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The Contribution of Agroforestry Practices in Reducing Deforestation and Improving Livelihoods of Households in Kombolcha District, East Hararghe Zone, Ethiopia

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Abstract: Agroforestry practice produces different benefits, which enhance household incomes and sources of wood products. The study was based on a household survey conducted on 160 farm household heads; focus group discussions and key informant interviews. The data were analyzed using descriptive statistics. Independent T test and chi-squared test were used to compare the benefit households get from agroforestry practices and other land use practice. Besides, multinomial logit model was employed to estimate the determinants of the choice of agroforestry practice by the households. The data obtained from woody species inventory on the farmlands of 48 household were analyzed using Shannon diversity index. The result indicates that four AFPs exist in the study area namely; home gardens with coffee, boundary and intercropping, woodlots and intercropping and scatter trees and intercropping were dominant. A total of 60 woody species belonging to 36 families were identified and documented in the different agroforestry practices representing a total of 46 indigenous and 14 exotic tree/shrub species. The AF components include grain and vegetable crops and different livestock in addition to the woody species. Results of the multinomial logistic regression model showed that eight variables were significantly affected the choice of agroforestry practice by the households. The findings imply that agroforestry play a major role in bringing the desired level of diversification along with sustainability and potentially provide options to enhance livelihoods through simultaneous production of food and fuelwood.

Key words: Agroforestry · Deforestation · Livelihood · Household Choice · Logistic Regression Kombolcha · East Ethiopia

INTRODUCTION

More than 80% of the rural population in sub-Saharan Africa is poor and traditionally relies on forests for most of their livelihoods including fuel wood and timber as well as other non-timber forest products. Nevertheless, the products and services people get from forests is progressively declining globally due to deforestation as the loss of trees' cover [1]. The problem of deforestation is much higher in East Africa than other parts in the continent which have altered the natural forest cover to farmlands, grazing land, settlements and urban centers [2]. The main driving force for deforestation in developing countries, including Ethiopia, is population growth [3]. Population pressure is the main cause for the depletion of forest resources which in turn poses many social and economic problems in Ethiopia [4]. The majority of the Ethiopian population relies on biomass fuel for energy production [5]. Heavy dependence on woody biomass for fuel, increasing demand for grazing and agricultural land and demand for other wood products contribute to the severe deforestation and forest degradation in Ethiopia [6]. An increasing food demand as well as deforestation indicates the urgent need to find alternatives that have the potential to reduce deforestation by fully or partially substituting with wood products outside the forest area [7]. Agroforestry based integrated development program is a strategy that seeks to reconcile the dual goals of forest conservation and improved livelihoods for the local communities [8].

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Despite of the promotion agroforestry practices in various areas in the country and number of studies conducted to validate the contribution of agroforestry practices to the livelihood of farmers, yet little has been done regarding documentation and quantification of agroforestry products particularly in Kombolcha district. Therefore, this study was intended to assess and describe the existing agroforestry practices in the study area and also to assess the source of domestic wood markets and the implication to reduce the deforestation of the natural forests. In addition to identify factors that determines the rural households' participation in agroforestry practices in Kombolcha District.

MATERIALS AND METHODS

Description of the Study: The study was conducted in Kombolcha District (Fig. 1), which is located in East Hararghe Zone of Oromia Regional State about 542km East of Addis Ababa and 17km north of Harar city. It is one of the nineteen woredas of EasteHararghe Zone of Oromia Regional State and has total land area of 46, 461ha. The District is located at 9° 25' 60''north latitude and 42° 07' 0'' east longitude. The topography of the District is characterized by sloppy hills, mountains and rugged. The District ranges between 1200 to 2460 m.a.s.l in altitude. The total population of the District as estimated in year 2007 is 175, 822 persons [9]. The number of male and female population was 89, 136 (50.7%) and 86'686(49.3%) respectively. The total number of household is 21, 801. The crude population density of the District is 235 persons per square kilometer [10].

According to the traditional agro-climatic zone the study area is categorized as semi-arid which covers 26% (9 PAs) and sub-humid 74 %(10 PAs) of the District total area. The Rainfall is bimodal, erratic and unreliable, with the mean annual precipitating ranging from 600 mm-900 mm. The long rains season 'keremt' starts at the beginning of July and extend up to September, while the short rainy season 'belg' is from March up to April and the mean annual temperature ranging from 18-25°C. Soil type of the study area is broadly categorized under Alluvial which is attributed with various colors and geological formation. The agriculture is mixed farming practice which characterized by crop production and livestock husbandry. The common crops grown include maize, sorghum, coffee, chat and vegetable like potato, tomato, cabbage etc. The livestock husbandry, which mainly involves the raising of cattle, goats, sheep, poultry and pack animals like donkey, camels [10].

Sampling Procedures: A multi-staged sampling approach was used in the study. First, Kombolicha District was purposely selected based on the potential of the agroforestry practices. In the second stage four sample Kebeles (K) were selected using purposely sampling method based on their involvement in agroforestry practices. Then, random sampling was used to select households from each kebeles. Household surveys out of the 5487 household heads, 160 household head were selected and interviewed using PPS of the population of respective kebeles.

Methods of Data Collection

Household Survey: Both quantitative and qualitative data were obtained from the study. The data were generated from primary sources of household surveys. Primary data on household socioeconomic and demographic characteristics was collected using structured interview schedule. This interview schedule, involving both open-ended and close-ended questions, was constructed. In conducting the interview enumerators were selected carefully from DAs working in the District, oriented on objectives of the study and trained before commencing the work.

Focus Group Discussion: The focus group discussion was conducted with representatives of the community (elders' focus group discussion, women focus group discussion, youth focus group discussion). After the introductory meetings and the identification of participant household, focus group interviews were conducted in each group discussion. In the focus group discussions, the number of members was between 5 and 8 in a group to make the groups manageable.

Key Informant Interviews: Key informant interviews at each kebele level were conducted to gain an overview of the agroforestry practices and the interaction between local community and adjacent agroforestry practices in the study area. At kebele level, three key informants per PA and twelve for four PAs were used. The key informant interview was conducted with knowledgeable people from the community who have good knowledge about the area and the community (elders, traditional historians, religious leader) as well as experts at kebele and District level.

Tree/Vegetation Inventory: Vegetation/ tree inventory was done to know the tree density on the farm; all trees were counted with the help of household members present at the time of interviews. The farmland of sample

