Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.4, No.15, 2014
www.iiste.org

Woody Plant Inventory and Diversity in Traditional Agroforestry of Selected Peasant Association of South Gonder Zone, North West Ethiopia

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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. On home garden the common tree species 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 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.* And the common tree species on trees on grazing land are *Ficus vasta, Ficus sur, Albizia gummifera and Acacia nilotica*. In comparison of major agroforestry niche, grazing land 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 traditional conservation practices in highland areas of Ethiopia, have contribute 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 practising in people of Tigray, North Shoa and North Wello (Vivero JL. et al, 2005).

Agro forestry is a dynamic, ecologically based, natural resources management system through integration of trees on farms and agricultural landscapes, diversifies and sustains production for increased social, economic, and environmental benefits for land users at all levels (Leakey, 1996). According to Rochelau (1998), multipurpose trees increase soil fertility, provide fuel wood, timber, animal fodder and modify microclimate of the area. Similarly, Schroeder (1994) also discussed the importance of agroforestry systems in keeping carbon in the terrestrial ecosystems and out of the atmosphere.
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 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; the 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).

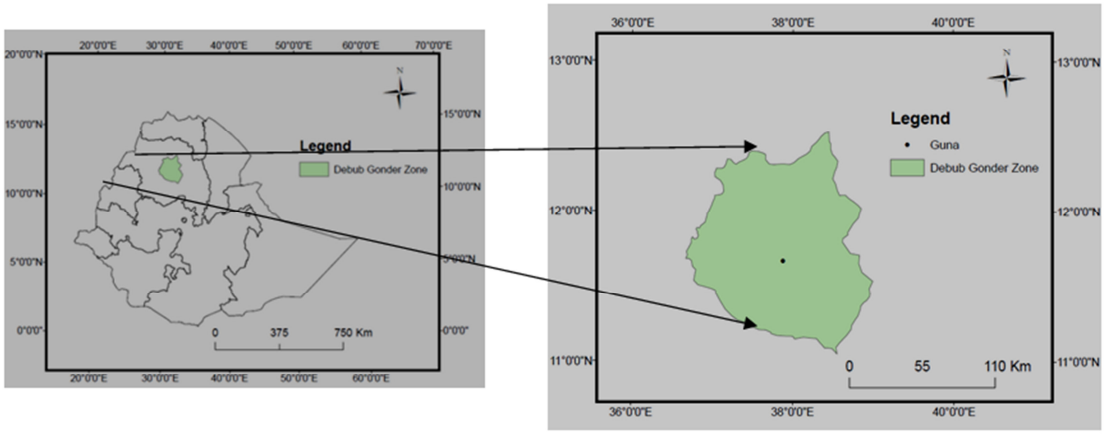


Figure 1.1. Map of the study area

3.2.1 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.
The criteria of selecting of sample Kebeles is based on agroecology. Accordingly, Muket & Genetemariam from *Kolla* agroecology (Andabet Woreda), Wonchet & Wegdame Kebeles from *Woinadega* agroecology(Dera Woreda) and Kebele 13 & Kebele 8 from *Dega* agroecology (Tachgaint Woreda). 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, three rural and agricultural development experts and eight key informants were selected randomly from each Woreda.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).

3.2.2 Woody species inventory in traditional agroforestry

Woody species inventory was carried out to record all woody found in the traditional agroforestry practices. The

farmland of sample households was used as a sample plot for inventory. Accordingly, woody species inventory were carried out on the farmlands of 96 households located in the kebeles. Local name of all woody species found in the sample plots were recorded by 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) as a guideline .

For comparison woody species diversity in the selected Weredas, quadrants were laid on major niches of agroforestry home garden, crop lands and grazing land on farmlands of randomly selected household heads. Accordingly, 9 quadrants in three replication were laid out in each niche in each Woreda. The size of quadrants on home garden was 20mx20m while it was 40mx40m and 40mx40m on crop lands and grazing lands respectively (Nikiema, 2005).

