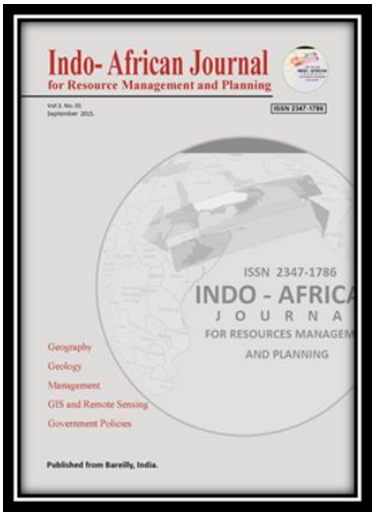

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Woody Species Diversity and Composition in Agricultural Land Scape in South Gonder Zone, North West Ethiopia

Abrha Asefa, Debre Tabor University, Department of Natural Resource Management
(abrea09@gmail.com)

Abstract

The study is aimed to assess the traditional agroforestry practice and tree composition in six selected peasant association of South Gonder Zone, Northern Ethiopia. In addition, variation of woody plant species on major niches of agroforestry was also assessed. Peasant association were selected based agro ecology, two peasant associations from Dega agro ecology, two peasant associations from Woinadega agro ecology and two peasant associations from Kolla agroecology were selected. Accordingly, 96 household heads were selected randomly from the peasant association for the study. The study was also supported by key informant interview to triangulate the data. Woody species inventory was conducted on the farmlands of the 96 selected farmers and quadrant was also laid on major agroforestry niches home garden, crop land and grazing land which were analyzed using Shannon diversity index to compare their variation.

The results of this study have shown that home gardens, farm boundary, crop land, grazing lands and degraded lands are the common traditional agroforestry practices in the study area. Tree inventory showed that common tree species in home garden are Acacia nilotica,Capparis tomentosa, Persea Americana and Rhamnus prinoides while on crop land the common tree species are Cordia Africana Croton macrostachyus Adansonia digitata and Syzygium guineense. Similarly, the common trees species on boundary planting are Eucalyptus spp, Rosa abyssinica, Carissa spinarum and Sesbaina sesban while the common tree species on degraded land are Eucalyptus spp, Justicia schimperiana, Vernonia amygdalina and Rosa abyssinica. The common tree species on grazing land are Ficus vasta, Ficus sur, Albizia gummifera and Acacia nilotica. In comparison of major agroforestry niche, home garden is more diversified followed by crop land and grazing land as their mean Shannon diversity index value is 1.52, 1.44 and 1.24 respectively. The study recommends that conservation of the existing indigenous trees and the importance of each potential tree species for soil fertility improvement, animal feed, biological soil conservation, and ecological importance should be studied further.

Keywords: agroforestry practice, woody species inventory and diversity

Introduction

Biodiversity degradation is an issue of both scientific and political concern at global level primarily because of an increase in extinction rates caused by human activities (Ehrlich & Wilson 1991). Ethiopia is a country of varied plant species by sharing 6200 species out of the total floral species of 7850 found in East Africa. Of these about 12% of them are endemic only to Ethiopia (Tewoldebirhan, 1991). Despite the potential, Vegetation resources in the country are decreasing at alarming rate due to increased population, deforestation and land degradation (Baillie et al, 2004). This has resulted in the deterioration of forest resources, reduction of biodiversity, incidence of soil erosion, land degradation and desertification.

The practice of agroforestry has been an age-old practice in the Ethiopian farming system. In the drylands of Ethiopia there are a number of indigenous agroforestry systems involving mixed cereal-livestock, agrosilvopastoral, and silvopastoral systems (Kindeya, 2004). The traditional conservation practices in highland areas of Ethiopia have also contributed to the conservation of forest genetic resources for centuries. Some of these practices are farm forestry in the south-western highlands, tree-based soil and water management in Konso, forest-based resources management in Borena, Ecologically sound land use system where fairly dense natural trees are left on farms in Gedeo and area closures where the regeneration of the natural vegetation is enhanced is practicing in people of Tigray, North Shoa and North Wello (Vivero JL. et al, 2005).