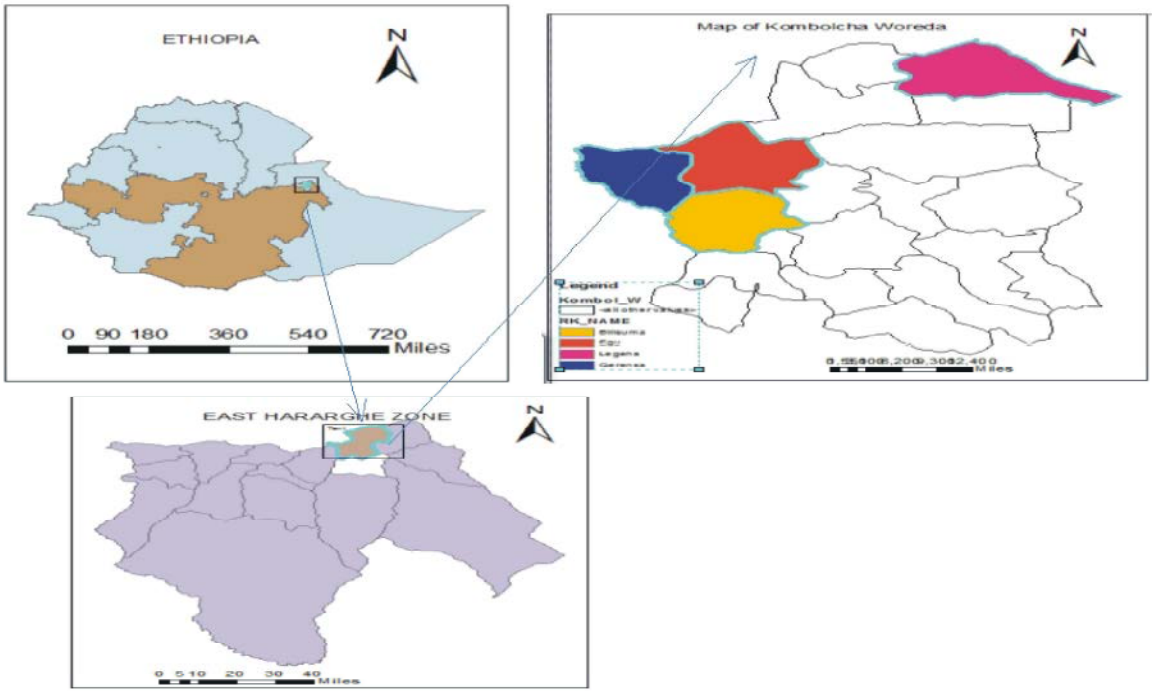

Fig. 1: Map of the Kombolcha District

households was used as a sample plot for inventory. Accordingly, woody species inventory were carried out on the farmlands of 138 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 Flora of Ethiopia and Eritrea [11, 12]as a guideline . A total of 48 quadrats (10 quadrats from home gardens and 38 quadrats from on farmlands), 12 quadrats in each selected Kebele, were used for vegetation assessment. The size of quadrants on home garden was 20mx20m while it was 40mx40m on farmlands like woodlots, boundary plants and scattered trees respectively.

Methods of Data Analysis

Descriptive Statics: Descriptive statistical like the mean, standard deviation, tables, percentage and frequency of occurrence were employed for analysis of socioeconomic data. Also descriptive statistics methods such as frequencies, abundance, relative dominance were used to analyze data. The data was then further analyzed using chi square statistics and t-independent

Tree Species Diversity: Data from inventory of woody plant species were also analyzed using Shannon diversity index [13]. To compare tree diversity among different agroforestry practices of kebeles, Shannon diversity index was used. The data gained from Shannon diversity index were entered to SPSS version 16 software to compare the variation among them. To calculate the trees species diversity, Shannon diversity index formulas were used which is given as;

$$H' = -\sum_{i=1}^{n} pilnpi \quad (1)$$

where;

H = Shannon's diversity index

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

Pi = Proportion of *S* made up of the i^{th} species

Econometric Analysis: Multinomial logistic model was employed to determine the factors that affect choice of agroforestry practice by households in the study area. According to Oscar *et al.* [14] the model was preferred because it permits the analysis of decisions across more than two categories in the dependent variable. In this study the logistic formulation led to the estimation of the probability of making the choice of a particular agroforestry practice given the demographic and the socio-economic characteristics of the households. Let there be dependent variable categories 1, 2, ..., *J* with 1 being the reference category. One regression is run for

Table 1: Definitions and unit of measurement of explanatory variables used for multinomial logistic regression

Variable code	Definition and unit of measurement
AGEHH	Age of the head of the household's measure in years
GEDHH	Gender of household head, dichotomous measure (1=Male; 0= Female)
FAMSIZ	The family size measured by the number of members in the HHs
MASHH	Marital status of HH heads, classifying into three categories value: 1=married; 2=divorced and 3= widowed
EDSHH	The education status of HH head classifying into three categories value 1=Don't attend formal education; 2= Elementary and 3= secondary school
FARLAN	Farm land size owned by the household in hectares
LIVSTK	The total livestock unit holds by the households
AGROECL	Agro-ecology of the household, dichotomous (1=mid land; 0= low land)
IRRAVA	Access to irrigation land use, dichotomous value (1=yes and; 0=no)
MOPHH	Main occupation of heads of HHs classifying into three categories value: 1=Agriculture; 2=Agriculture plus nonfarm and 3=agriculture plus off farm
HHINC	Household Total income (ETB)
DSNEFO	Distance of the nearest forest in kilometer (km)

each category 2, 3... J to predict the probability of Yi (the dependent variable for any observation i) being in that category. Then the probability of Yi being in category 1 is given by the adding-up constraint that the sum of the probabilities of Yi being in the various categories equals one. The regressions are, for $k = 2, 3, ..., J$:

$$\Pr(Yi = \frac{j}{c}) = \frac{\exp(xi\beta k)}{1 + \sum_{i=2}^{j} \exp(xi\beta j)} \quad (2)$$

where: Y = a random variable taking on the values (1, 2, 3, … , J) for a positive integer J and these include; small scale woodlots, boundary planting, scattered trees and home gardens. A baseline alternative is usually included in a choice set category. This was because one of the options must always be in the respondent's currently feasible choice set in order to be able to interpret the results in standard welfare economic terms. x = a set of conditioning variables. x is a 1 × k vector with first element unity and βj is a $K \times 1$ vector with $j = 2,\ldots, J$. Here, y represents categories of participation while x represents specific personal and socioeconomic characteristics of household.

Definition of the Model Variable for Multinomial Logistic Regression Model

Dependent Variables: The dependent variable participation of household in various agroforestry practice (small scale woodlots, boundary planting, scattered trees and home gardens) which were polychotomous in nature. Let P_{ji} 0r Y_{ji}(j=0-3) denotes the probability associated with choice of rural household i with j=0 if the household practice in small scale woodlots; j=1 if the household practice in boundary planting; j=2 if the household practice in scattered trees and j = if the household practice in home gardens agroforestry practice.

Independent Variables: The independent variables of the study area were those variables hypothesized to have associations' agroforestry practices.

RESULTS AND DISCUSSION

Socioeconomic and Demographic Characteristics of Respondents: In line with the sustainable livelihood framework, livelihood assets (resource endowment) are the five categories of livelihood capitals (resources) known as human capital, natural capital, social capital, physical capital and financial capital are presented and discussed in detail, in the preceding sections.

Human Capital: The result in Table 2 shows that the respondents were composed of both male and female household heads. As the Chi-square ($\chi^{2)}$ testresult indicates that, there was a significant difference between AF practicing and non-AF practicing (χ^2 =14.049) households with respect to the sex of households. The result suggested that for livelihood improvement through agroforestry practice in the District male headed household was better use of income and implementation of agroforestry practices. This was in agreement with male-headed household's plant trees and woodlots on farms more than female headed households.

The result in Table 2 shows that the age of sample HH heads ranged between 16 and 68 years with mean age of 39.5 years and standard deviation of 8.67. This result shows that the age of the households belong to young.

