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Full length Research paper

Assessing contribution of agroforestry in sustaining the rural livelihoods and factors affecting their adoption:-the case of Hadero-Tunto District, South Ethiopia

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Agroforestry practices are one of the most important land use systems that improve the livelihoods of farm families. Densely populated areas such as Hadero-Tunto district, the importance of this land use system is high. There are various types of AFPs in the study area, but information on their management practices, benefits, and expansion is rather limited. Households for the formal survey were selected using stratified and simple random sampling. Data were collected from 140 households through structured interviews, focus group discussions, key informant interviews, and field observation. Data were analyzed using descriptive statistics and econometric analysis. Logit model was used to identify the factors affecting the expansion of agroforestry practices (AFP). The result of the study showed that home gardens, living fences, parklands and border plantations were the most commonly adopted agroforestry practices. Farmers in the study area used various management practices (e.g. fertilization, composting, etc.) to manage AFPs, and activities such as pruning, clearing, thinning, weeding, etc. were used to manage tree species. The result of the econometric logit model used to identify the factors affecting the expansion of AFPs showed that five variables (farm size, source of income, farming experience, family workload, and education) had a statistically significant effect on the expansion of AFPs.

Key words: Agroforestry; Smallholder-farmers; Logit Model; Livelihoods; Land use

INTRODUCTION

Bearing in mind that the rate of population growth is high, there is increasing level of poverty and shortage of farming land, the necessity for different modern machineries that would increase food production, including improved varieties of crops and genetically hybrid animals, no-timber forest products and in addition to ensure sustainability of the use of land the attention cannot be given (Young, 2004). Finding an alternative land use system that is culturally acceptable to farmers and economically and ecologically sustainable is a preoccupation of international communities. Today the farm communities' uses different land use systems like Agroforestry land use system which includes the mixture of woody perennials, agricultural crops and animals (these components are integrated in different arrangements and/or sequence)to increase the productivity and production of agriculture (ICRAF, 2003).As suggested by (Rocheleau *et al*, 1986) several development experts found that agroforestry land use system as a new solution to rural development needs. An agroforestry practice denotes as a distinctive arrangement of components in space and time (Nair, 1993). Examples of agroforestry practices are tree home gardens, woodlot, windbreaks/shelterbelts, boundary planting, live fences, alley cropping, improved fallow, Taungyas, plantation crop combinations, silvopastoral practices, Agroforestry for fuel-wood production, intercropping under scattered or regularly planted trees, Agroforestry for reclamation of problem soils, Buffer – zone agroforestry, apiforestry and aquaforestry. Therefore, Agroforestry practice is a land use system in

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which diversified agroforestry products like non-timber products (i.e., gums, resin, essential oils, tannins waxes and fiber) and other products like fuel wood, fodder, food and fruits can be harvested (Rehm and Espig, 1991).As indicated in the findings of (Oram, 1993) wide ranges of products are obtained from agroforestry which diversifies income of farm communities in order to secure subsistence life and to buy food. As indicated by (Nair, 1993)diversified products harvested from agroforestry practices help the farmers to meet their basic needs and reduces the risk of the total failures of production system.

Agroforestry plays a great role (production and protection role) for environment like, erosion control and/or soil conservation by the presence of permanent soil cover and construction of different soil and water conservation structures as a barrier for run-off. And also they play an important role in maintaining the fertility of soil through the incorporation organic matter in to the soil nutrient impelling from the layers of the soil through the roots of trees. The nutrients released from the roots of different tree species crop growth, production and productivity and enhance nitrogen fixation or maintain soil physical properties (Young, 1989).Also, agroforestry practices, through different products, help farmers to pay schools fees for the children, provide house building materials, and fodder for the animals, honey and stakes among others. An Agroforestry practice contributes in diversifying income of farm communities and they are able to keep their health and increase social relations among communities. Agroforestry is the land use system in that helps in helps to alleviating deforestation, combat depletion of land productivity, and as a result, can play important role in reducing poverty of the rural communities (ICRAF, 2001).

Agroforestry contributes in providing different products to rural communities in the form of medicines, feeding materials for livestock, fiber, gums, food and nutritional requirements. In addition many agroforestry products like honey, wax and bamboo generate income to rural communities once they are marketed, hence of improving the well-being or livelihood of rural populations (FAO, 2009).

This study has determined the contribution of agroforestry practices in sustaining to the livelihoods of rural farmers in Hadero-Tunto District. The results also can be used for decision making on agroforestry use in order to improve the well-being of the rural people while promoting the sustainable use of agroforestry practices without compromising our environment.

