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Economic Importance of Smallholder Farmers' Agroforestry Practices at Gombora District, Hadiya Zone, Southern Ethiopia

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Abstract

Agroforestry practices (AFP) are the integration of trees in farmland that diversifies and sustains production. Whereas, the rapidly escalating population have put the future of Ethiopia's agricultural land and forest under great threat. So, this study was carried out in the Gombora district to assess the economic importance of smallholder farmers' agroforestry practices. To achieve the objective, the target sample households were selected in a purposefully multistage sampling process. Then the Primary data were collected from randomly selected households and analyzed by using SPSS version 25. Additionally, the Chi-square test was used at a 5% level of significance and the OLS model was employed to analyze factors influencing the income of smallholder farmers. The survey revealed that out of the sampled household (140) in the study area, (25.7%) of them were used the product of AF tree for income generation whereas (20%) and (14.3%) were used it as a source of food/fruits and fuelwood respectively. Similarly, (15.7%) of the respondents have used the leaves of the AF tree for their cattle as sources of fodders and (12.9%) for medicinal purposes. However, Regression analysis of estimated (OLS) coefficients for family size, land size, livestock holding, and education level, coffee dummy, education dummy, and AF dummy were found to significantly affect the income derived from AFP ($p<0.05$). Despite the fact, that every farmer did not fully implement the AFP on their farmland. Therefore, the concerned stakeholders should encourage the farmers and create adequate awareness to promote agroforestry technologies in the district.

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Introduction

Agroforestry practices (AFP) are the integration of trees in farmland that diversifies and sustains production. Subsequently, it enhances food and nutritional security by supporting crop production and the provision of edible tree and livestock products (Franzel *et al.*, 2014).

Currently, in Ethiopia, there are several types of traditional AFP in different parts of the country such as coffee shade-based systems, scattered trees on farmlands, home gardens, woodlots, farm boundary tree planting, and trees on grazing lands (Eshetu *et al.*,2018; Dobo *et al.*,2018).

Moreover, agroforestry trees play an essential economic role in the livelihood of rural farmers. Thus, for example, using the leaves of *Borassusa ethiopium* to make mats and hand fans whereas the bark of *Adansonia digitata* is harvested and used for making ropes (Jamnadass *et al.*, 2013).

According to recent meta-analyses Kuya *et al.* (2019), average yields of staple crops were almost twice as high in agroforestry compared to yields in treeless systems. Therefore, in addition to improving soil fertility, AFP also increases crop yield and biomass transfer.

Furthermore, agroforestry also provides opportunities for households to generate income through processing and value addition for tree products and the establishment of tree nurseries (Murthy and Prasad, 2018). Accordingly, Value addition allows farmers to obtain high prices such as from Shea nuts, cashew, mangoes, and gum and resins (Place *et al.*, 2011). In this regard, Shea butter is sold at both local markets and exported to use in the chocolate, cosmetics, and pharmaceutical industries (Angulo and Mezgebu, 2016).

Since the successful practice of agroforestry has economic and ecological implications; generally, in Hadiya Zone particularly in the Gombora district most smallholder farmers did not carry out AFP on their farmland. Furthermore, the extent of tree species inventory and diversity on farmlands, identifying the importance and constraint of AFP and its documentation in the Gombora district has not been yet conducted.

Therefore, this study was designed to assess the economic importance of AFP in the Gombora district, Hadiya Zone, Southern Ethiopia.

Material and methods

Description of the Study area

The study was conducted in Gombora district, Hadiya zone, Southern Ethiopia. Specifically, the district is found 259 km from Addis Ababa (capital city of Ethiopia) and 27km from Hosanna town. It is geographically located at the point of 7° 37′ N latitude and 37° 40′ E longitudes (Fig 1). Moreover, the total land area coverage of the district is 48,325 ha, and four different districts such as Lemo in the east, Yem Special Woreda in the west; Misha and Gibe in the North, and Soro in the south border the study area.

The demographic characteristic of the Gombora district show, that it has 24 Kebeles (peasant association (PA)) with a total population of 92,332. Out of these, 46,225 and 46,107 are males and females respectively and the population density of the district is about 270 persons per square kilometer (DoANR, 2018).

The topographic feature of the Gombora district is mostly flat and moderately gentle lands within the altitudinal range of 1600-2400 meters above sea level. However, the rainfall distribution is bimodal type, which occurs in two main rainy seasons that is, Belg and Maher.