Table 2: Human capital of sample households

Variables	Total cases (N=160)	AF Practicing (N=126)	Non-AF Practicing (N=34)	t/χ^2 value
Gender				
Male (%)	81.2	86.4	55.9	χ^2 value
Female (%)	18.8	11.9	44.1	14.049***
Age				
Mean	39.2	42	32	t-value
SD	9.261	11.03	6.93	5.071***
Family size				
Mean	6.74	6.79	5.26	t-value
SD	1.74	1.74	1.4	10.411***
Education status				
Don't attend formal	35.2	24.6	79.4	χ^2 value
Elementary School	51.9	60.3	20.6	35.462**
Secondary School	11.9	15.1	0	

Note: **, ***, Significant at less than 5% and 1% probability level

Source: Own field survey, 2018

Specifically the household heads with age that ranges from 18-64 years representing 70 % of the sampled population. The independent sample t-test, confirmed that their, mean age of agroforestry practice and non- agroforestry practice was 41 and 32 years respectively and were statistically significantly different ($p < 0.001$).This shows that the farmer household heads age and experience significantly influenced the decision to modify agroforestry practices and integrate trees into an agricultural system. Also the result in table 2 shows that the maximum and minimum family size was 12 and 3 respectively with a mean family size 6.47 and standard deviation of 1.78. The independent sample t-test analysis revealed that, the two means difference between the two categories of households were statistically significant ($p < 0.035$). This means that the larger the household size, the more likely they are participating in agroforestry than those with small family size. The finding agree with Bzugu *et al.* [15] which indicates that; the larger the household size the more labour available to carry out agricultural practices like agroforestry as agroforestry as a practice.

The distribution of the respondents in terms of education level (Table 2) indicates that, about 65% of the sample household heads have at least acquired primary education showing that farmers were capable of accessing useful skill to integrate agroforestry practices for livelihood improvement. The Chi square (χ^2) analysis revealed that the household head was statistically different between the agroforestry practicing and non-agroforestry practicing in terms of their educational status ($p < 0.046$). This means that the more educated household head is likely to practice agroforestry than those with low level of education. The level of education of the household head has a positive effect on the presence of trees on farms [16], educated people have more income opportunities and can afford to use more land for growing trees.

Social Capital: Marital status of respondents was also considered since it helps to critically draw out the total number of dependents in a household and how inference can be drawn to examine extent of impact on household agroforestry participation. The result indicates that from the total sample households 75.6%, 18.8% and 5.6%, were married, widowed and divorced respectively. The chi-square (χ^2) test showed that there was significant difference between agroforestry and non- agroforestry practicing household heads.

Natural Capital: The land holding size household heads, agro-ecological location of household heads and the distance to the nearest distance of natural forest of the households head are the natural assets that influence households' likelihood to participate in agroforestry practices.

The land holding size in the study sites ranged between 0.125 and 1.5 hectares with average holding of 0.5898 ha (Table 4). Specifically, 53.1% of the respondents owned land size which is below 0.5 hectares and 46.9 % of the respondents owned land sizes of 0.51-1.5 hectares. The result from the independent sample t-test showed that, the farm size holding of households practicing agroforestry and those do not practicing agroforestry had a significant difference ($p < 0.001$). This means that average farm size holding was by agroforestry practicing than non- agroforestry practicing who had 0.6384 ha and 0.4097 ha respectively. The land availability to farmers influences their decision to modify their practices and integrates trees in to their production system [17].

Table 3: Social capitals of sample households

Variables	Total cases (N=160)	AF Practicing (N=126)	Non-AF Practicing (N=36)	χ^2 value
Marital status				
Married (%)	75.6	87.3	32.4	7.298**
Widowed (%)	18.8	11.2	47.1	
Divorced (%)	5.6	1.6	20.6	

Note: ** significant at less than 5% probability level; N= Number %= Percentage
Source: Own field survey, 2018

Table 4: Natural capital of sample households

Variables	Total cases (N=160)	AF Practicing (N=126)	Non-AF Practicing (N=36)	t/χ^2 value
Size of farm (ha)				
Mean	0.5898	0.6384	0.4097	t-value
D	0.31556	0.3157	0.2443	10.341***
Agro-ecology				
Lowland (%)	36.2	39.7	23.5	χ^2 value
Midland (%)	63.8	60.3	76.5	3.023NS
Distance to the nearest forest				
Mean	2.895	3.65	2.69	t-value
SD	2.62	2.72	2.57	-1.817**

Note: **, *** significant at less than 5 and 1% probability level and NS = Non Significant, Source: Own field survey, 2018

Out of the 160 sample households, 102(63.75%) live in mid land and the remaining 58 (36.25%) in lowland area. The livelihood of people living in mid land differs from that of lowland and this difference is manifested in brining different opportunity to better wellbeing. Most midland farms have their own farm and keep trees on farms. This is because of the climatic condition and other characteristics have influence on the presence of trees. However the chi-square (χ^2) test revealed that the agro ecological difference has not brought statistically significant between households who practice agroforestry and those does not practice agroforestry. This means that the geographical location of the household has not impacted on participating in different agroforestry practices.

The independent sample t-test showed that the mean distance to the nearest forest was significantly different between the agroforestry practicing and non-agroforestry practicing households ($p < 0.057$). The negative and significant effect of this variable means that households close to natural forest/bush lands appeared less likely to belong to the category of participating in agroforestry compared to households headed by far way to natural forest/bush lands. This corroborates with finding that the availability of forest affects the planting of trees on farms [18].

Physical Capital: Physical capital in the study area comprises the irrigation and livestock holding in TLU of household head to support livelihoods of the rural people including sample households.

Households who have access to irrigation can have a possibility to produce more food, cash crops and earn better income than those who have less or none. In the study area irrigation services are provided mainly for the cash crops such as chat, vegetables like potato, carrot, cabbage, beet root and onion. Of 160 samples household heads 70% and 30% respectively had access to irrigation and non-irrigation access to produce cash crops. The major water source for irrigation in the study area is underground water. The farmers construct hand dug well to collect the underground water. The chi square (χ^2) analysis revealed that there were statistically significantly difference between the agroforestry practicing and non-agroforestry practicing with regards to access to irrigation use. The implication of this is that irrigation required more investment and better off households have more access to irrigation than poor.

Livestock production in general is an integral part of the farming and undertaken mainly using traditional management practice. The husband the livestock as source of drought power; food (milk and meat; source of cash; animal dung for organic fertilizer and means of transport. In order to make comparison of the livestock size among the categories, the herd size was converted in to Tropical Livestock Unit (TLU) based on Stork *et al*., 1991. The mean number of livestock holding in TLU for the sample households' is 3.74 with standard deviation 3.35. The range of TLU holding among the sample respondents, the minimum holding was zero and the maximum is 15.4 TLU. The mean number of livestock owned by agroforestry households practicing AF is 4.27

Table 5: Physical capital of sample households

Variables	Total cases (N=160)	AF Practicing (N=126)	Non-AF Practicing (N=36)	t/χ^2 value
Irrigation access				
Yes (%)	70	78.6	38.2	χ^2 value
No (%)	30	21.4	61.8	20.744***
Livestock holding in TLU				
Mean	3.57	4.27	0.978	t-value
SD	3.44	3.43	1.925	5.359***

Note: *** Significant at less than 1% probability level; N= Number, % = Percentage

Source: Own field survey, 2018

Table 6: Financial capital of sample households

Variables	Total cases (N=160)	AF Practicing (N=126)	Non-AF Practicing (N=36)	t/χ^2 value
Livelihood				
Ag (%)	43.8	50.8	17.6	χ^2 value
Ag +NF (%)	33.8	33.3	35.3	18.322**
Ag + OF (%)	22.5	15.9	47.1	
Total annual income ETB				
Mean	20, 001	22, 173	11, 950	t-value
SD	14, 446.7	15, 056.9	7875.8	3.815***

Note: **, *** Significant at less than 5% and 1% probability level

Ag= Agriculture, Ag + NF= Agriculture plus non-farm, Ag + OFF= Agriculture plus off-farm

TLU while households who do not participate in agroforestry owned only 0.978 TLU. Thereis a significant statistical difference between households participating in agroforestry and those who do not participate in agroforestry ($p < 0.001$).

