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The Contribution of Agro forestry System to Tree Biodiversity Conservation and Rural Livelihood: The Case of Lay Armachiho District, Gondar, Ethiopia.

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Abstract: The aim of this study was to assess the contribution of agro forestry system to tree biodiversity conservation and rural livelihood improvement, specifically, on-farm tree species diversity, evenness, richness indices, to examine the role of agro forestry system to biodiversity conservation and analyzing the contribution of agro forestry system to rural livelihood improvement. A total of 112 households were selected for the study based on simple random sampling. The collected primary data were analyzed by descriptive and inferential statistics by using Statistical Package for Social Science (SPSS) and MS Excel.Shannon and Simpson's diversity index, evenness and species richness were used to analyze on-farm tree species diversity, evenness and richness. Sorensen coefficient of similarity was used to analyze on-farm tree similarity. Species richness and evenness were very high in study area, which is higher in Weyna dega parkland than home garden and trees on pasture land. Similarly, home garden is lower than trees on pasture lands. Agro forestry systems showed the direct relationship of biodiversity conservation and planted/maintained of multipurpose tree species on farmland especially in parkland with the contribution of diverse benefits of the farmers to improve their socioeconomic condition. There were 77 tree/shrub species with their respective number of 36 families found in the study area. More than 18% of annual average of household income comes from agro forestry practices. Some of the agro forestry tangible product that benefits the households was fodder, fruit, fuel wood, and cash crops.

Key words: Agro forestry System, Biodiversity, Agro-Ecological Zone, Diversity, Evenness, Richness, Livelihood

Back ground of the study:

Population growth and its demands are increasingly threatening the sustainable management and use of natural resources, including natural forests in the tropics. Consequently, in many parts of the tropics, a great proportion of natural forests and the associated biodiversity have either been modified into more open and species-poor secondary forests or converted to other land uses. As in many countries in the tropics forest destruction, land degradation and loss of biodiversity are major environmental problems in Ethiopia (Motuma, 2006).

In the world there are so many types of agro forestry practices. The main agro forestry practices include improved fallows, growing annual agricultural crops during the establishment of a forestry plantation, home gardens, alley cropping, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pasture and apiculture with trees (Nair, 1993; Sinclair, 1999). In Ethiopia there are also several types of traditional agro forestry practices in different part of our country. Coffee shade based, parkland agro forestry , home gardens, hedgerow intercropping, woodlots, farm boundary practices, trees on grazing lands, enclosures and natural regeneration of species in woodlands and pasture etc (Yeshanew, 1997; Mesele, 2002; Zebene, 2003; Tesfaye, 2005; Biruk, 2006; Azene, 2007).In developing countries like Ethiopia agro forestry products play a significant role in rural livelihoods, particularly for the rural poor. Its provide benefits in the form of direct output like wood, food, income and services watershed protection which enables people to secure stable and adequate food supply.

Despite the previously mentioned potentials of the agro forestry practices, less emphasis is given to them and hence there is scanty information about their roles in the study area, lay Armachiho district. Most of the agro forestry research has dealt with biophysical factors of the systems whereas the economic value of agro forestry products has not been quantified to assess the contribution of agro forestry at farm level (Naire, 1993). The contribution of these practices to the tree biodiversity conservation and livelihood of the agrarian community in the district is never addressed.

Objectives of the study:

General objective:

The general objective of the study is to assess the contribution of agro forestry systems to tree biodiversity conservation and rural livelihood improvement in Lay Armachiho district.

Specific objectives:

The specific objectives of the study are:-

i) To assess tree distribution in the agro forestry system in different agro-ecological zone
ii) To study on-farm tree species diversity, evenness and richness indices
iii) To examine roles of agro forestry system in biodiversity conservation
iv) To analyze the contribution of agro forestry system to rural livelihood improvement

Research Methodology:

In this study both qualitative and quantitative research methods were applied. To meet the research objectives a household survey and on-farm tree species diversity assessment was conducted in purposively selected sample Kebeles and randomly selected households. In household survey questionnaires with open and closed ended was developed to collect the required information.

Sample size determination:

The overall sample size was determined by the method proposed by Bartlett *et al*. (2001). A total of 112 sample households were randomly selected using simple random sampling technique from Kebeles household list of 1504 households provided by the Kebeles agricultural development office and administration. According to the District Finance and Economy development Office total households in each sample Kebeles: Kerker B/ezabher = 542, Shumar Lomiye = 613 and Kamfenta = 349.