In this regard, Belg is a short rainy season that starts from the end of March to May and Maher occurs as a long rainy season that is June to the end of September. Similarly, the mean minimum and maximum annual precipitation and temperature vary between 500-2200mm and 15-25°C respectively (DoANR, 2018).

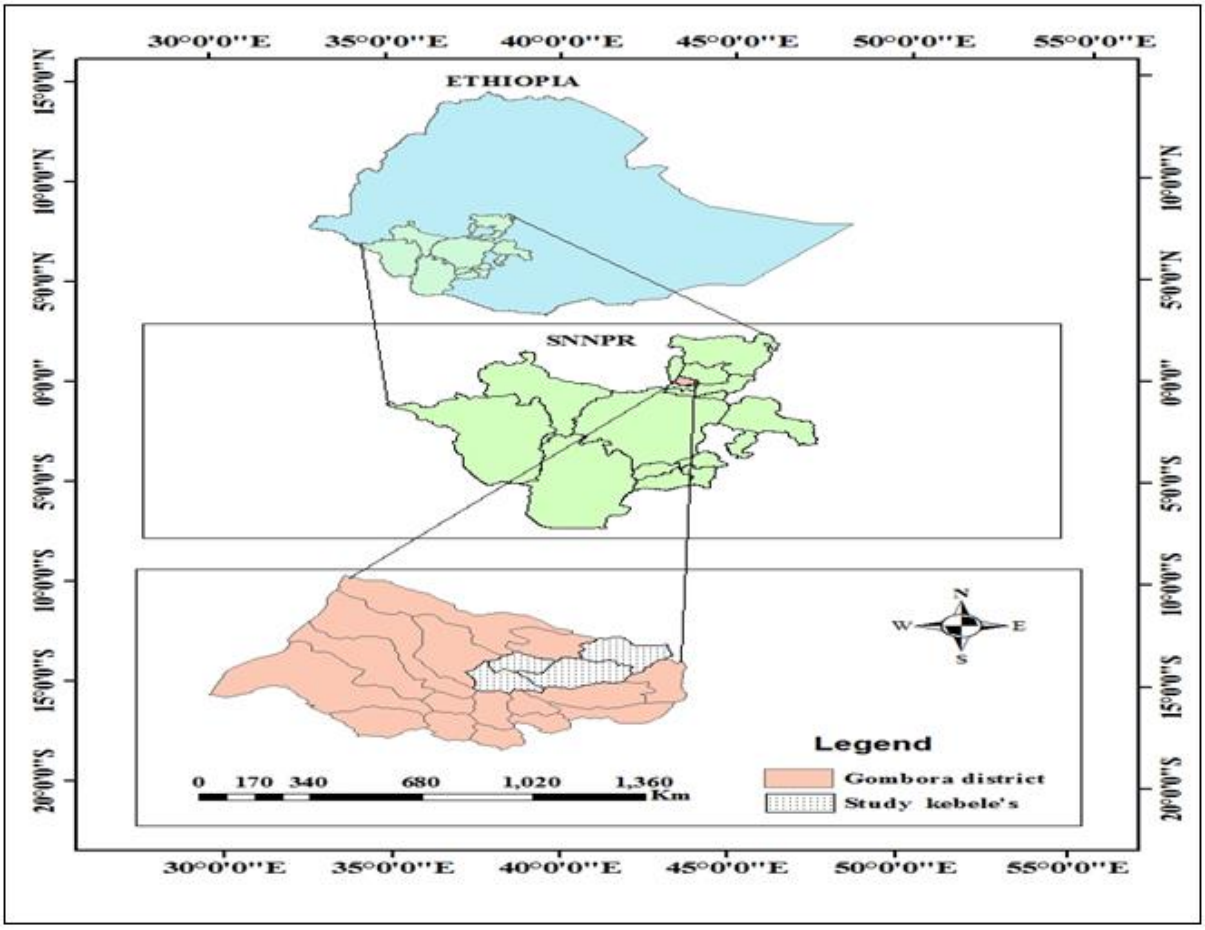

Fig. 1. Map of the Study Area.

