiopia (Mussa et al, 2018).

2.2.4. Climate change

Is the third emerging threat; it affects stability and productivity of forests and woodland dynamics in Ethiopia (Dale et al, 2001; Krepkowski et al, 2011), the livelihoods of forest-dependent communities, and increased forest susceptibility to fires, pests, and diseases. Climate change may also increase the spread of invasive species (McNeely, 2004) and can exacerbate degradation of forest/woodland ecosystems and the people depending on these ecosystems.

The large-scale deforestation and degradation of woodlands have had significant social, economic, and environmental consequences both at local and national levels. Because of deforestation, there is an acute shortage of fuel wood, construction timber and non-timber forest products (NTFPs) in addition to disrupted ecosystem functions (soil erosion, hydrological imbalance, loss of biodiversity, etc.). Moreover, deforestation coupled with poor forest-sector development has resulted in severe

industrial wood shortages, causing the country to rely mostly on imported wood and wood products. At the same time, the local communities blame the invasive plant species for their negative impacts on biodiversity, degrading ecosystems, livestock and livestock products, crops, animal and human health (Mussa et al, 2018).

2.2.5. Over population and overgrazing

The growth of animal and human populations is increasing at an alarming rate. In contrast, the size of pasture resource on which they depend on is diminishing both in size and productivity (Grandin, 1987; Coppock, 1994; Desalew, 2008). Usually, increase in human population implies increase in livestock population in order to maintain survival. Increase in the size of population and overstocking are in turn causing imbalances, for example, in Borana range system and have already resulted in overgrazing and range degradation (Alemayehu, 2004). (Gamado, 2004)Reported that overgrazing has been one of the major factors that have caused degradation in rangeland in Borana. In this area, the relatively good rangeland condition in ranches and *kalos* may show that overgrazing is a major cause of degradation in rangeland.

2.2.6. Socio-economic and Institutional problems

Dry land areas in Ethiopia have historically had a weak State presence. There has not been formal recognition and full support for customary governance systems. The attitudes of local communities towards traditional authorities are also changing rapidly. Thus, weakened governance institutions at all levels characterize these areas (Lawy et al, 2015) The socio-economic and Institutional problems include: poverty, population growth and poor economic performance, absence of forest policy and legislation, absence of land and tree tenure/ownership /rights, the lack of pricing and incentives policies, absence of land use classification and land use planning policy, lack of stable institutional set up for forestry, also insufficient information dissemination (Georgis et al, 2010).

In most documents reviewed (e.g. The Ethiopian cases), the issue of institutional arrangement is suspended in the documents, assuming that it will be defined in land management regulations, which is yet to be formulated. Still in many other cases, it is hard to identify which institution will be specifically responsible. The government structure largely concentrates on the sendenteralization process (in Ethiopia) and developing basic infrastructure and service facilities. Customary rules are getting weaker while government policies and structure are not strong either.

The ultimate result is that land degradation and deterioration of its productivity in the pastoral community is currently increasing. Ugandan and Kenyan governments have recently recognized the need of building the capacity of and working with the pastoral customary institutions in rangeland management. This should be scaled-up, if pastoral land is to be saved from further degradation and to support sustainable development (Tadesse, 2016).

2.2.7. Over harvesting of plant resources

Overexploitation of plant resources is a growing threat to biodiversity in dry forest and woodland countries in sub-Saharan African (Chidumayo and Gumbo, 2010). For example, of the 13 tree species, nearly 90 per cent of them are threatened by overexploitation and 11 per cent are threatened by habitat loss. Over-reliance on traditional medicinal plants for primary health care by the majority of the sub-Saharan population has contributed to the overexploitation of some other species, such as *Walburgia salutaris* in Zimbabwe and *Albizia brevifolia* in Namibia and many others that are now threatened. Similarly, the commercialization of crafts, like baskets and wood curios, has led to a decline in tree species such as *Berchemia discolor* which is used as a palm leaf fibre dye in Botswana and Namibia. There has also been overharvesting of *Afzelia quanzensis* and *Pterocarpus angolensis* in a number of woodland countries in response to the flourishing woodcraft industry (Cunningham et al, 2005; Shackleton, 2005). Some of these shortages and losses can be at local level (site specific) while this may not be the case at the regional level, e.g. *Berchemia discolor* which is under threat in Namibia but actually spreads from Ethiopia to northern parts of South Africa. Some tree species may be facing acute pressure at a country level, but because of their abundance at regional level may not qualify to be placed on the IUCN Red Data List. Management and conservation measures in the past had always been influenced by taboos that restricted people from destructive harvesting (Osemeobo, 1994). However, these have become largely dysfunctional under increasing pressures and have not been replaced by alternatives. Indeed, management services provided by the government are weak and ill equipped. Alternative lesser-known substitutes need to be brought to light to reduce the pressure on over-sourced species. The importance of some species for multiple uses should also be highlighted. As a management strategy, proper records of plant status must be kept and abundance and collection rates monitored. The perception and orientation of harvesters must also be changed for they believe that plants can never be overexploited.

3. METHODOLOGY

3.1. Description of study area

3.1.1. Geographical Location

The study was conducted in Sawena Pastoral District, East Bale Zone, Oromia Regional state, Southeastern Ethiopia. The district is geographically located at Latitude7°23'08"N and Longitude 41°15'27"E(Fig.1) and found at the distance of 622 km Southeast to Finfine (Addis Ababa) and 64 km from zonal town Ginnir. The district is bordered by Laghidda, Rayitu, Gololcha, Ginnir and Somale Regional State in the north, south, northwest, west and east, respectively. The district has 28 rural Pastoral Association (PA) and 1 town. The total area covers about 9543.36 km^2 of land (OoARD, 2010).

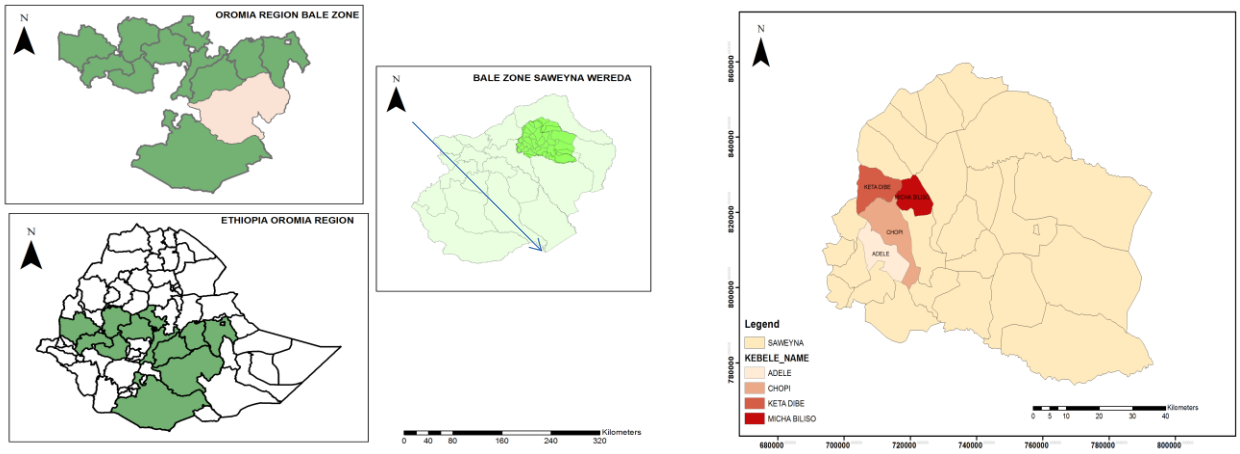


Figure 1. Map of the study area

3.1.2. Climate

The district experiences a bimodal rainfall pattern (‘Arifesa and Hageya’) characterized as long and short rains. The short rains are experienced in September to November. While the long rains from February to the end of May. There is usual a dry spell in January and February. The rains is erratic rainfall vary from year to year in timing, amount, duration and intensity. The mean annual rainfall for the area ranges from about 250mms to around 850 mms (NMA, 2019). About 90% of the districts receive mean annual rainfall of 250 to 750mms. The district is characterized by mean annual temperature, which ranges between 26°C and 38°C. The daily temperature becomes high during the

month December to February and it reaches 40°C.In the area, unless there are seasonal small streams, there are no perennial rivers. Since the area is often affected by the recurrent drought, it was categorized as food insecure area.

3.1.4. Population and economic activity

The human population of the district is about 65832 (Male=49.8% and Female=50.2%), of which 1.9% live in urban areas and the remaining 98.1% live in rural areas, requiring people to walk more than 5 kilometers to access basic facilities such as schools, water dams, and health centers. The district can be characterized as pastoralists (70%) and agro-pastoralists (30%). The main source of income is livestock rearing and subsistence rain-fed agriculture with small-scale irrigation, with the majority of people growing maize, sorghum, and teff (OoARD, 2010**). Other** economic activities include charcoal production, fuel wood collecting, bee keeping and poultry farming. However, the unreliability of rainfall with the district experiencing droughts every year makes the inhabitants highly vulnerable to drought related risks (OoARD, 2010). It has a very large livestock resource, which has been playing an important role in the life of the district population since early days. Cattle production (as draft of power, milk, meat, and income), shoat production (income, meat, and milk), camel production (milk, meat, income, and transport), donkey, horse, and mule production (as transport), and poultry production were all common. According to OoARD (2010), the districts' livestock population consists of 74414 cattle, 156722 goats, 35590 sheep, 8098 donkeys, 18669sssss poultry, 22698 camels, 329 horses, 3714 mules, and 29456 beehives.

3.1.5. Vegetation

The vegetation type of the area belongs to *Acacia-Commiphora* woodland, which is characterized by small-leaved and deciduous nature (Firis, *et al.,* 2010). The estimated total area of this woody species cover is 52697ha. (OoARD, 2010).The major part this woody plant species woodland is located on communal pastoral areas, enclosure rangeland/kalo/, riverside and in some sedentary farmland. *Acacia bussei, A. robusta, A. mellifera, A. tortilis, A. Senegal* and *Commiphora* species are the dominant trees and shrubs species in the woodland vegetation. The largest vegetation has occupied in the woodland part of the terrain dominated by *Acacia bussei, A. mellifera, A. Senegal, A. robusta, A. tortilis* and *Commiphora erythraea* these tree species are presently competing for grazing land and agricultural land.

3.2. Methods

3.2.1. Reconnaissance survey

Reconnaissance surveys were conducted from September to October 2020 to select and view the appropriate study and to gather relevant information concerning to woodland degradation and household survey was gathered. The study was done in two phases:-The first was inventory of the woodland plant species; and the second phase was household survey.

3.2.2. Study design and Data collection

3.2.2.1. Study design and Plant data collection

Woody plant species were collected from mainly occupies PAs such as Adele, Chopi, Keta-dibe and Bilso of Sawena pastoral district woodland along five transects of 3km long. Transects lay out was done systematically in stratified way to ensure that sample PAs, cover representative of woody plant species occurring in the Sawena pastoral district woodland namely, Adele (3transect), Chopi(1), Keta-dibe(1) and Bilso(1). Along each, transect fifteen 20m by 20m plots (60 plots) were established at 200m distance interval. Accordingly, 15 plots in each study PAs were sampled. The starting point of the first transect line was located purposively. In each 20X 20m plot, trees and shrubs with (DBH) ≥ 5cm and tree height >2m were measured. Sapling (those below 5cm DBH) and stumps were also identified, measured and recorded. Circumference of each tree/shrub was measured by meter tape and DBH values were by dividing circumference by phi (3.14) while the data of total height were taken on ocular estimation.

Additionally, the growth habit and number of stems of each species existing in the plots were recorded. Beside plant data environmental factors such as altitude was recorded. The identification of plant species was done using the flora of Ethiopia and Eritrea.

Figure 2. Field woody plant species inventory data collection

3.2.2.2. Sampling design and household socio-economic data collection

Four PAs Adele, Chopi, Keta-dibe and Bilso were purposively selected for the study based on the criteria of woodland resources, importance to livelihood as ecological, economic and environmental services to Pastoral districts. Moreover, by assuming a standard error of 5% at a precision level of 5%, and the confidence interval of 95%, the final sample size was fixed to be 100 households by Arsham (2007) formula and proportionally allocated in to select PA.

$N=0.25/(SE)^2$

$N=0.25/ (0.05)^2$

N=100, wherein=sample size, SE=standard error of the proportion

Accordingly, a total of 100 households were calculated and proportionally allocated to the total number of household (Table 1).

Table 1.Total number of household and sample size

Name of PAs	Total household	Sample size
Adele	695	30
Chopi	591	26
Keta-dibe	558	24
Bilso	450	20
Total HH	2294	100

The interview households were selected randomly using the lottery approach. Using techniques such as questionnaire in selected PA of namely; Bilso, Chopi, Adele and Keta-dibe you have to generate socio-economic information of the district. The household socio-economic factor of family size, land size and use, Livestock levels and mobility, income source, Pastoralists outlook on status and utilization woody plant species and management problem driver to woodland degradation data were collected by the data collection instrument through a sample house hold survey by administering a semi-structured questionnaire. A semi-structured questionnaire that includes both close and open-ended designed and employed to generate quantitative and qualitative data from respondents. The questionnaire was prepared in English language and translated to Afan Oromo.

3.3. Data Analysis

3.3.1. Plant Data

The species richness of woody plants were determined from the total number of woody species recorded at Sawena woodland while Species diversity were computed by Shannon's Wiener Diversity Index and Simpson's diversity index using the following formula:

$H' = -\sum piln\,(pi)$, Where, H' is the Shannon-Wiener diversity index;; p_i is the proportion of *S* made up of the *i*th species (pi= ni/N); Ln is natural logarithm. The evenness (E) of species calculated as;

E = H`/lnS, Where E= evenness's= is the number of species.

This index explains how equally abundant each species would be in the PA woodland and high evenness is a sign of ecosystem health. This is because it does not have a single species dominating the ecosystem. The evenness or equitability assumes a value 0 and 1 with 1 being complete evenness and 0 a single species dominating the area.

Density of woody species was determined by converting the total number of individuals of each woody species encountered in all the plots to the equivalent number per hectare. Relative density was calculated as the percentage of the density of each species divided by the total stem number of all species ha. Frequency, which refers to the degree of dispersion of individual species in an area, were expressed as the ratio of the number of plots in which a species occurred to the total number of plots, whereas relative frequency were computed as the ratio of the frequency of the species to the sum total of the frequency of all species (Kent and Coker, 1992; Akwee et al, 2010). Dominance were calculated as the sum of the basal areas of the individual woody species in m^2 per ha. Basal area were calculated for all woody species as BA=Πd2/4, where BA=Basal area in m^2, d=Diameter at breast height in cm, Π=3.14.Relative dominance were calculated as the percentage of the total basal area of a species out of the total basal areas of all species. The IVI is used to give an overall indication of the importance of a plant species in a plant community (Kent and Coker, 1992; Akwee et al, 2010). It is the sum of the values of relative frequency, relative density and relative dominance of the species. In addition, population structures of the entire woody plant were investigated via constructing diameter frequency histograms.

3.3.2. Socio-economic data

The collected household survey data sample questionnaire of Socio-economic factor of household size, land size and use, Livestock levels and mobility, income source, Pastoralists outlook on status, utilization woody species and management problem driver to woodland resources degradation data was organized and analyzed by using Microsoft Excel and SPSS software version16.0. Descriptive statistics such as mean and standard error of the means were used to present the results of the respondents in the districts.

Household survey data related to factor causes of woodland degradation was analyzed using ranking index method (Musa et al, 2006).

4. RESULTS

4.1. The woody plant species

A total of 58 species, representing 37 genera and 23 families were recorded based only for standing trees and shrubs in the study sites of Sawena Pastoral District Woodland as shown in Appendix 2. Out of these, trees species in number were 36 (62.1%) and shrubs were 22(37.9%) For stumps a total of 16 Species from 10 families of trees were identified.

4.1.1. Frequency and density

The woody species recorded *Acacia bussei*, *Boscia mossambicensis*, A.*mellifera*, *Commiphora erythraea*, *A. brevispica* and *A. tortilis* were *the most frequent species and Berchemia discolor, Cordia gharaf, Filicium decipiens, Rhamnus staddo, Dichrostachys cinerea, Olea europaea subspp cuspidate, Dobera glabra* and Acacia species were the least recorded woody species. Similarly, the highest species density was for *A. bussei*, Boscia *mossambicensis and A. mellifera while the least specie density was Rhamnus staddo, Cordia gharaf, Capparis tomentosa, Rhamnus staddo, Dichrostachys cinerea,* Acacia species, *and Dobera glabra* and refers to (table 2).

