

*Full Length Research Paper*

# **Analysis of socio-economic contribution of agroforestry systems to smallholder farmers around Jimma town, Southwestern Ethiopia**

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**Integration of trees into land use practices is an old-aged experience of smallholder farmers in Southwest Ethiopia. The contribution of this practice is much undermined. The objective of this study was to assess socio-economic contributions of agroforestry system to smallholder farmers around Jimma town, Southwest Ethiopia. A total of 199 households were proportionally sampled from the three selected sites (Mazora, Waro kolobo, and Merawa). A semi-structured questionnaire was used to collect data from sampled households. Data collected were analyzed using descriptive statistics and an econometric model. The results show that tree-based agroforestry, land-use practice is an integral part of smallholder farmers' livelihoods in the study sites, and furthermore a tree has socio-economic benefits. An average household income from trees was estimated to be 2592, 4652 and 1922 ETB in Mazora, Waro kolobo, and Merawa sites, respectively. Smallholder farmers appreciated trees more importantly from the socio-economic points of view in home garden, pasture land and woodlot, across sites. Education level, tree planting experience, and major livelihood positively and significantly influenced income derived from tree products, while livestock possession was negatively and significantly affecting income in the study sites. In general, tree-based agroforestry land use practice is the most crucial for improving smallholder farmer's livelihoods. Therefore, tree-based agroforestry land use practice should be encouraged in the study sites.**

**Key words:** Agroforestry system, income, livelihoods, socio-economic.

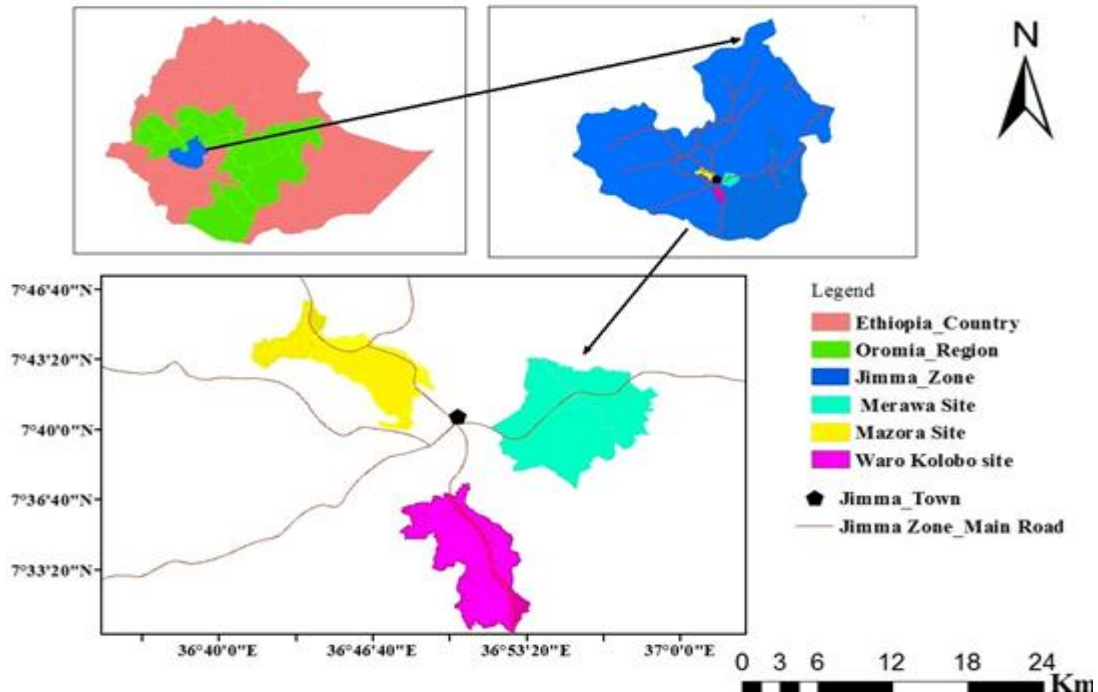
## **INTRODUCTION**

Agroforestry system is an integrated approach to solving land use problems. According to FAO (2013), it is a form of sustainable land use systems that combine tree with

crop or animal husbandry simultaneously and sequentially. Literature has shown that due to its economic and social benefits, agroforestry is the common

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**Figure 1.** Map of the study sites.

experience that has been promoted throughout Africa (Mbow et al., 2014).