Totally, 1504 (N) households in sample Kebeles were the target households of the study. Therefore, in order to determine the sample household size in each Kebeles, the researcher was applied proportional sampling formula.

$$n_i = \frac{n(s_i)}{N} \text{-----------------} Eq\ [1]$$

Where:

n_i = samples size of each kebele, n= total sample size of the study;

s_i = Total households of each kebele; N= total number of households in all sample Kebeles;

Hence, 40 households from Kerker B/ezabher, 46 from Shumar Lomiye and 26 from Kamfenta were selected proportionally based on the number of heads of households residing in each Kebeles.

Methods of data collection:

Secondary data was collected from various sources and records like reports. Biophysical data's of the district like a temperature, rain fall, agro-climatic zone, soil type, topography, vegetation type and farming system etc collected from District Agriculture Office, and the secondary data collected by questionnaire, FGD, and field observation

Method of data analysis:

Quantitative data from household questionnaire survey was collected, coded and fed in computer and analyzed using computer software Packages MS Excel and SPSS (Statistical Package for Social Science) 16 versions. Descriptive statistics method of data analysis was used to analyze the data collected from the sample households. Household characteristics such as sex, age, family size, marital status, educational level, landholding size, and other characteristics were summarized using descriptive statistics like the frequencies, percentage; summarized tables and graphical presentations of variables were indicated

The relationship between explanatory variables and the dependent variable, the degree of associations of each independent variable to dependent variables were analyzed by using inferential statistics like chi-square method. Qualitative data information also was systematically organized and analyzed.

In order to get a better picture tree species diversity several diversity indices (ecological model) were used to compare the assemblages of the tree/shrub species. The species diversity on different agro forestry practices were estimated using species richness, Shannon diversity index, Simpson diversity index and species evenness. Species richness is the total number of species in the community. It is the oldest and simplest concept of species diversity. The Shannon-Wiener function (commonly referred as Shannon diversity index) is the most widely used type of diversity index. It measures the uncertainty that, how difficult it would be to predict correctly the species of the next individual collected in the sample. Two components of diversity are combined in the Shannon diversity index: (1) the number of species and (2) equitability or evenness of allotment of individuals among the species.Shannon diversity index was used as diversity indicator in agricultural landscapes. This index takes a value of zero when there was only one species in a community and a maximum value when all species were present in equal abundance.Shannon diversity index (H') was calculated as:

$$H' = -\sum_{i=1}^{s}(pi * \ln pi) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{Eq [2]}$$

Where: H' = the Shannon diversity index, P_i = fraction of the entire population made up of species I, ln = is the natural logarithm of this proportion, S = numbers of species encountered

∑ = sum from species 1 to species S

Values of the index (H') usually lie between 1.5 and 3.5, although in exceptional cases, the value can exceed 4.5 (Kent and Coker, 1992). Usually, Shannon diversity index place most weight on the rare species in the sample (Krebs, 1999). It is also moderately sensitive to sample sizes (Magurran, 1988). The Simpson's diversity index was derived from probability theory and it is the probability of picking two organisms at random which are of different species (Krebs, 1985; Magurran, 1988). We get Simpson's diversity (D):

$$D = 1 - \sum p_i^{\,2} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots Eq[3]$$

Where: D = Simpson's diversity index, P_i = proportion of individuals found in the i^{th} species. Simpson's diversity index gives relatively little weight to the rare species and more weight to the most abundant species. It ranges in value from 0 (low diversity) to a maximum of (1-1/S), where S is the number of species (Krebs, 1985). Although as a heterogeneity measure Shannon and Simpson diversity indices take into account the evenness of abundance of species, it is possible to calculate a separate additional measure of evenness. The ratio of observed Shannon index to maximum diversity (Hmax = ln S) can be taken as a measure of evenness (E) (Krebs, 1985; Maguran, 1988; Kent and Coker, 1992).

Equitability (evenness)

$$E = \frac{H'}{H'_{\max}} = \frac{\sum_{i=1}^{s} p_i \ln p_i}{\ln s} ------------.Eq[4]$$

Where: s = the number of species

E has values between 0 and 1.0, where 1.0 represents a situation in which all species are equally abundant. The higher the value of E, the more even the species is in their distribution within the sample (Kent and Coker, 1992). The above species diversity indices are generally referred to as alpha diversity, indicate the richness and evenness of species within a locality, but they do not indicate the identity of the species and where they occurs.