Table 2.Woody plant species frequency and their density in Sawena pastoral district woodland

Species name	Species frequency	Species Density
Acacia bussei	61.67	136.67
Boscia mossambicensis	48.33	111.67
Acacia mellifera	43.33	80.00
Commiphora erythraea	35	31.25
Acacia brevispica	23.33	16.67
Combretum molle	23.33	21.25
Eucleae divinorum	23.33	50.83
Acacia tortilis	21.67	42.5
Dodonea angustifolia	20.00	58.33
Acokanthera schimperi	20.00	12.08
Acacia robusta	15.00	38.75
Commiphora africana	13.33	9.58
Rhus natalens	13.33	14.58
Acmella caulirhiza	13.33	45.00
Balanites aegyptica	11.67	5.83

Pistacia aethiopica	11.67	9.17
Juniperus procera	11.67	28.33
Papea capensis	11.67	5.83
Phyllanthus sepialis	11.67	21.67
Arele	11.67	20.83
Acacia oerfota	11.67	55.42
Ozoroa reticulate	10.00	12.50
Acacia senegali	10.00	14.58
Olea capensis	8.33	2.92
Delonix elata	8.33	7.08
Acacia prasinata	8.33	5.83
Kirkia burgeristannard	8.33	6.67
Combretum collinum	6.67	4.58
Opuntia ficus-indica	6.67	3.75
Commiphora myrrha	6.67	7.08
Salvadora persica	5.00	5.83
Zizyphus mucronata	5.00	2.92
Terminalia browni	5.00	3.75
Premna schimperi	5.00	5.83
Grewia velutina	5.00	2.50
Cordia gharaf	3.33	0.83
Tamarindus indica	3.33	3.75
Berchemia discolor	3.33	2.08
Grewia pencillata	3.33	7.92
Croton macrostachyus	3.33	5.42
Hagenia abyssinica	3.33	5.83
Capparis tomentosa	3.33	0.83
Acacia seyal	3.33	1.25
Ehretia cymosa	3.33	2.92
Filicium decipiens	3.33	7.08
Ricinus communis	3.33	3.33
Cassia singueana	3.33	3.33
Turfo	3.33	1.25
Grewia tenax	1.67	8.33
Opuntia cylinderica	1.67	3.75

Ficus syhomorus	1.67	1.67
Commiphora boranesis	1.67	0.83
Rhamnus staddo	1.67	0.42
Bubisa	1.67	0.42
Dichrostachys cinerea	1.67	0.83
Olea europaea subspp cuspidate	1.67	1.25
Acacia spps.	1.67	0.42
Dobera glabra	1..67	3.33
	615.00	969.00

4.1.2. Woody species diversity

The PA high woody species diversity was Adele PA followed by Keta-dibe, Bilso and the PA with less woody species diversity was Chopi and refers to the (table 3).

Table 3.Diversity indices of woody species in recorded in woodland of Sawena Pastoral district.

Study PA Woodland	**Diversity indices**		
	Shannon diversity index(H)	**Evenness**	**Species richness**
Adele	2.774	0.683	34
Chopi	2.262	0.557	20
Keta-dibe	2.568	0.632	26
Bilso	2.415	0.595	24

4.1.3. Ecologically Important species

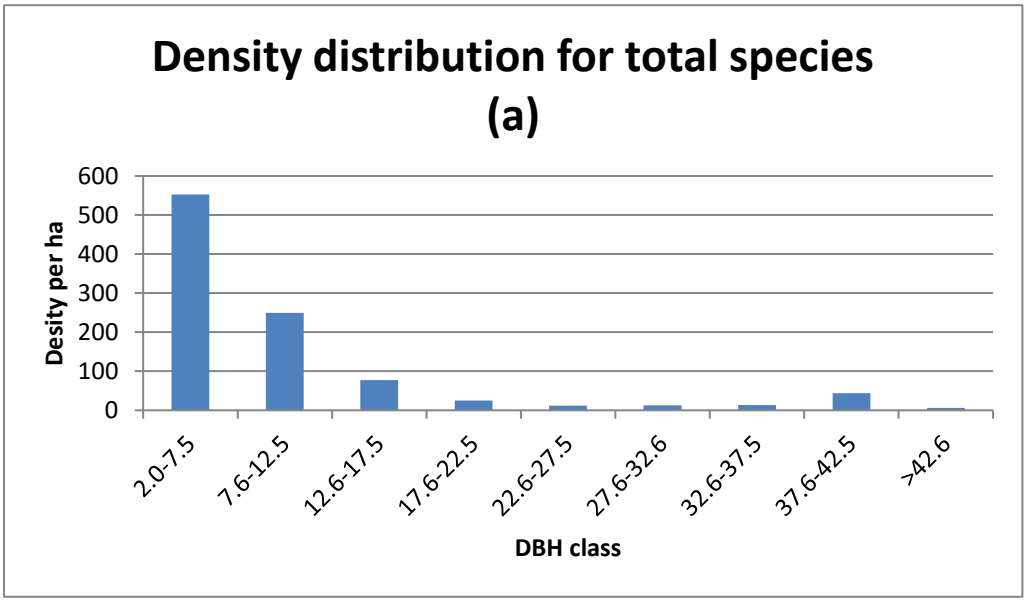
The most ecologically important Woody plant species with high IVI was *Acacia bussei* followed by *Commiphora erythraea, Boscia mossambicensis, Acacia mellifera, Acacia robusta and Acacia tortilis.* The Woody species with the least ecologically importance was *Rhamnus staddo, Dichrostachys cinerea, Olea europaea subspp cuspidate, Dobera glabra, Berchemia discolor,* and Acacia species and refers to the (Appendix 9).

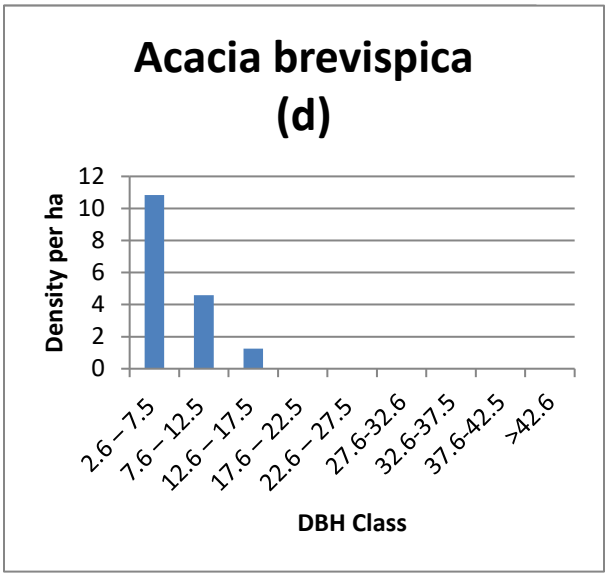
4.1.4. Vegetation Structure

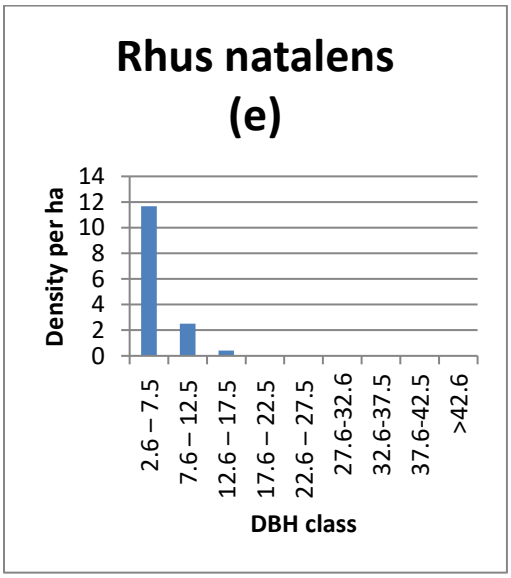
The DBH was classified into nine DBH classes based on field manual data collection checklist prepared by IBC and tree height was also classified into three classes (Fig. 3a and 4). The results showed the existence of variations in diameter and height classes of the woody plant of species in the

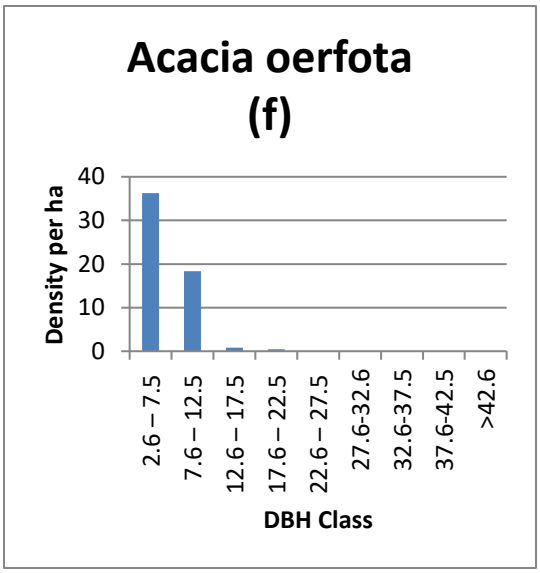
Sawena pastoral district woodland. A considerable number of woody plants species (with >2 cm DBH) were found in the lower diameter classes (fig 3a). For example, 80% of the Woody plant species were found in the DBH class between 2 and 12.5cm. The number of woody plant species within the largest diameter class >42 cm ranged between 1 to 5 percent in Sawena pastoral district woodland. The maximum diameter (DBH) was recorded in the Sawena woodland, i.e. 79.62 cm for *Tamanindus indica* followed by 63.69cm for *A. tortilis*, 50.96cm *A. robusta*, 47.78cm for *A. bussei and* 47.77cm for *Commiphora erythraea, B. aegyptica and A.seyal*(see Appendix 3).

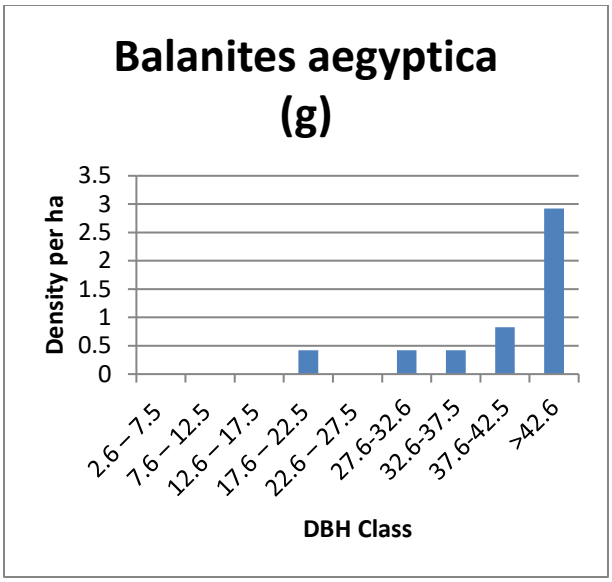
Analysis of diameter size distribution of all woody plants species were found in the lower diameter classes, which showed similar patterns, inverted J-shape curve in the woodland (Fig.3a). Twelve woody plant species from fifty-eight total woody plant species were selected for this study based on preference selection of the Pastoralists and the dominance in the study PAs. These are *Boscia mossambicensis, Acacia mellifera, A. brevispica, A. oerfota, Commiphora africana, Rhus natalens, Commiphora erythraea, Pistacia aethiopica, B. aegyptica* and *Juniperus procera*. The analysis of density distribution by diameter classes of woody species resulted in different patterns (see Fig. 3b-m). These are 1) inverted J-shape curve for *Boscia mossambicensis, Acacia mellifera, A. brevispica, A. oerfota, Commiphora africana* and *Rhus natalens*; 2) J-shape curve for species *Commiphora erythraea, Pistacia aethiopica* and *B. aegyptica* which was an unhealthy distribution; 3) bell –shaped curve for *A. senegali* and *Acokanthera schimperi* and ;4) U-shape curve for *Juniperus procera* (fig.3m)

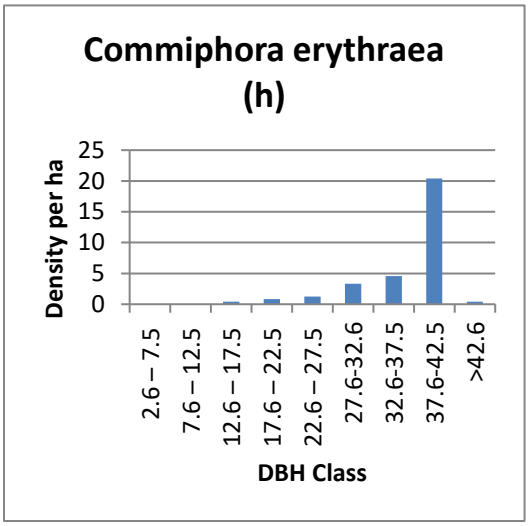

Density distribution for total species
(a)
Desity per ha
600
500
400
300
200
100
0
2.0-7.5
7.6-12.5
12.6-17.5
17.6-22.5
22.6-27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH class

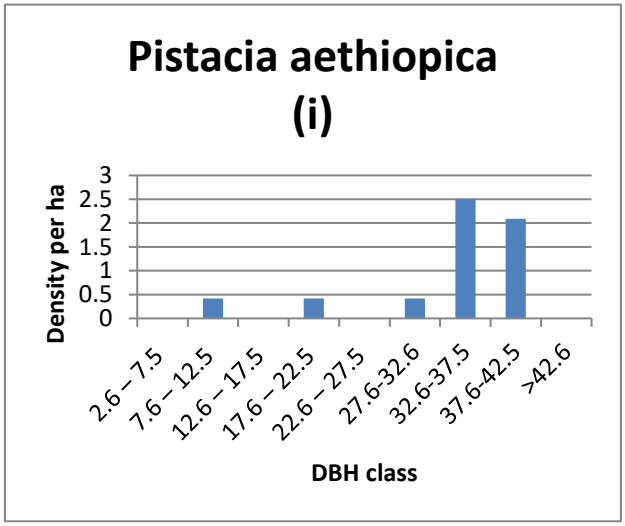

Acacia brevispica
(d)
Density per ha
12
10
8
6
4
2
0
2.6 – 7.5
7.6 – 12.5
12.6 – 17.5
17.6 – 22.5
22.6 – 27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH Class


Rhus natalens
(e)
Density per ha
14
12
10
8
6
4
2
0
2.6 – 7.5
7.6 – 12.5
12.6 – 17.5
17.6 – 22.5
22.6 – 27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH class


Acacia oerfota
(f)
Density per ha
40
30
20
10
0
2.6 – 7.5
7.6 – 12.5
12.6 – 17.5
17.6 – 22.5
22.6 – 27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH Class


Balanites aegyptica
(g)
Density per ha
3.5
3
2.5
2
1.5
1
0.5
0
2.6 – 7.5
7.6 – 12.5
12.6 – 17.5
17.6 – 22.5
22.6 – 27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH Class


Commiphora erythraea
(h)
Density per ha
25
20
15
10
5
0
2.6 – 7.5
7.6 – 12.5
12.6 – 17.5
17.6 – 22.5
22.6 – 27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH Class


Pistacia aethiopica
(i)
Density per ha
3
2.5
2
1.5
1
0.5
0
2.6 – 7.5
7.6 – 12.5
12.6 – 17.5
17.6 – 22.5
22.6 – 27.5
27.6-32.6
32.6-37.5
37.6-42.5
>42.6
DBH class

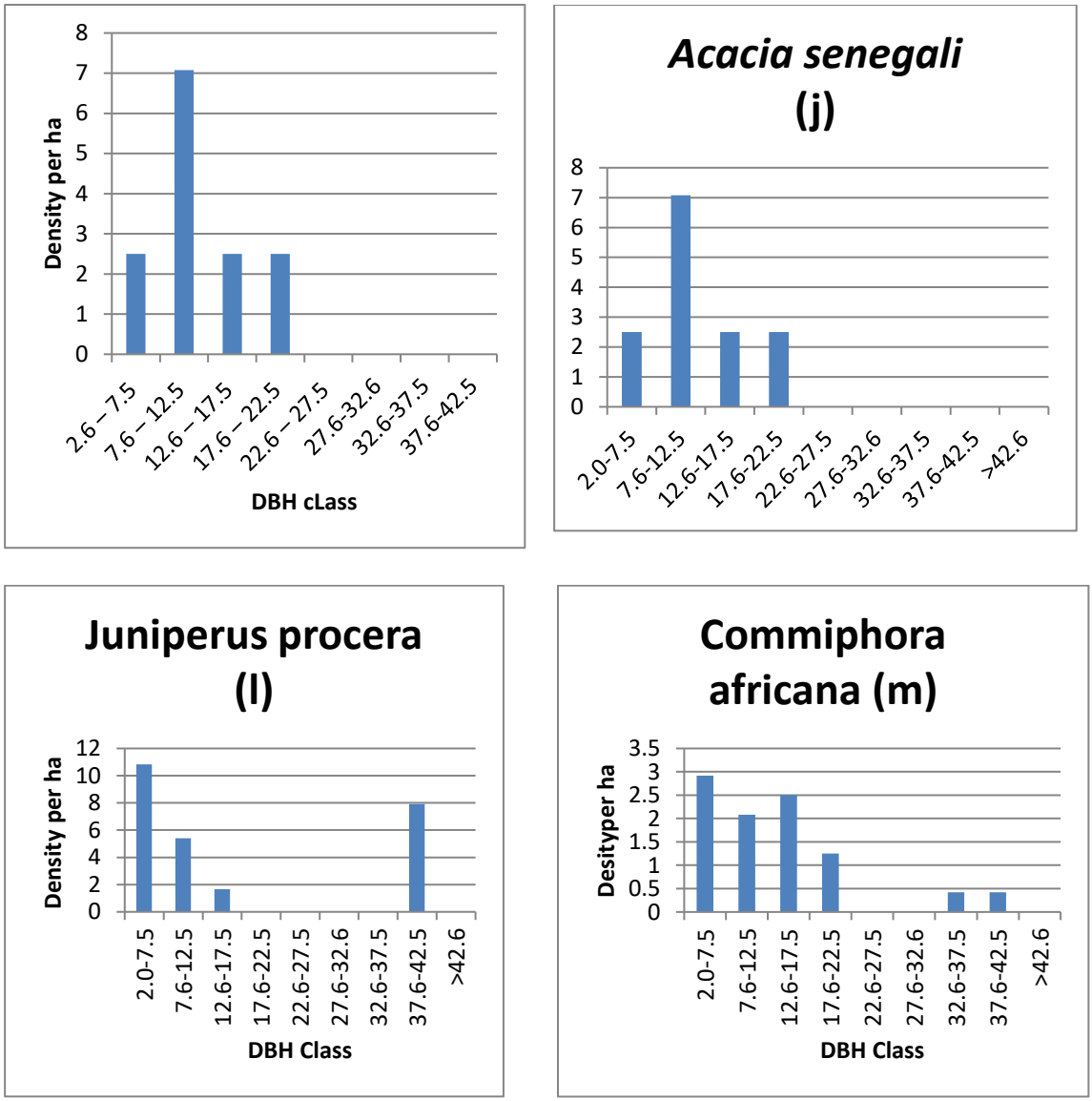


Figure 3. Diameter class density distribution of selected woody plant species

The result of the height class analysis also depicted that there is a higher total density in the lower classes and then this decreases towards the higher height classes (Fig.4).

