Research Article
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The contribution of a fruit tree-based agroforestry system for household income to smallholder farmers in Dale District, Sidama Zone, Southern Ethiopia

Abstract

Fruit tree based agroforestry system has great roles to play in the livelihood improvement and it provides multiple contributions of household income and supplementary food for smallholder farmers. However, there is limited quantitative empirical evidence on the contribution of fruit based agroforestry system. Therefore, this study was initiated to examine fruit tree based agroforestry system and its contribution of household income for livelihood improvement in Dale District. Data was collected through a combination of focus group discussions, key informant interviews, household survey and field inventories. A total of 145 respondents from three kebeles were interviewed and data were analyzed by using descriptive statistics and econometric analysis. The results revealed that the status of fruit based agroforestry in the study area varies with land holding size. Fruit trees such as; *Musa acuminate, Persea americana* and *Mangifera indica* were the major types of tree species grown in the system in the study area. The contribution of fruit for poor, medium and rich households was 3166.8 Birr, 3713.8 Birr and 1380 Birr respectively. The fruit tree contributes 24.75% for poor HHs, 23.34% for medium HHs and 5.16% for rich HHs from the total income. The average income earned from fruit trees was 2754 Ethiopian Birr (ETB) per year. Besides, the result from the econometric analysis indicates that access to extension service, family size, land size, and the number of livestock influenced the income from fruit trees. Further studies of examining of the market value chain, areas of intervention along the chain and economic value of the fruit tree based agroforestry system including environmental function served by the system is needed to fully understand the contribution of fruit tree based agroforestry system and livelihood improvement.

Keywords: agroforestry, contribution, fruit, household income

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Introduction

Agroforestry is an intensive land management system that seeks to optimize the benefits from the biological interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock.[1] Agroforestry involves the cultivation and use of trees in farming systems and is a practical and low-cost means of implementing many forms of integrated land management, especially for small-scale producers.[2] Agroforestry can reduce the risks associated with agriculture, small scale or large, and may also increase the sustainability of agriculture.[3] Such systems can, therefore, make a significant contribution towards reducing poverty and resource degradation in Africa. For instance, agroforestry technologies such as fruit trees can provide a more diverse farm income and reduce food insecurity.[4] Fruit tree based agroforestry system is one of agroforestry system which comprises combinations of plants to maximize the natural resource use efficiency and enhance total factor productivity.[4] Fruit-tree-based agroforestry is highly popular among resource limited producers worldwide due to its relative pre-production phase of fruit trees, the high market value of their products and the contribution of fruits to household dietary needs.[5,6] Tropical fruit tree species diversities are abundant in homesteads and farms of fruit tree growers' households and have a number of economic, social, cultural, aesthetic and ecological functions important to livelihoods. Fruit trees based agroforestry system has great roles to play in the livelihood of the farming community because of its multiple benefits. Some of the benefits are income generation, food, fuel, construction material, fodder and shading for shade loving crops.[7] Therefore, this study attempted to assess the status, contribution and factors in fruit based Agroforestry system for livelihood improvement of smallholder farmers in Dale District, Sidama Zone, Southern Ethiopia.

Materials and methods

Description of the study area

Dale is one of the District in Sidama zone, Southern Nation, Nationalities, and peoples Region of Ethiopia. Dale is located at about 320 km from Addis Ababa and 45km from Hawassa, the regional capital. Geographically, it is located 6° 50' 30'' to 6° 39' 30'' North and 38° 17' 0'' to 38° 32' 0'' East. The district has an altitudinal range of 800 to 2600 meter above sea level (Figure 1). Mixed agriculture, Enset, fruit tree and crops are the main livelihood strategy of the district, which is characterized by subsistence production. Annual and perennial crops are predominant and rain-fed agriculture is mainly practiced. The most commonly cultivated crops in the study area are Enset, Coffee, Maize, Haricot Bean and some other root crops such as sweet potato is one of the most common staple foods and whereas Coffee, fruit and tree products are a source of cash crops. Fruits such as Avocado, Mango and Banana, are cultivated both for household consumption and income generation.