The Federal Government of Ethiopia has strengthened the agroforestry extension package as one of the rural development strategies in the country Ministry of Agriculture and Rural Development (MOARD, 2005). As a result, the agroforestry practice has been expanded throughout the country to maximizing production and maintaining livelihoods of farmers from fixed land use. For example, in Sidama, South Nations, Nationalities and People Regional State (SNNPRS), there are different types of agroforestry practices such as tree-enset-coffee, tree-enset, woodlot, scattered trees on farmland and pasture land, and boundary planting (Asfaw and Agren, 2007; Madalcho and Tefera, 2016). Smallholder farmers are more habituated with enset-coffee home garden agroforestry system in Sidama zone (Abebe et al., 2010). This is due to the fact that its contribution in providing income is well known (Kebebew and Urgessa, 2011), including sources of firewood, coffee shade and timber (Muleta et al., 2007). Given this, many studies have been conducted on agroforestry systems (AFS) in Southwestern Ethiopia; however, most of them have given little or no emphasis on the socio-economy of AFS. As a result, there is a gap of information to policymakers, to the government and to smallholder farmers because they do not have an equal understanding about the socio-economy of the AFS. These show that there is an inadequate study of research in the study sites. Therefore,

this research was conducted to fill a gap in the study sites.

The aims of this study were to: (1) assess the socio-economic benefits of agroforestry for smallholder farmers, (2) investigate and estimate the income contribution of tree products of AFS to smallholder farmer's annual income, and (3) determine factors that influence income derived from tree products of AFS in the study sites.

## MATERIALS AND METHODS

### Study sites

The study was conducted around Jimma town of Oromia Regional State within a 20-km radius, at Mazora, Waro kolobo, and Merawa sites, in Southwest Ethiopia. Jimma town is located at 352 km distance to Southwest from Addis Ababa, the capital city of Ethiopia (Tefera et al., 2014). Geographically, it lies between latitude 7°40' N and 36°50' E longitude with an average elevation of 1750 m above sea level (Figure 1).

The temperature fluctuates between 6 and 31°C. An average annual rainfall ranges from 1138 to 1690 mm (Alemu et al., 2011). Table 1 shows a detailed description of the study sites. The Oromo are the dominant inhabitants in the area; because of this, Afan Oromo language is the most commonly spoken language.

### Socio-economic activity

The livelihood of smallholder farmers depends on the mixed crop-livestock system on a subsistence scale. Teff, maize, sorghum,

**Table 1.** Description of the study site.

Variable	Mazora site	Waro Kolobo site	Merawa site
Total population size	9540	15281	18665
Male	4660	7616	10262
Female	4880	7665	8403
Household head	2360	2646	3094
Area (Ha )	3403.5	3516.5	7932
Elevation	2029	1814	1459

Source: Woreda Agriculture and Natural Resource Management Offices (WANRMO) (2016).

**Table 2.** Number of households and sample size proportional determined across the study sites.

Site	Numbers of households	Sample size determined proportional
Mazora	2360	58
Waro Kolobo	2646	65
Merawa	3094	76
Total	8100	199

coffee, fruit crops, vegetables, potato, pulse, and enset are the dominant crops grown in the study sites (Kechero et al., 2013). Maize is the most staple food crop in the study sites. Cows, oxen, goats, sheep, and poultry are a livestock commonly known in the study sites. Tree-based agroforestry land use practice is commonly known in the sites. Smallholder farmers have experience in the use of the home garden, farmland, coffee farm, and woodlot land uses agroforestry practices (Kebebew and Urgessa, 2011). Among them, coffee-based agroforestry practice is the main one in the sites.

Smallholder farmers obtain their annual income from crops, livestock, trees products, and off-farming activity. Coffee and khat are the most important cash crops in the study sites.

### Study site selection

A reconnaissance survey was conducted before the actual survey to capture information about the agroforestry practice and coverage surrounding of Jimma town within a 20 km radius. During this, the intensity and extent of tree-based agroforestry practice and accessibility of roads were identified. Consequently, four districts were chosen: Mana, Seka chekorsa, Dedo and Kersa of Jimma Zone; including eight sites, namely Mazora, Yabu, Somoddo, Doyyo, Waro kolobo, Bore, Kachama, and Merawa.