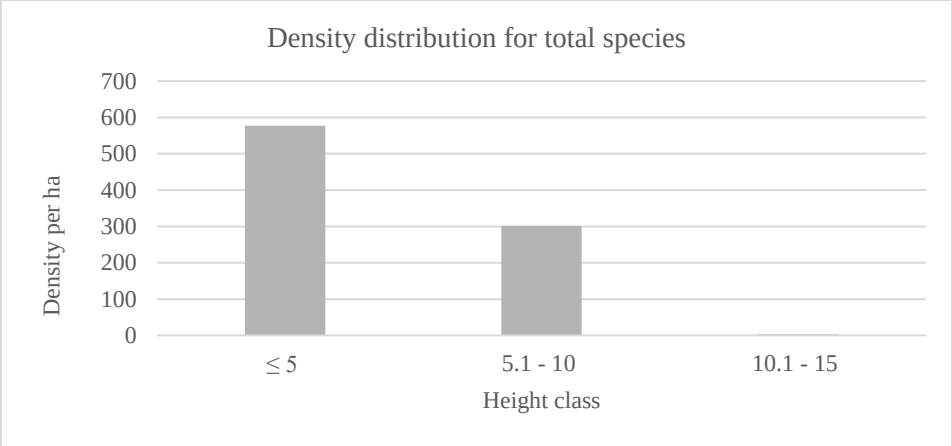


Figure 4. Height class density distribution of the woody plants

4.2. Threatening factor

Over all, the household survey demographic characteristics of the respondents showed of the 100 interviewed households, 97 were male-headed and 3 were female-headed, who were either widows or divorced .The average number of family size in the household was 7.5 ± 4.45 (± SD) . In terms of household age composition, 44.3% were in the 0–15 year's group, 41.0 % in the 15–64 years (working age) group, and 14.7 % in the 65+ year's group. The educational background of respondents consisted of 3% Secondary education, 19% primary or basic education and the rest have never been to school.

In the Sawena Pastoral district woodland the major threatening factor identified during woody plant species inventory and judging from the questionnaire responses, asked what factors were driving the trend of continuous depletion of Woodland resources in the studied areas, the respondent pastoralist ranked charcoal production as mainly, followed by Livestock pressure, deforestation for the expansion of farmland, construction purposes, human population pressure and invasive species were the major problems to the woodland resources and rifer to the (table 4). There were very little efforts made by government, non-government institutions and the community to plant and rehabilitate the Woody plant species that was cleared in the area. Above 85% of respondents replied that there was no tree seedling nursery site in the district.

Table 4. Pastoralists Perceived factor causes of woodland degradation in the rank 1st-7th in Sawena District (n = 100)

Factors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Index**	**Rank**
Charcoal Production	49	25	15	10	3	-	-	102	0.159	1
Farmland expansion	35	20	16	15	11	-	-	97	0.151	3
Fuel wood selling	-	-	8	13	7	24	30	82	0.128	6
Livestock pressure	40	24	18	11	5	-	-	98	0.152	2
Construction of house	3	5	10	17	11	22	28	96	0.149	4
Invasive Species	-	-	5	19	10	16	26	76	0.118	7
Settlement expansion	3	5	8	11	14	21	30	92	0.143	5
Total								643		

4.3. Scio-economic importance of woody plant species

Sawena district Pastoralist district uses woody plant species for a wide range of services and multiple uses mainly for construction purposes 41species (61.2%), followed by use as livestock feed 34 species (50.7%),for medicinal purposes 29 species (43.3%), household equipment 28 species (41.8%), fuel and charcoal making 23 species(34.3%), bee forage 21species(31.3%), shelter 19 species(28.4%), edible fruit 17 species (25.4%), soil fertility and erosion control 12 species (17.9%), Hygienic 11 species (16.4%), Fragrant 8 species (11.9) and to some extent for timber 6 species (9 %), environment indicator 6 species (9%) and myrrh and incense 2 species (3%) and rifer to (table 5).

Table 5 .Trees and shrubs use based on pastoralists perception in Sawena district woodland (n=100)

Scientific Name	**Local name**	**con**	**For**	**Mp**	**tim**	**fc**	**Hu**	**wf**	**sh**	se	**fra**	**Hyg**	**ec**	**bf**	myi.
Commiphora erythraea	Hagarsu	x	x	x	x		x			x		x		x	
Acmella caulirhiza	Gorsa	x				x				x					
Commiphora africana	Hamessa	x	x		x	x						x			
Boscia mossambicensis	Kelkelcha	x	x	x		x									
Acacia bussei	Halo	x	x	x		x			x	x				x	
Acacia oerfota	Ajo		x	x										x	
Combretum collinum	Hereri	x					x								
Commiphora myrrha	Qumbi			x							x				x
Premna schimperi	Urgesa		x	x	x			x	x					x	
Acacia mellifera	Bilala	x	x	x										x	
Commiphora boranesis	Riga werabesa														

Acacia robusta	Wangaya	x		x		x	x		x				x		
Combretum molle	Ruku	x	x				x						x		
Capparis tomentosa	Denga gala		x	x											
Berchemia discolor	Jejeba								x						
Delonix elata	Sukela						x		x			x		x	
Acacia spps.	Halo kebecha	x				x									
Filicium decipiens	Chana	x		x		x	x			x					
Grewia velutina	Haroresa						x								
Eucleae divinorum	Mi'esa	x	x	x			x		x					x	
Acokanthera schimperi	Keraru	x	x	x			x	x	x						
Dichrostachys cinerea	Jirime	x													
Cordia gharaf	Mendera	x				x		x	x		x	x			
Acacia brevispica	Hamaresa	x	x			x	x								
Tamarindus indica	Roqa	x	x	x		x		x	x	x			x		
Grewia pencillata	Ogomdi	x	x					x							
Acacia tortilis	Dedacha	x				x			x	x				x	
Phyllanthus sepialis	Dhigri		x												
Hagenia abyssinica	Heto			x		x									
Opuntia ficus-indica	Cira			x										x	
Zizyphus mucronata	Kurkura	x	x	x			x			x					
Rhus natalens	Debobesa							x	x		x				
Salvadora persica	Ade						x	x				x			
Dobera glabra	Ade kulo						x	x				x			
Terminalia browni	Birensa	x	x	x		x^f	x	x	x	x	x			x	
Ficus syhomorus	Oda						x	x	x				x		
Ricinus communis	Kobo		x	x											
Pistacia aethiopica	Girarsa	x	x	x			x	x	x			x		x	
Juniperus procera	Hindesa	x		x	x	x^f	x		x	x	x				
Dodonia angustifolia	Itacha	x	x			x^f						x		x	
Ozoroa reticulate	Gari	x	x			x			x			x		x	
Olea capensis	Gomgoma	x	x			x^f	x	x	x						
Balanites aegyptica	Bedena	x	x	x		x^f	x	x		x					
Papea capensis	Biqaa		x	x		x	x	x		x			x		
Acacia prasinata	Dodoti	x				x			x					x	
Rhamnus staddo	Qedida					x									
Acacia Senegal	Saphensa dimaa	x	x			x		x							
Cassia singueana	Cekata		x	x											
Grewia tenax	Sarkama	x	x			x									
Croton macrostachyus	Bekenisa	x	x				x							x	
Ehretia cymosa	Ulaga				x		x			x					
Acacia seyal	Wacu	x	x	x			x	x							
Olea europaea subspp cuspidate	Ejersa	x		x			x					x		x	
Podocarpus falcatus	Birbirsa	x			x									x	
Boswellia neglecta	Dakkara			x							x				
Hyphaeru thebaica	Meti	x					x								
Kirkia burgeristannard	Busdhuga	x	x				x		x				x	x	
Carissa spinarum	Agamisa	x	x					x							
Boswellia species	Muka Itana														x

Steculiaceae stencarpa	Qarari						x								
Mimusops kummel	Qolati										x				
Turfo		x										x			
Arele		x	x	x										x	
Bubisa		x	x				x								
Kenchara		x	x	x										x	
Bakisa iyo				x							x			x	

Con= House and fence construction; For= Fodder; Med=Medicinal plant and pest control; Tim =timber; FC = Firewood and charcoal making(x^F =use fuel wood only); Hu = Household utensil and farm implements; Wf= Wild edible fruit; myi= myrrh and incense ; Sh = shade and shelter; Fra= Fragrant/perfuming ; Hyg = Hygienic, EC= environment indicator and change environment ; Bf= Bee forage; Se=Soil fertility and erosion control.

5. DISCUSSION

5.1. The woody plant species

Sawena Pastoral district woody species richness poor compared with other Woodlands like Taltallee Woodland vegetation, which had 85 species (Lemesa, 2009). However, it is richer in species compared to Borana woodland which had 46 species (Worku et al, 2012), South East Ethiopia range land woody vegetation with 45 plant species(Abate, 2012) and South Omo Woodland with 27 Woody plant species (Adem et al, 2014). Woody species with a high extent of human disturbance due to encroachment shows relatively fewer species number than others (Urban et al, 2000) do. According to Song et al.(2003);Ackerly and Cornwell(2007); Richard et al.(2014), the difference in species composition over various woodlands could be due to topographic differences among the woody plant species compared and the amount of available suitable environmental conditions in the respective woodland. Such difference may also due to the various physical and edaphic characteristics of the

5.1.1. Frequency and density

The present study revealed that variation in frequency distribution and density between woody plant species in the study SPDW. This is may be attributed to ,PAs house hold species preference, habitat differences, habitat preferences among the species, species characteristics for adaptation, degree of exploitation and conditions (Lemage and Legesse, 2018).

Our finding has showed that the Woody plant species including *A. bussei*(61.67%), *Boscia mossambicensis*(48.33%),*A. mellifera*(43.33), *Commiphora erythraea*(35%), *A. brevispica*(23.33%) and *A. tortilis*(21.67%) were the top six frequently verified species are the most frequent woody plant species found in SPDW.

Similarly, the total density of woody Species in SPDW was 969 per ha and density among species ranged between 0.42-136.67 per ha. Species contributing most to the total plant population density of the area were *A. bussei* (136.67/ha, 14.1%) followed by, Boscia *mossambicensis* (111.67/ha, 11.5%) and *A. mellifera* (80/ha, 8.25%). Comparing the total density of woody plants reported here with other similar Woodland ecosystem sites in Ethiopia indicated that it was comparable to that of South Omo woodland Bena-Tsemay(Adem et al, 2014) and Taltalle woodland (Lemesa, 2009), but was greater West Shewa woodland vegetation (Demie, 2019).

5.1.2. Woody species diversity

The description of woody plant species involves the analysis richness and diversity (Whittaker, 1975). Species richness, or the number of species, is the most direct measure of biological diversity. The observed variation in species richness and evenness between the study site could be due to habitat heterogeneity, site productivity, and/or disturbance regimes (Adem et. al, 2014). Even though, there was no big difference in species richness among Adele, Keta-dibe and Bilso, Adele PAs woody plant species had more species than any others did. The least species rich woodland PAs was Chopi woody plant species. The higher the value of J, the more even the species is in their distribution. Thus, Adele PAs woody plant species had the highest even distribution whereas Chopi PA woody plant species had the least even distribution. Chopi PA woody plant species had the least evenness, diversity and richness this might be due to the high overgrazing and human influence, and drought in this PAs woodland area. In general, since the area was severely degraded, the species found there now was mostly *Acacia and Commiphora species* of drought resistant and low soil fertility tolerant(Mekonnen, 2006)..

5.1.3. Ecologically Important species

The IVI of woody plant species varied from 0.31(0.1% of the total IVI) to 42.13(14.04%) and only six species contributed over 46.27% of the IVIs: *A. bussei* (14.04%), *Commiphora erythraea* (8.45 %), *Boscia mossambicensis* (7.12 %), *A. mellifera* (6.55%), *A. robusta* (5.6%) *and A. tortilis* (4.52%). Over half of the all species [28 (48.3%) species] had IVI of greater than 1, while species relatively considered to be the most rarest in the SPDW included *Rhamnus staddo* 0.31(0.1%), *Commiphora boranesis* 0.36(0.12), *Dichrostachys cinerea* 0.36(0.12%), Acacia species 0.7(0.23%),*Capparis tomentosa* 0.63(0.21%), *Olea europaea subspp cuspidate* 0.79(0.26),*Dobera glabra* 0.74(0.25%), *Berchemia discolor* 1.01(0.32%) and *Cordia gharaf* 1.27 (0.42%). The species with high IVI were the most dominant while the lower ones were less in the woodland. This might be due to fire damage, natural selection and livestock grazing or trampling of other species. Woody species that constitute the lowest IVI depicted that the species could be prioritized for conservation. Woody species with high resistance to anthropogenic disturbance and those with efficient regeneration capacity have relatively high chance of remaining dominant in the Woodland. Therefore, those species with least

IVI should need conservation measure, as they are important in terms of ecological, social and economic services they provide.

5.1.4. Vegetation Structure

Sawena pastoral district woodland the overall patterns of population structure were inverted J-shaped types, which indicate normal population distributions with a high number of individuals in the lower size classes and only few individuals in the higher size classes. This pattern is an indicator of healthy regeneration of the woodland and species, and shows good reproduction and recruitment capacity (Bekele, 1994; Khan et al, 1987; Esthete et al, 2011).

The general pattern of 'inverted J-shape' curve seen when all the species was considered together was not detected when species-specific DBH size distributions was examined separately. Four different patterns revealed based on the analysis of the number of individuals in each DBH size class for twelve selected species.

Six of these species**,** *Boscia mossambicensis*, *Acacia mellifera*, *A. brevispica*, *A. oerfota*, *Commiphora africana* and *Rhus natalens* in similar to the general trend of the diameter class total density distribution, this shows the pattern, which has the highest species density distribution in the lower diameter class and a gradual decrease towards the higher classes. Species with such population structural pattern can be considered as in a good reproduction and healthy regeneration condition (Senbeta, 2006).

Three species, J-shape' pattern was displayed by *B. aegyptica*, *Commiphora erythraea* and *Pistacia aethiopica* with low number of individuals in the lower DBH size classes and high number of individuals in the higher DBH size classes. These findings of Pistacia *aethiopica* is similar with results from study (Lemesa, 2009), but contrast with *B. aegyptica* and *Commiphora erythraea* have reported to show an inverse j-shape and bell shape respectively. These tree species are more palatable to livestock and have more economical importance for the local people (for house construction, charcoal and firewood) compared with other woody plant species in the SPWD. Thus, the discrepancy among previous studies and the present study could be due to varying nature and levels of biotic pressures (tree cutting and browsing) posed on the different age sizes of these species at different sites. In SPDW, it seems that over-exploitation of matured trees that might have led to reduced reproduction (that is, flower production, pollination and seed production) by pastoralists and

livestock browsing and grazing of seedlings or samplings might have led the population structures of these species to exhibit such poor regeneration and/or abnormal recruitment. From conservation point of view, these three species are at higher risk of local extinction and hence should be prioritized for conservation management actions.

Other species, such as *A. senegali* and *Acokanthera schimperi* showed relatively a 'bell-shape', where number of individuals in the middle diameter classes are high but are low in lower and higher diameter classes. These species, therefore, can be considered to be with poor reproduction a recruitment, which could be associated with intense competition from the surrounding trees and/or other forms of disturbances such as browsing activities (Senbeta, 2006; Gebrehiwot and Hundera, 2014).