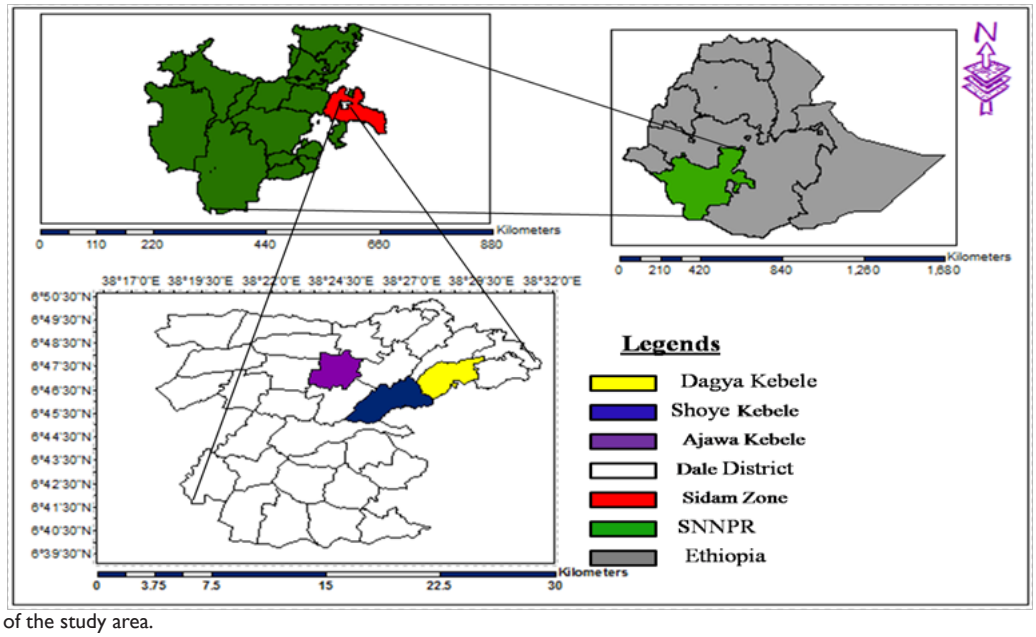

Figure 1 The map of the study area.

Sampling techniques

In this study, a multi-stage sampling technique was employed. Dale District was purposively selected as the presence of fruit trees on their home gardens and three potential kebeles (Showoa, Ajawa and Dagiya) were selected purposively from the study area. A reconnaissance survey was undertaken on October 2016 in order to familiarize with the study area and to obtain an insight into the farming systems. Ten percent (10 %) of the total household were randomly selected from each kebele. Households (HHs) with different wealth status who practing homegarden agroforestry practice were selected by using stratified sampling techniques. The sample households were stratified based on the basis of wealth classes (poor, medium and rich) with the help of key informants (KI). The wealth stratification was used to get a representative sample from all wealth groups and to assess the status of fruit trees found in homegarden. Hence a total of 145 households were considered for the household survey in this study (Table 1). The questionnaire was comprised of both open and close-ended questions regarding household characteristics (e.g. family size, land holding size, age, sex, education, distance from the market, access to extension, income sources). The questionnaire also incorporated amount of fruit produce per year, income contribution from fruit production. The interview was conducted through face to face in either head of the HHs or member of the household who is familiar for fruit tree production.

Methods of data analysis

The focus group and farm survey data were analyzed by using descriptive and econometric procedures. Quantitative data were analyzed by Statistical Package for Social Sciences (SPSS Version 16), STATA 9 software and Microsoft Excel 2007.

Descriptive analysis

Descriptive statistics like mean, standard deviation, percentages and tabular analysis were used to examine and understand the socioeconomic situations of sampled respondents.