Data collection methods

Sampling strategy and sample size determination

The target sample households were selected in the multistage sampling process. In the first stage, representatives (PA) were purposefully selected among the total of PA based on having traditional AFP. In the Second Stage, the households in the selected PA were stratified into male-headed and female-headed households. So far, Individual household units were randomly selected from each stratum. Moreover, Sample sizes for each PA were determined proportionally based on their household heads. Finally, the sample size was determined by using the formula of Kothari (Kothari, 2004).

$$n = \frac{Z^2 q.p.N}{e^2(N-1) + Z^2.p.q}$$

where, n = sample size, p= maximum possible proportion which is 5% (0.05), q= 1-p (1-0.05)= 0.95 , e- allowed error which is now 5%, Z- Confident interval which is now 95%, 1.96 from z- table and N- Total number of households.

Data collection

All the necessary data were gathered from the selected household and focus group discussion through the semi-structured questionnaire and field observation.

Data Analysis

The quantitative data were analyzed through descriptive statistics such as frequency, mean, percentages, and standard deviation by using computer software Statistical Package for Social Studies (SPSS version 25). In addition to descriptive analysis, an econometric analysis using the ordinary least squares (OLS) and weighted least squares (WLS) model, best fits the data for socio-economic factors influencing the smallholder agroforestry income. Accordingly, HH AFP and their socioeconomic factors

were used as dependent and independent variables respectively. Transformation of data and various tests such as natural log transformation, heteroskedasticity, and multicollinearity were conducted to ensure model robustness.

OLS model can be expressed as:
$yi = \beta 0 + \chi i \beta i + \varepsilon i$
Where;
y: HH AF practice
x: HH's socioeconomic factors
i: Number of observations
β0: coefficient of intercept
βi: Parameter to be estimated
ε: Error term

Empirical specification for the model can be given by:
HH AF practice = β0 + β1 (Age) + β2 (coffee production) + β3 (education level) + β4 (land size) + β5 (Family size) + β6 (livestock holding) + β7 (ln income) + ε,
Where; ln = natural log.

Result and discussion

Benefits of AF tree to smallholder farmers in Gombora District

The survey revealed that out of the sampled household (140) in the study area, (25.7%) of them were used the product of AF tree for income generation whereas (20%) and (14.3%) were used it as a source of food/fruits and fuelwood respectively. Similarly, (15.7%) of the respondents have used the leaves of the AF tree for their cattle as sources of fodders and (12.9%) for medicinal purposes. Moreover, (11.4%) of the sampled farmers produce the building materials for the construction of their houses and fence (Fig 2). This implies that the households use these trees for their consumption as well as for sale and profit. Besides this, almost all of the farmers in the study area trying to implement AFP in their farmland in addition to the crop production because the livelihoods of the farmers were highly integrated with AFP. This finding concurs with Emukule *et al.* (2013) who reported that AFP provides fruit in Northern Rwanda were as (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) reported that trees growing on farmland provide various benefits such as fodder, fuelwood, and building equipment. Moreover, Krishna *et al.* (2019) supported this result; his finding revealed that tree crops produced in AFP in Southern Ethiopia accounted for 62% of family cash income. However, 36.2% of the AF practicing farmers obtain their income from salary while 8.8% of them got their income from trading nonfarm products and smaller proportions (0.6%) got their income from oil mills. Similarly, Dar *et al.* (2018) stated that high-income earners are likely to hire people to carry out the AF management practices on their farms, hence a higher adoption of the AFP rate for high-income earners.

Table 1. Services obtained from AF trees in the study area.

Services	Frequency (f)	Percentage (%)
Recreation activities	30	21.4
Soil Enrichment	20	14.2
Wind Break	25	17.9
Improve soil quality	20	14.2
Increased carbon sequestration	20	14.2
Boundary demarcation	25	17.9
Total	140	100%

Services of AFP to smallholder farmers in the Gombora District

According to the field observation and focus group discussion, among the major AF trees planted in the study area, were Avocado *(Persea Americana),* papaya *(Carica papaya),* mango *(Mangifera indica),* Kok *(Prunus persica),* Kasimir*(Casimiroa edulis),* lomme *(Citrus aurantifolia),* kchat *(Catha edulis),* coffee *(Coffea arabica),* wanza *(Cordia africana), Eucalyptus globules, Grevillea robusta, Juniperus*

procera, etc.