Finally, the pattern of U-shape curve 'regeneration curve' for *Juniperus procera* which is it indicates recovery of species. Hence, the pattern of the height class density distribution is showing the declining trend when it goes from the lower to the higher class. In this regard, similar kind of population pattern was also obtained by Debissa Lemesa (2009) in Woody plant species Diversity of Taltallee woodland (Acacia–Commiphora woodland Ecosystem) areas indicating a high proportion of individuals in the lowest height class and few individuals in the largest height class.

5.2. Threatening factor of Woody plant species in Sawena Pastoral district

5.2.1. Charcoal production

The value of fuel wood is of special interest, as the main energy source for about 80% of the rural population in Ethiopia (Gebreegziabher, 2009; Dirba, 2012). The acacia dominated dry-woodland and shrub land areas, which cover over 60% of the total landmass of Ethiopia, constitute the largest source of wood for the bulk of charcoal coming to urban centers in the country (Girmay, 2013). Private households consume by far the greatest proportion of the energy generated for cooking and baking purposes. The unreliability of rainfall with the district experiencing droughts year makes the inhabitants highly vulnerable to drought related risks as this time Charcoal production mostly as a coping strategy to drought in the district(OoARD, 2010). These charcoal makers are principally involved in charcoal production due to the following pull factors.

Firstly, localities were involved in the production and sale of fuel wood and charcoal as easy means of money making to cope up to the impacts of prolonged dry seasons. This is mainly because of

charcoal making is free of charge, easy and unhindered delivery to charcoal traders. Particularly, traditional earth mound and or earth method of charcoal production has decimated natural woodland resources, which were feed, shelter and breeding ground to wild and domestic animals in a very short period of time.

Secondly, in the light of charcoal economy, the price of charcoal has attracted poor and landless peoples as it was sold 75 to 120 and 120 to 200 Eth Birr per sack in the study sites and district town respectively. Additionally, charcoal is transported and supplied to Ginnir district at a better price than to Sawena district.

Thirdly, the main use of the trees harvested in the study area is charcoal production as there is a direct linear relationship that of observed tree stumps. The producers practice selective logging targeting large diameter hardwood tree species while leaving the softwoods standing. Some of the targeted tree species are *Acacia bussei,* Acacia *tortilis*, *Acacia robusta, Commiphora Africana, Acacia seyal*, *Acacia Senegal, Acacia prasinata, Berchemia discolor* and *Hagenia abyssinica.*

The last but not the least, degradation is manifested through reduction in preferred tree species density and basal area. In addition, the affected woodlands have a significantly lower number of tree species and lower Shannon diversity and evenness indices. As such, it is clear that charcoal production through selective logging leads to degradation of the woodlands.

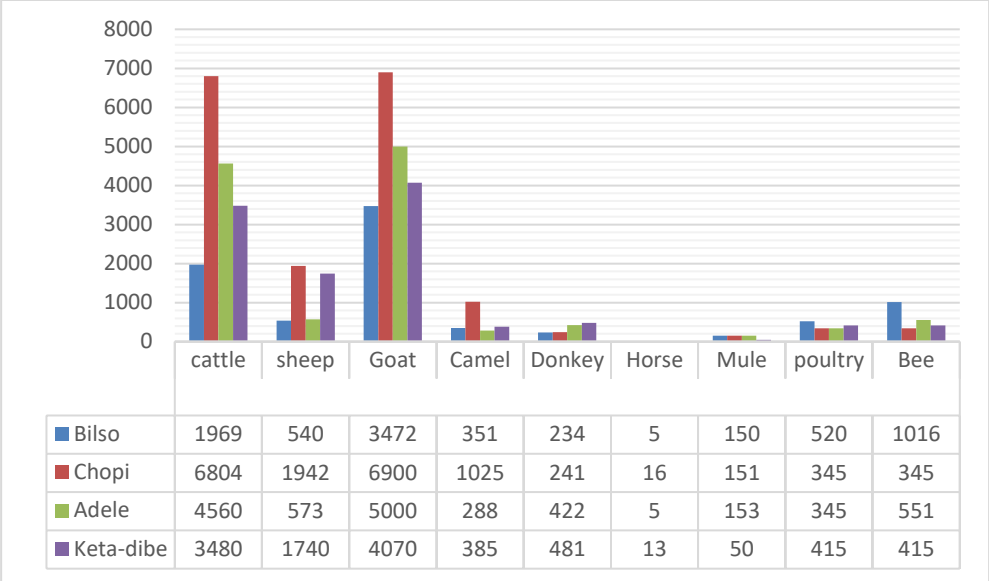
Furthermore, currently commercial sale of charcoal and firewood from Acacia and many other woody species, there is active regeneration through seedlings and coppices from the harvested stumps after prolonged dry seasons as a coping strategy to drought induced shocks. This is a good indicator that the woodlands can easily recover if wood extraction is sustainably managed. Therefore, the above discussed facts have accentuated the degradation rate of woodland vegetation.

Figure 5.Charcoal production and fuel wood collection in study PAs woodland

Figure 6. Charcoal transportation by government vehicles from PAs woodland

5.2.2. Livestock Pressure and Overgrazing

Since, majority of the localities are pastoral and agro-pastoralists, animal husbandry is the principal means of livelihood in the study PAs. Pastoralist is widely practiced in the prior mentioned PA due to better pasture availability, dense woodland plant species coverage and wide territorial extent PA. The study areas have a total of 48972 livestock population with a density of 106.7/km^2(fig. 5)



	cattle	sheep	Goat	Camel	Donkey	Horse	Mule	poultry	Bee
Bilso	1969	540	3472	351	234	5	150	520	1016
Chopi	6804	1942	6900	1025	241	16	151	345	345
Adele	4560	573	5000	288	422	5	153	345	551
Keta-dibe	3480	1740	4070	385	481	13	50	415	415

Figure 7. Livestock population

Hence, Wood land trees play an important role as sources of feed for the animals. In the study sites pasture lands and woodland plant species are communal open access resources, therefore unrestricted access has been triggered depletion of the resources. According to OoARD (2010) about 70% of the local people are pastoralists and look after the big herds of cattle and goats frequently moving from place to place in the woodland for browsing and grazing. This brings not only the physical damage on trees, saplings and seedlings but also indirectly affects the regeneration potential of the vegetation through changing the structure of the soil forming the hard-pan layer (prevents aeration, infiltration or percolation of water) while these herds are trampling in. As given in Appendix 1 the livestock grazing and browsing are heavily degrading the Sawena woodland more than the impact of converting the land for agriculture consequently, woody plant species as fodder for livestock has been increased and beyond serve as an outlet to drought induced shocks.

Additionally, woodlands are under intense pressure mainly because the pastoralists are now adapting agriculture land expansion, edible wild plants valuable as animal fodder and food crops for people harvesting at time of recurrent drought season, which resulted in permanent settlement, over-utilization and led to clearing of shrubs, trees and overgrazing.

Figure 8. Livestock grazing, browsing woody plant species areas

5.2.3. Agricultural land expansion

Agriculture plays an important role in the country's economic activities in Ethiopia (Asresie and Zemedu, 2015; Iizuka and Gebreeyesus, 2016). One of the problems facing the dry land forest and woodland resources in Ethiopia there is no clear land use policy, which would provide guidelines for institutions involved in land-use planning (Georgis et al, 2010). This leads to forests being cleared for agricultural settlement. For instance, between 2000 and 2008 alone, agricultural lands expanded by about 4 million ha, and 80% of these new agricultural lands came from conversion of forestlands, woodlands, and shrub lands (Federal Democratic Republic of Ethiopia, 2010; Brown et al, 2010).

Judging from the questionnaire responses and during woody plant species inventory environmental data, the local people are heavily dependent on their farming practices and woody plant species products for their subsistence. The respondents were mainly engaged on rearing of Livestock main occupation of pastoralists and also agriculture was an additional occupation of respondents, with their land holdings raging between 0.5ha and 5ha. Intercropping of tree and crop species in rare characterized the farming systems. The main crops grown by Agro-pastoralists maize, Sorghum and teff. Their also pastoralist living near 'Dhare' River using seasonal flow pumping irrigation and household water harvesting pond cultivate vegetable and fruit like pepper, tomato, onion, banana, avocado, papaya, mango, orange, sugar cane, coffee and 'chat'.

Figure 9. . Disturbance based on deforestation and fire damage for agricultural land expansion

5.2.4. Invasion by Parthenium hysterophorus

Parthenium hysterophorus belongs to the family Asteraceae (Aster), subfamily Heliantheae and genus Parthenium (Shiferaw et al, 2018). The most important reasons for its fast invasion into semiarid and arid ecosystems are due to the role of livestock, harvesting vehicles, road construction, wind and flood in dispersal of the seeds (Abiyot and Getachew, 2010;Mussa et al, 2018). Parthenium is dry tolerant, growing near crop land and along road side at low altitude in Southeast lowlands of Ethiopia (Mussa et al, 2018).The invasion has resulted in a decline in biodiversity loss caused by displacement of indigenous flora, loss of habitat for wild fauna, and crop land and walking trails (Mussa et al, 2018). *Parthenium hysterophorus* is rapidly invading the grazing and agricultural land was observed during the inventory work. And also dense and intensified *Parthenium hysterophorus* semi-woody invader coverage was observed at nearby distant of the study area along the way to highway vicinity to *Ginnir* town. Therefore, beyond its benefit to the localities has to patrol *Parthenium hysterophorus* expansion towards the major woodland area.

Figure 10. Disturbance observed on woodland parthenium encroachment

5.3. Scio-economic importance of woody plant species

Woody plant species multipurpose use services for pastoralist areas (Gemado et al, 2005). The broad range of uses to which they were put indicated the importance of woody plants to households in the study area. While construction represented the most widespread use, the importance of trees and shrubs as forage sources for livestock was the second and this was similar to Abate et al. (2012) but, in contrast to the report of Gemado et al. (2006) and Solomon et al. (2006) which indicated that woody species utilization as forage was the primary. The high degree of dependence of the pastoralists on woody plants for forage reflects that the livestock is the main production system in the area. Some of the most important browse species mentioned by pastoralists were: *Acacia bussie*, *A. brevispica, A. senegal,Commiphora africana, Capparis tomentosa, Eucleae divinorum, Commiphora erythraea, Delonix elata, Boscia mossambicensis, B. aegyptica, Dodonea angustifolia, Phyllanthus sepialis, Premna schimperi, Grewia velutina, Kirkia burger* and *Acokanthera schimperi.*

The use of plants for medicinal purpose was their major benefit for most indigenous rural people (Gemedo-Dalle et al., 2005), but this was their third-ranked role for Sawena pastoralists. Pastoralists, in particular, depend heavily on some woody plant species for medicines because they live in remote areas where health centers are limited. Some of woody plant species used for medicine are *Olea europaea subspp cuspidate* (used for cough and pest control), *Pistacia aethiopica* (disease like amoeba), *Juniperus procera* (anti pest like ticks and flies), *B. aegyptica* (leaf used for mental disorder person), *Capparis tomentosa* (specially in the past when there was no health center people use its bark for treatment of infection of breathing and also Traditional healers cultural medicine mostly taken from this species. In addition to their current uses, these plants may play potential role for the development of drugs in the future.

Wild edible plants were 16 % of the total identified species in this study. More commonly, fruits of plant species were eaten, especially those of *Grewia pencillata* (Ogomdi), *Olea capensis (Gomgoma)*, *Premna schimperi* (Urgesa), *Rhus natalens* (Debobesa), *Papea capensis* (Biqqaa), *Acokanthera schimperi* (keraru) and *Tamarindus indica* (Roqa), which are widely used at time of drought season. *Tamarindus indica* also sold in towns.

In the study, 58 plants were identified as having multiple use value. The importance of some species for multiple uses should be highlighted, such multipurpose plants are intensively utilized by the

pastoralists, which may lead to decrease in species abundance and, finally, even to local extinction in the study were, similar to those reported by Gemado et al (2005) study made in Borana pastoralist Southern Ethiopia and overexploitation of plant resources is a growing threat to biodiversity in dry forest and woodland countries in sub-Saharan Africa (Chidumayo and Gumbo, 2010). In other words, through excessive or unsustainable harvesting practices, plant species may be at risk. For example, *Juniperus procera*, *Olea europaea subspp cuspidate*, *Dichrostachys cinerea* and *Combretum collinum* are the most highly targeted trees for construction, rare in study PA woodland. Therefore, pastoralists should take part in the planning, design and implementation of development projects that combine conservation and economic development.

Figure 11. *Juniperus procera*, most preferred tree for construction, on the Adele PA Sawena Pastoral woodland

6. CONCLUSION AND RECOMMENDATION

The major aims of this study was focus on assessment of the diversity of the woodland and factors for their degradation in Sawena Pastoral district, based on species richness, diversity, structure and household socio-economic survey. This information provides a basis for management and conservation strategies of Sawena Pastoral district woodland. The study conducted in the woody species mainly occupies 4 PAs such as Adele, Chopi, Keta-dibe and Bilso of Sawena Pastoral district woodland.

The result of woody species from the study Sawena Pastoral district showed that 58 woody plant species belongings to 37 genera and 23 families were identified and recorded ,of which 62.1% trees and were 37.9% shrubs. The total density of woody species per hectare was 969/ha indicating that the woody plant species of the Sawena pastoral district has higher species richness, frequent and dominated by *Acacia bussie, A. mellifera, A. tortilis. robusta and Commiphora erythraea* woody plant species that belongs to Fabaceae and Burseraceae families. Even though high species richness, diversity, structure and their importance of the vital role of trees and shrubs since they provide a range of products and services in their daily life in the Sawena Pastoral district woodland have been subjected to degradation. From woodland PAs studied Adele PAs woodland was the most diverse and even distribution where as Chopi PAs was the least diverse of plant species and least even distribution of species was recorded, in the place where inhibited by the pastoralists this may be due to high overgrazing, human influence, and drought in this PAs woodland area. However, similar to the other areas of the woodland ecosystem of Ethiopia, this woodland is also under population pressure largely because of the pastoral farming system are exercised in the area.

Very low mean tree diameter classes, low basal area and very low stem density of large trees indicating that the woodland has been subjected to degradation caused by human activities characterize the majority of woody plant species structure of woodland. The observed factors and house hold response that threatening the woody plant species structure of the woodland have been found to selective exploitation of mature wood for house construction, charcoal making, grazing, browsing, agricultural land expansion, *Parthenium hysterophorus* invasion and fire damage. These factors have caused the stunted growth and thereby the presence of low woody plant species at the

higher diameter and height classes. Therefore, the cumulative effect of above factors has contributed to the fast deterioration of some woodland plant species.

The result of the IVI analysis showed that *Rhamnus staddo, Commiphora boranesis, Dichrostachys cinerea, Olea europaea subspp cuspidate , Dobera glabra, Cordia gharaf,Berchemia discolor, and Capparis tomentosa, Filicium decipiens,* and *Acacia* species deserved the the least ecologically importance. The woody plant species population structure showed different dynamics. From the viewpoint of population structure analysis most woody species were in good state of reproduction and recruitment but some species like *Commiphora erythraea, B. aegyptica* and *Pistacia aethiopica* species with high IVIs, were also among those species that exhibited poor regeneration and abnormal recruitment. The main causative agent may be anthropological activities such as clearing woody species for charcoal, overgrazing and over browsing by domestic stocks. Therefore, setting high priority is needed to conserve these endangered woody plant species. The other remaining species require monitoring and management efforts in a sustainable way and also, all concerned bodies, especially local agricultural office, security or police office departments has to work in collaboration to patrol woodland degradation.

Finally, further investigation sustainable usage of grazing woodland vegetation and you have to future necessitating the need for improvement of the overall woodland resources by controlling the human activities within the woodland.

Based on the findings, the study recommends a holistic intervention that entails and for the sustainable genetic conservation of the woody plant species of the area, the following recommendations were put forward.

i. Analysis of woody plant species with high focus is required for those species identified *Rhamnus staddo, Commiphora boranesis, Dichrostachys cinerea, Dobera glabra, Cordia gharaf, Berchemia discolor, Capparis tomentosa, Filicium decipiens,* and Acacia species and priority is set by IVI, analysis, while regular monitoring and management is also needed for the remaining woody plant species.

ii. Some important woody plant species including *Commiphora erythraea, Balanites aegyptica* and *Pistacia aethiopica* are in poor regeneration and abnormal recruitment conditions due to over browsing, fire, selective cutting owing to high demand for firewood and building

materials. There is a need of proper conservation measures for some woody species such as *Commiphora erythraea, Balanites aegyptica* and *Pistacia*

iii. Performing awareness creation for the local pastoralists on the socio-economic and ecological importance of the conservation of woody species and their genetic resources,

iv. Carefully designed community based and participatory approaches to control bush encroachment.

v. Enhancing the value of the woodland for the pastoralists by devising mechanisms on how to generate cash income, for example from beekeeping, incense and gum production; since traditional beekeeping is practiced in the area on one hand and there are also incense and gum producing tree species like *Commiphora* and *Acacia* species on the other hand.

vi. Diversification of the livelihood sources of the producers to gradually reduce their dependence on charcoal by promotion of efficient combustion technology and cooking Practices to reduce demand side pressure and encourage fuel switching to other fuels Like LPG, stove and electricity

vii. The sustainable use and conservation of woody plant resources need to be addressed by development programs, since pastoralists depend heavily on woody plants with their multiple uses. Hence, pastoralists must be involved in the planning, design and implementation of development projects in integrated and participatory ways

viii. Erratic and unreliable nature of the rainfall cannot support crop production in the area. However, pastoralists can be supported by small-scale fallow spite irrigation, water harvesting household pond and pump irrigation in the area presence of large seasonal ‘dhare’ river flow. Therefore, government and non-government organization should intervene on such facilities.