The existence of these systems is a great potential for further development and the introduction of new agroforestry systems. However, except for a general description, the existing agroforestry systems have not so far been studied in detail (Kindeya, 2004). In South Gondar Zone, agroforestry is practiced by the farmers, being this a potential no study has been conducted so far on woody species inventory and their diversity. The study assumes that there is difference in plant composition in different niches of agroforestry. Thus the objectives of the study are to document the tree species found in different agroforestry niches and to compare tree diversity on major agroforestry niches which helps for further development and research activities.

Methods and Materials

Description of the Study Area

South Gondar zone is bordered on the south by Misraq Gojjam, on the southwest by Mirab Gojjam and Bahir Dar, on the west by Lake Tana, on the north by Semien Gondar, on the northeast by Wag Hemra, on the east by Semien Wollo, and on the southeast by Debub Wollo. Abbay River separates Debub Gondar from the two Gojjam Zones. The physiographic setting of the study area is characterized by plain (28.9%) and the rest are mountainous, plateau, hills and valleys. Its elevation ranges from 1300 to 4231 meters above sea level. About 1.15, 27.35%, 58.48 % and 13.02% of the study area occur in *Dega* (highland), *Woinadega* (midland) and *Kolla* (lowland) respectively (Agriculture and rural development office of SGZ, 2012).

Methods of Data Collection and Source

Data was collected from household interviews, key informant interviews, direct observation and transect walk with the local people. Woody species inventory and diversity comparison using Shannon diversity index was employed in the farm to assess the woody species composition of the study areas.

To make representative sample woredas were selected based on agroecology. Accordingly, two kebeles from *Kolla* agroecology, two Kebeles from *Woinadega* agroecology and two from *Dega* agro ecology were selected. Out of the 9111 household heads of the six Kebeles, household for survey were selected based on the following formula;

$$n = \frac{N}{(N+1)\ (e2)}$$

(Payne and Morris, 1976)

Where n = Sample size in percent

- N = Total population
- E = Confidence level (95%)

Accordingly, 101 household heads were selected for questionnaire respondents randomly. Beside to these, key informants were selected proportionally from each woredas.The key informants were individuals who are knowledgeable about agroforestry practice and tree composition and are willing to be interviewed. The selection of key informants was be done by adapting techniques used by den Biggelaar (1996).

Woody species inventory and quadrant laying

Woody species inventory was carried out in 96 selected household heads to record all woody species found in the