If diversity index is calculated for a number of samples the indices themselves will be normally distributed (Taylor, 1978). This property makes it possible to use parametric statistics including the powerful analysis of variance methods. Hence, analysis of variance (ANOVA) was carried out using the values on species richness, evenness and diversity index to test if there is significant difference in tree species diversity between different agro-ecological zone and agroforestry practices. Tukey was used for mean separation for those properties that were found to be significantly different. The association of household characteristics with different diversity index correlate with correlation.

Similarity indices measure the degree to which the species composition of different systems is a like. Many measures exist for the assessment of similarity or dissimilarity between vegetation samples. Some are qualitative and based on presence/absence data, while others are quantitative and will work on abundance data. Of the large choice available, the Sorensen similarity coefficient is applied to qualitative data and is widely used because it gives more weight to the species that are common to the samples rather than to those that only occur in either sample (Kent and Coker, 1992). The Sorensen coefficient of similarity (S_s) is given by the formula:

$$S_s = \frac{2a}{2a+b+c} ---------------------------Eq[5]$$

Where S_s = Sorensen similarity coefficient, a = number of species common to both samples b = number of species in sample 1, c = number of species in sample 2

The coefficient is multiplied by 100 to give a percentage.

Results and Discussion:

Demographic characteristics of households:

Although the majority of the respondents were male headed HHs, female household heads were also included in the household survey. As portrayed in Table 3.1 of all the households interviewed, the number of male respondents was found to be 96%, while females were 4%. The average age of household heads was 47 years with standard deviation of 10.24 with the minimum and maximum age of 29 and 74years respectively. Among the respondent households about 12 percent of the household heads were found under the age groups of 35 (youth), 94.9 percent in the age groups below 65 and only 5.1 percent in the age group above 65 years. The household survey result shows that majorities of the respondents are in active labor force group, farming community which is hypothesized to plant trees and accept new innovations rapidly. Among the interviewed households 4 %, 26.3%, 37.4% and 32.3% has 1-2, 2-5, 5-7and above 7 family sizes respectively (Table 3.1). The household family size ranges 1 to 12 members with an average of six family sizes. This implies that majority of respondents family sizes is five and above. Out of the total surveyed households 96% were married, 3% were divorced/ separated and only 1% widowed (Table 3.1).

Table 3.1: Sex, age category, marital status and family size of households in the study area

Household characteristics		Frequency (N=112)	Percent
Sex	Male	108	96.0
	Female	4	4.0
	Total	112	100
Age category	25-35	14	12.1
	35-45	37	33.3
	45-55	38	34.3
	55-65	17	15.2
	>65	6	5.1
	Total	112	100
Marital status	Married	108	96.0
	Divorced	3	3.0
	widowed	1	1.0
	Total	112	100
Family size	1-2	5	4.0
	2-5	29	26.3
	5-7	42	37.4
	>7	36	32.3
	Total	112	100

Source: Household survey, 2014

Landholding size of respondent households :

Agro forestry is a system to manage the agricultural resource, land, for the benefits of the owner, and the long-term welfare of society. While this is appropriate for all land, it is especially important in the case of hillside farming where agriculture may lead to rapid loss of soil. Normally land will be what the farmer owns, and thus farmers must think conservatively, how the land can be maintained over long periods of time.

Land is the basic asset of farmers. The average landholding size of the sample households in the study area was 2.04ha, while the average land holding size of kolla, weyna dega and dega agro-ecology zone were 2.73ha, 1.78ha and 1.89ha respectively. The minimum and maximum land holding size of the respondent households were 0.25ha and 12ha respectively. The maximum and minimum land holding size was found in the kolla agro-ecology zone of the study area (Table 3:2). As illustrated in Table 4:3 below the distribution of landholding size between farmers in all agro-ecological zones is not even, especially in dega and kolla agro-ecology zones.