Financial Capital: The availability of strong financial service encourages farmers to diversify their livelihood activity so as to ensure households' livelihood security. The households in the study area are found to pursue different sources of livelihood in their day-to-day struggle, to earn their living and fulfill their aspirations for improved and better livelihood options. In the study area households' income is derived normally from more than one source. The main sources of income the households include agriculture (43.8%), agriculture plus non-farm (33.8%) and agriculture plus off farm (22.5%). The study area was characterized by mixed farming system such as crop and livestock production and all respondents in the study area were dependent on agriculture, largely on subsistence crops (maize and sorghum), cash crops (vegetables, perennial crops) and livestock rearing. The diversity of crops within one village ranges from rain fed sorghum and maize to the irrigated cash crops like khat, coffee, vegetables (potato, cabbage, carrot, beet root) and fruits (papaya, banana, mango). The major purposes of producing these crops were for family consumption. Besides livestock holding was an important indicator of household's wealth position.

Off-farm income is another source of livelihood in the study area and it mainly refers all activities away from one's own property including agricultural wage, processing of chat and fire wood collection and charcoal making. Whereas non-farm sources of livelihood in the study area mainly refers all activities outside the agricultural sector like trading of different kinds of agricultural produce (chat and vegetables); petty trading like commodity (soap, match, salt) and remittances. In this study, household's obtained income from crops (vegetables, Khat and coffee); livestock's; livestock products and off farm/ nonfarm activities. Farmers in study area were net buyers of grain by selling cash crops such as khat, vegetables and non-farm and off-farm activities. The average annual income for sample HHs was 20, 000 Birr with standard deviation 14, 446.7 Birr. In the study area, as it was observed from the household survey result the relative income source from crop farming such as khat, vegetables (potato, cabbage, carrot and beet root) and coffee respectively account 86.3% , 57.5% and 8% from the total annual income. Whereas sell of livestock and livestock product (milk and egg) were also the main sources income for 36.9% and 27.5% of sample HHs, respectively. Similarly, vegetables trading, fuel wood and charcoal selling, chat trading, agricultural wage, from the off/nonfarm activities were an income sources for about 25.5%, 24.4% 22.3% and 21.3% the sample households, respectively. Besides, fire wood collection and charcoal making and selling were important sources of off farm

incomes for many lowland rural households in the study area. About 24.4% of sample households were involved in these activities. Fire wood was collected from the dry bush, dead wood, broken branches, fallen trees and green wood and transported by donkey, camels and person to Kombolcha market. In this regard about 45-60 donkeys and 14-18 camels load of fire wood were brought in to Kombolcha market every day from Egu and L/Hama and the households can earn about 60 to 85 birr for each donkey load and 350-450 birr for each camel load. The reported average total annual income of agroforestry participating and non- agroforestry participating was ETB 22, 173.4 and ETB 11, 950.3 respectively and there were statistically significantly difference between the two categories of households ($p < 0.001$) (Table 6). This means that the more the household heads earn, the more they were likely to participate agroforestry than those with low income levels.High income earners were likely to hire people to carry out the agroforestry management practices in their farms, hence a higher adoption rate among high income earners. The findings agree with Mulatu *et al.*[19] that indicated income has a positive correlation with agroforestry practices.

Description of Major Agroforestry Practices

Major Agroforestry Components

Hedgerow Intercropping with Small-Scale Woodlots: In the study area, the first agroforestry practice which account 45 (28.1 %) rural households were own small scale woodlots on their farms. Eucalypts species were the most exotic commonly used for on farm woodlots. The two common species used for small-scale woodlots were *Eucalyptus camaldulensis*and *Eucalyptus globulus*.These species were fast growing and respond positively to frequent cutting. Rural households were also motivated to manage farm woodlots for other economic incentives including income from the selling of fuel wood, building poles and timber. The size of the woodlots was not more than 0.0625 ha. Households with such small size woodlots can maximize their income by selling wood on local markets. The income derived from the selling of wood products (including fuel wood) may be used to buy a variety of food for household consumption.

Boundary Trees Planting: 19.4 % of the respondents planted or retained trees/shrubs along the boundary of their farms to protect their crops and as a source of different wood products. *Eucalyptus camaldulensis*were the familiar trees planted on farm boundaries. Trees were planted in a single or multiple rows consisting of a mixture of different species like *Allophilusabssyinicus, Oleaeuropeavarafricana, Doviyalesabysinicus, Entadaabyssinica*. The first two tree species are large size trees commonly used in plot demarcation, boundary marking and stabilization of roads and as windbreaks. In addition to fuel wood, they are also used for other products including construction poles and timber. *Sesbaniasesban, Vernoniaamygdalina and Solanumgigantium* pruned materials/branches were used as mulch and fodder. The shrub species that planted or retained along the boundary of the farm were like Myretacea etc.

Hedgerow Intercropping and Scattered Trees and Shrubs on the Farm: A hedgerow intercropping and scattered trees on the farm is the most common form of agroforestry practiced in Hararghe Highlands of eastern Ethiopia specifically in Kombolcha district. The shrub khat was a stimulant cash crop that generates cash for the farmer. Its succulent, young and fresh leaves were chewed as stimulants. Over the last two decades, demand for Khat has increased and thus its production, at some sites. An advantage of Khat as a cash crop was that it can be harvested 2-3 times a year and this result in a fair distribution of annual farm income. The use of scattered trees and shrubs were the common practice in various land use system in the study area. In this agroforestry practice, trees are managed to produce timber, firewood, fodder, poles, fruit and shade during processing Khat for market. This practice involves the growing of individual trees and shrubs in wide spaces in hedgerow intercropping lands. Indigenous tree species including *Cordiaafricana, Oleaeuropeavarafricana, Acacia albida, Croton macrostachyus, Ficusvasta, Syzgiumguineese, Casuarinaequisitifolia and Erythrinaabyssinica were commonly found in land use system as scattered trees*.

The Homegardens and Coffee Farm: About 19.4 % of the respondent practiced mixed farming in a form of homegarden and coffee farm most in Laghamakebele lowland area. Also livestock production was the major means of livelihood of the rural community low land area. Hence, result showed that household basis the combination of agroforestry plays a major role in strengthening land uses than single land use. Homegardens was dominated by perennials such as coffee with scattered shade trees and fruit trees.

Fig. 2: Hedgerow intercropping and small scale woodlots in the study area

Fig. 3: Hedgerow intercropping and boundary trees planting in the study area

(a) (b) (c)

Fig. 4: Scattered trees in hedgerow intercropping khat with (a. potatoes and b & c , khat with sorghum) crops on farmland, Kombolcha

The *common* fruit trees in the homegardens and coffee farm were *Psidiumguajava, Mangiferaindica, Annona reticulate, Casimiroaedulis, Mangiferaindica*. Trees like *Cordiaeuropeavarafricana, Carissa edulis, Maytenusarbutifolia, Syzygiumguineense, Acacia Senegal, Acacia dicures Milletiafruginea, Albezziagummifera* and Acacia species were among the species that form the upper story of home gardens. Fruit trees, coffee, susbania, Khat and Cordiaeuropeavarafricana were planted in the homegarden. In addition to perennials farmers produce different type of annual crops either in the form of inter-cropping high coffee and oil crops (groundnuts) production.