Furthermore, these trees provide several services for households. In this regard, Table.1 shows the services, obtained from AF trees such as boundary demarcation, recreation activities, wind Break, and Soil enrichment. Additionally, it was observed that smallholder farmers used these trees for the beatification of land, soil erosion prevention, rain attraction, restore degraded lands, improving water conservation, water quality, climate change adaptation, and help mitigation. These results suggest that the use of AFP could help the soil to regain its fertility without the use of inorganic fertilizer. Particularly, in addition to preventing soil erosion, Nitrogen-fixing trees increase soil fertility and the incorporation of these trees adds more biomass into soils and enables efficient use of inorganic fertilizers. Similarly, AFP plays an important role in increasing the amount of carbon stored in the soil, enhancing nutrient cycling, and improving overall soil quality (World Agroforestry Centre, 2013).

Table 2. OLS and WLS determinants of farmers' income (n=140).

Ordinary Least Square (OLS)				Weighted Least Square (WLS)			
Variable	Estimated coefficient	t-value (S.E.) [p-value]	H.S. t-value (H.S. S.E.) [H.S.p value	Variable	Estimated coefficient	t-value (S.E.) [p-value]	H.S. t-value (H.S. S.E.) [H.S. p-value
Constant	-135,493*	-1.89 (62,418) [0.019]	-1.80 (52,680) [0.035]	Constant	9.15**	7.49 (1.10) [0.000]	8.96 (1.01) [0.000]
AG	-718	-0.68 (1015) [0.336]	-0.84 (878) [0.302]	LOGAG	0.04	0.13 (0.32) [0.782]	0.16 (0.20) [0.756]
FS	10,971**	3.02 (3,620) [0.002]	3.05 (3,480) [0.002]	LOGFS	0.22**	3.10 (0.08) [0.002]	3.48 (0.05) [0.0002]
LS	26,627**	4.24 (5,203) [0.000]	3.91 (5,452) [0.000]	LOGLS	0.42**	8.12 (0.04) [0.000]	6.87 (0.05) [0.000]
NA	2,605**	3.45 (740) [0.000]	3.09 (813) [0.001]	LOGNA	0.16**	4.32 (0.03) [0.000]	3.60 (0.03) [0.000]
ANDM	127,114**	4.25 (28,162) [0.000]	5.24 (21,365) [0.000]	ANDM	0.57**	7.12 (0.06) [0.000]	6.64 (0.07) [0.000]
EDDM	66,292**	2.42 (25,742) [0.013]	2.10 (30,012) [0.026]	EDDM	0.06	1.02 (0.05) [0.303]	1.02 (0.05) [0.302]
CFDM	212,041**	5.45 (32,754) [0.000]	5.27 (37,012) [0.000]	CFDM	1.14**	10.14 (0.10) [0.000]	8.35 (0.12) [0.000]
				AG2	-0.0002	-0.22 (0.0007) [0.628]	-0.26 (0.0006) [0.746]
				LS2	-0.0076	-0.45 (0.001) [0.416]	-0.50 (0.00) [0.520]
Adjusted R^2			0.42	Adjusted R^2			0.62
F (7, 132)			18.47 [0.000]	F (9, 130)			38.45 [0.000]
Jarque-Bera/Salmon-Kiefer (normality test)			200.52 [0.000]	Jarque-Bera/Salmon-Kiefer (normality test)			1.02 [0.526]
Breusch-Pagan (heteroscedasticity test)			65.12 [0.000]	Breusch-Pagan (heteroscedasticity test)			14.42 [0.054]

* Significant at 5% level; ** Significant at 1% level.

Socio-economic factors influencing the income of AFP

Regression analysis of estimated ordinary list square (OLS) coefficients for family size, land size, livestock holding, and education level, coffee dummy, education dummy, and AF dummy were found to be significantly affecting the income derived from AFP ($p<0.05$). However, ages were statistically non-significant (Table 2). Furthermore, the weighted list square (WLS) coefficients were similarly significant for the above-listed variables except for the education dummy and age variable. The non-significance of the age of the household head variable suggests that the land ownership pattern in the Gombora district is independent of age. In some cases, young farmers were found to own a large landholding, which led to substantial income regardless of age.