The combination of several types of products in agroforestry, which are both subsistence and income generating helps farmers to meet their basic needs and minimizes the risk of the production system's total failure. In Agroforestry system there is planting of multipurpose tree species which helps in combating reduction of the productivity of land because of its potential for water and soil conservation and can help to mitigate deforestation and as a result contribute to the alleviation of rural poverty (ICRAF, 2003).

There is no wonder that it is promoted to enhance adoption of agroforestry in developing countries by the farmers in a land with low productivity and enforced to be cultivated for long time which gives huge agricultural and environmental potential of this land use system. Diversified agroforestry products obtained from different agroforestry a practice (like, food, fodders for animals, building materials and other non-timber products) which helps in diversifying the income sources of farm communities. The aims this studies were: i) to assess the contribution of agroforestry systems / practices in improving livelihoods and food insecurity in the study area; ii) to examine the attitude of farmers towards agroforestry systems and iii) to investigate the major problems encountered during the expansion of AFPs.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Hadero Tunto District of the Kembata Tembaro Zone in the SNNP, which is located at about 343km and 151km south of Addis Ababa and south west of Hawassa, the regional capital, respectively. The Hadero Tunto Zuria District was composed of 16 administrative Kebeles and bordered by Wolaita Zone in the south, Qachabira District in the east, Hadiya Zone in the north and Tembaro District in the west. Astronomically, it is situated between 7^0 7'30''19'and30''N7 lat and from 37^0 34' 30''43'30''. Altitude ranges from 1300m and 2600m a.s.l. The total area of the District is about 16,689.64km^2 (HTZWAO, 2012).
Map of the Study area.

In the study area there are three different agro-climatic zones like Kolla (1%) Weynadega (87%) and Dega (12%) The study area consists of three distinct agro-climatic zones, Kolla (1%), Weynadega which is dominant agro-climatic zone (87%), and Dega (12%). The mean annual rainfall ranges from 800mm - 1200mm with mean annual temperature of 18oC-32oC. Although the rainfall has bimodal distribution, most of the crop production takes place during the "Kiremt" (May to September) season. The dry months in the area extends from middle of October to end of March and May is also included in dry season (HTZWAO, 2012).

The District was once known by its dense natural forest mainly found in the periphery of Omo River and near to the main town of Mudula and the plantation forest in the degraded areas of the District until the down fall of the Derge regime. Currently a number of small areas are covered by different tree species which are multi-purpose tree species like *Ficus spp., Acacia spp*., *Cordia africana* and other endemic vegetation. Mixed agriculture (crop-livestock production) is the main livelihood strategy of the District, which was characterized by subsistence production. This study area was mainly characterized by rain-fed agricultural system and annual corps are predominant. The most commonly cultivated crops in the study area are maize, teff, and some other root crops such as sweet potato and taro are some common staple food, whereas coffee and gingers are cash crops. Fruits such as avocado, mango and banana, are cultivated for household consumption and income generation. Livestock like cow, ox, sheep, goat, and donkey are common in the area.

Methods of data collection

Sampling procedure and data collections

There are different formulas that can be used to determine sample size for the study. As stated by (Green 1991), with increasing number of independent explanatory variables (IVs) the general rule of thumb is no less than 50 participants for a correlation or regression was formulated. And also he provides the procedure that was used to determine regression sample sizes. He suggests $N \geq 50 + 8$ m (where m is the number of IVs) for testing the multiple correlations. Where N = the minimum number of subjects or a minimum ratio of number of subjects to number of predictors (m). Using the general rule of thumb a total of 138 respondents were selected [i.e., N ≥ 50 + 8m (50 + 8*11) = 138].Then Stratified sampling was employed to identify farmers as practitioners and non-practitioners of agroforestry practices. Both practitioners and non-practitioners of AFPs were included in the survey. For this study a total sample of 140 individuals (80 practitioners and 60 non-practitioners) were selected by simple random sampling method and interviewed.

Data Collection

Before actual data collection, a pre-testing questionnaire was conducted in order to revise and adjust those questionnaires that couldn't provide the required answers. Next to that, the required data was collected through farm household survey using revised and well-structured questionnaire. Five enumerators were selected with the help of the district agricultural office. The enumerators were college graduates and above and working as development agent in the Kebeles. They were familiar with the study Kebeles. They also speak the local language and know local customs and traditions. Their role was to convince farmers to voluntarily respond without hesitation and give actual information during the interview. The role of the researcher at the interview was to forward the interview question to the interviewees and facilitate the focus group discussion.