Econometric analysis

The multiple linear regression analysis was used to explain the relationship between a dependent variable and one or more independent variables. It is also a technique that allows additional factors to enter the analysis separately so that the effect of each can be estimated.[8] It is valuable for quantifying the impact of various simultaneous influences upon a single dependent variable. Further, because of omitted variables bias with simple regression, multiple regression is often essential even when the investigator is only interested in the effects of one of the independent variables.[9,10]

Table 1 Distribution of sample households by wealth class with respect to kebeles

Kebeles	Total HH				Number of respondents			
	Poor	Medium	Rich	Total	Poor	Medium	Rich	Total
Showa	250	200	50	500	25	20	5	50
Ajawa	180	170	70	440	18	17	7	42
Dagiya	240	200	90	530	24	20	9	53
Total	670	570	210	1450	67	57	21	145

The general formula of the multiple linear regression models is:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_k X_k + \varepsilon$$

Where y is the dependent/explained variable and $x_1 \ldots x_k$ are the independent/ explanatory variables. In the case of this study xi… xk, were age, experience, family size, land size, access to extension service, distance from market, number of livestock kept, off farm activity and Y is income earned from fruit based agroforestry and ε is error term. The equation can be written as,

$$Income = \beta_0 + \beta_1 age + \beta_2 exp + \beta_3 family\ size + \beta_4 farm\ size + \beta_5 Ext + \beta_6 market\ distance + \beta_7 livestock + \beta_8 OFF +, + \varepsilon$$

Regression coefficients β_1, β_2 and…. β_n are known as partial regression or partial slope coefficients. β_1 measures the change in the mean value of y, E(y), per unit change in X_1*(*age*)*, holding the value of all other explanatory variables constant and β_0 is intercept of the model.

The multiple linear regression analysis/Ordinary Least Square estimations (OLS) was used to capture the cause and effect relationship between the dependent variable, gross income from fruit tree based agroforestry system and the independent variables.

Result and discussions

Households' characteristics

A total of 145 individuals' (households) of which 90.3% male and the remaining 9.7% female were involved in the study. Households with different occupation were involved in the study.The majority of the households (95.9%) age ranged from 18 to 64 and some proportion of the households (4.1%) households' age ranged above 65 years, showing that availability of more productive working.The result shows that almost all respondents are in the productive age category, whereas less than 5% of the respondents belong to age category beyond 65 years. Regarding the education level of the households, 26.8% were not attended formal education, 52.4% were attended primary 1st cycle (grade 1-4), and 21.4% primary 2nd cycle (grade 5-8) and the rest1.4% were high school (grade 9-10). The result shows that about three fourth of the fruit tree producers (75.2 %) attended formal education. But one fourth of the fruit tree producers (24.8%) did not attend formal education (Table 2). Farming experience of fruit producer's household head is an important variable considered in this study. The result shows that the sampled household heads have a minimum of 4 years of farming experience and a maximum of 50 years of experience in farming. The average year of farming experience was 21.64 years. The result shows that the respondents have good farming experience (Table 3). The average family size of fruit tree producers was 5.5 persons although it ranges between 2 to 12 persons with a standard deviation of 1.92 (Table 3). This shows that the household heads in the study area can be categorized in medium family size category. The result in Table 4 shows that distribution of the family size of respondents in three categories and 64.8% of respondents have a family size within the category 4 to 6 persons (medium family size) and 10.4 % of respondents have a family size of the category 1 to 3 persons(low family size). Whereas, about one fourth of the respondents (24.8%) in the study area have a family size of greater than 6 person's which is a large family size category. The result shows that the majority of respondents have a family size of 4 to 6 family members. As farming is one of the labor intensive activities that need more labor, the implication is that households in the study area may not be constrained by labour and the family members can engage themselves in different farming activities and can increase the income from fruit. This result is more evident as the majority of the respondents in the study area are already identified as they belong in the productive age category as described above. This result is consistent with the finding of ,[11] which shows that 47% respondents have a family size of 5 to 7 persons and found that farming is very labor-intensive and tedious because it is done manually in developing countries and the family's needs to have more members in order to provide sufficient labour to work on their farm land.