Multistage sampling techniques were applied to select sampled households. At the first stage, Jimma zone was selected purposively. In the second stage, three districts Mana, Dedo, and Kersa were purposively selected based on reconnaissance results. In the third stage, three sites, namely Mazora from Mana, Waro kolobo from Dedo and Merawa from Kersa districts were selected purposively. On the final stage, a total of 199 household heads were randomly sampled, which were determined by using the Yemane (1967) Equation 1.

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

where n is sample size, N is the size of population and e is the desired level of precision.

According to Yemane (1967), the margin of error varies between 5 and 10%. The marginal error of 7%, the confidence level of 95% and tabulated  $Z_{0.25} = 1.96$  were used. Then the proportional size samples in each kebele were determined by Equation 2, and finally by summing up the total sample size of each site; which defines the entire sample of the study sites as well.

$$n_i = \frac{N_i \cdot n}{N} \quad (2)$$

where  $n_i$  is the determined proportional sample size,  $N_i$  represents the household (HHs) size of the  $i^{\text{th}}$  strata, n is the sample size determined in Equation 1 and N is the total number of HHs (Table 2).

### Data collection

Both primary and secondary data were collected and used. Primary data was collected from sampled households through semi-structured and structured questionnaires, key informant interview, focus group discussion (FGD) and field observation. Secondary data was collected from a different source such as books, reports, journal articles and websites, and unpublished sources. The questionnaire was initially written in English, and then translated into the local language 'Afan Oromo' for the purpose of avoiding an information impurity during data collection and enhancing the validity of the data. Before using it in the main survey, the questionnaire was pre-tested using 30 farmers from the three sites. Then, a questionnaire was modified by incorporating the results obtained in order to collect accurate data for this study site.

Information about socio-economic and demographic characteristics of household (HHs); name, age, family size, level of education, numbers of livestock, total land size and major livelihood activity were collected from the sampled HHs.

**Table 3.** Description of dependent and independent variables with their expectation.

Independent variable	Unit	Description	Hypothesis
Sites (X1)	Categorical	0=Mazora site 1=Waro kolobo site 2=Merawa site	Positive relationship
Sex (X2)	Dummy, takes the value of 1 if female and 0 otherwise		Male head HHs positive relationship and other negative
Age (X3)	Year	Continuous	Negative relationship
Family size (X4)	Number	Continuous	Negative relationship
Education level (X5)	Grade	Continuous	Positive relationship
Total land size (X6)	Hectare	Continuous	Positive relationship
Experience of tree planting (X7)	Year	Continuous	Positive relationship
Livestock (X8)	TLU	Continuous	Positive relationship
Livelihoods activities (X9)	Dummy, takes the value of 1 if agriculture and 0 otherwise (agriculture and off-farm)		Agriculture and off-farm activity is negative relationship

The total annual HHs income was quantitatively collected from individual HHs in the study sites. In this case, any products (tree, livestock, and crop) used for house consumption was not included in cash. The amount of income estimated was only for one year (January 1, 2016-December 31, 2016). Data about annual household income from tree products (timber, fruit, firewood, pole, and charcoal) was collected from individual farmers by asking the amount of actual cash they obtained. An annual household income from crop products (coffee, khat, maize, teff) and from livestock products (egg and milk) and animal sales (cattle, donkey, mule, horse, sheep, goats and poultry) was collected from individual households. The qualitative information about the benefit (socio-economic) of tree-based agroforestry land use practice was collected from sampled HHs.

#### Data analysis

Both quantitative and qualitative data were first summarized, categorized and coded, then entered into Microsoft Excel 2007, and finally copied into Statistical Package for the Social Science (SPSS) Version 20. Socio-economic and demographic characteristics of HHs such as ages, family size, level of education, land holding size, wealth status and the contribution of AFS to HHs were analyzed through descriptive statistics such as frequency, percentage, mean, maximum and minimum then presented in the form of a table. Finally, a Chi-square test was used to test the significance of some categorical variables while mean comparisons were tested by one-way analysis of variance (ANOVA). The data obtained from FGD, key information and field observations were expressed in narrative forms.