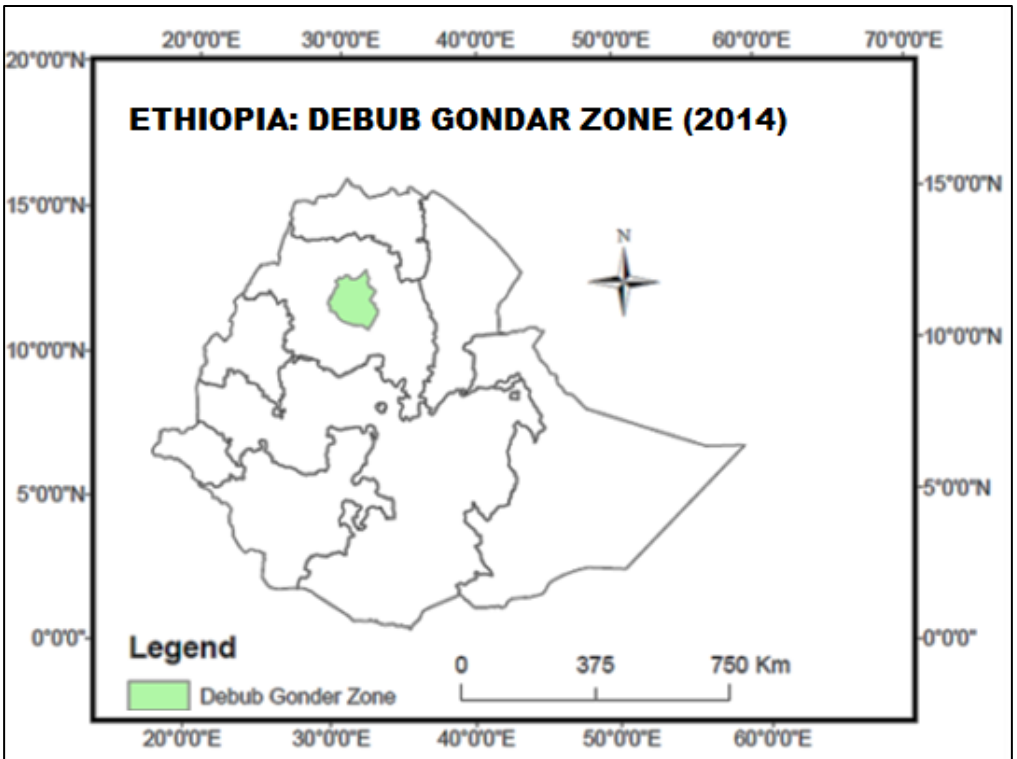


Figure 1.1. Map of the study area

traditional agroforestry practices. Local name of all woody species found in the sample plots were recorded with the help of local community and identification of the scientific names of species were carried out using the books of Wolde Michael Kelecha (1980, 1987), Flora of Ethiopia (1989), Flora of Ethiopia and Eritrea(1995) & Azene Bekele (2007).

For comparison woody species diversity in the selected Woredas, quadrants were laid on major niches of agroforestry home garden, crop lands and grazing land on farmlands of randomly selected household heads. Accordingly, 3 quadrants in 9 replication were laid out in each niche in each Woredas. The size of quadrants on home garden was 20mx20m while it was 40mx40m and 40mx40m on crop lands and grazing lands respectively as recommended by Nikiema (2005). At every sampling point, number of individuals per plot counted, DBH was measured by caliper, height by hypsometer, and crown diameter by measuring tape, were measured recorded. Woody plant species outside the study quadrats were also recorded to prepare a complete checklist of plants in the area.

Method of data analysis

SPSS version 16 software was used for readily quantifiable data and the output was discussed using tabulation and graphs with percentage values in descriptive statistics. To compare tree diversity among different niches of kebeles, Shannon diversity index was used. The data gained from Shannon diversity index were entered to SPSS to compare the variation among them.

To calculate the trees species diversity, Shannon diversity index formulas were used which is given as

$$H = -\sum_{i=1}^{n} pilnpi$$

Where; H= Shannon's diversity index

n=Total number of species in the community (richness)

P_i=Proportion of *S* made up of the *i*th species

Result and Discussion

3.1 Impact of household size and land holding size for woody species diversity

The average land holding size per individual farmers is 0.9974 hectare and average family size per individual farmers is Five (5). This small size of land holding and increasing population number forced the farmer to manage their agroforestry practices at plot level and to destroy the scattered trees in their farm land.

Table 3.1 Mean of land holding size and household size

	N	Min	Max	Mean	Std.D
Landholding	96	.50	2.00	.9974	.39151
Household	96	2.00	15.00	5.3542	1.66689
Valid N (listwise)	96				

Landholding size plays a vital role in smallholders' decision to integrate trees/shrubs in the existing land use patterns. As the correlation indicates in table 4.4 there is a positive relationship between land holding and tree number (r=0.226). Increase in landholding will result in increase in tree number in the farmland. That means land holding size is a factor in determining number of trees which is 5% of the tree number is explained by the landholding size while the remaining 95% is explained by other factors. The result of this study is similar to many of previous researchers (Rogers, 1993) who have reported positive effect of landholding and the implementation of agroforestry extension package.