Table 2 Status of respondent on the base of sex, occupation and education levels (N=145)

Respondents states		No. of respondents	Percentage
Sex	Male	131	90.3
	Female	14	9.7
Age	18-64	139	95.9
	>65	6	4.1
Education level	Illiterates	36	24.8
	1-4 grade	76	52.4
	5-8 grade	31	21.4
	9-10 grade	2	1.4

Table 3 Farm experience and family size of the respondents (N=145)

Respondents	Minimum	Maximum	mean	Std. Deviation
Farming experience(year)	4	50	21.64	11.34
Family size(number)	2	12	5.5	1.92

Table 4 Family size of the respondents (N=145)

Category	Description	Frequency	Percent
1-3	Small	15	10.4
4-6	Medium	96	64.8
>6	Large	34	24.8

Thus it can be concluded that the family size of the household head is an important variable in smallholder agriculture notably in agroforestry. This is in line with the notion that large family size is normally connected with higher labor resources, which would enable a household to accomplish various agricultural tasks particularly during peak seasons.[12] The average land holding of the sample respondents was about 0.30 ha, 0.90 ha and 1.83 ha for poor, medium and rich HHs respectively. This means that the average land holding size for poor and medium HHs in the study area is below the national average of 1.18 hectare.[13] This shows that the rich group has the largest land holding and the poor have the smallest in the study area (Table 5). Regarding the proportion of the households home garden size, the result shows that 46.9%, 38.6% and 14.5% of the total land holding in small, medium and large respectively were allocated to home garden

agroforestry practices (Table 6). Accordingly, compared to their total landholding size, rich and medium households owned relatively larger landholding size than the poor households; they preferred production of annual crops rather than fruits. The result is agreed with[14] who reported that small farms allocate a large share of their land for home gardening compared to those with medium and large size farms in Western Amhara for reason of economies of scale, households with large farm sizes overridingly concentrate on annual crops like maize that can satisfy their demand in the absence of fruits. The dominant source of income in the study area is from agricultural activities. However, the ofarm activities have a great potential to provide additional incomes during the slack season to rural households. The result in Table 7 shows that (97.2%) of respondents in the study area had to access to extend service whereas, only (2.8 %) had no access to extend the service. This implies that the DAs reached the majority of the respondents. According to the survey result, the development agent (DA) help farmers by providing training on crop cultivation and harvesting, livestock production and management, land management, visiting field activities and other services. The farmers were attending training in Farmers Training Center (FTC) in their respective kebele. Therefore access to extension service for farmers is more recommendable to increase the dual benefit from the agroforestry system, economic benefit and environmental benefit. This is supported by[15] who revealed that farmers who had access to extension service from the government through the office of agriculture including technical support, training and to some extent provision of improved planting material had improved production from the whole system and improved their livelihood.

Table 5 Mean (±SD) Land holding size among wealth category (N=145)

Wealth	Minimum	Maximum	Mean (±SD)
Poor	0.24	0.5	0.30±0.08
Medium	0.56	1	0.90±0.25
Rich	1.2	2.5	1.83±0.55
Total land			0.72±0.55

Table 6 Amount of home garden agroforestry in fruit tree practice (N=145)

Homegarden/ha	Frequncy	Percentage
Small(<0.5)	68	46.9
Medium (0.5-1)	56	38.6
Large(>1)	21	14.5

Table 7 Access to extension service (N=145)