Due to the limited period of time for the study, the key informants were used to quickly provide or generate new information through interactive learning, knowledge sharing and assurance of high-level of local people's participation in research. During the study, relaxed relationship, open dialogue, brainstorming and mutual sharing of knowledge, skills and experiences were included to generate new information from KIs.

Data Analysis

The responses to the individual household questionnaires with respect to individual technologies was processed and analyzed using standard univariate and bivariate statistical techniques (frequency, tables, cross-tabulations, graphs, and mean) using the software SPSS V20 (Agresti and Finlay, 2009;Bryman and Cramer, 2009).

Descriptive analysis was used to explain and interpret the data obtained from household survey of the study. Information that is obtained from the respondents includes their socio-economic characteristics (such as age, gender, marital status, household size), as well as farm size, types of agroforestry practices practiced, and the benefits obtained from AFPs were analyzed. Combinations of different statistical tools were used for this study. These includes descriptive statistics (e.g. tables, means, frequencies and percentages), and to examine the socio-economic characteristics of the respondents. The result of the questionnaire survey was analyzed by the help of statistical package for social sciences (SPSS) version 20.0 Statistical Software and Microsoft excels 2010 after editing, coding and arranging the raw data collected from the household survey.

Analytical Model

In order to conduct this study, a model reflecting the observed implementation of early introduced agroforestry practices on any given farm was needed. Such observations reflect explanatory variables (i.e., factors influencing expansion agroforestry practices). Linear probability models estimated by ordinary least squares are not applicable since they cause certain problems. Instead a logit model was used. Maximal likelihood method overcomes the majority of the problems associated with linear probability models that provide parameter estimates that are asymptotically consistent and efficient, allowing the probit and logit model to serve as an analogy to regression t-tests(Pindyck and Rubinfeld, 1981)

In a logit model, the probability of a particular outcome, such as agroforestry, is determined by a set of explanatory variables that were hypothesized to influence it (Neupane et al., 2002). In our study we used the logit model based on the cumulative logit probability function, as Pindyck and Rubinfeld (1981) noted that it is computationally easier to use than the other types.

The logit distribution function for practicing agroforestry practices can be specified as [20];

$$Pi = \frac{1}{1 + e^{-Zi}} = \frac{e^{Z}}{1 + e^{Z}} \qquad (1)$$

In this equation, Pi is the probability that the ith farmer will practice agroforestry, ranging from 0 - 1. P is the observed response of the ith farmer (i.e., a binary variable, P = 1 for a practitioner, P = 0 for a non-practitioner), and Zi is a function of mindependentvariables (X_i) and stated as:

$$Zi = \beta o + \beta_1 X_1 + \beta_2 X_2 + \dots\dots\dots + \beta_m X_m \qquad (2)$$

β_i stands for the parameters of slope and $\beta_0$representsfor the intercept. The slope of the model indicates that log-odds play a great role tells how the log-odds approvingpractitioners of agroforestry practices change of explanatory variables.

The probability of non-occurrence occasion (1- P_i), if $P_i$is the chance of occurrence of an event, was calculated (Gujarati, 2004),

$$1 - Pi = \frac{1}{1 + e^{Zi}} \qquad (3)$$

The formula Pi/ (1-P_i) indicates the odds ratio variables approving of occurrence of the event, this ratio (probability of occurrence of an event to the probability of non-occurrence of an event), was specified as;

$$\frac{Pi}{1 - Pi} = \frac{1 + e^{Zi}}{1 + e^{-Zi}} = e^{Zi} \qquad (4)$$

And

$$\frac{Pi}{1 - Pi} = \frac{1 + e^{Zi}}{1 - e^{-Zi}} = e^{\beta.} + \sum_{i=1}^{m} \beta i\, Xi \qquad (5)$$

$Z_i$represents- a function of m explanatory variables (X_i) and also explained by taking natural log of two sides of the equation (4);

$$\ln\left[\frac{Pi}{1 - Pi}\right] = \ln\,[e^{\beta.} + \sum_{i=1}^{m} \beta i Xi] = e^{Zi} \qquad (6)$$

If U_i(the disturbance term) is considered in to account the model becomes:

$$Zi = \beta o + \sum \beta i Xi + Ui \qquad (7)$$

Hence, the above econometric model was used in this study to treat eleven explanatory variables (IVs) were hypothesized to see their influence on the practice of agroforestry practices in the study area.

Test for Multi-Collinearity: -It is important to check multi-Collinearity problem for continuous and dummy variables before running the model. Multi-Collinearity is a high degree of correlation among several independent variables. It is commonly occurring when a large number of independent variables were incorporated in a regression model that may measure the same phenomena (Jeeshim and KUCC, 2002). As indicated by (Maddalla, 1992) multi-Collinearity was defined to a condition which becomes unable to separate refers to a situation where it becomes difficult to disentangle the separate effects of explanatory variables on the dependent variable because of strong relationships.