Table 3.2. Correlation between land holding size and total tree number

Correlations between land holding and total tree number			
		Landholding	Total number of trees
Landholding	Pearson Correlation	1	.226*
	Sig. (2-tailed)		.027
	N	96	96
Total number of trees	Pearson Correlation	.226*	1
	Sig. (2-tailed)	.027	
	N	96	96
*. Correlation is significant at the 0.05 level (2-tailed).			

As the correlation indicated in table 4.5 there is a positive relationship between land holding and tree diversity (r=0.383). Increase in landholding will result in increase tree species in the farmland. That means 14.7% of the total tree species is explained by the landholding size while the remaining 85.3% is explained by other factors

Table 3.3. Correlation between land holding size and total tree number

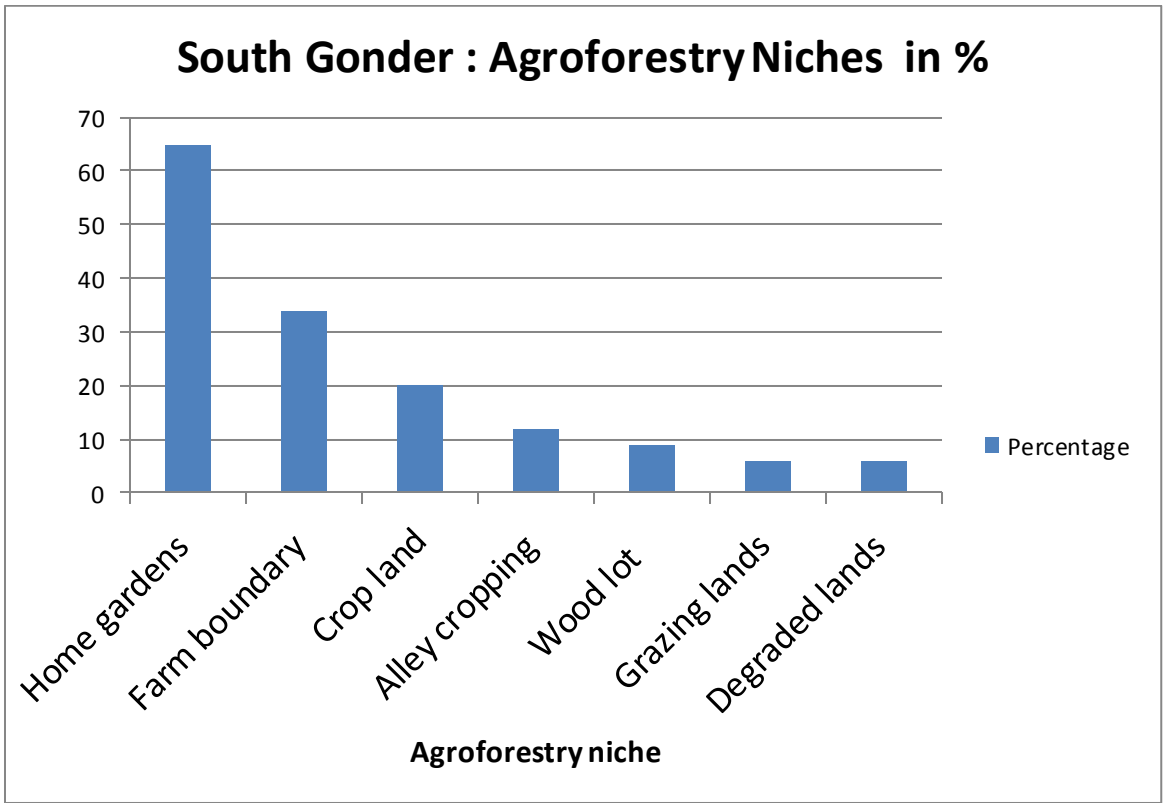
Correlation between Total tree species and land holding			
		Landholding	Total number of species
Landholding	Pearson Correlation	1	.383**
	Sig. (2-tailed)		.000
	N	96	96
TreesDiversity	Pearson Correlation	.383**	1
	Sig. (2-tailed)	.000	
	N	96	96
**. Correlation is significant at the 0.01 level (2-tailed).			