Table 3.2 Mean, minimum, maximum and standard deviation of farm size across AEZs

Agro-ecological zone	Farm size in ha				
	Minimum	Maximum	Mean	Std. Deviation	Total
Dega	0.5	3.5	1.89	0.87	75.63
Weyna Dega	0.5	9	1.78	1.27	81.98
Kolla	0.25	12	2.73	3.08	71
Grand total					228.61

Source: Household survey, 2014

Among of the total respondent households 73.2% of the households had more than one hectares of land while 26.8% had less than or equal to one hectares of land (Table 3.2). 55.4% of respondent households had land holding size between 1 to 2.5ha .The result of chi-square analysis ($\chi2$=33.301, df =10 P=0.05) revealed that there was significant relationship between landholding size and agro-ecological zone at 5% probability level (Table 3.2).

Table 3.2.1 Land holding category of the respondent in hectares across agro-ecological zone

No	Landholding size in Ha	Agro-ecological zone				Chi-square	Sign.
		Dega	Weyna dega	Kolla	Total		
1	< 0.5	4	3	2	9	33.301	*
2	0.5-1	3	8	10	21		
3	1-1.5	11	12	3	26		
4	1.5-2.5	12	19	5	36		
5	2.5-3.5	10	3	1	14		
6	>3.5	10	1	5	6		
Total		40	46	26	112		

Source: Household surveys, 2014

* significant at the 0.05 level (2-tailed)

Agro forestry System Effects on -Farm Tree Species Diversity :

Farm tree species composition in the agro forestry system:

In total, 77 tree/shrub species were recorded in the various agro forestry practices across the assessed agro-ecological zones representing at least 36 families in the area. The total numbers of species found common to both the agro-ecological zones were eight. Among them 36 species were recorded from the dega agro-ecology zone, 66 were from the weynadega agro-ecology zone and 28 were from the kolla agro-ecology zone. The total numbers of exotic tree species recorded from all the surveyed farms were 14, and were found to represent 9 families. On average, each farm had 10.46 species and each hectare of farms had 5 species of trees and shrubs.

Agro forestry practices have a considerable number of tree species, which in some cases are more diverse than the forest lands. For instance, a study conducted by Behonegn (2010) reported the existence of only 54 species in forest land at Gondar Zuria Woreda as compared to 55 species in home garden, 58 species in parkland identified in this study. Likewise, a study conducted by Motuma (2006) in Arsi Negelle district reported only 31 woody species in natural forest as compared to 77 tree/shrub species in agro forestry land use system identified in this study. Furthermore, the result of the present study fits with the findings of several other studies that examined tree species richness in agro forestry practices. Ewuketu *et.al* (2014) reported a total of 44 woody species from the home garden of Jabithenan district in North-Western Ethiopia. Compared to the results found in southern Ethiopia by Tesfaye (2005), reported a total of 120 tree/shrub species without including fruit trees and coffee from the home garden of Sidama the diversity of trees and shrubs in the study area is very low. The low diversity in tree species composition may be due to ecological limitation and high human interference.

Truly these results support the hypothesis that not only natural ecosystems but also human managed ecosystems can be used for conservation and sustainable utilization of biological diversity, especially floral diversity. In fact, the different agro forestry practices vary in their potential to accommodate woody plant diversity.

Tree species diversity across agro-ecological gradient and agro forestry system :

Simpson's mean tree species diversity calculated for the agro forestry practices (home garden, parkland agro forestry and Trees on pasture lands) across agro-ecological zones manifested that there was no significant difference for all of the AEZs. Shannon's mean tree species diversity of the agro forestry practices of home garden and trees on pasture lands was statistically significantly ($p< 0.05$) between Kolla and Weyna dega agro-ecological zones. Similarly, Weynadega Shannon's mean tree species diversity of parkland agro forestry practices was statistically significantly ($p<0.01$) with Kolla agro-ecological zones. The mean species evenness calculated for the different agro forestry practices did not show statistically significant difference for all agro-ecological zones (Table 4.5.3). Species evenness of trees on pasture lands was higher than other agro forestry practices on all ago-ecological zones. The average species richness of home garden was differed significantly ($P < 0.05$) between kolla and Weynadega agro–ecological zones. Likewise, the mean species richness of parkland agro forestry practices in Weyn dega were differed significantly ($P < 0.01$) with Kolla and Dega agro-ecological zones (Table 4.6). The mean species richness of trees on pasture lands of kolla agro-ecology was statistically significantly ($p< 0.05$) with Weynadega and dega agro-ecological zones (Table 3.4.3).