Factors affecting income derived from tree products were analyzed by using multiple linear regression models. It was developed to visualize whether or not the dependent and independent variables were significantly related or not. The general model used in multiple linear regressions was as follows:

$$Y_i = B_0 + B_1X_1 + B_2X_2 + \dots + B_9X_9 + \epsilon_i \quad (3)$$

where  $Y_i$  is the  $i^{\text{th}}$  total annual income obtained from tree products,

$B_0$ =intercept,  $B_1$  to  $B_9$  are coefficients of an independent variable.  $X_1$  to  $X_9$  are explanatory variables (age, sex, family size, land holding size, sites, livestock holding, tree planting experience, level of education, and livelihood activity) which influence ( $Y_i$ ); and  $\epsilon_i$  is an error term.

The study hypotheses indicated that these independent variables have an effect on the amount of income derived from tree products in the study sites. The pretesting of explanatory variables were explained in Table 3. The assumption for SPSS and Multiple regression was tested through normality (predicted probability (P-P) plot), linearity (Histogram and scatterplots), homoscedasticity, and multicollinearity (Variance Inflation Factor (VIF) and tolerance).

## RESULTS AND DISCUSSION

### Socio-economic and demographic characteristics of household

The results for socio-economic and demographic characteristics showed that among the sampled households 86.2% were male heads of households in Mazora and Waro kolobo, whereas 88.2% were male-headed households in Merawa site (Table 4). The range in ages of respondents in Mazora site was a minimum of 20 and a maximum of 70 and in Waro Kobolo, a minimum of 22 and maximum of 75; while in Merawa site the minimum was 21 and maximum was 75. The average age of respondents was 43.40, 47.77 and 42.63 years in Mazora, Waro Kobolo, and Meraw sites, respectively. The difference in average age of members of HHs was statistically significant ( $p < 0.05$ ) among the study sites. The minimum and maximum education levels of respondents were estimated to be zero and ten (10), with a mean of 3.9, 2.74 and 2.66 in Mazora, Waro Kobolo, and Merawa sites, respectively. There was a statistically

**Table 4.** Socio-economic and demographic characteristics of household farmer per the study site.

Household characteristic		Mazora (%)	Waro Kolobo (%)	Merawa (%)	Average (%)	( $\chi^2$ )
Sex	Female	13.8	13.8	11.8	13.1	0.922
	Male	86.2	86.2	88.2	86.9	
<b>Major sources of livelihoods</b>						
Agriculture only	-	93.1	92.3	94.7	93	0.837
Agriculture and off-farm	-	6.9	7.7	5.3	7	
Wealth status	Rich	22.4	38.5	11.8	24	0.006*
	Medium	37.9	29.2	47.4	38	
	Poor	39.7	32.3	40.8	38	
<b>P-value</b>						
Age (years)	Minimum	20.0	22.0	21.0	21	0.012*
	Maximum	70.0	75.0	75.0	73	
	Mean	43.40	47.77	42.6	44.6	
Family size (Numbers)	Minimum	3.0	3.0	3.0	3	0.325
	Maximum	10.0	10.0	10.0	10	
	Mean	6.6	6.2	6.1	6.3	
Education level (Years)	Minimum	0.0	0.0	0.0	0	0.032*
	Maximum	10.0	10.0	10.0	10	
	Mean	3.9	2.74	2.66	3.1	
Tree planting experience (years)	Minimum	2.0	2.0	3.0	2	0.003*
	Maximum	32.0	39.0	32.0	34	
	Mean	13.26	14.92	12.9	14	

\*The mean difference is significant at the 0.05.  
Source: Field Survey (2016).

significant difference in education levels ( $p < 0.05$ ) among the study sites.

### Land use types

Land-use types identified in the study sites were: home garden, farmland, coffee farm, pasture land and woodlot (Table 5). The total average of home garden landholding size per HHs was 0.19, 0.34 and 0.76 ha in Mazora, Waro Kolobo, and Merawa sites, respectively. Kebebew et al. (2011) reported that the size of each home garden ranged from 0.01 to 1 ha, with an average of 0.15 ha from Southwestern, Ethiopia. Differences in the size of home gardens were statistically significant different ( $p < 0.05$ ) among the study sites.

The size of land classified in the category of coffee farm estimated in descending order for Mazora and Waro kolobo and Merawa sites was 26.9, 14.7, and 19.1 ha.