3.2. Agroforestry Niches in the Study Area

According to Kindeya (2004), the practice of agroforestry has been an age-old practice in the Ethiopian farming system. In the drylands of Ethiopia there are a number of indigenous agroforestry systems involving mixed cereal-livestock, agrosilvopastoral, and silvopastoral systems. The existence of these systems has a great potential for further development and the introduction of newagroforestry systems.

Likewise in the study area, tree plantation and management was found on crop lands, home gardens, farm boundary, fencing, grazing lands and degraded lands. Farmers in the study area are found practicing tree planting knowingly or unknowingly in their farm land. Different from other agroforestry practice, alley cropping agroforestry is a new event in the study area. Just as in some areas of the country, it is possible to see some examples of traditional agroforestry practices in south Gonder Zone. These examples have emerged through the experience of people living in these areas. Individuals living in the areas developed their own version of traditional agroforestry practices.

Different types of woody perennials have deliberately been grown together with agricultural crops and /or livestock components on the same land management unite.



3.2.1. Trees on Home Garden

Home gardens in the study area are characterized by being near residence, composed of a high diversity of plants, small, and an important source of household subsistence and cash needs. In comparison to other agroforestry niches, home gardens do not face shortage of labor because home gardens are planted and maintained by members of the household. Farmers in the study area use the trees for shelter belt, fodder, cash income and soil fertility. The most common tree species found in this area *Olea Africana, Albizia gummifera, Rosa abyssinica, Eucalyptus camaldulensis and Eucalyptus globules, Croton macrostachyus, Schinus molle, Carica papaya, Mangifera indica, Rhamnus prinoides, Ficus vasta, Acacia nilotica, Citrus medica and Persea Americana* are common trees. The result is more similar with the findings of the study conducted in Gallessa zone by Birhane *et al*. (2004).

Table 3.4 Trees on Home garden		
Local name	**Scientific Name**	**(%) respondents**
Wanza,	*Cordia Africana*	17
Woira,	*Olea Africana*	6
Sesa	*Albizia gummifera*	7
Qega,	*Rosa abyssinica*	6
Simiza	*Justicia schimperiana*	21
Gesho	*Rhamnus prinoides*	17
Bahirzaf	*Eucalyptus sps*	19
Bisana	*Croton macrostachyus*	4
Avalo	*Combretum molle*	5
Buna	*Coffee Arabica*	6
Lomi	*Citrus aurantifolia*	9
Avocado	*Persea Americana*	20
Papaya	*Carica papaya*	14
Zeitun	*Psidium guajava*	18
Mango	*Mangifera indica*	16
Gumero	*Capparis tomentosa*	24
Birbira	*Millettia ferruginea*	6
Chebah	*Acacia nilotica*	23
Warka	*Ficus vasta*	17
Banana	*Musa sapientum*	8
Tiringo	*Citrus medica*	15
Birtukan	*Citrus sinensis*	10
Kontir	*Entada abyssinica*	10
Qundo berberie	*Schinus molle*	13
Spatodiya	*Sepatodia nilotica*	11
Chat	*Catha edulis*	4
Source: field study		

3.2.2 Trees on Crop Land

According to Rocheleau *et al.* (1988), the practice of growing and maintenances of scattered trees on cropland may be based on protection and management of selected matured trees already on the site. Similar to this study the trees on this niche are trees that are naturally grown and are very scattered. The density of these trees was highly decreased in 1990s E.C and people are developing an interest to manage these trees on croplands since 2000 E.C. on these niche trees are highly endangered as compared to other niches as farmers need to increase the size of their farm land. These trees are important for soil fertility, animals fodder and shading. The trees species commonly found on crop lands are *Croton macrostachyus, Cordia Africana, Olea Africana, Grewia ferruginea, Adansonia digitata, and Syzygium guineense.*