Table 3.4.3 Simpson's and Shannon species diversity index, evenness and richness of different agro forestry practices across AEZs in the study area

Species diversity index	Agro-ecological zones	Kolla	Weyna dega	Dega	ANOVA result
		Mean ± .E			
Simpson's mean diversity	Homegarden	0.81±0.05	0.72±0.05	0.65±0.03	ns
	Parkland	0.79±0.05	0.53±0.05	0.81±0.03	ns
	Trees on pasture	0.75±0.05	0.80±0.07	0.86±0.05	ns
Shannon mean diversity	Homegarden	1.98^{a}±0.11	1.96^{b}±0.10	1.44±0.07	*
	Parkland	1.95^{a}±0.09	1.61^{b}±0.14	2.24±0.07	**
	Trees on pasture	1.51^{a}±0.09	2.37^{b}±0.17	2.17±0.09	*
Mean Evenness	Homegarden	0.64±0.07	0.53±0.05	0.46±0.03	ns
	Parkland	0.62±0.05	0.42±0.05	0.66±0.03	ns
	Trees on pasture	0.84±0.07	0.69±0.12	0.86±0.06	ns
Mean Richness	Homegarden	3.23^{a}±0.48	6.34^{b} ±0.77	5.48±0.40	*
	Parkland	4.88^{a}±0.45	8.86^{b}±1.04	6.28^{a}±0.65	**
	Trees on pasture	0.85^{a}±0.34	3.41^{b}±0.90	1.55±0.30	*

Note: ns=not significant; *, ** = Significant (F-test) at $p < 0.05$, $p < 0.01$, respectively

Means in the same rows followed by the same superscript letter are not significantly different at 5 % level

Source: Field tree species inventory, 2014

Tree species diversity across ecological gradient:

The mean species diversity calculated using Simpson's diversity index (0.82) and Shannon diversity index (2.04) is higher for the kolla agro-ecology zone (Table 4.5.4).Tree species diversity based on Simpson's diversity index is statistically significant ($p<0.001$) between dega and weynadega agro-ecological zones, while kolla agro-ecology zone is not significant (p<0.05) with others (Table 4.7). Weynadega zone tree species diversity based on Shannon's diversity index is statistically significant (p<0.001) with dega agro-ecological zone and statistically significant (p<0.05) with kolla agro-ecological zones. There is no significant difference between dega and kolla agro-ecological zones. Tree species evenness in the dega zone is significantly ($p < 0.05$) lower than that in the kolla zones (Table 4.5.4). Likewise, dega mean tree species evenness of on-farm is lower than the Weynadega agro-ecology zone (Table.4.5.4). On average, about 7.85, 13.58, and 9.6 species are recorded per on farm in the kolla, weynadega and dega zones respectively (Table 4.5.4). Tree species richness (the number of species) per on farm varied significantly ($P < 0.001$) between the weynadega and the other two zones. Relatively, higher species richness was observed in weynadega zone compared to other zones (Table 3.4.4).

Table 3.4.4 Tree species diversity, evenness and richness in agro forestry practices of different AEZs of the study area

Diversity index	Kolla	Weyna dega	Dega	ANOVA result
	Mean ± S.E.			
Simpson's diversity index (D)	0.82±0.04	0.72^{a}±0.03	0.24^{b}±0.04	***
Shannon's diversity index (H)	2.04^{b}±0.08	1.91^{a}±0.11	0.66^{b}±0.09	*
Mean Evenness (E)	0.61^{a}±0.04	0.46±0.04	0.18^{b}±0.04	*
Mean Richness	7.85^{a}±0.48	13.58^{b}±1.11	9.60^{a}±0.41	***

Note: *, ***= Significant (F-test) at p < 0.05, p < 0.001, respectively.
Means in the same rows followed by the same superscript letter are not significantly different at 5 % level
Source: Field tree species inventory, 2014

3.4.5. Species similarity index across ecological gradient

The Sorensen's similarity coefficient shows considerable differences in the species compositions of vegetation across agro-ecological gradient varying between 0.21-0.39 (Table 3.4.5).This implies that there is dissimilarity of species across agro-ecological zones. The species composition similarities index for the various agro-ecological zones revealed that the species composition changes with different agro-ecological zones. Composition of tree/shrub species on the farmers managed landscapes of the kolla and Weyna dega agro-ecological zones similarity is 30% (Table 3.4.5). This result implies that 70% of the species composition of trees/shrubs in these two agro-ecological zones is dissimilar. About 21 % of woody species composition similarity is noted between the Kolla and Dega agro-ecological zones. In addition, there is about 39 % similarity in woody species composition between the weynadega and dega agro-ecological zones (Table 3.4.5).