Woody Plant Species and Diversity in Farmlands: A total of 60 woody species belonging to 36 families were gathered, identified and recorded in four agroforestry practices of the study sites. Forty-six (76.7%) of these species were indigenous while the remaining 14 species (23.3%) were exotic. *Fabaceae* family had the highest number of (7) woody species, also *Myrtaceae and*

Moraceae families had the second highest number of woody species (4 each). While *Sepindaceae, Annonaceae, Borginaceae, Euphorbaceae, Fabanceae, Rocaceae, Rhamnaceae*and*Anacardiaceae* had each two numbers of woody species. Out of the total 60 woody species found in the area, the dominantly observed species were *Catha edulis* (83.75%), followed by *Eucalyptus camaduless* (65.63%), followed by *Cordia Africana* (59.38%), followed by *Oleaeuropeavar africana* (59.38%), followed by *Maytenusarbutifolia* (51.88%), followed by *Croton macrostachyus* (43.13%) followed by *Entadaabyssinica* (41.88%) while 18 species had the lowest frequency (3.75%). The highest and lowest numbers of wood species recorded in the different farmlands were 12 and 2, respectively while the average number of wood species was about six. The five most abundant wood species, namely *Catha edulis*, *Eucalyptus Camaduless*, *Oleaeuropeavar africana*, *Calpurnia aurea* and *Cordia africana* accounted for 37%, 23.7%, 3.5%, 3.3% and 3.2% of the total stems on the farmlands, respectively(Appendix 3). Whereas the highest and lowest numbers of wood species recorded in the different homegardens were 17 and 5, respectively while the average number of wood species was about nine. The five most abundant wood species, namely *Catha edulis, Eucalyptus Camaduless, C5offea arabicae, Lantana camara, Maytenusarbutifolia, Oleaeuropeavar Africana* and *Cordia africana* accounted for 26%, 21.3%, 20%, 14.2%, 3.4% and 2.7% of the total stems on the farmlands, respectively.The result in this study kebele revealed that, among the different agroforestry practices, homegardens was the best preferred one followed by farm boundary and trees on farm lands respectively. In this homegardens trees are grown for shelter belt, fodder, cash income and soil fertility improvement. Tree species found in this area; *Coffeaarabica, Cordiaafricana, Oleaeuropeavarafricana, Entadaabyssinica, Croton macrostachus, Capparistomentosa and Eucalyptus species* were commonly grown trees.

Bilisumakebele mid land area which is known in Khat and vegetables production. In this study kebele household heads were with more better off income and most of them grow agroforestry on their farm lands like scattered, woodlots and boundary plants. These were trees important for fuel wood, pole, animals fodder, cash income and timber. The trees species commonly found on cash crop lands were; *Eucalyptus camaduless, Oleaeuropeavarafricana, Calpumiaaurea, Cordiaafricana, Croton macrostachyus, Maytenusarbutifolia* and *Entadaabyssinica*.

Qereensakebele was the most well-known vegetables production in irrigation and also khat production common in lowland area. Mainly the trees on this were trees that are naturally grown, large in size and are very scattered, woodlots and boundary plants. These were trees important for fuel wood, pole, animals fodder, cash income and timber. The trees species commonly found on cash crop lands were; *Eucalyptus camaduless, Oleaeuropeavarafricana, Calpumiaaurea, Cordia Africana, Croton macrostachyus , Maytenusarbutifolia* and *Entadaabyssinica*.

Egukebele was one well known maize and sorghum production in addition to khat production in midland. In this study kebele there was high population growth at result large percent of household heads were participating in off farm activities mainly fire wood and charcoal selling from bush lands. At result the natural forest degradation was very high. Mainly the trees on this were trees that a very rear scattered, woodlots and boundary plants. The trees species commonly found on cash crop lands were; Catha edulis, Eucalyptus camaduless, Oleaeuropeavarafricana, Calpumiaaurea, *Croton macrostachyus, Maytenusarbutifolia, Lantana camaraand Entadaabyssinica*. Furthermore, the tree species found in crop land were listed in (appendix 2, 3 and 4) and their order as rated by the respondents.

The calculated Shannon diversity indices Bilisuma, Egu, L/hama and Qereessa were 2.41, 2.28, 2.58 and 2.57 respectively for farmland woody plant species. Shannon diversity index in this study was relatively higher than the result found in northern Ethiopia who reported a Shannon diversity index of 0.58. However, the value of the Shannon diversity index in this study is lower than the studies reported from the forest areas of Ethiopia for woody species by Yirdaw [20] and Zegeye *et al.* [21] who found the Shannon diversity index of 3.0 and 2.98, respectively.

Contribution of Agroforestry on Livelihood of Households

The Role of Agroforestry Practice as Income Diversification: Income diversification refers to a continuous process of portfolio engagement activities of the farm households categorized as farm, non-farm and off-farm income sources. The result in (Table 7) indicates that the agroforestry practice is known to contribute 80.2% of the total annual income of the households.

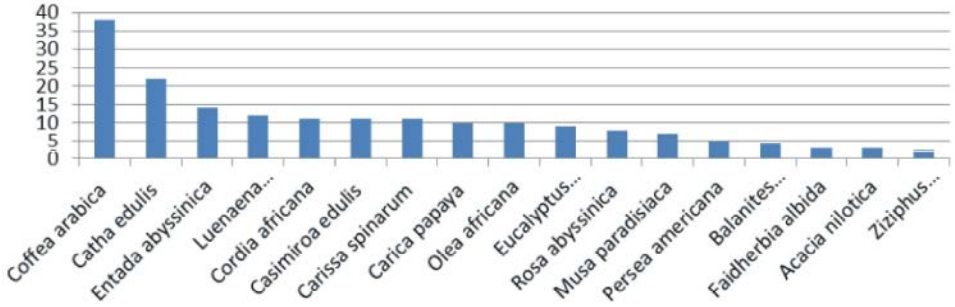

Fig. 5: Frequency occurrences of woody species across agroforestry practices in LagahamaKebele, Kombolcha District and Eastern Ethiopia

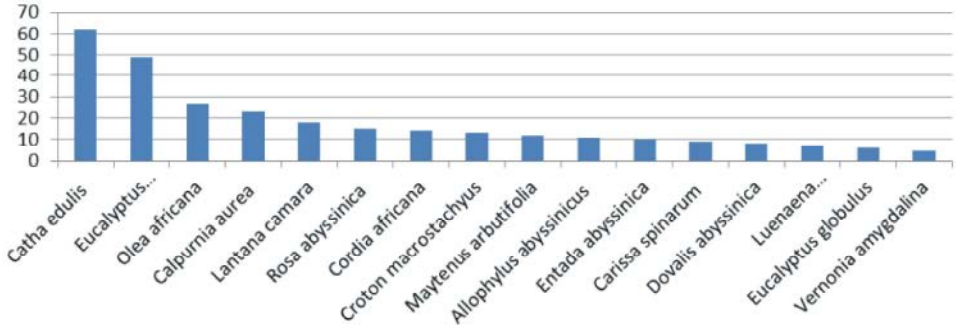

Fig. 6: Frequency occurrences of woody species across traditional agroforestry practices in BilisumaKebele, Kombolcha District and Eastern Ethiopia

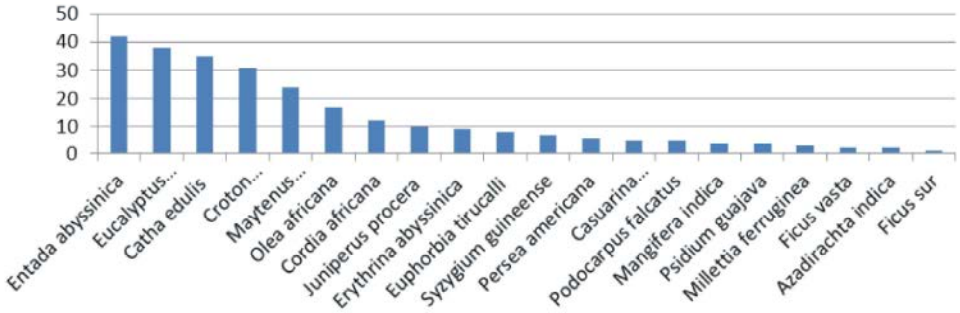

Fig. 7: Frequency occurrences of woody species across common agroforestry practices in QereessaKebele, Kombolcha District, Eastern Ethiopia