The Government through the all concerned bodies, especially local agricultural office, Climate change office, security or police office departments has to work in collaboration to .ensure that woodland should be the focus for conservation woodland management against inappropriate use, overgrazing, charcoal production and fire damage.

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APPENDIX OF TABLE

Appendix 1. Geophysical features, woody plant Species abundance, Altitude, and disturbance type were recorded in Sawena Pastoral district woodland inventory

PA name	Plot	Species name	Abundance	Stump of species in plot	Disturbance type in each plot	Coordinate in each plot		
						Altitude	latitude	Longitude
Adele	P_1	*Pistacia aethiopica*	1		Grazing	1449	7°18'42.138"	40°53'55.122"
		Dodonea angustifolia	16		Browsing			
		Juniperus procera	21	x	foot path			
		Combretum molle	7					
		Ozoroa reticulate	6					
		Rhus natalens	1					
		Eucleae divinorum	10					
		Boscia mossambicensis	1	x				
		Olea capensis	1					
	P_2	*Dodonea ~~a~~ angustifolia*	16		Grazing	1741	7°18'39.966"	40°53'55.452"
		Juniperus procera	3	x				
		Combretum molle	13					
		Rhus natalens	6					
		Papea cappensisi	2					
		Eucleae divinorum	11					
		Terminalia browni	1					
		Balanites aegyptica	1					
		Acacia brevispica	1					
		Acokanthera schimperi	1					
	P_3	*Pistacia aethiopica*	3		browsing“	1733	7°18'37.89"	40°53'55.752"
		Dodonea angustifolia	21					
		Juniperus procera	6	x				
		Combretum molle	2					
		Ozoroa reticulate	9					
		Papea capensis	1					
		Eucleae divinorum	14					

		Olea capensis	1					
		Acokanthera schimperi	4					
		Acacia prasinata	1					
	P_4	*Dodonea angustifolia*	11		browsing“	1754	7°18'36.952"	40°53'54.444"
		Juniperus procera	24	x				
		Combretum molle	1					
		Ozoroa reticulate	9					
		Eucleae divinorum	21					
		Olea capensis	3					
		Acokanthera schimperi	1	x				
	P_5	*Dodonea angustifolia*	20		browsing“	1742	7°18'35.142"	40°53'54.114"
		Juniperus procera	3	x	Grazing			
		Combretum molle	1					
		Ozoroa reticulate	1					
		Rhus natalens	1					
		Papea capensis	1					
		Olea capensis	1					
		Acokanthera schimperi	2					
		Rhamnus staddo	1					
	P_6	*Pistacia aethiopica*	7		agricultur al land	1731	7°18'33.792"	40°53'51.888"
		Dodonea angustifolia	11		browsing			
		Juniperus procera	3	x				
		Combretum molle	2					
		Ozoroa reticulate	4					
		Papea capensis	7					
		Olea capensis	1					
		Acokanthera schimperi	3	x				
		Acacia senegali	3					
		Acacia bussei	4					
	P_7	*Pistacia aethiopica*	4		browsing	1732	7°18'31.176"	40°53'49.8"
		Dodonea angustifolia	14		Grazing			
		Juniperus procera	8		fire damage			
		Combretum molle	6					
		Ozoroa reticulate	1	x				
		Papea capensis	1	x				
		Eucleae divinorum	6					
		Balanites aegyptica	1					

		Acacia brevispica	4					
		Acacia prasinata	1	x				
		Acacia mellifera	3					
	P_8	*Pistacia aethiopica*	1		grazing“	1723	7°18'29.766"	40°53'46.998"
		Dodonea angustifolia	9					
		Combretum molle	3					
		Rhus natalens	5					
		Papea capensis	1					
		Eucleae divinorum	20					
		Boscia mossambicensis	6					
		Acokanthera schimperi	1					
		Cassia singueana	7					
	P_9	*Dodonia angustifolia*	10		Grazing	1735	7°18'28.494"	40°53'44.448"
		Combretum molle	1		browsing			
		Rhus natalens	3					
		Eucleae divinorum	8					
		Boscia mossambicensis	3					
		Balanites aegyptica	1					
		Acacia brevispica	1					
		Acokanthera schimperi	5					
		Acacia prasinata	1	x				
		Acacia senegali	9					
		Salvadora persica	5					
	P_{10}	*Dodonea angustifolia*	6		agricultur al land	1332	7°18'30.342"	40°53'39.576"
		Acacia tortilis	12	x	Grazing			
		Rhus natalens	3		browsing			
		Croton macrostachyus	7					
		Grewia tenax	20	x				
		Acacia mellifera	5					
		Opuntia cylinderica	9					
	P_{11}	*Eucleae divinorum*	3		browsing	1740	7°18'25.602"	40°53'34.26"
		Cassia singueana	1		agricultur e land			
		Acacia tortilis	12	x	fire damage			
		Croton macrostachyus	6					
		Ehretia cymosa	3					

		Commiphora erythraea	1					
		Acacia seyal	2	x				
		Olea europaea subspp cuspidate	3					
		Cordia gharaf	1					
		Zizyphus mucronata	1					
		Commiphora africana	1					
	P_{12}	*Rhus natalens*	1		Grazing	1743	7°18'20.514"	40°53'31.782"
		Papea capensis	1		browsing			
		Eucleae divinorum	7					
		Balanites aegyptica	4					
		Acacia brevispica	5					
		Acacia prasinata	4					
		Commiphora erythraea	1					
		Bubisa	1					
		Phyllanthus sepialis	3					
	P_{13}	*Eucleae divinorum*	8			1739	7°17'20.622"	40°53'30.546"
		Balanites aegyptica	5					
		Acokanthera schimperi	1					
		Commiphora africana	5					
		Acacia bussei	1	x				
	P_{14}	*Pistacia aethiopica*	3		agricultural land			
		Dodonea angustifolia	3		browsing	1752	7°18'14.748"	40°53'31.884"
		Eucleae divinorum	3		Grazing			
		Balanites aegyptica	1		foot path			
		Acokanthera schimperi	2					
		Acacia prasinata	7	x				
		Commiphora africana	2					
	P_{15}	*Pistacia aethiopica*	3		agricultural land	1312	7°27'4.122"	41°0'12.168"
		Dodonea angustifolia	3		browsing			
		Combretum molle	2		Grazing			
		Eucleae divinorum	5					
		Balanites aegyptica	1					
		Acacia brevispica	2					
		Acokanthera schimperi	2					

Chopi	P_{16}	*Commiphora erythraea*	4		browsing	1399	7°22'56.538"	40°57'49.752"
		Kirkia burgeristannard	3		Grazing			
		Acacia bussei	6	x	foot path			
	P_{17}	*Boscia mossambicensis*	17	x		1399	7°22'45.876"	40°57'56.76"
		Acacia senegali	3					
		Acacia tortilis	1	x				
		Acacia mellifera	5					Agricultural land
		Commiphora erythraea	3					Browsing
		Kirkia burgeristannard	1					Grazing
		Combretum collinum	1					Foot path
	P_{18}	*Boscia mossambicensis*	21	x	browsing	1420	7°22'43.884"	Fire damage
		Commiphora erythraea	3	x	Grazing			
		Delonix elata	3					
		Acacia bussei	8	x				
	P_{19}	*Boscia mossambicensis*	11		browsing	1408	7°22'39.666"	40°58'2.664"
		Acacia tortilis	4	x	Grazing			
		Phyllanthus sepialis	17					
		Acacia bussei	12	x				
	P_{20}	*Boscia mossambicensis*	9	x	browsing	1407	7°22'39.066"	40°58'4.854"
		Phyllanthus sepialis	8		Grazing			
		Acacia bussei	37	x	foot path			
	P_{21}	*Boscia mossambicensis*	20	x	agricultural land	1407	7°22'40.374"	40°58'8.1"
		Commiphora erythraea	5		browsing			
		Acacia bussei	24	x	Grazing			
	P_{22}	*Boscia mossambicensis*	18	x	agricultural land	1407	7°77'36.462"	40°58'9.408"
		Acacia brevispica	5					
		Phyllanthus sepialis	8					
		Arele	4					
		Acacia bussei	2	x				
	P_{23}	*Boscia mossambicensis*	9		agricultural land	1407	7°22'34.14"	40°58'10.074"
		Acacia bussei	12	x	browsing			
	P_{24}	*Boscia mossambicensis*	8		Grazing	1407	7°22'31.512"	40°58'10.488"
		Acacia mellifera	1					
		Commiphora erythraea	1					

		Acacia bussei	24	x				
	P_{25}	*Boscia mossambicensis*	10		browsing	1407	7°22'29.916"	40°58'8.658"
		Acacia mellifera	6					
		Commiphora erythraea	4	x				
		Opuntia ficus-indica	2					
		Acacia bussei	7					
	P_{26}	*Boscia mossambicensis*	2	x	agricultural land	1416	7°22'27.354"	40°58'7.344"
		Acacia senegali	11		browsing			
		Acacia mellifera	30		Grazing			
		Commiphora erythraea	3					
		Phyllanthus sepialis	8					
		Commiphora africana	6					
		Kirkia burgeristannard	3					
		Opuntia ficus-indica	6					
		Grewia pencillata	15					
		Premna schimperi	6					
		Ricinus communis	3					
	P_{27}	*Acacia mellifera*	6		agricultural land	1429	7°22'25.314"	40°58'4.65"
		Commiphora erythraea	6		browsing			
		Kirkia burgeristannard	1					
		Delonix elata	1					
		Ricinus communis	5					
		Acacia bussei	1					
	P_{28}	*Boscia mossambicensis*	16		agricultural land	1429	7°22'27.576"	40°58'4.944"
		Acacia mellifera	8	x	browsing			
		Commiphora erythraea	1		Grazing			
		Kirkia burgeristannard	8					
		Opuntia ficus-indica	5					
		Premna schimperi	7					
	P_{29}	*Boscia mossambicensis*	4		agricultural land	1411	7°21'27.985"	40°56'4.999"
		Acacia brevispica	4		fire damage			
		Acacia senegali	2		Grazing			
		Acacia mellifera	4		foot path			
		Commiphora erythraea	3					
		Grewia velutina	3					
		Acacia robusta	7					

		Acacia bussei	5	x				
	P_{30}	*Acacia brevispica*	2		agricultural land	1402	7°23'27.420"	40°57'.545"
		Acacia senegali	7		browsing			
		Acacia mellifera	3	x	Grazing			
		Phyllanthus sepialis	3					
		Opuntia ficus-indica	4					
		Acacia oerfota	6					
		Acacia bussei	4	x				
Keta-dibe	P_{31}	*Acacia brevispica*	3		browsing	1389	7°28'4.446"	40°53'3.612"
		Commiphora erythraea	8	x	Grazing			
		Acmella caulirhiza	24		foot path			
		Turfo	1					
	P_{32}	*Boscia mossambicensis*	2		agricultural land	1392	7°28'3.402"	40°53'9.822"
		Acacia brevispica	2		browsing			
		Commiphora erythraea	5	x	Grazing			
		Combretum collinum	3					
		Acacia robusta	3					
		Acmella caulirhiza	4					
		Commiphora myrrha	1					
		Acacia bussei	3	x				
	P_{33}	*Boscia mossambicensis*	1	x	browsing			
		Acacia brevispica	1		Grazing			
		Premna schimperi	1		foot path			
		Acacia oerfota	2					
		Acacia bussei	3					
	P_{34}	*Boscia mossambicensis*	3	x	browsing	1374	7°28'4.464"	40°53'13.89"
		Acacia brevispica	5		Grazing			
		Acacia mellifera	2	x				
		Commiphora erythraea	4	x				
		Arele	2					
		Acmella caulirhiza	1					
		Turfo	2					
		Commiphora myrrha	9					
		Commiphora boranesis	2					
	P_{35}	*Acacia brevispica*	3		agricultural land	1378	7°28'2.256"	40°53'15.918"

		Commiphora erythraea	3	x	browsing			
		Combretum collinum	3	x				
		Acmella caulirhiza	3					
	P_{36}	*Combretum molle*	6		browsing	1376	7°27'45.726"	40°52'50.634"
		Acacia mellifera	7	x	Grazing			
		Commiphora erythraea	6	x	foot path			
		Combretum collinum	2					
		Commiphora myrrha	1					
		Capparis tomentosa	1					
		Berchemia discolor	1	x				
		Acacia bussei	5			1383	7°27'46.32"	40°52'52.686"
	P_{37}	*Boscia mossambicensis*	1	x	browsing			
		Acacia mellifera	1		foot path			
		Delonix elata	2					
		Arele	2					
		Acacia bussei	1	x				
	P_{38}	*Acacia mellifera*	3	x	browsing	1382	7°27'45.102"	40°52'55.02"
		Commiphora erythraea	3	x	Grazing			
		Acmella caulirhiza	4					
		Acacia spps.	1					
		Acacia bussei	4					
	P_{39}	*Boscia mossambicensis*	5	x	browsing	1379	7°27'45.426"	40°52'57.324"
		Acacia mellifera	4	x				
		Commiphora erythraea	4	x				
		Arele	4					
		Berchemia discolor	4					
		Acacia bussei	4	x				
	P_{40}	*Commiphora erythraea*	6		agricultur al land	1379	7°27'45.246"	40°52'59.766"
		Acacia oerfota	4		browsing			
		Acmella caulirhiza	11		Grazing			
		Capparis tomentosa	1		foot path			
		Acacia bussei	1	x				
	P_{41}	*Combretum molle*	1		agricultur al land		7°27'30.078"	40°52'47.142"
		Grewia velutina	2		browsing			
		Acacia robusta	4	x	Grazing			

		Filicium decipiens	1					
	P_{42}	*Combretum molle*	1		agricultural land	1442	7°27'30.882"	40°52'45.634"
		Eucleae divinorum	4		Browsing			
		Acacia mellifera	1					
		Grewia velutina	1					
		Acacia robusta	7					
		Acacia bussei	1					
	P_{43}	*Acokanthera schimperi*	3		agricultural land	1380	7°27'33.732"	40°52'39.774"
		Cordia gharaf	1					
		Acacia robusta	7					
		Filicium decipiens	16					
		Dichrostachys cinerea	2					
		Acacia bussei	3					
	P_{44}	*Acacia brevispica*	2		agricultural land	1385	7°27'34.008"	40°52'38.646"
		Acokanthera schimperi	4		Browsing			
		Acacia mellifera	1		Grazing			
		Acacia robusta	6		foot path			
		Ehretia cymosa	4		fire damage			
	P_{45}	*Eucleae divinorum*	2		Browsing	1370	7°27'33.504"	40°52'38.082"
		Acacia robusta	5		Grazing			
		Acmella caulirhiza	52					
Bilso	P_{46}	*Boscia mossambicensis*	5	x	Browsing	1309	7°27'7.752"	40°69'876"
		Acacia tortilis	29	x	Grazing			
		Acacia mellifera	11		foot path			
		Acacia seyal	1					
		Acacia bussei	57	x				
	P_{47}	*Boscia mossambicensis*	16		Browsing	1304	7°27'5.628"	40°59'57.576"
		Acacia tortilis	2		Grazing			
		Acacia mellifera	12	x				
		Phyllanthus sepialis	5					
		Acacia bussei	11	x				
	P_{48}	*Boscia mossambicensis*	16	x	Browsing	1316	7°27'3.714"	40°59'57.24"
		Acacia tortilis	4	x	foot path			
		Commiphora africana	2	x				
		Acacia oerfota	32					
		Acacia bussei	5	x				