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

3.1.4. 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.

4. Results

4.1 Socioeconomic Characteristics of the Households

During household surveys, data of households' family size, land holding size, educational status, domestic animals number and age were collected.

Table 4.1 Household Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.0	1.0	1.0
	3	8	8.2	8.3	9.4
	4	21	21.4	21.9	31.2
	5	23	23.5	24.0	55.2
	6	23	23.5	24.0	79.2
	7	16	16.3	16.7	95.8
	8	3	3.1	3.1	99.0
	15	1	1.0	1.0	100.0
	Total	96	98.0	100.0	
Missing	System	5	2.0		
Total		101	100.0		

Table 4.2 Land Holding Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0.5	16	16.3	16.7	16.7
	0.75	20	20.4	20.8	37.5
	1	37	37.8	38.5	76.0
	1.25	9	9.2	9.4	85.4
	1.5	7	7.1	7.3	92.7
	2	7	7.1	7.3	100.0
	Total	96	98.0	100.0	
Missing	System	5	2.0		
Total		101	100.0		

From the above two tables we can understand most of the households (47%) have household size of 5 and 6

person and similarly most of the households (37.8%) have land holding size of 1 ha. As indicated from table the average number of animal (goat, sheep and cattle) per individual farmer is 8.
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. However, farmers reported that they are advantageous from the large house hold size.

Tabl3 4.3 Mean of land holding size and household size

	N	Minimum	Maximum	Mean	Std. Deviation
Number of Animals	96	1.00	25.00	8.2917	3.63873
Landholding	96	.50	2.00	.9974	.39151
Household	96	2.00	15.00	5.3542	1.66689
Valid N (listwise)	96				

Most of the respondents can read and write (47.9%) followed by illiterate (40.6) while the proportion of respondents above grade 1 is small. In the study area educational status is low but it has its own contribution towards agro forestry management.

Table 4.4 Educational Status of households

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Illiterate	39	39.8	40.6	40.6
Read and Write	46	46.9	47.9	88.5
Grade 1-8	8	8.2	8.3	96.9
Grade 9-12	3	3.1	3.1	100.0
Total	**96**	**98.0**	**100.0**	

4.2. Traditional agroforestry practice

Similar to some parts of Ethiopia, traditional agroforestry practice was found on crop lands, home gardens, farm boundary, fencing, grazing lands and degraded lands. And alley cropping is a new event in agroofrestry. Local people in the areas developed their own traditional agroforestry practices which are managed with indigenous knowledge accumulated over years.

The tree species found in their farm land is through retention of naturally regenerated indigenous tree species and plantation activities. But most of the tree found in the farm land is through natural regeneration and most of these trees are indigenous trees. Key informants notified that the uses and benefits they obtain from trees were mentioned as the drive for tree retention and plantation in the study area. Because of this people in the study area have been accruing diversified uses and services from the trees that were retained and planted in their lands. Among the uses and services are: fuel wood, construction materials, fruit, traditional medicine, farm implement, shade, bee keeping, soil fertility and timber.