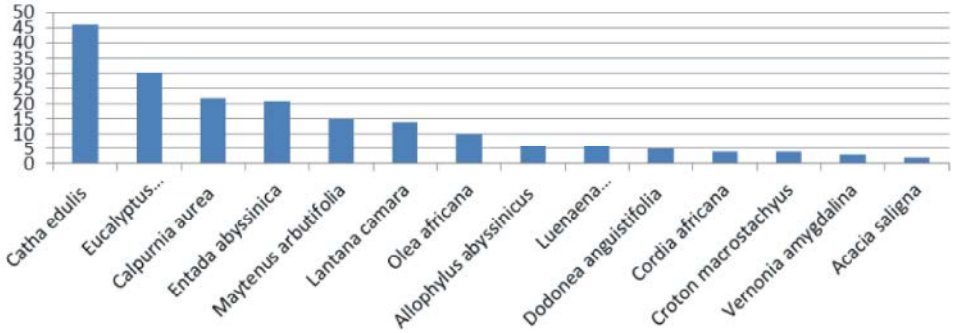

Fig. 8: Frequency occurrences of woody species across common agroforestry practices in EguKebele, Kombolcha District, Eastern Ethiopia

Table 7: The role of agroforestry practice as income diversification

Source of income HH	Average total annual income	Contribution (%)
Agroforestry practice	Total	80.2
Horticulture	5543	25.0
Khat	8425	38.0
Coffee	532	2.4
Livestock	1663	7.5
Wood	1441	6.5
Fruit	177	0.8
Non agroforestry	Total	19.8
Vegetable and Khat trading	1663	7.5
Petty Trading	111	5.0
Labour	776	3.5
Fire wood and charcoal	44	2.0
Remittance	399	1.8

In this case, the relative income source from vegetables (potato, cabbage, carrot and beet root), Coffee and Khat account 25%, 2.4% and 38% of the total annual income respectively. Perennial crops particularly Khat contributes relatively high to the total household income. Timber including fuel wood, charcoal, fruits and fodder, were also important sources of AF income. The average income from cereal crops (mainly sorghum and maize), coffee and Khat was higher for AF practices than non- agroforestry practice because of interaction between different components. The sale of livestock and livestock product (milk and egg) was also the main sources incomes that contribute 7.5% total annual income of the HHs. The gross incomes HHs generate from sale of livestock and livestock product comprised of for oxen fattening, cow sale, goat and sheep sale and milk sold. Income, income from trees on farms contributed on average 6.5% of overall annual gross household income (Table 7). Cash tree growers were on average substantially better off and indeed there are increased number of trees on farms among households with higher on-farm and total incomes. Therefore, integration of agroforestry practice into ongoing farming system was enhancing households' income through increased on-farm income and tree planting on farm brought improvement on overall household income and alleviation of rural poverty.

The Level of Income from Agroforestry Practice: The result in table 8 indicates that income from Khat and vegetables production comes first and income from livestock and livestock products sells stand second whereas income from nonfarm and off farm activities comes third. However, here we need to note that since valuation of AF products and services were technically difficult farmers often underestimate the contribution of AF in the household livelihood income. More than 78 percent of the respondents consider that AF has been important and has a potential to make a sizeable contribution in improving the livelihood strategies of farming households. The study reveals that, AF farmers were more beneficial than non-AF farmers, because they acquired additional money through selling of horticulture, tree cash crop, livestock and livestock products, poles and fuel wood and also saved money and food security. Although, tree component in AF systems contributes 6.5% to the annual total household income still less attention is given by farmers as compared to cash crops mostly Khat, vegetables and coffee.

The Role of Practicing AF as a Strategy for Livelihood Diversification Strategy: The main livelihood diversification strategies pursued in the study area, based up on the relative contribution to overall income include crop production, livestock and nonfarm and off farm activities. Notably, agroforestry has a great potential for alleviating the land degradation problems associated with poor traditional farming practices in the study area. It also played a great role in improving agriculture and forest production on a sustainable basis by providing food, fuel wood and fodder and farm income for agroforestry participants. In addition to these, farmers used agroforestry practice as livelihood diversification strategy like intercropping with woodlots, boundary plants, scatter trees and home gardens. Farmers have adopted intensive production system involving intercropping of several crops on the same plot and multiple cropping whereby different crops were grown on the same plot during different seasons of the year. As shown in Table 8, about 38% and 25% of the farmers earn their livelihoods from khat and horticulture production, respectively. Due to limited grazing area, only 7.5% of the respondents depend on livestock production, which wasmajor source

Table 8: Reasons for practicing agroforestry

Reasons for practicing Agroforestry	Frequency	Percentage
Fuel wood	69	54.7
Building materials & fuel wood	25	19.8
Additional income	23	18.3
Timber	5	4.0
Shade	4	3.2
Total	126	100.0

Sources: Own survey, 2018

of income following crop production. Firewood collection for sale as a livelihood strategy the livelihood diversification model incorporates the situation of farmhousehold income diversification activities towards participating in on-farm, nonfarmand off-farm livelihood diversification activities. The living standard of household was dependent largely on household's income.

The Contribution of Agroforestry Practices in Reducing Deforestation

Source of Domestic Wood Market: The major source of fuel wood were from different sources, which indicated that about 79.4% of the energy comes from wood based sources and around 15% comes from crop residues and tree leaves and the rest 5.6% energy source comes from kerosene. Comparing the two wood sources of fuel (natural forests and shrub lands and own farm agroforestry trees and shrubs) at the household level, the majority (79.5%, N = 101) of the households used agroforestry trees and shrubs sources for their fuel demand during the study year. About (20.5%, N=26) of the households relied on natural forests and shrubs. From this, it can be understand that the main source of fuel for farmers in the study area was trees and shrubs from different components of agroforestry. Most of this fuel wood is sold by the farmers to urban consumers mostly Kombolcha town, Harar city and Dire Dawa city in order to gain cash income.

Reducing Wood Demands from the Natural Forest and Shrub Land Areas: In order to get a better insight into the source of energy, respondents were asked where they obtain their energy for cooking and heating and they indicated that they get energy from four major sources during the year 2017/18. Overall, this result was very similar with the national level estimates of fuel from different sources, which indicated that about 79.4% of the energy comes from wood based sources and around 15% comes from crop residues and tree leaves and the rest 5.6% energy source comes from kerosene. Comparing the two wood sources of fuel (natural forests and shrub lands and own farm agroforestry trees and shrubs) at the household level, the majority (69.4%, N = 111) of the households used agroforestry trees and shrubs sources for their fuel demand during the study year. About (21.4%, N=34) of the households relied on natural forests and shrubs, while the remaining 9.4% of the households were totally using the nearby natural forests and shrub lands for their fuel wood demands. From this, it can be understand that the main source of fuel for farmers in the study area was trees and shrubs from different components of agroforestry. Overall, this result is very similar with the national level estimates of fuel from different sources, which indicated that about 68.5% of the energy comes from wood based sources and around 27.7% comes from crop residues and animal dung [22]. Participants mainly gather the forest products they need from their own farm forests leaving the non-participants to continue collecting from nearby natural forest stands. The farmer-participants' attributed the decrease in their dependence on the natural forests mostly to their realization of the importance to protect the nearby forests for the environmental and economic services these provide.