Table 3.5 Trees on Crop Land

Local name	**Scientific Name**	**(%) respondents**
Wanza	*Cordia Africana*	39
Bisana	*Croton macrostachyus*	34
Lenquta	*Grewia ferruginea*	11
Grawa	*Vernonia amygdalina*	19
Woira	*Olea Africana*	12
Azamira	*Bersama abyssinica*	10
Bamba	*Adansonia digitata*	21
Dokma	*Syzygium guineense*	27
Girar	*Acacia species*	7
Digita	*Senna siamea*	2
Kitikita	*Dodonaea viscose*	1
Dinda	*Calotrois procera*	4

Source: field study

3.2.3 Trees as Fencing

Living fences are most common practices in rural landscapes of Ethiopian (Mehari, 2003). Similarly growing trees as living fences is the most common socio cultural practices in the study area. But beside the deliberate benefits of as fencing, trees are providing other services and benefits. On this niche trees are as shelter belt, fencing of croplands from animals and as ornamentals of homesteads. Mostly the tree species in this niche are shrubs and thorny like. Widely grown tree/shrub species as living fence are; *Rosa abyssinica*, Carissa spinarum *Justicia schimperiana, Buddleia polystachya, Capparis tomentosa, Euphorbia tirucalli, Juniperus procera, Arundo donax,* Chirt *, Eucalyptus globules and Eucalyptus camaldulensis.*

Table 3.6 Trees as Fencing		
Local name	**Scientific Name**	**(%) respondents**
Kega,	*Rosa abyssinica*	34
Agam,	*Carissa spinarum*	31
Sespania	*Sesbaina sesban*	32
bahirzaf	*Eucalyptus sps.*	49
Anfar	*Buddleia polystachya*	5
Simiza	*Justicia schimperiana*	25
Sesa	*Albizia gummifera*	17
Nim	*Azadirachta indica*	7
Yehabesha tsid	*Juniperus procera*	4
Chebah	*Acacia nilotica*	21
Gumero	*Capparis tomentosa*	10
Girawa	*Vernonia amygdalina*	11
Azamira	*Bersama abyssinica*	4
Shenbeko	*Arundo donax*	23
Kenchib	*Euphorbia tirucalli*	30
Saligna	*Accacia saligna*	18
Albedia	*Acacia albedia*	19
Source: field study		

3.2.4 Trees on Degraded Lands

Soil and water conservation has been practiced in many parts of Ethiopia, and it has been promoted by the governments for more than 20 years. In this light, native tree species have a lot to contribute. Introduced tree species have been also incorporated in many of the conservation structures to conserve and rehabilitate the eroded area in sustainable way (Kindeya, 2004). These are trees of recent phenomena for management of degraded lands. People were planting trees mainly on gullies and river banks since the past but it was not for rehabilitation degraded lands. Farmers found this practice important for soil erosion control, rehabilitation of degraded lands and water ways. Widely grown trees on this niche are; *Ficus indica, Millettia ferruginea,* Chirt (kacha), *Justicia schimperiana, Olea Africana, Azadirachta indica, Eucalyptus globules and Eucalyptus camaldulensis.*

Table 3.7. Trees on Degraded Land		
Local name	**Scientific Name**	**(%)respondents**
Nech Bahirzaf	*Eucalyptus globulus*	27
Girawa	*Vernonia amygdalina*	21
Sespania	*Sesbaina sesban*	11
Girar	*Accacia species*	40
Nim	*Azadirachta indica*	5
Yehabesha tsid	*Juniperus procera*	7
Qega	*Rosa abyssinica*	17
agam	*Carissa spinarum*	23
Gumero	*Capparis tomentosa*	2
Biribira	*Millettia ferruginea*	9
Simiza	*Justicia schimperiana*	29
Azamira	*Bersama abyssinica*	2
Beles	*Ficus indica*	3
Source: field study		