4.2.1 Agroforestry Types in the Study Area

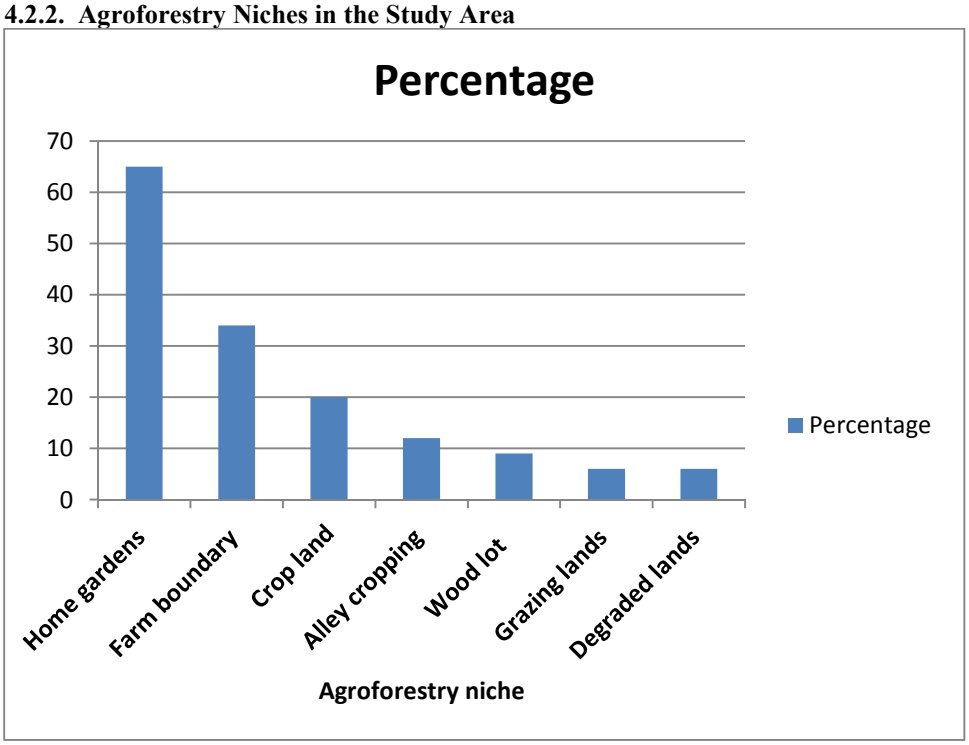
In the study area, Agrisilvicultural, Silvopastoral and Agrosilvopastoral Systems of agroforestry in different degree are found practiced.

Table 4.5 Agro forestry types in the study area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agrisilvicultural	57	58.2	59.4	59.4
	Silvopastural	29	29.6	30.2	89.6
	Agrosilvopastural	10	10.2	10.4	100.0
	Total	96	98.0	100.0	
Missing	System	5	2.0		
Total		101	100.0		

The dominant agroforestry type in the study area is agrisilvicultural with 59.4% respondents, followed by silvopastural and agrosilvopastural with 30.2% and 10.4% systems respectively.

4.2.2. Agroforestry Niches in the Study Area



The result of the study revealed that, among the different niches of agroforestry practices, homestead is the best preferred one followed by farm boundary and trees on farm lands respectively. Key informants reason out why home stead is the most preferred niche for tree plantation is because of ease for management by old aged people and children who cannot travel and work far away from home. Similarly, key informants revealed that next to home garden they prefer boundary planting to protect their land from heavy wind and animal damage.

4.2.3. Trees on Home Garden

On this niche, more number and diversity of trees were identified. Differ from other niches the purpose of trees is also more diverse. In this niche trees are for shelter belt, fodder, cash income and soil fertility. Tree species found in this area; *Acacia nilotica ,Capparis tomentosa, Persea Americana, Psidium guajava, Justicia schimperiana, Eucalyptus spp.* and *Rhamnus prinoides* are common trees. Furthermore, the tree species found in home garden are listed in table 4.6 and their order as rated by the respondents.

Table 4.6 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

4.2.4. Trees on Crop Land

Table 4.7 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

Mainly the trees on this niche are trees that are naturally grown, large in size 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. These are trees important for soil fertility, animals fodder and shading. The trees species commonly found on crop lands are; *Cordia Africana, Croton macrostachyus ,Adansonia digitata, Syzygium guineense ,Vernonia amygdalina and Olea Africana.* Furthermore, the tree species found in crop land are listed in table 4.7 and their order as rated by the respondents.