As predicted, the education level of the farmer was positively and significantly ($p<0.01$) related to the amount of income generated from AFP. This implies that farmers with at least five years of schooling have higher farm incomes than illiterate farmers because the educated farmers have an interest in tree planting. This result was inlined with the report; educated farmers are more interested in planting tree species than uneducated ones in Tigray, Northern Ethiopia (Gebreegziabher *et al.*, 2010).

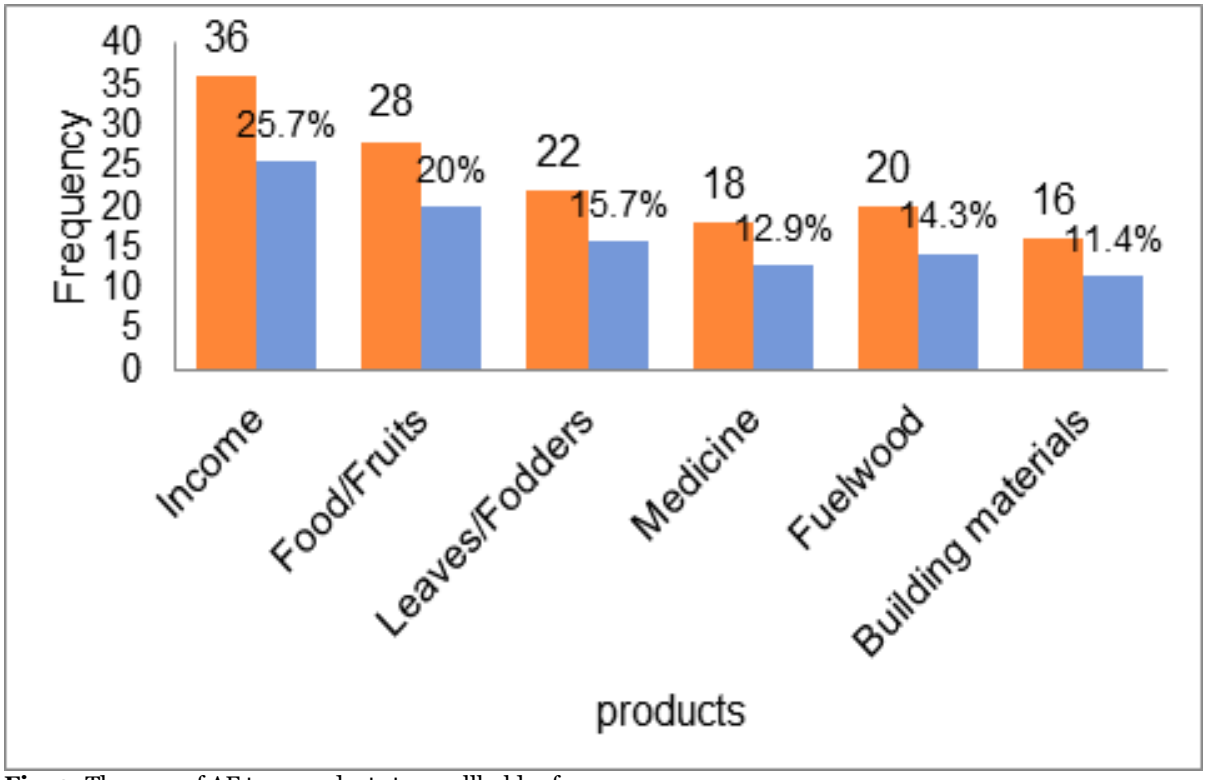

Fig. 2. The uses of AF tree products to smallholder farmers.

Moreover, Land sizes are significantly and positively related to farmers' income. This suggests that the farmers who have large land sizes participate in the planting of different tree species, which in turn it maximizes their income. This result was agreed with (Orisakwe and Agomuo, 2011) from Ekiti State, Nigeria, and (Abiyu *et al.*, 2012) from Ethiopia, who reported that farmers who have large land sizes participated more in tree planting than farmers with a relatively smaller size of land.

Conclusions

Smallholder agroforestry practices prevailing economic, social, and environmental benefits. Moreover, in the Gombora district farmers believed it was a means of providing soil quality improvement; mitigating climate change through carbon sequestration, recreational activities, and used for medicinal purposes. Furthermore, AFP increases the smallholder farmers' income through its product. However, every farmer did not fully implement the

AFP on his or her farmland. Therefore, the concerned stakeholders should encourage the farmers and create adequate awareness to promote agroforestry technologies in the district since it increases food security.

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