Fuel Wood Consumption: The use of fuel wood as a primary source of energy for domestic use is attributed to deforestation. To determine fuel wood consumption, the actual amount of charcoal and firewood consumed daily was measured. Measurements of the actual consumption for 1 day were conducted using a bundle survey method. During the course of interviews, the data collector weighed some fuel wood that was greater than the amount that the main cook indicated they used on a daily basis. The cook was requested to use that fuel wood for the day's cooking. The following day, the data collector revisited the households, weighed the remaining fuel wood and calculated the actual amount consumed. From the daily consumption the monthly consumption was calculated. The average weight of a bundle of wood splits and a bag of charcoal was 13.5 kg and 38 kg, respectively. The amount of fuel consumption from the agroforestry trees and shrub lands showed significant difference among the three wealth classes of the households. The result show that the better off household heads significant ($p < 0.05$) difference in the amount of fuel consumption from agroforestry trees and shrubs was found among the wealth classes Thus, the rich households consumed the highest amount of fuel from

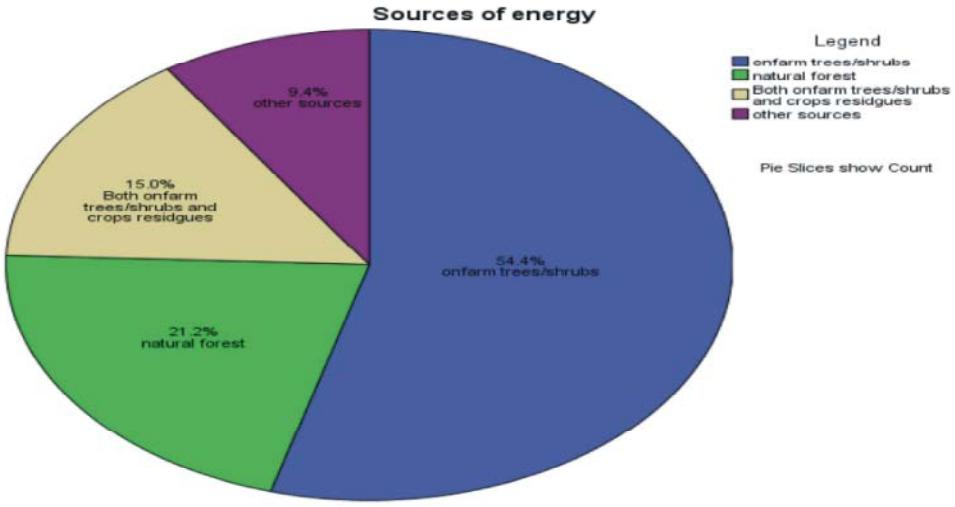

Fig. 9: Energy source of sample respondents
Sources: Own survey, 2018

Table 9: Monthly fuel consumption per household from different sources for wealth categories

	Fuel wood consumption per month (kg)	
Wealth categories	Mean	SD
Poor	71.94	17.032
Medium	75.85	19.282
Better-off	88.57	24.102

Sources: Own survey, 2018

their own farm, whereas the poor consumed the lowest amount. This might be related to the number of trees and shrubs that existed on their farms since the rich farmers had the highest number of trees and shrubs on their farms. Usually, it was found that the amount and source of fuel consumption is affected by the wealth status of households [23]. The result is in agreement with the present result, Bekele-Tesemma [12] that reported non-significant difference in fuel consumption among wealth classes.

Factors That Determine the Rural Hhs Choice to Participate in Agroforestry Practices: The multinomial logistic model was also employed to determine the factor that determines farmers' choice of small scale woodlots, boundary plants, scattered trees and homegardens of agroforestry practice. Therefore, the multinomial logit regression model was employed to the factors that determine the choice of agroforestry practice by household with 12 explanatory variables. Before using the multinomial logistic regression model for hypothesized variables, it is necessary to test the problem of multicollinearity or association among the potential independent variables.

The goodness of fit measures were checked and validated that the model fits the data well. The likelihood ratio test statistics exceeds the Chi-square critical value at less than 1% probability level. This implies that the hypothesis, which says all coefficients except the intercept is zero, was rejected. The value of Pearson Chi-square test shows the overall goodness of fit of the model at less than 1% probability level. A total of 12 explanatory variables were considered in the model, out of which coefficient of 8 variables were significant in explaining the factors that affects the choice of agroforestry practice by household. These were Gender of household heads (GENHH), Family size of household heads (FAMSHH), Age of the household head (AGEHH), Educational level of household heads (EDLHH), Number of livestock in total livestock unit (LIVSTKS), Total annual income of household heads (HHINC), The main occupation of household heads (MOPHH) and Distance to the nearest natural forest or nearer to natural forest (DSNEFO).

The age of the head of household was positive and significant at less than 10% probability level determine the choice of household to practice in woodlots implying; household keeping woodlots on farm were likely to be planted by older heads of households than younger ones because the older households have been exposed to the benefits of the trees through experience over many years of their life. The odds ratio indicates that, farmer decision being choice in participation in woodlots, with the other factors constant, increase by a factor of 0.095, as the age increase by one unit. This finding corroborate with study [24] who found that age is one of the demographic characteristics of households that influence the participation of agroforestry like woodlot.

Table 10: MLR estimates of the effects of explanatory variables on the relating to determine the factors that affect the choice of agroforestry practice by household, in the study area

Dependent variables	Explanatory variables	B	Std. Error	Wald	Sign.	Odds ratio [Exp(B)]
Woodlots	Intercept	-15.491	2.550	36.900	.000	
	GENHH0	.299	1.399	.046	.831	1.348
	AGEHH	2.354	1.379	2.912	.088*	.095
	MASHH	-.503	1.555	.105	.746	1.654
	FAMSIZ	4.421	2.306	3.675	.055*	0.012
	EDLHH	.218	1.046	0.044	.835	1.244
	LIVSTKS	.837	.790	1.122	.290	2.309
	HHINC2	1.228	1.528	.646	.422	3.414
	FARLAN	.522	.860	.369	.544	1.685
	MOPHH	19.588	.710	760.649	.000***	3.214
	AGROECL	.103	.618	0.028	.868	1.108
	IRRAVAS	1.113	.954	1.360	.243	3.042
	DSNEFO1	-1.976				
	.996	3.932	.047**	.139		
Scattered trees	Intercept	1.072	3.483	.095	.758	
	GENHH0	-.847	1.507	.316	.547	.429
	AGEHH	2.080	2.318	.805	.370	.125
	MASHH	-3.522	1.966	3.209	.173	.130
	FAMSIZ	1.964	1.788	1.206	.272	7.12
	EDLHH	1.606	.974	2.716	.099*	.201
	LIVSTKS	.410	.982	.174	.677	1.51
	HHINC2	.630	1.66	.144	.704	1.87
	FARLAN	-.765	1.041	.539	.463	.466
	MOPHH	2.962	1.704	3.023	.082*	19.34
	AGROECL	.174	.704	.061	.805	1.190
	IRRAVAS	-1.017	.947	1.152	.283	.362
	DSNEFO1	-.664	1.316	.255	.614	.515
Homegardens	Intercept	-4.4118	6.764	.371	.543	
	GENHH	-14.665	1.360	116.203	.000***	2.339
	AGEHH	.099	2.824	.001	.972	1.104
	MASHH	-11.382	.432	.000	.998	1.140
	FAMSIZ	-3.277	2.300	2.030	.154	.038
	EDLHH	3.094	1.572	3.874	.049**	22.06
	LIVSTKS	-2.720	1.426	3.637	.057*	.066
	HHINC	4.436	2.169	4.181	.041**	84.42
	FARLAN1	-.524	1.396	.141	.708`	.592
	MOPHH3	3.969	1.762	5.077	.024**	.019
	AGROECL	1.039	.947	1.203	.273	2.825
	IRRAVAS	3.451	1.453	5.641	.118	31.54
	DSNEFO1	13.190	1.230	1.887	.997	5.348
Model fitting (χ^2)	133.908***	0.003				
-2 Log likelihood	266.356					
Likelihood Ratio Tests	2.679***	0.000				
Negelkerke R^2	0.612					
Cox & shell R^2	0.569					
Mcfadden	0.318					
Classification accuracy	92.5					

Note: ***, **, * significant at less than 1%, 5% and 10% probability level, respectively

Source: Own survey, 2018

Gender of the heads of the household was negative and significant at less than 1% probability level to determine the choice of household to participate in homegarden. The negative and significant effect of this variable means that households headed by men appeared less likely to belong to the category of homegardens owners compared to households headed by women. In other words, households headed by women were more likely to own homegardens on their farms than households headed by men.The odds ratio indicate that, other things being constant, the farmer decision to choice being participate in homegarden by factor of 2.339 as male HH head decrease by one unit.