4.2.5. Trees as Fencing

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 thorny like. Widely grown tree/shrub species as living fence are; *Eucalyptus spp., Rosa abyssinica, Carissa spinarum and Sesbaina sesban, Justicia schimperiana and Euphorbia tirucalli.* Furthermore, the tree species found in boundary planting are listed in table 4.8 and their order as rated by the respondents

Table 4.8. 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

4.2.6. Trees on Degraded Lands

These are trees of recent phenomena for management of degraded lands. These are practice s related to watershed management practices, soil erosion control, rehabilitation of degraded lands and water ways. But this does not mean there were no practices on degraded lands. People were planting trees mainly on gullies and river banks. Widely grown trees on this niche are; *Accacia species, Justicia schimperiana, Vernonia amygdalina, Sesbaina sesban Rosa abyssinica* and *Rosa abyssinica.* Furthermore, the tree species found in degraded land are listed in table 4.9 and their order as rated by the respondents.

Table 4.9 Trees on Degraded Land

Local name	Scientific Name	(%)respondents
Bahirzaf	*Eucalyptus spp.*	27
Girawa	*Vernonia amygdalina*	21
Sespania	*Sesbaina sesban*	11
Nim	*Azadirachta indica*	5
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

4.2.7. Trees on grazing lands

Different from other niches, the trees identified on this niche are very large in size and are very scattered. The following are tree species identified by field observation and interview**.** *The common tree species in grazing land are Ficus vasta, Ficus sur, Millettia ferruginea Albizia gummifera, Croton macrostachyus* and *Acacia nilotica.* Furthermore, the tree species found in grazing land are listed in table 4.11 and their order as rated by the respondents.

Table 4.10 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
Chebah	*Acacia nilotica*	34
Warka	*Ficus vasta*	51
Birbira	*Millettia ferruginea*	19
Bamba	*Adansonia digitata*	27
Sholla	*Ficus sur*	43

4.3. Tree 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 4.11 Mean Shannon Diversity Index in Tachgaint Woreda

	N	Minimum	Maximum	Mean	Std. Deviation
Home garden	3	1.18	1.60	**1.4067**	.21197
Crop land	3	1.09	1.54	**1.3533**	.23459
Grazing land	3	.85	1.55	**1.1267**	.37233
Valid N (listwise)	3				

Table 4.12 Mean Shannon Diversity Index in Dera Woreda

	N	Minimum	Maximum	Mean	Std. Deviation
Home garden	3	1.62	1.97	**1.8367**	.18930
Crop land	3	1.25	1.62	**1.4933**	.21079
Grazing land	3	.80	1.36	**1.0867**	.28024
Valid N (listwise)	3				

Table 4.13 Mean Shannon Diversity Index in Andabet Woreda

	N	Minimum	Maximum	Mean	Std. Deviation
Home garden	3	1.19	1.49	**1.3167**	.15535
Crop land	3	1.45	1.51	**1.4700**	.03464
Grazing land	3	1.13	1.95	**1.5100**	.41328
Valid N (listwise)	3				

Table 4.14 Shannon Diversity Index comparison across Woredas

	N	Min	Maxi	Mean	Std. Deviation
Mean diversity in Tachgaint	3	1.13	1.41	**1.2956**	.14866
Mean diversity in Andabet	3	1.32	1.51	**1.4322**	.10203
Mean diversity in Dera	3	1.09	1.84	**1.4722**	.37544
Valid N (listwise)	3				

As the Shannon diversity index shows in kebeles of Tachgaint Woreda, homegarden is more diversified followed

by crop land and grazing land. Similarly in Dera Woreda homegarden is more diversified followed by crop land and grazing land. But in case of Kebelles of Andabet Woreda there is variation where grazing land is more diversified followed by crop land and home garden.

In case of diversity comparison across niches of Woredas, Dera is more diversified in home garden niche 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. While 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. Andabet wereda is more diversified in grazing land 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.

In comparison of major agroforestry niche, grazing land is more diversified followed by crop land and grazing land as their Shannon diversity index is 1.52, 1.44 and 1.24 respectively.

Conclusion

The results of this study have shown that home gardens, farm boundary, crop land, grazing lands, degraded lands 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. 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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