Extension service	Frequency	Percent
Yes	141	97.2
No	4	2.8

Status of fruit tree based Agroforestry (FTBAF) practice in the study area

Mixed homegarden, locally called as "Gattae"/Qaie, is an essential part of the food production system in the study area. Distribution of the fruit tree species varied across the wealth categories. The result in Figure 2 shows that the majority of the rich household 96% have grown *Persea americana*, 95% have grown *Musa acuminate and* 57% *Mangifera indica* indicating that they were the most recorded fruit tree species in the study area. Whereas, in the medium wealth class households, the most recorded fruit tree species are *Persea americana* which is grown by 96% of the respondents, *Musa acuminata* by 91% of the respondents and *Mangifera indica* by 55% of the respondents. Whereas, for the poor households the results the total fruit tree species recorded were *Persea americana* by 91%, *Musa acuminate* 80% and *Mangifera indica* 50%. The result revealed that in all wealth categories the fruit trees such as; *Musa acuminata*, *Persea americana* and *Mangifera indica* are frequently represented by more individuals. While *Psidium guajava*, *Prunus persica*, *Citrus medica, Annona senegalensis, Citrus sinensis*, *Citrus aurantifolia* and *Casimiroa edulis* are the less frequent fruit tree species (Figure 2). The overall result shows that the three fruit tree species mentioned above were the most recorded ones in comparison to the other fruit tree species. The possible reason is that most of the time households prefer high value fruit tree species and good marketability, such as *Musa acuminata*, *Mangifera indica* and *Persea Americana*.[16]

Table 8 Amount of fruits produced in fruit tree based agroforestry (N=145)

Type of fruits	Number of HHs	Total Volume of production in quintal	Percent
Banana	136	1698	44.39
Avocado	126	1224	32
Mango	77	268	7.01
Papaya	49	149	3.9
Others fruits	30	486	12.7
Total		3825	

Source: survey 2016.

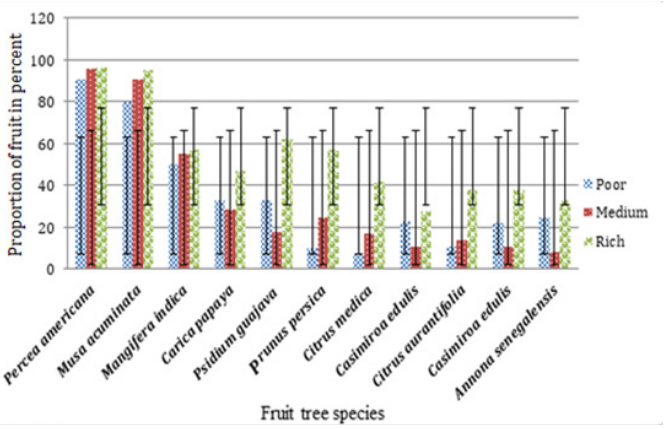

Figure 2 Proportion of fruit tree producers/households with respect to the type of fruits and wealth category (N=145).

Amount of fruit produced in fruit tree based agroforestry

Among the total volume of fruits production, Banana comprises 44.39% and followed by Avocado 32%, Mango 7.01%, Papaya 3.9% and other fruits accounts (12.7%) (Table 8) and (Figure 3). The result indicates that Banana, Avocado and Mango were the three most dominant fruits produced by households in the study area.

The contribution of FTBA for income of smallholder farmers

The contribution of fruit for poor, medium and rich households was 3166.8 Birr, 3713.8 Birr and 1380 Birr respectively in the study area. The fruit tree contributes 24.75% for poor HHs, 23.34% for medium HHs and 5.16% for rich HHs from the total income. The income that farmers earn from fruit production was investigated and the result shows that most respondents plant different types of fruit trees in the study area both for income generation and consumption. The amount of income earned from fruit tree based agroforestry system depends on the type of fruits. The average income earned from fruit trees was 2754 Ethiopian Birr (ETB) per year. This indicates that fruit tree production in the agroforestry system plays a great role in generating additional income and contributes to the livelihood of smallholder farmers in the study area. The finding was in line with[17] who reported that home garden Agroforestry contribute various benefits to households and elsewhere in Ethiopia.[18] The poor and medium households got relatively higher annual income from fruit production than rich housheulds in the study area.