3.2.5 Trees on grazing lands

The production of woody plants combined with pasture or rangeland is often referred to as silvopastoral system. Native tree species having high fodder values in rangelands are incorporated (Mehari, 2003). The trees in the niche are scattered irregularly. Different from other niches, the trees identified on this niche are very large in size and old aged. The following are tree species identified by field observation**.** The most common tree species are *Ficus vasta, Ficus sur,Albizia gummifera* and *Acacia nilotica*

Table 3.8. Trees on Grazing Land		
Local name	**Scientific Name**	**(%) respondents**
Wanza,	*Cordia africana*	8
Woira,	*Olea africana*	5
Sesa	*Albizia gummifera*	43
Bisana	*Croton macrostachyus*	12
Girar	*Euclaptus species*	9
Yehabesha tsid	*Juniperus procera*	10
Chebah	*Acacia nilotica*	34
Warka	*Ficus vasta*	51
Birbira	*Millettia ferruginea*	19
Bamba	*Adansonia digitata*	27
Sholla	*Ficus sur*	43
Source: field study		

3.3 Woody Species Diversity

On different niches and agro ecologies of the study area, diversity of trees was studied by using Shannon diversity index. In between the niches and agro ecologies of the study area significant difference of tree diversity was found.

Table 3.9. Mean Shannon Diversity Index in Tachgaint Woreda

Niches	N	Minimum	Maximum	Mean	Std. Deviation
Home garden	27	1.18	1.60	**1.4067**	.21197
Crop land	27	1.09	1.54	**1.3533**	.23459
Grazing land	27	.85	1.55	**1.1267**	.37233
Valid N (listwise)	81				

Mean Shannon Diversity Index in Dera Woreda

Niches	N	Minimum	Maximum	Mean	Std. Deviation
Home garden	27	1.62	1.97	**1.8367**	.18930
Crop land	27	1.25	1.62	**1.4933**	.21079
Grazing land	27	.80	1.36	**1.0867**	.28024
Valid N (listwise)	81				

Table 3.10. Mean Shannon Diversity Index in Andabet Woreda

Niches	N	Minimum	Maximum	Mean	Std. Deviation
Home garden	27	1.19	1.49	**1.3167**	.15535
Crop land	27	1.45	1.51	**1.4700**	.03464
Grazing land	27	1.13	1.95	**1.5100**	.41328
Valid N (listwise)	81				

Table 3.11. Shannon Diversity Index comparison among Woredas

Niches	N	Min	Maxi	Mean	Std. Deviation
Mean diversity in Tachgaint	27	1.13	1.41	**1.2956**	.14866
Mean diversity in Andabet	27	1.32	1.51	**1.4322**	.10203
Mean diversity in Dera	27	1.09	1.84	**1.4722**	.37544
Valid N (listwise)	81				

The woody species diversity in home garden, Dera is more diversified as its Shannon diversity index value is 1.84 while the Shannon diversity index value for Taqchgaint and Andabet 1.4 and 1.3 for respectively. In crop land Dera is more diversified as its Shannon diversity index value is 1.49 and followed by Andabet and Tachgaint 1.47 and 1.35 respectively. On grazing land, Andabet wereda is more diversified as its Shannon diversity index value is 1.51 and followed by Tachgaint and Dera 1.2 and 1.10 respectively. In over all diversity comparison in the three woredas Dera is more diversified followed by Andabet and Tachgaint.

Conclusion

The results of this study have shown that home gardens, farm boundary, crop land, alley cropping, grazing lands, degraded lands and woodlot are the common traditional agroforestry practices in the study area. Woody plant species composition on each niche was also indentified and recorded. Based on the quadrant laid on major agroforestry niches home garden is more diversified followed by crop land and grazing land. Shannon diversity index indicates that over all woody species diversity in the study area is 1.4 which is below the minimum requirement (H' ranges from 1.5 to 3.5 and above).

The study recommend that the existing woody plant species should be conserved and should be more diversified than the current status by planting seedling which can suit to the agro-ecology and the socio-economic condition of the local area. The importance of each potential tree species for soil fertility improvement, animal feed, biological soil conservation, and ecological importance should be studied further.

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