Table 3.4.5 Sorensen coefficient of similarity across AEZ

Agro-ecological zones	Kolla	Weyna dega	Dega
Kolla	-	0.30	0.21
Weyna dega		-	0.39
Dega			-

Note: 1= very similar, 0= very dissimilar
Source: Field tree species inventory, 2014

On-farm species composition similarities decrease with increasing distance between the inventoried sites. The result shows that as distance between the sample sites increases the beta diversity of species decrease. On the other hand, on-farm species composition similarities between the inventoried sites decrease with increasing altitudinal differences between the sites. The result shows that as the difference in altitude between the sites increase the beta diversity of species is decrease. On-farm tree/shrub species composition across ecological gradient is dissimilar for the studied sites. On-farm species composition in the kolla zone is highly distinct from that of the Dega. The difference is due to the specific ecological adaptability of each species within the study area and altitudinal differences. Species composition similarities decrease also with increasing distance and altitudinal difference between the study areas. Similarly, another study also confirmed the same result. For instance in the homegardens of southern Ethiopia, similarity in the composition of tree species decrease with increasing geographical distance and elevation differences between the sites (Tesfaye, 2005).

3.4.7. The effect of socio-economic settings on species diversity, evenness and richness

Household's socioeconomic features can influence on-farm tree selection, management and species diversity. The Pearson correlation coefficients of socio-economic variables such as age, educational background of household head, farm size, and number of animal owned by the household do not have significant effect on the species diversity maintained by farmers (Table 3.4.7). The Pearson correlation coefficients showed that on-farm tree/shrub species diversity on the base of Shannon's diversity index is significantly (*P < 0.05*) correlated with family size. Annual income of the household is inversely significantly (*P < 0.05*) correlated with species diversity and evenness. Species richness is positively correlated with the age, family size, educational level and farm size, though the correlation is not a significant at p<0.05(Table 3.4.7).

Table 3.4.7 Pearson correlations coefficients for the effect of selected socio-economic factors on Simpson's and Shannon's species diversity, richness and evenness

Household characteristics	Simpson's species diversity	Shannon's species diversity	Species evenness	Species richness
Age	-0.09	-0.08	-0.21	0.09
Family size	0.20	0.25*	0.16	0.17
Educational level	0.11	0.16	0.00	0.25
Farm size	0.10	0.11	0.08	0.01
Annual income	-0.28*	-0.22*	-0.26*	-0.02
Animal population	-0.08	-0.09	-0.05	-0.09

*. Correlation is significant at the 0.05 level (2-tailed).
Source: Household survey and field tree species inventory, 2014

Species diversity, evenness and richness along the ecological gradient are affected both by local socio-economic factors and physical environments. In general, species richness is positively correlated with farm size in all the agro-ecological zones though the correlation was not significant and strong. This implies that farmers with larger land sizes plant/retain more species on their farms as compared to farmers with small size of landholdings. Similarly, Tesfaye (2005) reveled that larger farms had more trees and more tree species. The increasing of tree species richness with increasing landholding was also reported by other studies from homegardens (Mendez *et* al., 2001). The effects of household age on species evenness either positively/negatively. The results confirm species evenness is negatively correlated with the age of the household. This is attributed most likely to the fact that aged farmers maintained existing trees rather than planting different cash generating tree/shrub species. This finally reduces the evenness of the species on the farm. No significant correlation has been found between farm sizes and educational background of the household heads. This implies that slightly educated farmers do not necessarily have large land sizes.

3.5 The Contribution of agro forestry systems to local livelihood improvement

The results of the present study revealed that across all agro-ecological zones, mixed farming system incorporating crop cultivation and animal-rearing is the major sources of household livelihood strategies in kolla agro-ecological zone, whereas crop cultivation , animal-rearing and tree planting is main sources of household livelihood in dega and weynadega agro-ecological zones (Table 3.5). On the other hand, only 3.8% and 2.5% in of the households generate their cash income from sales of trees/shrubs products in combination with crop cultivation in kolla and dega agro-ecological zones respectively. The contributions of crop cultivation and animal-rearing to household cash income are specifically higher in the kolla agro-ecological zone, while crop cultivation, animal-rearing and tree planting in dega and weynadega (Table 3.5).