Coffee land size was statistically significant different ( $p < 0.05$ ) among the study sites. Around 4.3, 14.1 and 3.3 ha of land was allocated as woodlots in Mazora, Waro kolobo, and Merawa sites, respectively. Generally, an average landholding size per HHs was 1.46 ha, 1.84 ha and 1.73 ha in Mazora, Waro kolobo, and Merawa sites, respectively. Correspondingly, Kechero et al. (2013) also reported that the size of land holding per HHs varied, generally from 0.25 to 2.5 in Jimma, Southwestern Ethiopia.

### Socio-economic contribution of tree-based agroforestry practice to smallholder farmer

In the study sites, tree-based agroforestry practices contribute various socio-economic benefits, which enabled smallholder farmers to fulfill their livelihood requirements. Those tree products are firewood, charcoal,

**Table 5.** Land use types across Mazora, Waro Kolobo, and Merawa sites.

Land use types	Mazora site		W/kolobo ste		Merawa site		Average values (ha)	P- value
	Area (ha)	%	Area (ha)	%	Area (ha)	%		
Home garden	10.8	13	21.8	18	25.9	20	19.5	0.000*
Farmland	34.6	41	52.4	44	60.3	46	49.1	0.026*
Coffee farm	26.9	32	14.7	12	19.1	14	20.2	0.000*
Pasture land	8.1	10	16.6	14	23.2	18	16.0	0.014*
Woodlot	4.3	5	14.1	12	3.3	3	7.2	0.000*
Average of land size per HHS	1.46		1.84	-	1.73	-	1.19	-
Total land size	84.7	100	119.6	100	131.8	100	112.0	0.051*

\*The mean difference is significant at the 0.05.

Source: Field Survey (2016).

**Table 6.** Socio-economic benefits of tree-based agroforestry land uses across the study sites.

Site		Socio-economic benefits						
		Income (%)	Charcoal (%)	Construction (%)	Firewood (%)	Fodder (%)	Timber (%)	Fruit (%)
Mazora	HG	60	6.9	46.6	46.6	13.8	34.5	62.1
	FL	41.4	15.5	15.5	46.6	25.9	20.7	-
	CF	46.6	20.7	15.5	25.9	10.3	15.5	-
	PL	20.7	10.3	25.9	41.4	36.2	10.3	-
	WL	82.8	-	51.7	48.3	-	-	-
Waro kolobo	HG	62.1	-	41.5	32.3	18.5	36.9	55.4
	FL	32.3	9.2	13.8	41.5	9.2	46.2	-
	CF	32.3	4.6	18	18.5	23.1	9.2	-
	PL	41.5	4.6	41.5	36.9	32.3	13.8	-
	WL	85.6	-	55.4	46.2	-	-	-
Merawa	HG	59.2	-	43.4	27.6	15.8	35.5	71.1
	FL	39.5	3.9	63.2	35.5	15.8	43.4	-
	CF	51.3	19.7	7.9	23.7	7.9	15.8	-
	PL	43.4	3.9	15.8	15.8	26.3	32.9	-
	WL	68.4	-	71.1	63.2	-	-	-

HG: Home garden, FL: farm land, CF: coffee farm, PL: pasture land, WL: woodlot.

Source: Field Survey (2016).

construction materials, timber, fruit, animal fodder and income (Table 6). These tree-based agroforestry products help the farmer as a source of income and also for household consumption. The integration of trees into different forms of land uses assists the farmer by providing multiple benefits. For instance, 62.1, 55.4 and 71.1% of the sampled households reported that the trees planted in the home garden provide fruit products in Mazora, Waro Kolobo, and Merawa sites, respectively. This finding concurs with Emukule et al. (2013) who reported that agroforestry practice provides fruit in Northern Rwanda. Agize et al. (2016) also reported that

farmers obtain fruit from home garden trees in Wolaita Zone, Southern Ethiopia. Similarly, Emukule et al. (2013) and Gideon and Verinumbe (2013), also reported that trees growing on farmland provide various benefits such as fodder, fuelwood, and building equipment. About 48.3, 46.2, and 63.2% of farmers were collecting their firewood from woodlot in Mazora, Waro kolobo, and Merawa sites, respectively. Therefore, household source of energy is one advantage of tree-based agroforestry products, which save many farmers from the problems that arise from shortages of energy; because, there are no alternative energy sources. This is in line with Missanjo et