	P_{49}	*Acacia tortilis*	2		Browsing	1329	7°27'1.116"	40°59'56.334"
		Acacia mellifera	3		Grazing			
		Commiphora erythraea	1		foot path			
		Commiphora africana	1					
		Acacia oerfota	60					
		Commiphora myrrha	3					
		Acacia bussei	3	x				
	P_{50}	*Boscia mossambicensis*	7		Browsing	1309	7°26'58.572"	40°59'57.168"
		Acacia tortilis	6	x	Grazing			
		Acacia mellifera	3	x				
		Commiphora africana	3					
		Delonix elata	3					
		Acacia oerfota	24					
		Acacia bussei	4	x				
	P_{51}	*Boscia mossambicensis*	14		agricultural land	1311	7°26'58.032"	40°59'58.53"
		Acacia tortilis	24		Grazing			
		Acacia mellifera	17					
	P_{52}	*Acacia mellifera*	27		Browsing	1312	7°26'58.512"	41°0'0.042"
		Delonix elata	8		Grazing			
		Arele	11					
		Acmella caulirhiza	9					
		Acacia bussei	2	x				
	P_{53}	*Boscia mossambicensis*	7		Grazing	1306	7°26'59.634"	41°0'1.086"
		Acacia tortilis	1	x	foot path			
		Acacia mellifera	6					
		Acacia bussei	6	x				
	P_{54}	*Combretum molle*	5		agricultural land	1243	7°29'.739"	40°59'.003"
		Terminalia browni	5		Browsing			
		Zizyphus mucronata	4		Grazing			
		Grewia pencillata	4					
		Acacia robusta	41					
		Acacia oerfota	5					
		Tamanindus indica	4					
		Ficus syhomorus	2					
		Dobera glabra	8					
		Acacia bussei	10					
	P_{55}	*Rhus natalens*	15		agricultural land	1252	7°29'.722"	40°59'.053"

		Terminalia browni	3		Browsing			
		Salvadora persica	4		Grazing			
		Zizyphus mucronata	2		foot path			
		Acacia robusta	13					
		Tamarindus indica	5					
		Ficus syhomorus	2					
		Acacia bussei	4					
	P_{56}	*Boscia mossambicensis*	23		Browsing	1308	7°27'0.252"	41°0'2.49"
		Acacia tortilis	4	x	Grazing			
		Acacia mellifera	7					
		Commiphora africana	3					
		Arele	10					
		Acacia bussei	7	x				
	P_{57}	**Arele**	9		agricultural land	1304	7°27'1.206"	41°0'4.758"
		Acacia bussei	10		Browsing			
	P_{58}	*Boscia mossambicensis*	7		agricultural land	1309	7°27'2.412"	41°0'7.482"
		Acacia tortilis	1	x	Browsing			
		Acacia bussei	20	x	Grazing			
		Hagenia abyssinica	2					
	P_{59}	*Boscia mossambicensis*	6		agricultural land	1314	7°27'5.13"	41°0'7.668"
		Acacia bussei	12	x	Browsing			
		Hagenia abyssinica	12					
	P_{60}	*Salvadora persica*	2	x	agricultural land	1312	7°27'4.122"	41°0'12.168"
		Acacia mellifera	16		Browsing			
		Arele	8		Grazing			
		Acacia bussei	5	x	foot path			
		Total	*2326*					

Appendix 2. Woody plant species of Sawena Pastoral District woodland

No.	**Scientific name**	**Local name**	**Language**	**Family**	**Habit**
1	*Pistacia aethiopica*	Girarsa	Afan Oromo	Anacardiaceae	T
2	*Juniperus procera*	Hindheessa	Afan Oromo	Cupressaceae	T
3	*Combretum molle*	Ruku	Afan Oromo	Combretaceae	T
4	*Dodonea angustifolia*	Itacha	Afan Oromo	Sapindaceae	S
5	*Ozoroa reticulate*	Gari	Afan Oromo	Anacardiaceae	T
6	*Rhus natalens*	Debobesa	Afan Oromo	Anacardiaceae	T
7	*Eucleae divinorum*	Mi'esa	Afan Oromo	Ebenaceae	S
8	*Olea capensis*	Gomgoma	Afan Oromo	Oleacea	T
9	*Boscia mossambicensis*	Qalqalchaa	Afan Oromo	Copparidaceae	T
10	*Terminalia browni*	Birensa	Afan Oromo	Combretaceae	T
11	*Balanites aegyptica*	Bedena	Afan Oromo	Balanitaceae	T
12	*Acacia brevispica*	Hamaresa	Afan Oromo	Fabaceae	T
13	*Papea capensis*	Biqqaa	Afan Oromo	Sapindaceae	T
14	*Acokanthera schimperi*	keraru	Afan Oromo	Apocynaceae	T
15	*Acacia prasinata*	Dodoti	Afan Oromo	Fabaceae	T
16	*Rhamnus staddo*	Qedida	Afan Oromo	Rhmnaceae	S
17	*Acacia bussei*	Halo	Afan Oromo	Fabaceae	T
18	*Acacia senegali*	Saphensa dimaa	Afan Oromo	Fabaceae	T
19	*Acacia mellifera*	Bilala	Afan Oromo	Fabaceae	T
20	*Cassia singueana*	Cekata	Afan Oromo	Caesalpiadaceae	S
21	*Salvadora persica*	Adee	Afan Oromo	Salvadoraceae	S
22	*Dobera glabra*	Adee kulo	Afan Oromo	Salvadoraceae	S
23	*Acacia tortilis*	Dhadacha	Afan Oromo	Fabaceae	T
24	Grewia tenax	Sarkamaa	Afan Oromo	Tiliaceae	T
25	*Croton macrostachyus*	Bekenisaa	Afan Oromo	Euphorbiaceae	T
26	*Opuntia cylinderica*	Arboo	Afan Oromo	Cactaceae	S
27	*Ehretia cymosa*	Ulaga	Afan Oromo	Boraginaceae	S

28	*Commiphora erythraea*	Hagarsu	Afan Oromo	Burseraceae	T
29	*Commiphora africana*	Hamessa	Afan Oromo	Burseraceae	T
30	*Zizyphus mucronata*	Qurquraa	Afan Oromo	Rhmnaceae	T
31	*Acacia seyal*	Wacuu	Afan Oromo	Fabaceae	T
32	*Olea europaea subspp cuspidate*	Ejersaa	Afan Oromo	Oleacea	T
33	*Cordia gharaf*	Mendera	Afan Oromo	Boraginaceae	T
34	*Phyllanthus sepialis*	Dhigri	Afan Oromo	Euphorbiaceae	S
35	*Acacia oerfota*	Ajo	Afan Oromo	Fabaceae	S
36	*Commiphora myrrha*	Qumbi	Afan Oromo	Burseraceae	T
37	*Delonix elata*	Sukela	Afan Oromo	Fabaceae	T
38	*Acmella caulirhiza*	Gorsa	Afan Oromo	Asteraceae	S
39	*Acacia robusta*	Wangayaa	Afan Oromo	Fabaceae	T
40	*Tamarindus indica*	Roqa	Afan Oromo	Fabaceae	T
41	*Ficus syhomorus*	Oda	Afan Oromo	Moraceae	T
42	*Grewia pencillata*	Ogomdi	Afan Oromo	Tiliaceae	`S
43	*Hagenia abyssinica*	Heto	Afan Oromo	Rosaceae	T
44	*Combretum collinum*	Hereri	Afan Oromo	Lamiaceae	T
45	*Opuntia ficus-indica*	Cira	Afan Oromo	Cactaceae	S
46	*Premna schimperi*	Urgesa	Afan Oromo	Lamiaceae	S
47	*Ricinus communis*	Qobo	Afan Oromo	Euphorbiaceae	S
48	*Grewia velutina*	Haroresa	Afan Oromo	Tiliaceae	S
49	*Commiphora boranesis*	Riga werabesa	Afan Oromo	Burseraceae	S
50	*Capparis tomentosa*	Dhanga gala	Afan Oromo	Copparidaceae	S
51	*Berchemia discolor*	Jejeba	Afan Oromo	Rhmnaceae	T
52	*Acacia spps.*	Halo qabeecha	Afan Oromo	Fabaceae	S
53	*Filicium decipiens*	Chana	Afan Oromo	Sapindaceae	T
54	*Dichrostachys cinerea*	Jirime	Afan Oromo	Fabaceae	S
55	Kirkia burgeristannard	Busdhuga	Afan Oromo	Simaroubaceae	T
56	Unidentified	Arele	Afan Oromo		S
57	Unidentified	Bubisa	AfanOromo		T
58	Unidentified	Turfo	Afan Oromo		S
	T: Tree, S: Shrub				

Appendix 3. Woody plant Species dimensions of Sawena Pastoral District Woodland

No.	Species name	Maximum (DBH)	Mean (DBH)	Maximum height (m)	Mean height(m)	No. of Stem measure d
1	*Acacia bussei*	47.78	12.33	9.00	5.60	328
2	*Acacia mellifera*	21.66	7.20	8.00	5.09	192
3	*Acacia tortilis*	63.69	8.76	10.00	4.72	102
4	*Acacia oerfota*	10.19	2.24	6.00	4.24	133
5	*Acacia robusta*	50.96	14.33	15.00	7.30	93
6	*Acacia seyal*	47.77	22.51	8.00	5.67	3
7	*Grewia tenax*	12.74	5.78	6.00	4.10	20
8	*Acacia senegali*	10.50	4.99	8.00	5.71	35
9	*Acacia brevispica*	13.38	4.42	7.00	5.13	40
10	*Acacia prasinata*	27.39	18.45	8.00	6.57	14
11	*Acacia spps.*	27.07	27.07	5.00	5.00	1
12	*Commiphora erythraea*	47.77	21.89	10.00	6.67	75
13	*Commiphora africana*	12.74	4.35	7.00	4.48	23
14	*Commiphora myrrha*	30.57	13.95	8.00	4.50	14
15	*Commiphora boranesis*	1.91	1.75	8.00	7.50	2
16	*Balanites aegyptica*	47.77	19.56	8.00	6.14	14
17	*Boscia mossambicensis*	29.62	3.61	7.00	3.21	268
18	*Dichrostachys cinerea*	6.37	5.10	5.00	5.00	2
19	*Pistacia aethiopica*	24.52	12.90	7.00	5.55	22
20	*Juniperus procera*	30.25	10.69	8.00	5.43	68
21	*Combretum molle*	19.43	8.16	8.00	5.29	51
22	*Dodonea angustifolia*	6.05	2.66	7.00	4.28	140
23	*Ozoroa reticulate*	27.39	3.04	4.00	3.17	30

24	*Rhus natalens*	16.24	3.25	7.00	4.86	35
25	*Eucleae divinorum*	15.29	2.75	7.00	3.85	122
26	*Olea capensis*	13.69	5.78	5.00	3.86	7
27	*Terminalia browni*	7.32	3.79	6.00	5.56	9
28	*Papea capensis*	28.98	17.81	8.00	6.	14
29	*Acokanthera schimperi*	23.57	7.33	7.00	4.59	29
30	*Rhamnus staddo*	3.18	3.18	4.00	4.00	1
31	*Cassia singueana*	4.46	1.91	5.00	2.88	8
32	*Salvadora persica*	21.34	6.66	6.00	4.55	11
33	*Dobera glabra*	7.32	5.89	6.00	5.25	8
34	*Croton macrostachyus*	37.90	17.91	8.00	6.62	13
35	*Opuntia cylinderica*	14.33	11.11	8.00	7.56	9
36	*Ehretia cymosa*	21.34	8.60	6.00	4.43	7
37	*Zizyphus mucronata*	12.74	4.00	7.00	6.14	7
38	*Olea europaea subspp cuspidate*	38.22	14.75	8.00	6.00	3
39	*Cordia gharaf*	38.22	28.34	7.00	7.00	2
40	*Phyllanthus sepialis*	1.91	1.45	3.00	2.79	52
41	*Delonix elata*	30.89	18.21	10.00	7.53	17
42	*Acmella caulirhiza*	7.64	2.25	6.00	3.86	108
43	*Tamarindus indica*	79.62	40.23	15.00	9.56	9
44	*Ficus syhomorus*	38.22	25.64	8.00	7.00	4
45	*Grewia pencillata*	2.55	1.88	5.00	3.32	19
46	*Hagenia abyssinica*	19.75	12.76	8.00	6.50	14
47	*Combretum collinum*	24.84	7.01	8.00	3.89	9
48	*Opuntia ficus-indica*	17.20	11.15	6.00	5.06	17
49	*Premna schimperi*	3.82	2.21	4.00	3.57	14
50	*Ricinus communis*	4.46	2.47	5.00	3.75	8
51	*Grewia velutina*	19.75	7.96	7.00	5.33	6
52	*Capparis tomentosa*	6.37	5.25	5.00	4.50	2
53	*Berchemia discolor*	28.34	9.24	5.00	3.80	5
54	*Filicium decipiens*	8.92	3.26	7.00	4.18	17
55	Kirkia burgeristannard	40.45	20.92	8.00	6.75	16
`56	**Bubisa**	10.51	10.51	6.00	6.00	1
57	**Arele**	12.10	2.46	6.00	3.60	50
58	**Turfo**	9.55	6.37	5.00	4.33	3

Appendix 4. The Woody species distribution in Sawena Pastoral Districts in the woodland

No	**Species name**	**Species Frequency**	**Relative Frequency**	**Frequency class**	**Rank**
1	*Acacia bussei*	61.67	10.03	B	1
2	*Boscia mossambicensis*	48.33	7.86	C	2
3	*Acacia mellifera*	43.33	7.05	C	3
4	*Commiphora erythraea*	35.00	5.69	C	4
5	*Acacia brevispica*	23.33	3.79	D	5
6	*Combretum molle*	23.33	3.79	D	5
7	*Eucleae divinorum*	23.33	3.79	D	5
8	*Acacia tortilis*	21.67	3.52	D	6
9	*Dodonea angustifolia*	20.00	3.25	E	7
10	*Acokanthera schimperi*	20.00	3.25	E	7

11	*Acacia robusta*	15.00	2.44	E	8
12	*Commiphora africana*	13.33	2.17	E	9
13	*Rhus natalens*	13.33	2.17	E	9
14	*Acmella caulirhiza*	13.33	2.17	E	9
15	*Balanites aegyptica*	11.67	1.90	E	10
16	*Pistacia aethiopica*	11.67	1.90	E	10
17	*Juniperus procera*	11.67	1.90	E	10
18	*Papea capensis*	11.67	1.90	E	10
19	*Phyllanthus sepialis*	11.67	1.90	E	10
20	**Arele**	11.67	1.90	E	10
21	*Acacia oerfota*	11.67	1.90	E	10
22	*Ozoroa reticulate*	10.00	1.63	E	11
23	*Acacia senegali*	10.00	1.63	E	11
24	*Olea capensis*	8.33	1.35	E	12
25	*Delonix elata*	8.33	1.35	E	12
26	*Acacia prasinata*	8.33	1.35	E	12
27	Kirkia burgeristannard	8.33	1.35	E	12
28	*Combretum collinum*	6.67	1.08	E	13
29	*Opuntia ficus-indica*	6.67	1.08	E	13
30	*Commiphora myrrha*	6.67	1.08	E	13
31	*Salvadora persica*	5.00	0.81	E	14
32	*Zizyphus mucronata*	5.00	0.81	E	14
33	*Terminalia browni*	5.00	0.81	E	14
34	*Premna schimperi*	5.00	0.81	E	14
35	*Grewia velutina*	5.00	0.81	E	14
36	*Cordia gharaf*	3.33	0.54	E	15
37	*Tamarindus indica*	3.33	0.54	E	15
38	*Berchemia discolor*	3.33	0.54	E	15
39	*Grewia pencillata*	3.33	0.54	E	15
40	*Croton macrostachyus*	3.33	0.54	E	15
41	*Hagenia abyssinica*	3.33	0.54	E	15
42	*Capparis tomentosa*	3.33	0.54	E	15
43	*Acacia seyal*	3.33	0.54	E	15
44	*Ehretia cymosa*	3.33	0.54	E	15
45	*Filicium decipiens*	3.33	0.54	E	15

46	*Ricinus communis*	3.33	0.54	E	15
47	*Cassia singueana*	3.33	0.54	E	15
48	**Turfo**	3.33	0.54	E	15
49	*Grewia tenax*	1.67	0.27	E	16
50	*Opuntia cylinderica*	1.67	0.27	E	16
51	*Ficus syhomorus*	1.67	0.27	E	16
52	*Commiphora boranesis*	1.67	0.27	E	16
53	*Rhamnus staddo*	1.67	0.27	E	16
54	**Bubisa**	1.67	0.27	E	16
55	*Dichrostachys cinerea*	1.67	0.27	E	16
56	*Olea europaea subspp cuspidate*	1.67	0.27	E	16
57	Acacia spps.	1.67	0.27	E	16
58	*Dobera glabra*	1..67	0.27	E	16
		615.00	100.00		

Appendix 5. Woody Plant Species density in Sawena Pastoral Districts in the woodland