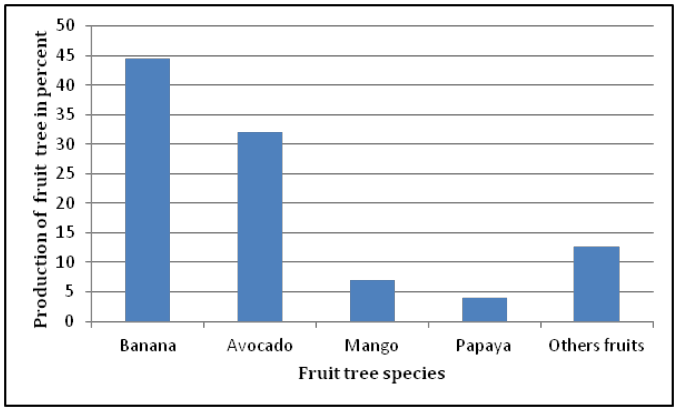

Figure 3 Fruit tree production in percent in the study area.

The mean annual net income from fruit trees was highest for medium followed by poor households. The income difference among wealth categories could be due to the variation of fruit trees and the size of land to plant a given fruit tree species.[19] This was perhaps due to more dependency of the rich HHs in crop farming or related activities than fruit production. This finding was supported by what was reported by[20] in India. Fruits contribute to livelihoods through income generation and as a safety-net for consumption and income smoothing[21] and fruits play an important role especially during a time of famine and other stress as food, nutrition and cash income.[22] In the study area households used fruits for both household consumption and as a source of income. However, according to the discussants, household consumption of fruits was higher in rich wealth categories due to their diverse livelihood sources than the poor. Contrarily, poor households usually deliver most of the fruit they produced to the market since they consider it as their main source of income. According to the survey result, about 89.98% of incomes were earned from on-farm activities and remain 10.02 were from off-farm activities (Table 9).

Factors that influence the contribution of FTBAF for household's income

The results reveal that four of the eight explanatory variables included in the analysis such as extension service, family size, land size and number of livestock kept were statically significant, whereas, farming experience, education, distance from market and household age were not significant ($p<0.05$) (Table 10). This implies that the four predictors which significantly explain variations had an impact on the household's net income in the study area than others. Increase in size of these predictors brought about an increase in the household's annual net income at magnitudes indicated by their respective coefficients and thus contributing to livelihood improvement.Consistent with the prior expectation farm size was found to be positively associated with income generated from agroforestry practice. Therefore, those who have large farm size get high income than those who have a small size. The coefficient value of 8.579 indicated that other factors held constant when the farm size increase by one unit the income generated from FTBAF increase by 8.579 ETB. This is because when there is a large size of land there is more diversification of components, which increases the income from the system. This finding revealed that the increase of components of agroforestry can increase the income of the system, but the diversification of component is directly affected by the size of the farm.[23,24] Livestock holding by the household as measured by Tropical Livestock Unit (TLU) is also found to influence the income from agroforestry system. The result in table 10 indicates that the possession of livestock positively influences the income from agroforestry system. In line with the prior expectation, it is positively associated with income generated from fruit-tree based agroforestry system. The coefficient value of 1.273 indicatedthat other factors held constant when the number of livestock increases by one unit, the income generated from FTBAF increase by 1.273 ETB. In a ruralarea, livestock dung is also the major source for soil fertility. Thus, farmers who have more livestock can get more dung, which increases soil fertility and increase the yield of the agroforestry system. Therefore, the number of livestock has a positive impact on income generated from agroforestry system. This result supported by a study conducted in Nepal livestock is a major source of income, manure for agricultural crop and power for ploughing and the number of tree species per household increased with the number of livestock units.[25] Family size is statistically significant and positively associated with the income generated from the fruit-tree based agroforestry system. The coefficient value of 5.1624 indicated that other factors held constant when the family size increase by one unit the income generated from FTBAF increase by 5.1624ETB. This positive impact may be due to the nature of farm activity, which is labour intensive, and that needs more family labour. The households who have more family size are favorable to supply more family labour. The finding was consistent with the study carried out by[26] in Nigeria and other studies elsewhere in Ethiopia, large family size has a positive impact on farm income.[27] The regression result indicated that extension service is statistically significant. Consistent with the prior expectation it is positively associated with the income generated from the fruit-tree based agroforestry system. The coefficient value of 3.1008 indicated that other factors held constant when the farmers have access to extension service it increasethe income generated from FTBAF by 3.1008 ETB. This is because extension service is a means to deliver the message that comes from the research center and development agencies at a different time and enhance the accuracy of implementation of the technology which is important for improving farming activities. Extension services are also important to expand the knowledge and skills of farmers to increase income. Similar study by.[28] from Tigrai indicated that provision of technical advice on farming issues such as what to produce, how to produce and when to produce to facilitating credit availability and input supplies and even to the provision of market information and capacity building training to farmers and other study report.[27] shown that membership in extension service program is positively associated with total crop production.