**Table 7.** Mean annual source of household income across in the study sites.

Sources of HHs annual income (ETB)	Sites						Average values	P-values
	Mazora		Waro kolobo		Merawa			
	Mean	%	Mean	%	Mean	%		
Annual income from crop	6382.1	60.15	2409.9	26.3	3817.6	49.45	4203.2	0.000*
Annual income from trees products	2592.6	24.43	4652.2	50.8	1922.1	24.90	3055.6	0.006*
Annual income from livestock	1204.8	11.36	1399.9	15.3	1592.7	20.63	1399.1	0.784
Annual income from off-farm activity	431.0	4.06	691.5	7.6	388.2	5.03	503.6	0.632
Mean annual income	10,610	-	9154	-	7721	-	9162	-

1USD= 22.0799 Ethiopia Birr (ETB) in 2016 year. \*The mean difference is significant at the 0.05. Source: Field Survey (2016).

al. (2015) and Ndalama (2015) who reported that in the rural area, farmers obtained their primary energy from tree products in Malawi. On the other hand, the value of tree products that the farmer used for house consumption, or provided as a gift to neighbors, is called subsistence income. About 51.7, 55, and 71.1% of respondents responded that they obtained construction materials from woodlot tree products in Mazora, Waro kolobo, and Merawa sites, respectively. Relatively smallholder farmers appreciate trees more importantly from the socio-economic points of view in the home garden; pasture land and woodlot across sites.

### Source of households' annual income

Data in Table 7 shows that the farmers earn their annual income from a crop, tree products, livestock, and off-farm activities in the study sites. The average income from sales of crops was estimated to be 6382 (60.15%), 2409 (26.33%) and 3817 (49.46%) Ethiopian birr (ETB) in Mazora, Waro kolobo, and Merawa sites, respectively. In Mazora and Merawa sites, a crop accounted as a major source of income, because this area is mostly known by cash crop production like coffee and khat rather than other uses recorded in the Waro kolobo site. This is in agreement with Woldemariam (2003) and Megerssa et al. (2013) who reported that coffee and khat are a cash crop in Southwestern Ethiopia. The mean annual sources of household income from the agricultural crop were statistically significantly different among the study sites ( $F(2,196) = 8.82, p = 0.000$ ).

Tree products contribute an average income of 2592 (24.43%), 4652 (50.82%) and 1922 (24.90%) ETB to annual household incomes in Mazora, Waro kolobo, and Merawa sites, respectively. This coincides with Safa (2005) who also reported from Yemen, that AFS contributes extra income for farmers who incorporate the practices of AFS compared to those who do not adopt the practice. The mean annual income from tree products was statistically significant between the study sites ( $F$

$[2,196] = 5.31, p = 0.006$ ).

### Mean annual income from tree-based agroforestry products

Table 8 shows the relative mean annual income from differently integrated tree products across land use types. In general, tree products help the farmer as an extra source of income through sales of timber, wooden poles, fruit, charcoal, and firewood. However, the amount of income received from tree products differs from land use types to land use across the study sites. As the sampled HHs responded that they have been getting an average annual income of 1197, 1452 and 898 ETB from home garden tree products in Mazora, Waro kolobo and Merawa sites, respectively. This concurs with Agize et al. (2016) who reported that a home garden provides an average annual income from 800 to 1500 ETB in Wolaita Zone, Southwestern Ethiopia. But it is less than findings reported by Kebebew and Urgessa (2011). They reported that home garden tree products contribute an average income of 1683 ETB to household income in Jimma zone, Southwest Ethiopia. This may be due to a different location of the study sites. The income contributed from home garden tree products (e.g., poles) to total annual household income was statistically significant ( $p < 0.05$ ) among the study sites; whereas it is not significant for timber and fruit tree products. This may be due to the extent of *Grevillea robusta* and *Cupressus lusitanica* trees around the home garden, which the farmers used for fencing purposes in the study sites.

The average annual income contributed from woodlot tree products was estimated to be 1257, 2917 and 644 ETB in Mazora, Waro kolobo and Merawa sites, respectively. Average income obtained from woodlot products was relatively higher in Waro kolobo than other sites. This is due to the extent of woodlot cultivation in Waro kolobo site. The average annual income obtained from woodlot was statistically significantly different ( $P < 0.05$ ) among the study sites.