No	Species name	Total stem	Species Density Per ha	Relative density	Density>10cm DBH(A)	Density > 20 cm DBH(B)	Ratio (A: B)
1	*Acacia bussei*	*328*	136.67	14.10	107.92	95.42	1.13
2	*Boscia mossambicensis*	*268*	111.67	11.52	30.83	14.17	2.18
3	*Acacia mellifera*	*192*	80.00	8.25	50.80	43.75	1.16
4	*Commiphora erythraea*	*75*	31.25	3.22	28.75	26.67	1.08
5	*Acacia brevispica*	*40*	16.67	1.72	10.42	3.33	3.13
6	*Combretum molle*	*51*	21.25	2.19	15.83	12.50	1.27
7	*Eucleae divinorum*	*122*	50.83	5.26	5.00	2.50	2.00
8	*Acacia tortilis*	*102*	42.50	4.39	27.50	21.25	1.29
9	*Dodonea angustifolia*	*140*	58.33	6.02	10.83	0.00	0.00
10	*Acokanthera schimperi*	*29*	12.08	1.25	9.58	3.75	2.55
11	*Acacia robusta*	*93*	38.75	4.10	21.67	20.83	1.04
12	*Commiphora africana*	*23*	9.58	1.00	5.42	0.83	6.53
13	*Rhus natalens*	*35*	14.58	1.50	4.58	1.25	3.67
14	*Acmella caulirhiza*	*108*	45	4.64	6.67	0.42	15.89
15	*Balanites aegyptica*	*14*	5.83	0.60	5.83	5.83	1.00
16	*Pistacia aethiopica*	*22*	9.17	0.95	9.17	7.92	1.16
17	*Juniperus procera*	*68*	28.33	2.92	25.00	15.42	1.62

18	*Papea capensis*	*14*	5.83	0.60	5.83	5.83	1.00
19	*Phyllanthus sepialis*	*52*	21.67	2.24	0.00	0.00	0.00
20	**Arele**	50	20.83	2.15	2.92	0.83	3.52
21	*Acacia oerfota*	*133*	55.42	5.72	7.50	0.83	9.04
22	*Ozoroa reticulate*	*30*	12.50	1.29	1.25	0.42	2.98
23	*Acacia senegali*	35	14.58	1.50	10.42	4.58	2.28
24	*Olea capensis*	*7*	2.92	0.30	2.50	0.42	5.95
25	*Delonix elata*	*17*	7.08	0.73	7.08	7.08	1.00
26	*Acacia prasinata*	*14*	5.83	0.60	5.83	5.83	1.00
27	Kirkia burgeristannard	*16*	6.67	0.69	6.67	6.67	1.00
28	*Salvadora persica*	*11*	4.58	0.47	2.50	1.67	1.50
29	*Combretum collinum*	*9*	3.75	0.39	1.67	1.25	1.34
30	*Opuntia ficus-indica*	*17*	7.08	0.73	7.08	6.25	1.13
31	*Commiphora myrrha*	*14*	5.83	0.60	7.08	4.58	1.55
32	*Zizyphus mucronata*	*7*	2.92	0.30	0.83	0.42	1.95
33	*Terminalia browni*	*9*	3.75	0.39	2.50	0.42	5.95
34	*Premna schimperi*	*14*	5.83	0.60	0.42	0.00	0.00
35	*Grewia velutina*	*6*	2.50	0.26	1.25	1.25	1.00
36	*Cordia gharaf*	*2*	0.83	0.09	0.83	0.83	1.00
37	*Tamarindus indica*	*9*	3.75	0.39	3.75	3.75	1.00
38	*Berchemia discolor*	*5*	2.08	0.21	0.83	0.83	1.00
39	*Grewia pencillata*	*19*	7.92	0.82	0.00	0.00	0.00
40	*Croton macrostachyus*	*13*	5.42	0.56	5.42	5.00	1.08
41	*Hagenia abyssinica*	*14*	5.83	0.60	5.83	5.83	1.00
42	*Capparis tomentosa*	*2*	0.83	0.09	2.00	0.00	0.00
43	*Acacia seyal*	*3*	1.25	0.13	1.25	1.25	1.00
44	*Ehretia cymosa*	*7*	2.92	0.30	2.92	1.25	2.34
45	*Filicium decipiens*	*17*	7.08	0.73	2.08	2.08	1.00
46	*Ricinus communis*	*8*	3.33	0.34	3.00	0.00	0.00
47	*Cassia singueana*	*8*	3.33	0.34	1.00	0.00	0.00
48	**Turfo**	*3*	1.25	0.13	0.83	0.83	1.00
49	*Grewia tenax*	*20*	8.33	0.86	7.92	1.67	0.21
50	*Opuntia cylinderica*	*9*	3.75	0.39	3.75	3.75	1.00
51	*Ficus syhomorus*	*4*	1.67	0.17	1.67	1.67	1.00
52	*Commiphora boranesis*	*2*	0.83	0.09	0.00	0.00	0.00
53	*Rhamnus staddo*	*1*	0.42	0.04	0.00	0.00	0.00
54	**Bubisa**	*1*	0.42	0.04	0.42	0.42	1.00

55	*Dichrostachys cinerea*	*2*	0.83	0.09	2.00	0.00	0.00
56	*Olea europaea subspp cuspidate*	*3*	1.25	0.13	0.83	0.42	1.98
57	Acacia spps.	*1*	0.42	0.04	0.42	0.42	1.00
58	*Dobera glabra*	*8*	3.33	0.34	3.75	1.67	2.25
		2326	969.00	100			

Appendix 6. Stand diameter profile and species density distribution in the woodland

No	Species name	Diameter class (cm)									
		2.0 – 7.5	7.6 – 12.5	12.6 – 17.5	17.6 – 22.5	22.6 – 27.5	27.6-32.6	32.6-37.5	37.6-42.5	>42.6	Total
1	*Acacia bussei*	43.33	50.83	20	8	6	6	0.83	1.25	0.42	*136.66*
2	*Boscia mossambicensis*	86.67	17.91	6.25			0.83				*111.66*
3	*Acacia mellifera*	*32.5*	*27.9*	10.83	3.73						80.00
4	*Commiphora erythraea*			0.42	0.83	1.25	3.33	4.57	20.43	0.42	*31.25*
5	*Acacia brevispica*	10.84	4.58	1.25							*16.67*
6	*Combretum molle*	14.58	6.67								*21.25*
7	*Eucleae divinorum*	46.66	2.5	0.42							*49.58*
8	*Acacia tortilis*	19.58	11.67					0.83	0.42	0.42	*32.92*
9	*Dodonea angustifolia*	55	3.33								*58.33*
10	*Acokanthera schimperi*	*2.92*	*7.08*	0.83	1.25						12.08
11	*Acacia robusta*	17.5	16.68	0.83					2.5	1.25	*38.76*
12	*Commiphora africana*	2.92	2.08	2.5	1.25			0.42	0.42		*9.59*
13	*Rhus natalens*	11.67	2.5	0.42							*14.59*
14	*Acmella caulirhiza*	30.42	12.5	1.67							*44.59*
15	*Balanites aegyptica*				0.42		0.42	0.42	0.83	2.92	5.01
16	*Pistacia aethiopica*		0.42		0.42	0.83	2.5	2.09	2.92		9.18
17	*Juniperus procera*	10.84	5.41	1.67					7.92		25.84
18	*Papea capensis*		4.17	1.25	0.42	3.75					9.59
19	*Phyllanthus sepialis*	21.67									21.67

20	**Arele**	18.75	1.66	0.42							20.83
21	*Acacia oerfota*	36.25	18.33	0.83	0.42						55.83
22	*Ozoroa reticulate*	7.08	5.42								12.5
23	*Acacia senegali*	2.5	7.08	2.5	2.5						14.58
24	*Olea capensis*	2.08	0.42					0.42			2.92
25	*Delonix elata*	0.42	4.58	1.67	0.42						7.09
26	*Acacia prasinata*		1.25	4.17	0.41				4.58		10.41
27	Kirkia burgeristannard	0.42	5	0.83	0.42						6.67
28	*Salvadora persica*	2.5	1.25	0.83							4.58
29	*Combretum collinum*	2.08	0.83	0.83							3.74
30	*Opuntia ficus-indica*	1.25	4.17	0.83				0.83			7.08
31	*Commiphora myrrha*		1.25	4.16	0.42						5.83
32	*Zizyphus mucronata*	1.25	1.67								2.92
33	*Terminalia browni*	3.34	0.42								3.76
34	*Premna schimperi*	3.33	2.08	0.42							5.83
35	*Grewia velutina*	1.25	0.83	0.42							2.5
36	*Cordia gharaf*							0.42	0.42		0.84
37	*Tamarindus indica*							2.09	0.83	0.83	3.75
38	*Berchemia discolor*	1.25	0.42	0.42				0.42			2.51
39	*Grewia pencillata*	7.91									7.91
40	*Croton macrostachyus*		0.83	3.75	0.83						5.41
41	*Hagenia abyssinica*		2.09	2.08	1.67						5.84
42	*Capparis tomentosa*			0.42	0.42						0.84
43	*Acacia seyal*				0.83				0.42		1.25
44	*Ehretia cymosa*	2.09	0.83								2.92
45	*Filicium decipiens*	5	2.09								7.09
46	*Ricinus communis*	2.5	0.83								3.33
47	*Cassia singueana*	2.92	0.42								3.34
48	**Turfo**	0.42	0.83								1.25
49	*Grewia tenax*	1.25	5.83	1.25							8.33
50	*Opuntia cylinderica*	0.83	1.67	1.25							3.75
51	*Ficus syhomorus*										
52	*Commiphora boranesis*	0.83	0.42						0.42		1.67
53	*Rhamnus staddo*	0.42									0.42

54	**Bubisa**				0.42						0.42
55	*Dichrostachys cinerea*	0.42	0.42								0.84
56	*Olea europaea subspp cuspidate*	0.83							0.42		1.25
57	Acacia spps.								0.42		0.42
58	*Dobera glabra*	1.25		2.08							3.33
	Total	**522.52**	**249.2**	**77.5**	**25.1**	**11.83**	**13.08**	**13.34**	**44.2**	**6.26**	**963**

Appendix 7. Stand Height profile and Species Density distribution in the SPDW

No	**Species name**	**≤ 5**	**5.1 - 10**	**10.1 - 15**	**Total**
1	*Acacia bussei*	*110.83*	25.83		136.66
2	*Boscia mossambicensis*	*106.67*	5.00		111.67
3	*Acacia mellifera*	*49.58*	30.42		80.00
4	*Commiphora erythraea*	*5.83*	25.42		31.25
5	*Acacia brevispica*	*9.17*	7.50		16.67
6	*Combretum molle*	*14.17*	4.58		18.75
7	*Eucleae divinorum*	*47.08*	3.75		50.83
8	*Acacia tortilis*	*30.00*	12.50		42.50
9	*Dodonea angustifolia*	*50.83*	7.50		58.33
10	*Acokanthera schimperi*	*9.17*	2.92		12.09
11	*Acacia robusta*	*9.58*	26.25	2.92	38.75
12	*Commiphora africana*	*2.08*	7.50		9.58
13	*Rhus natalens*	*8.33*	6.25		14.58
14	*Acmella caulirhiza*	*40.00*	5.00		45.00
15	*Balanites aegyptica*	*2.50*	3.33		5.83
16	*Pistacia aethiopica*	*4.58*	4.58		9.16
17	*Juniperus procera*	*13.33*	45.00		58.33
18	*Papea capensis*	*0.42*	5.42		5.84
19	*Phyllanthus sepialis*	*3.33*			3.33
20	**Arele**	20.42	0.42		20.84
21	*Acacia oerfota*	50.00	5.42		55.42
22	*Ozoroa reticulate*	12.50			12.50
23	*Acacia senegali*	6.25	8.33		14.58
24	*Olea capensis*	*2.92*			2.92
25	*Delonix elata*	*1.25*	5.83		7.08
26	*Acacia prasinata*	*0.83*	5.00		5.83

27	Kirkia burgeristannard	*2.08*	4.58		6.66
28	*Salvadora persica*	*2.50*	2.08		4.58
29	*Combretum collinum*	*2.92*	0.83		3.75
30	*Opuntia ficus-indica*	*2.92*	4.17		7.09
31	*Commiphora myrrha*	*5.00*	0.83		5.83
32	*Zizyphus mucronata*	*2.50*	0.42		2.92
33	*Terminalia browni*	*1.25*	2.50		3.75
34	*Premna schimperi*	*5.83*			5.83
35	*Grewia velutina*	*1.67*	0.83		2.5
36	*Cordia gharaf*		0.83		0.83
37	*Tamarindus indica*		2.92	0.83	3.75
38	*Berchemia discolor*	*2.08*			2.08
39	*Grewia pencillata*	*7.92*			7.92
40	*Croton macrostachyus*	*0.42*	5.00		5.42
41	*Hagenia abyssinica*	*0.83*	5.00		5.83
42	*Capparis tomentosa*	*0.83*			0.83
43	*Acacia seyal*	*0.83*	0.42		1.25
44	*Ehretia cymosa*	*2.08*	0.83		2.91
45	*Filicium decipiens*	*5.00*	2.08		7.08
46	*Ricinus communis*	*3.33*			3.33
47	*Cassia singueana*	*3.33*			3.33
48	**Turfo**	*1.25*			1.25
49	*Grewia tenax*	*5.00*	3.33		8.33
50	*Opuntia cylinderica*		3.75		3.75
51	*Ficus syhomorus*		1.67		1.67
52	*Commiphora boranesis*		0.83		0.83
53	*Rhamnus staddo*	*0.42*			0.42
54	**Bubisa**	*0.42*			0.42
55	*Dichrostachys cinerea*	*0.83*			0.83
56	*Olea europaea subspp cuspidate*	*0.83*	0.42		1.25
57	Acacia spps.	*0.42*			0.42
58	*Dobera glabra*	*2.08*	1.25		3.33
	Total	*576.89*	301.65	3.75	882.29

Appendix 8. Basal Area and Dominance of woody species in the Sawena woodland

No	**Species name**	**Total stems**	**Mean Basal Area (m^2ha^{-1})**	**Dominance**	**Relative Dominance (%)**	**Rank**
1	*Acacia bussei*	328	0.01	1.37	18.00	1
2	*Commiphora erythraea*	75	0.04	1.25	16.43	2
3	*Acacia robusta*	93	0.02	0.78	10.25	3
4	*Acacia tortilis*	102	0.01	0.43	5.65	5

5	*Tamarindus indica*	9	0.13	0.49	6.44	4
6	*Acacia mellifera*	192	0.00	0.33	4.34	7
7	*Juniperus procera*	68	0.01	0.28	3.68	8
8	*Boscia mossambicensis*	268	0.00	0.15	1.97	12
9	Kirkia burgeristannard	16	0.03	0.20	2.63	10
10	*Balanites aegyptica*	14	0.03	0.18	2.37	
11	*Delonix elata*	17	0.03	0.21	2.76	8
12	*Acacia prasinata*	14	0.03	0.15	1.97	13
13	*Croton macrostachyus*	13	0.03	0.16	2.10	11
14	*Papea capensis*	14	0.02	0.12	1.58	14
15	*Combretum molle*	51	0.01	0.21	2.76	9
16	*Pistacia aethiopica*	22	0.01	0.09	1.18	15
17	*Ficus syhomorus*	4	0.05	0.08	1.05	16
18	*Acokanthera schimperi*	29	0.00	0.05	0.66	19
19	*Hagenia abyssinica*	14	0.01	0.06	0.79	18
20	*Acacia seyal*	3	0.04	0.05	0.66	19
21	*Opuntia ficus-indica*	17	0.01	0.07	0.92	17
22	*Cordia gharaf*	2	0.06	0.05	0.66	19
23	*Olea europaea*	3	0.02	0.03	0.39	20
24	*Eucleae divinorum*	122	0.00	0.03	0.39	20
25	*Dodonea angustifolia*	140	0.00	0.03	0.39	20
26	*Acacia senegali*	35	0.00	0.03	0.39	20
27	*Acacia brevispica*	40	0.00	0.03	0.39	20
28	*Opuntia cylinderica*	9	0.01	0.34	4.47	6
29	*Salvadora persica*	11	0.00	0.02	0.26	21
30	*Combretum collinum*	9	0.00	0.01	0.13	22
31	*Ozoroa reticulate*	30	0.00	0.01	0.13	22
32	*Acacia oerfota*	133	0.00	0.02	0.26	21
33	*Grewia tenax*	20	0.00	0.02	0.26	21
34	Acacia spps.	1	0.06	0.03	0.39	20
35	*Ehretia cymosa*	7	0.01	0.03	0.39	20
36	*Acmella caulirhiza*	108	0.00	0.02	0.26	21

37	*Grewia velutina*	6	0.00	0.01	0.13	22
38	**Arele**	50	0.00	0.01	0.13	
39	*Commiphora myrrha*	14	0.02	0.12	1.58	14
40	*Filicium decipiens*	17	0.00	0.00	0.00	23
41	*Berchemia discolor*	5	0.01	0.02	0.26	21
42	*Commiphora africana*	23	0.00	0.01	0.13	22
43	*Rhus natalens*	35	0.00	0.01	0.13	22
44	*Olea capensis*	7	0.00	0.01	0.13	22
45	*Dobera glabra*	8	0.00	0.01	0.13	22
46	*Zizyphus mucronata*	7	0.00	0.00	0.00	23
47	**Turfo**	3	0.00	0.00	0.00	23
48	*Terminalia browni*	9	0.00	0.00	0.00	23
49	*Phyllanthus sepialis*	52	0.00	0.00	0.00	23
50	**Bubisa**	1	0.01	0.00	0.00	23
51	*Premna schimperi*	14	0.00	0.00	0.00	23
52	*Grewia pencillata*	19	0.00	0.00	0.00	23
53	*Ricinus communis*	8	0.00	0.00	0.00	23
54	*Capparis tomentosa*	2	0.00	0.00	0.00	23
55	*Dichrostachys cinerea*	2	0.00	0.00	0.00	23
56	*Cassia singueana*	8	0.00	0.00	0.00	23
57	*Commiphora boranesis*	2	0.00	0.00	0.00	23
58	*Rhamnus staddo*	1	0.00	0.00	0.00	23
	Total	2326	0.72	7.61	100.00	