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Table 9 Annual contribution of fruit (Ethiopian Birr) and proportion of HHs income among wealth category (N=145)

Income source	Mean annual income in ETHB among Wealth			Contribution in %		
	Poor	Medium	Rich	Poor	Medium	Rich
Crop	4146.8	5648.7	20680	32.41	35.5	77.39
Trees	3351.6	2953.7	2417	26.2	18.56	9.05
Livestock	587.4	892.2	937	4.59	5.61	3.51
Fruit	3166.8	3713.8	1380	24.75	23.34	5.16
Of-.farm	1542.1	2703.8	1307.1	12.05	16.99	4.89
Total	12794.7	15912.2	26721.1	100	100	100

Source: survey, 2016.

Table 10 Multiple regression result of factors to contribute to HH's net income from FTBAF (N=145)

Variables	Beta coefficients	Std. Error	t	p-value
Age of HH	0.165	0.3	0.55	0.56
Extension	3.1008 ***	0.24	12.92	0
Family size	5.1624 ***	1.08	4.78	0
Experience	0.054	3.37	0.056	0.57
Education	0.3216	0.48	0.67	0.51
Market dist.	-0.684	1.52	-0.45	0.65
Land size	8.579 **	3.73	2.3	0.002
TLU	1.273*	0.67	1.9	0.006
Constant		17.14	-2.53	0.01

Note: *** Represents less than 1% significance level, ** represents less than 5% significance level and * represents less than 10% significance level.

The regression result indicated that extension service is statistically significant. Consistent with the prior expectation it is positively associated with the income generated from the fruit-tree based agroforestry system. The coefficient value of 3.1008 indicated that other factors held constant when the farmers have access to extension service it will increase the income generated from FTBAFS by 3.1008 ETB. This is because extension service is a means to deliver the message that comes from the research center and development agencies at a different time and enhance the accuracy of implementation of the technology which is important for improving farming activities. Extension services are also important to expand the knowledge and skills of farmers to increase income. Similar study by[28] from Tigrai indicated that provision of technical advice on farming issues such as what to produce, how to produce and when to produce to facilitating credit availability and input supplies and even to the provision of market information and capacity building training to farmers and other study report[27] shown that membership in extension service program is positively associated with total crop production.

Conclusion

The study has revealed that fruit tree based agroforestry system contribute several products. Financial analysis showed that the fruit tree based agroforestry practice is more profitable land use system than mono cropping land use system. Farm size, family size and number of livestock found to be the most important factors that affect the practice of fruit tree based agroforestry system. Further studies of examining of the market value chain, areas of intervention along the chain and economic value of the fruit tree based agroforestry system including environmental function served by the system is needed to fully understand the contribution of fruit tree based agroforestry system for household income to livelihood improvement small holder farmers.

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Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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