Table 3.5 Major sources of household cash income in the study area

Agro-ecology	Major source of livelihood	frequency	Percentage
Kolla (n=26)	Crop cultivation only	0	0
	Crop cultivation and animal-rearing	22	84.61
	Crop cultivation and tree planting	1	3.85
	Crop cultivation, animal-rearing and tree planting	3	11.54
Weyna dega (n=46)	Crop cultivation only	3	6.52
	Crop cultivation and animal-rearing	15	32.61
	Crop cultivation and tree planting	0	0
	Crop cultivation , animal-rearing and tree planting	28	60.87
Dega(n=40)	Crop cultivation only	0	0
	Crop cultivation and animal-rearing	10	25
	Crop cultivation and tree planting	1	2.5
	Crop cultivation, animal-rearing and tree planting	29	72.5
Total (N=112)	Crop cultivation only	3	2.68
	Crop cultivation and animal-rearing	47	41.96
	Crop cultivation and tree planting	2	1.79
	Crop cultivation, animal-rearing and tree planting	60	53.57

Source: Household survey, 2014

CONCLUSION:

Farmers are planting and deliberately maintained different tree species on their farm land in different forms of agro forestry system. Diversified agro forestry practices, which are rich in tree species diversity, were observed across agro-ecological gradient. Agro forestry practices in the study area support high number of tree/shrub species. A total of 77 tree and shrub species belonging to at least 36 families were found in different agroforestry practices across the various agro-ecological zones. Majority of the tree species were found in weyna dega agro-ecological zone. Among the total tree species identified, 63 tree species were indigenous and the rest were exotic. On average each farm had 11 tree species and each hectare of farms had 5 trees/shrubs species. The total numbers of species occurred in all agro-ecological zones were very few in number.

Differences in tree species composition, evenness and richness exist along the ecological gradients and agroforestry practices. For instance, *Eucalyptus* spp., *Coffea arabica* and *Rhamnus prinoides* are the most widely tree species thus they were the most dominant and frequent species in the dega and weynadega agro-ecological zones due to their beneficial market prices and better market demands. Therefore, this causes disproportionate abundance, lower species evenness and diversity in the dega and weynadega as compared to kolla agro-ecological zones. This implies that increased commercialization of certain tree crop species in the farmlands decreases species composition which leads to low species diversity. Species variation and composition are known to be affected by physical factors particularly by altitudinal variations across the agro-ecological zones. Socio-economic factors such as farm size and educational background of the household head appear to be responsible for species variation and heterogeneity in planting and management practices.

In terms of tree species diversity, trees on pasture lands exceeded both home garden and parkland by simpision, Shannon and evenness indices. The preservation of tree species biodiversity through natural reserve and other protected areas is an important short term ways but it is not sufficient to solve the biodiversity loss. The role of biological diversity in the functioning of ecosystem is not limited to protected areas. The result of this study confirms that agricultural landscapes play crucial roles in the conservation of native tree species. Conservation of tree species in different agro forestry practices needs efforts by focusing on maintaining forest species diversity and ecosystem services of the remaining forest by reducing disturbance and planting various species with in different agro forestry practices. The declining trends of tree species in agricultural landscapes shows that tree species diversity on the agricultural farm land is hardly sustainable unless an extension intervention is devised with the community to regenerate and /or introduce tree species in the farm lands without hampering agricultural production.

Farmers are knowledgeable about their environment and they described and listed the uses of various on-farm tree/shrub species for the socio-economic development of their households and soil fertility improvement. Diversity and significance of the uses of tree species are variable from one agro-ecological zone to the other. Cash generating trees are more important where environmental factors are favorable. Usually, farmers deliberately retain tree/shrub species on their farms for multiple uses and to optimize production of crops and livestock mainly for livelihood improvement.

RECOMMENDATIONS:

The following points are recommended based on the findings of the study:-

* To enhance the management, productivity and sustainability of agroforestry system towards enhanced socioeconomic development and tree biodiversity conservation in depth research is very vital on the biophysical, socio-cultural and economic environments.

* Tree diversification is important and one strategy to increase the abundance and frequency of tree growing niches in the landscapes

* Production of seedlings by the government and nongovernmental organization should be targeted to native tree species and encouraged farmers' tree seedling production through training, provision of seeds and technical assistance. Multipurpose trees should be given attention.

* Only few households' gained high income from agroforestry practices. It should be extended to all households and need to be supported by government

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