Appendix 9. Important Value Index (IVI) in the woody Plant species in the SPDW

NO	**Species name**	**Relative Frequency**	**Relative Density**	**Relative Dominance**	**IVI**	**%**	**Rank**
1	*Rhamnus staddo*	0.27	0.04	0.00	0.31	0.10	1
2	*Commiphora boranesis*	0.27	0.09	0.00	0.36	0.12	2
3	**Bubisa**	0.27	0.04	0.00	0.31	0.10	1
4	*Dichrostachys cinerea*	0.27	0.09	0.00	0.36	0.12	2
5	Acacia spps.	0.27	0.04	0.39	0.7	0.23	5
6	*Capparis tomentosa*	0.54	0.09	0.00	0.63	0.21	3
7	*Dobera glabra*	0.27	0.34	0.13	0.74	0.25	6

8	**Turfo**	0.54	0.13	0.00	0.67	0.22	4
9	*Olea europaea subspp cuspidate*	0.27	0.13	0.39	0.79	0.26	7
10	*Cassia singueana*	0.54	0.34	0.00	0.88	0.29	8
11	*Ricinus communis*	0.54	0.34	0.00	0.88	0.29	8
12	*Grewia pencillata*	0.54	0.82	0.00	1.36	0.45	16
13	*Opuntia cylinderica*	0.27	0.39	4.47	5.13	1.71	39
14	*Berchemia discolor*	0.54	0.21	0.26	1.01	0.34	9
15	*Ehretia cymosa*	0.54	0.30	0.39	1.23	0.41	12
16	*Cordia gharaf*	0.54	0.09	0.66	1.29	0.43	14
17	*Zizyphus mucronata*	0.81	0.30	0.00	1.11	0.37	10
18	*Terminalia browni*	0.81	0.39	0.00	1.20	0.40	11
19	*Grewia velutina*	0.81	0.26	0.13	1.20	0.40	11
20	*Ficus syhomorus*	0.27	0.17	1.05	1.49	0.50	19
21	*Filicium decipiens*	0.54	0.73	0.00	1.27	0.42	13
22	*Grewia tenax*	0.27	0.86	0.26	1.39	0.46	17
23	*Acacia seyal*	0.54	0.13	0.66	1.33	0.44	15
24	*Premna schimperi*	0.81	0.60	0.00	1.41	0.47	18
25	*Salvadora persica*	0.81	0.47	0.26	1.54	0.51	20
26	*Combretum collinum*	1.08	0.39	0.13	1.6	0.53	21
27	*Olea capensis*	1.35	0.30	0.13	1.78	0.59	22
28	*Hagenia abyssinica*	0.54	0.60	0.79	1.93	0.64	23
29	*Opuntia ficus-indica*	1.08	0.73	0.92	2.73	0.91	24
30	*Croton macrostachyus*	0.54	0.56	2.10	3.2	1.07	26
31	*Commiphora myrrha*	1.08	0.60	1.58	3.26	1.09	27
32	*Ozoroa reticulate*	1.63	1.29	0.13	3.05	1.02	25
33	*Commiphora africana*	2.17	1.00	0.13	3.30	1.10	28

34	*Acacia senegali*	1.63	1.50	0.39	3.52	1.17	29
35	*Acacia prasinata*	1.35	0.60	1.97	3.92	1.31	31
36	*Rhus natalens*	2.17	1.50	0.13	3.80	1.27	30
37	*Papea capensis*	1.90	0.60	1.58	4.08	1.36	33
38	*Phyllanthus sepialis*	1.90	2.24	0.00	4.14	1.38	34
39	*Pistacia aethiopica*	1.90	0.95	1.18	4.03	1.34	32
40	**Arele**	1.90	2.15	0.13	4.18	1.39	35
41	*Delonix elata*	1.35	0.73	2.76	4.84	1.61	37
42	*Balanites aegyptica*	1.90	0.60	2.37	4.87	1.62	38
43	Kirkia burgeristannard	1.35	0.69	2.63	4.67	1.56	36
44	*Acokanthera schimperi*	3.25	1.25	0.66	5.16	1.72	40
45	*Acacia brevispica*	3.79	1.72	0.39	5.90	2.00	41
46	*Tamarindus indica*	0.54	0.39	6.44	7.37	2.46	43
47	*Acmella caulirhiza*	2.17	4.64	0.26	7.07	2.36	42
48	*Combretum molle*	3.79	2.19	2.76	8.74	2.91	46
49	*Acacia oerfota*	1.90	5.72	0.26	7.88	2.63	44
50	*Juniperus procera*	1.90	2.92	3.68	8.5	2.83	45
51	*Eucleae divinorum*	3.79	5.26	0.39	9.44	3.15	47
52	*Dodonea angustifolia*	3.25	6.02	0.39	9.66	3.22	48
53	*Acacia tortilis*	3.52	4.39	5.65	13.56	4.52	49
54	*Acacia robusta*	2.44	4.10	10.25	16.79	5.60	50
55	*Acacia mellifera*	7.05	8.25	4.34	19.64	6.55	51
56	*Boscia mossambicensis*	7.86	11.52	1.97	21.35	7.12	52
57	*Commiphora erythraea*	5.69	3.22	16.43	25.34	8.45	53
58	*Acacia bussei*	10.03	14.10	18.00	42.13	14.04	54
	Total	100.00	100.00	100.00	300.00		

Appendix 10. *Sample questionnaire*

This questionnaire was used to collect information for a study on "Diversity of woody plant species and causes for the degradation of woodland in Sawena Pastoral District". All the information collected using this questionnaire was used specifically only for the purpose of this research and the findings were assisting understanding challenges related to woodland degradation and design of sustainable solutions. Your cooperation is highly appreciated.

Part I; Socio-economic characteristics

Section A : Household location

Questionnaire No._____ Date of interview_____

Name of enumerator_____

Location: Zone _____District _____If (PA) _____

Section B: Household identification

1. Name of respondent _____Gender _____ Male_____ Female_____
2. Relationship to households head
3. Marital status 1. Married 2.Single 3.Divorced 4.Widowed
4. Educational level:

a. Primary education (1-6) b. Secondary education (7-10)

c. Basic education (religion based) d. Illiterate (cannot read and write)e. Highest level of education

5. Family size

Family	Male	Female
Children (< 15years)		
Adult (15-64)		
Dependent (> 65 years)		

Section C: Household land use

1. Did you migrate to the current location? I_____I 1= Yes 2= No, if your answer is Yes, when? (Year)
2. How many land parcels do you have? I_____I 1=1; 2=2; 3=3; 4=4; 5=more than4 (specify)

Note: The number will be used as code for the rest of the interviews with being where the interview is taking place)

3. In average how far are your land parcels from your homestead (in the land parcel where interview is taking place) I_____I 1= less than 1km; 2=1-5km; 3=5-10km; 4=more than 10km

4. Do you cultivate the land parcels? 1= Yes 1=No If your answer above is Yes, go to 5.If no, go to 6.

5. Which crops do you cultivate? I___I(multiple answer accepted) 1= maize; 2= sorghum; 3= Teff; 4=wheat; 5= pea 99= other(specify)

5.1. What factors have influenced your decision to plant these crops in these particular parcels? I___I (multiple answer accepted) 1=-distance fromhomestead;2=security; 3= land tenure;4= topography; 5= soil condition; 6= water availability ; 7= market availability; 8= cultural values; 99= other(specify)

6. Among the crops grow you grow in **C.5**, which do you grow as a cash crops? I___I(use the same code as **C.5** above)

7. What type of irrigation do you use? I_____I 1= flood irrigation; 2= drip irrigation; 3= watering with watering can; 4=overhead irrigation

8. What are the sources of your irrigation water? I_____I 1= Tanks/ infrastructure with harvested water; 2= dams or water ponds; 3= bore hole; 4= water pumps; 5= river/stream/lake; 99= other (specify)

8.1. In Average how far is the water source from your land? I_____I 1= inside your land (0km); 2=1= less than 1km; 3= 1-5km; 4= 5-10km; 5= more than 10km

Section D: Livestock

1. Which of the following livestock do you have?

Livestock	Number	Breed 1=Indigenous; 2= Improved	Uses	Land parcel where the animals live**(use codes in section C)**
Cattle				
Goats				
Sheep				
Donkey				
poultry				
camel				
Other				

2. If you have cattle, sheep or Goats, what rearing practice have you adopted? I___I**1**=Zero grazing; 2= free rangegrazing;3=ranching;99=other

3. If you practice zero grazing, where do you get the feed/fodder? I___I 1=Buy; 2= Own farm**;** government/trust land; 4= friends/relatives land; 99=other

4. If you practice free range grazing:

4.1. Where do you normally take them for grazing? I___I1=in my land parcel; 2= in friends/relatives land; 3=in government/trust land; 4=on the roadside; 99= other (specify)

4.2. In which ecological niches do you mostly graze? I___I **1=** in the forest;2= open grassland**;**3= on the hills; 4= near river bank; 5= old farmland; 99= other (specify)

4.3. Do you protect crops/trees from being destroyed by the animals? I___I **1=Yes; 0=No**

4.5. If the answer in iv above is **Yes**, how? I___I 1=live fence;2= stacking thorn bushes;3= barbed wire; 99= other (specify)

Section E: Sources of income

1. Please indicate the sources of income for the household in the table below

No	Source	HH member(s) involved	How regularly (Days per month)	Amount (per month)	Amount (per Annum)
1	Pastoralist				
2	Agro-pastoralist				
3	Sedentary farming				
4	Formal employment				
5	Informal employment				
6	Sale of charcoal and fuel wood				
7	Food Aid				
8	Other (specify)				
	Codes				

SECTION G: Socio-economic status

1. Housing. Please indicate the status of your house

Ownership	No. of rooms	Roof material	Wall material

2. What is the source of your domestic water? I____**I 1=River/lake /swamp; 2= piped;** 3=borehole; 4=dam/water pan; 5=roof-top water harvesting

2.1. How far is the water source? I____I 0=within the homestead; 1= within 1km; 2=1-5km; 3=5-10km; 4=over 10km

3. How far is your household from the nearest primary school? I____I **1=within 1 km;2= 1-5km;**3= 5-10km; 4= over 5km

4. What are your sources of energy for lighting and cooking? **(Use an X to mark)**

	Firewood	Charcoal	LPG	electricity	solar	Crop residue	Cow dung	Candle	Other (specify)
Cooking									
lighting									

4.1. If your energy source for cooking is charcoal, where do you source it? I____I 1=ownfarm;2=Trustland;3=governmentforest;4=freelyfrom neighbors/relatives/friends;5=Bought; 99=other(Specify)

4.2. If the charcoal is produced within your household, who is responsible for the production? I__, __, __I (multiple answers accepted) 1= father; 2=mother; 3=daughter(s) 4=Son(s) 5=Hired labor; 99=other (specify)

4.3. If your energy source for cooking is firewood, where do you source it? I____I 1=own farm; 2=Trust land; 3=government forest; 4=freely from neighbors/relatives/friends; 5=Bought; 99=other (Specify)

4.4. Who is responsible for firewood collection? I__, __, __I (multiple answers accepted) 1= father; 2=mother; 3=daughter(s); 4=Son(s) 5=hired labor; 99=other (specify)

5. How far is the nearest health center from your household? I____I1=within 1 km; 2= 1-5km; three=over 5kmii) How regularly do you visit the health center? I____I 0=never; 1=Once per week; 2=once per month; 3= once every 3 months; 4=once every 6 months; 5=once per year

6. How far is the motor able road from your household? I___I1=less than 1km; 2= 1-5km; 3=over 5km

6.1. When you do not have access to motor able transport (car, motorcycle) what forms of transport do you use to transport goods? I___I 1=Human;2=bicycle;3= donkey cart; 99=other

6.2. How would you rate the quality of road infrastructure within your village? I___I 1=very good; 2=good; 3= fair; 4= poor; 5=very poor

7.How far is the market where you can buy farm inputs or sell farm produce from your household? I___I 1=less than 1km; 2=1-5 km; 3= 5-10km; 4= over 10 km

Part II: woodland plant species status, use and management problem

Section F: woodland resources

1. Do you have a natural woodland (that from the best of your knowledge was not planted but has naturally established and regenerated itself) in any of your land I___I;**1=Yes ; 0=No**

1.1.If the answer above is **yes**, what proportion? I___I; 1= Less than 10%; 2=10-25%; 3= 25-50%; 4=50-75%; 5=more than 75% 2. If your answer in **H.1.i.** Is **No**, did you in any of the locality have any natural forest in the last 10years? I___I; **1=Yes; 0=No**

2.1. If your answer in H2.i is yes, why did you clear the forest**?** I___,___,___,___,___,____I(multiple answer accepted):1= for agriculture;2= charcoalproduction;3= fuel wood selling; 4=construction; 5=mining;99=other(specify)

2.2. If your answer in above H1.i is yes, what is the status? I_____I

1= Increasing 2=decreasing 3. =No change 99. =Other

2.3. If your answer above H2.iii is decreasing? I_____I; 1. =Bush encroachment; 2. =Expansion of farmland; 3= woodland degradation; 99. =Other (specify)

3. Do you encounter Woodland degradation? I_____I 1=**Yes** 2=**No** , If **Yes** what are the causes of woodland degradation (rank in order of importance) 1=Charcoal production ;2= agricultural land *expansion;*3= Fuel wood selling ;4=Livestock pressure;5=Settle 6=Population pressure;7=Invasive species ;99=Other(specify)

3.1. If decreasing / degraded, what is your indicator? I_____I 1= Bush encroachment 2=Reduction of woody plant species in number

3.2. What is the current condition of Woodland? I_____I 1=Poor 2= Fair 3=Good 4=Excellent

4. If is poor, what are the possible constraints?(rank) I_____I;1=Charcoal production;2= agricultural land *expansion;*3= Fuel wood selling;4=Livestock pressure;5=Settlement expansion 6= Lack of technical knowledge(mismanagement);7=Invasive species;99=Other(specify)
5. For what purpose do you use trees/ shrubs / bushes? (Rank) I_____I 1=Construction; 2= Charcoal production; 3= Fodder & bee keeping
6. What is the status of tree and shrubs in the area? I_____I: One= Decreasing; 2=Increasing; 3. =Constant; 4=Not known
7. If decreasing , what is the cause for reduction (ranging it) I_____I: 1= Tree cutting for construction;2= charcoal production;3=Expansion of crop cultivation;4=Drought 99=Others(specify)
8. Please indicate the woody plant species which you consider most important, their use, abundance and preferably in your locality (in farmlands and natural woodlands) in order of their importance

Rank	Local name	Common name	Abundance.1=Very abundant; 2=abundant; 3= rare; 4=very rare; 5=extinct	Use*	Preferably*
1					
2					
3					
4					
5					

*Code for use: 1=Food/Fodder; 2=Timber;3=Shade and shelter; 4= Soil Fertility anderosion control; 6=Fire wood and charcoal making; 7= Household utensil and farm Implement; 8=Medicine; 9=Pest Control; 10= Wild edible fruit; 11= House and fence Construction; 12= Gum and **resins (myrrh, incense)**; 13=Fragrant; 14=Hygienic;15=environment indicator; 16= Bee forage

*code for prefer ability: HP = highly preferable; IP = intermediate preferable 99=other(Specify)

(Note: **Very abundant** when it comprises of the highest number of trees the in theLocality; abundant when it can be found in most farms in the locality; **rare** when it can be found only in a few

selected farms in the locality; **very rare** when in can hardly be found in the locality; **extinct** when it cannot be found anywhere in the locality but used to be there.)

9. Any tree planting activities in your locality. I _____I 1. **Yes** 2. **No**

9.1. If yes, by whom? I_____I 1. Government 2. NGO 3. Others (specify)

10.Is there any traditional tree management practice system in your locality? I ____I 1. Yes 2 No

11. Do you have any skills on sustainable woodland resources use and management? I____I

1=Yes; 0= No

11.1. If your answer is **yes**, how did you acquire them? I____I**1=**formal training in school/college;2=training from government/non-governmental organization;3=learnt from relative/friend;4=reading from literature;5= Mass media; 99=other (specify)

12. for the problem indicated woodland plant species cleaning indicated in the above what solution to suggestion orders to-do preserving woodland resources in your locality?

12.1. Government institution ----------

12.2. Non- Government institution----------

12.3. community----------