**Table 8.** Mean annual income of tree products per land use across the study sites.

Mean annual HHs income of tree products (ETB)		Mazora Site	Waro kolobo Site	Merawa site	Average values	P-value
Home garden	Timber	38.17	41.85	177.12	85.7	0.087
	Poles	220.08	320.62	109.54	216.7	0.038*
	Fruit	939.03	1089.23	610.85	879.7	0.437
	Sub-total	1197.28	1451.7	897.51	1182.2	0.368
Farm land	Timber	14.03	33.08	103.32	50.1	0.03*
	Charcoal	11.88	32.85	00	14.9	0.372
	Sub-total	25.91	65.93	103.32	65.1	0.177
Coffee farm	Timber	20.93	31.61	67.39	40.0	0.143
	Charcoal	11.88	36.85	62.60	37.1	0.843
	Firewood	27.48	35.61	21.50	28.2	0.05*
	Sub-total	60.29	104.07	151.49	105.3	0.260
Pasture land	Timber	10.58	31.61	67.38	36.5	0.039*
	Charcoal	28.26	46.46	34.44	36.4	0.684
	Firewood	13.21	34.96	24.11	24.1	0.018*
	Sub-total	52.05	113.03	125.94	97.0	0.15
Woodlot	Poles	1239.09	2885.16	620.72	1581.7	0.000*
	Firewood	17.97	32.26	23.10	24.4	0.018*
	Sub-total	1257.06	2917.42	643.82	1606.1	0.001*

\*The mean difference is significant at the 0.05.  
Source: Field Survey (2016).

Data collected during FGD, farmers mentioned that they accrued extra income from integrated tree-based agroforestry products. They also confidently reported that the income they earned from agricultural crop products like maize, teff; sorghum and coffee were not regular because of some problems. These problems include crop disease, climate changes (rainfall variation) and land degradation, which in turn brings low crop production. However, the income obtained from tree products is helping them as a supplement (to regular income), which empowers the farmers to cope with such situations by enhancing the capacity to purchase household materials, inputs, cereal crops, cover some costs like fees of school and festivals. This agrees with Kebebew and Urgessa (2011) who reported that agroforestry contributes an average of 4148 ETB per household, which in turn helps them to purchase food crops.

### Factors affecting income derived from tree products

The linear regression model analysis showed that out of the nine variable hypotheses, five of them were found to be significantly affecting income derived from tree products ( $p < 0.05$ ). Three of these that positively

affected income are: total land holding size, level of education and experience of tree planting. However, the other two (numbers of livestock holding and the source of livelihood activities) were negative in effect ( $p < 0.05$ ). The multiple coefficients of determination,  $R^2$  was above the moderate level of fitness, which showed that 76.1% of the variation of income could be explained by the explanatory variables (Table 9). As predicted, the education level of the household head was positively and significantly ( $p < 0.01$ ) related to the amount of income earned from tree products. This implies that educated farmers are relatively planting more trees than less-educated ones, as a means of income. For that reason when the farmer education level is increased by one grade, it would lead to increases in the income of farmers by 294.203 factors, when other variables are held constants. This coincides with Oyewole et al. (2015) who reported that educated farmer participated more in agroforestry adoption than a less educated farmer in Nigeria. Moreover, educated farmers are more interested in planting tree species than uneducated ones in Tigray, Northern Ethiopia (Gebreegziabher et al., 2010).

The total land size positively, statistically ( $p < 0.01$ ) affected the income that farmers earned from tree products as predicted. With other factors held constant,



**Table 9.** Multiple linear regression results in the study sites.

Determinant factor	Unstandardized coefficients		Standardized coefficients	T	p-value
	B	St. Error	Beta		
(Constant)	7870.833	1696.894	-	4.638	0.000
Sites	25.789	239.526	0.004	0.108	0.914
Sex	133.903	541.128	0.009	0.247	0.805
Age	40.528	21.049	0.096	1.925	0.150
Family size	-32.643	95.133	-0.013	-0.343	0.732
Level of education	294.203	82.567	0.167	3.563	0.000***
Total holding land size	627.952	220.213	0.111	2.852	0.005***
Tree planting experience	80.527	29.025	0.144	2.774	0.006***
Livestock numbers	-160.772	68.674	-0.099	-2.341	0.020**
Livelihoods activities	-9687.782	871.791	-0.536	-11.113	0.000***
R <sup>2</sup> =0.761	-		Adjusted R <sup>2</sup> =0.750		F =66.99

\*\* ,\*\*\* statistically significance at 5 and 1%, respectively.

when total land holding size was increased by 1 ha, the amount of income the farmer obtained from tree products also increase by 627.927 factors. This suggests that the farmers who have a large size of land participated more in retaining or planting of different tree species on their land, which in turn provided more income. This agrees with Oyewole et al. (2015) from Ekiti State, Nigeria, and Gebreegziabher et al. (2010) and Abiyu et al. (2012) from Ethiopia, who reported that farmers who have large land size participated more in tree planting than farmers with a relatively smaller size of land.