Family size of the household head was positively and significantly at less than 10% probability level that determine the choice of household in participate in woodlot on farm. This relationship indicated that an increase in family size increased the probability that households own woodlots on their farms. Household family size is positively and significantly related to farmers' choice of woodlots. If the other factor keep constant, the odds ratio in favor of sample households being participate in woodlot increase by a factor of 0.012 as the family size increase by one unit. The result is in agreement with Madalcho and Tefera conducted a study, who reported that the positive and significant effect of family size on number trees plant on farm.

The education status of household head was appear positive and significantly at less than 5% and 10% probability level to determine the choice of household in participating in homegarden and scattered trees respectively, which implies that holding other factors constant, more educated household heads have more likelihood of owner of homegardens and scattered trees than less educated household heads. The positive and significant sign education on homegardens indicates that educated farmers have greater likelihood of practicing homegardens. Household heads with more education qualification were likely to choice and plant homegardens. The odds ratio indicates that, keep the influence of other factors constant, the farmers decision being choice of participate in scattered trees and homegardens increase by factors of 0.201 and 22.06, respectively as education level increase by one unit. In agreement with results from this study, Sood *et al.* [25] who pointed out that, education of head of household and the family has significant influence on tree growing.

The number of total livestock unit was negatively and significantly at less than 10% probability level to determine choice of household in participating homegardens. The significant inverse relationship between livestock farming and the presence of homegardens as agroforestry indicated that larger number of total livestock unit owned household heads were less likely to grow homegardens. Therefore, the significant negative correlation between livestock farming and homegardens as agroforestry indicate that part of the farmland in the study area was fire wood and charcoal also source of income in addition to rearing their livestock. The odds ratio indicate that, other things being constant, the farmer decision being choice in participating in homegarden by factor of 0.066 as the number of total livestock decrease by one unit. These indicated that livestock farmers were more likely to grow woodlots and scattered trees on farm. Generally studies in different African countries suggest two different relationships: small livestock (goats and sheep) may be associated with greater presence of trees on farms while cattle may be seen as a competitor for space [26].

The total annual income was positive and significantly at less than 5% probability level that determines the choice of being participates in homegardens. The household heads with higher total annual income had chance of choosing and planting homegardens on their farm. This relationship indicated that increase total annual income household increase the likelihood of own homegarden on their farm. The odds ratio indicates that keeping the influence of other factors constant, the households' decision to choice household being participating in homegardens increase by a factor of 84.42 as household total income increase by one unit. This finding corroborate with study [27] who reported that farmers with a relatively high level of income planted more trees than those with small level of income.

The household heads by their main livelihood from agriculture was positively and significantly at less than 1%, 10% and 5% probability level, that determines the choice household being in participate in woodlots, scattered trees and homegardens respectively. If the other factor keep constant, the odds ratio in favor of sample households choice being participate in woodlots, scattered trees and homegardens increase by a factor of 3.214, 19.34 and 0.019, respectively as the agriculture increase by one unit. There were significant association between main occupation and farmers' choice of agroforestry practice i.e. woodlots, household full time on agriculture had high proportion of choice of woodlots as compared off farm and non-farms.

The distance to the nearest forest was negatively and significantly at less than 5% probability level that determine choice household being participate in woodlots on farm. This implied that, as the distance to the natural forest decrease, the probability of household ownership of woodlots on farm decrease also. The coefficient of the high forest cover near household was negatively and highly significantly related to the presence of woodlots on farm in the whole study area. This indicated that many households in areas with nearer the natural forest area were less likely to own woodlots on their farms. If the other factor keep constant, the odds ratio in favor of sample households being participate in woodlots decrease by a factor of 0.139 as the distance to the nearest forest increase by one unit. This result had a positive influence on the rural household choice to keep woodlots on farm for the purpose of fuel wood production instead of walking long distance to gather the resource from public and private forests. This result seems to corroborate the findings from many studies [28] that reported an increasing tree planting practices with increasing distances from public forests. Whereas the negative sign on the coefficient of homegardens on model suggest that many households in areas with nearer the natural forest area were less likely to own homegardens on their farms related to the proximity to market. This result corroborate with the findings with study [29] who found proximity to markets may also generate incentives to favor certain types of trees, especially those yielding perishable products like fruit.

CONCLUSION AND RECOMMENDATIONS

The finding shows in the study area huge potentials for agroforestry exist. Agroforestry, trees and shrubs were grown in agricultural fields in association with crops, either as single trees, linear formations or woodlots. Khat was the most commonly grown cash crops in terms of the number of growers which accounts 83.1 % household heads their farm. The most common agroforestry widely practice were hedgerow intercropping and small scale woodlots, followed by hedgerow intercropping and boundary planting, home gardens and coffee trees, hedgerow intercropping and scattered trees. The result of the study revealed that, among agroforestry practices, small scale woodlots is the best preferred one followed by farm boundary and trees on farm lands and home gardens respectively. The woodlot is the dominant agroforestry practice providing farmers with agroforestry products for household use and contributing to total annual household incomes. However, there was variation among farmers in practicing the in agroforestry practices based on different socio-economic variables; i.e. demographic and farm characteristics such as gender, age, family size, level of education, marital status, land holding size, irrigated land size, agro-ecology, source major occupation, total annual income, number of livestock and distance to the nearest forest among the factors that affect the participation of the tree based agroforestry system.

The importance of farm trees in providing fuel wood to farmers in the present study was shown that the best alternative to produce wood products and to conserve natural resources. Agroforestry plays a significant role in reducing pressure on the natural forests and shrub lands by providing fuel and construction wood as well as other forest products. These AFPs were contributing to ecological benefits, such as woody plant species conservation, soil nutrient improvement and reducing pressure on natural forest through provision of wood and non-wood products. Incomes obtained from agroforestry products are not as much as from agricultural crops and livestock keeping because of few trees established, narrow range of alternative tree species and poor management in some agroforestry practices.In addition, the proportions of pole wood extracted from the agroforestry trees were contributing now higher proportion of poles than the natural forest. This shows that there was a shift of supply from the natural forests and shrub lands towards agroforestry trees and shrubs for house construction through time. Therefore, agroforestry was high contribution for reducing deforestation by filling energy demand for the household. To improve the forest cover of the area, realistic community-based forest management strategies should be developed with the participation of the farmers in addition to participating different agroforestry practices. This needs initiating farmers as they were already aware of the deforestation problems. The government should give capacity building to encourage people to plant trees as agroforestry practice for own consumption and at the same time to restore the degraded forest area. This will help to empower the farmers in conserving the forest which has been degraded through deforestation.

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