The experience of tree planting by HHs head, as predicted, was positively and significantly ( $p < 0.01$ ) affecting income obtained from trees. This suggests that the income of households should increase by a coefficient of 80.527 when the experience of the farmer in tree planting increased by one year. This result agrees with Oyewole et al. (2015) who reported that more experienced farmers are purposively planting/retaining trees on their land compared to less experienced farmers.

Dissimilarly to the predicted results, the numbers of livestock held by HHs was negatively and statistically significant ( $p < 0.05$ ) affecting income derived from tree products. This implies that farmers who have large numbers of livestock allocated larger portions of land for pasture than tree planting in order to feed their livestock. This is due to traditional ways of keeping livestock through free grazing. Therefore, the farmer's income from tree products is decrease by 160.772 coefficients as the farmer's numbers of livestock increased by one TLU, keeping all other variables constant. Gebreegziabher et al. (2010) reported that when the number of cattle increased, the farmers paid more attention to the livestock, and comparatively they gave less attention to tree planting in Tigray, Northern Ethiopia.

As a prior assumption forecasted, the farmer's livelihood

activity (source) negatively affected the income obtained from tree products ( $p < 0.01$ ). This implies that a farmer who has additional livelihood source, excluding agriculture activity, they have an opportunity of getting additional income. Due to this reason, the farmers' livelihood sources were diversified. Particularly, farmers who have additional income from off-farm activity is less likely to be retaining/planting a tree, compared to farmers who have livelihood activity (crop production), because trees may take a long period to mature and return the income. Therefore, as the livelihood activity is diversified (crop production + off-farm) the amount of income obtained from trees decreases by 9687.782 factors, assuming all other factors remain constant.

## CONCLUSIONS AND RECOMMENDATION

Smallholder farmers are familiar with the benefits of tree-based agroforestry land use practices in Southwestern Ethiopia. This is because farmers obtain multiple benefits from tree-based agroforestry land use under different forms of arrangements. Accordingly, farmers substantially appreciated the value of trees from a socio-economic point of view in a home garden, pasture land, and woodlot. In Mazora, Waro kolobo and Merawa, the amount of an average annual income obtained from tree products was 2592, 4652, and 1922 ETB, respectively. Respondent farmers obtained an annual cash income of 22 to 55 ETB per hectare from tree products in the study sites. Woodlot agroforestry practices provide more income than other practices. This helps them as a supplementary source of income, which enables the farmers to fulfill their family needs.

From the total of nine (9) independent variables hypothesized to affect income from tree products, five variables were found to significantly affect income derived

from tree products. Among the significant variables contributing to income are: education level, tree planting experience and total land size positively; while livestock possession and livelihood activity negatively influenced income in the study sites. Generally, integrating tree in land use practice accounted as substantially as a keystone in improving the livelihoods of the households through providing socio-economic benefits in the study sites. Based on the study findings, the following recommendations are made:

- (1) Educated farmers participated relatively more in retaining/planting tree on their own land. So more education should be encouraged.
- (2) More experienced farmers participated relatively more in tree-based agroforestry land use practice. Therefore, empowering and inspiring more experienced farmers to engage in retaining/ planting trees should be increased.
- (3) The extent of retaining/planting tree increased as land size increased; this should be modified through integrating of the trees into land use intensively rather than extensively.
- (4) High numbers of livestock need large areas of land to graze, and consumes an excessive amount of land resources, because livestock has been traditionally kept in the study sites. This adversely affects the planting/regenerating of tree species. Therefore, intervention should be implemented through training farmers on how trees can be integrated with livestock on fixed land units and thus improve fodder without affecting planted/regenerated trees.
- (5) Further research is needed on the management system, cost-benefit analysis of AFS and market availability to tree products in the study sites.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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