Existence of multi-collinearity was tested by two measures. The first measure is a Contingency coefficient (CC) for the association between dummy variable and Variance Inflation Factor (VIF) for continuous variables. Variance Inflation Factor (VIF) was used to test the existence of multi-Collinearity for association among the continuous variables. If the value of RJ2 is greater than 0.90, the variable is said to be highly collinear and as Rj2 increase towards unity, which is considered as the Collinearity of Xj with the other repressive increase (VIF increases) as a rule of thumb, if the VIF greater than 10. Multi-Collinearity of continuous variables was also being checked using Tolerance.

As indicated by (Gujarati, 2003) tolerance is zero if it is perfectly correlated with other explanatory variables, whereas it one if Xj is not correlated with the other explanatory variable.

VIF (X) = $(1\text{- } Rj^2)^{-1}$

$$\mathrm{TOL} = \frac{1}{\mathrm{VIF}}$$

Where, R_j^2 refers to coefficient of determination between explanatory variables

VIF refers to variance inflation factor

TOL refers to tolerance

Contingency coefficient was used to check multi-Collinearity or association between discrete variables. It measures the relation between the row and column variables of a cross tabulation. The value ranges between 0 and 1, with 0 indicating no association between the variables and value close to 1 indicating a high degree of association between the variables.

Variables Descriptions and Expected Signs

The main hypothesized variables expected to influence the practice of agroforestry practices in the study are explained in the following way.

Dependent variable

Agroforestry Practices (AFPs): It is a dependent variable and it is one of the land use system that is practiced in the study area.

Independent variables:

The following independent variables (explanatory variables) are hypothesized to influence the practice of AFPs in the study area.

Age (X_1): It is a continuous variable and measured in years. Aged households are believed to be wise in resource use and it is expected to have a positive effect on practicing AFPs. As an individual stays long, he/she will have better knowledge and will decide to allocate more size of land to practice AFPs. In practicing of agroforestry practices the age of household is an important factor. For instance, in Western Uganda younger heads of households are more likely to practice agroforestry technology compared to the older farmers (Young, 1989).

Farm Size (X_2): It is a continuous variable and measured in hectares. The partiality of the farmers to cultivate more food for their household refers to farm size. As indicated by the findings of (Chitere, 1985) in central Kenya land size influences on farm tree planting. and also farmers were unwilling or reluctant to plant trees on their farms because trees shade on crops and their farms were small and the farm size influences the practices. Tree species, crops grown, farm size and local planting practices were found to influence Agro forestry practice in Western Kenya (Lal, 1993). Therefore, from this we can understand that there is a positive relation between agroforestry practices and the farm size; i.e., as the size of farm increases the farmers got the chance to practice agroforestry practices.

Sources of Income (X_3): It is a continuous variable and most studies show relationship between the practicing of agroforestry practices and income as a direct one. For instance, in Nigeria, practitioners were older, wealthier farmers who own more than average amounts of land (FAO, 1989). Therefore, in this study it is expected to be positive effect for probability income of farmers to practice agroforestry practices. And also the studies undertaken by (Hoekstra, 1985) indicates that high-income farmers may be less risk or unwilling, have more access to information, have a lower discount rate and longer-term planning horizon, and have greater capacity to mobilize resources in order to practice agroforestry practices.

Education(X_4): This is a continuous variable; this represents the level of formal schooling completed by the household during the survey time. It assumed that formal schooling is expected to enhance farmer's ability to perceive, interpret and respond to new events. Furthermore, education level increases farmer's ability to get process and use information and increase farmers' willingness to practice a new technology. It increases the awareness and skill of farmers to adopt the new farming technologies and solve the problems that they face during the farming seasons. In fruit based agroforestry system education increases the income of farmers positively (Adekunle, 2009).

As indicated by (Misiko, 1976) that the relationship between a farmer's level of Education and farm practice is indirect except where persons learn new practices in school and where this is not the case, education may merely create a favorable mental atmosphere for acceptance and practicing of new practices (agroforestry practices). It also improves the abilities of farmers to receive and analyze information that affects practicing of agroforestry technologies or practices (Ragland and Lal, 1993). Therefore, it is hypothesized that education influences the practice of AFPs positively. Previous research results have also revealed that education would influence the practice of AFPs positively.

Farming experience (X_5): It is a continuous variable. Farm communities with high farming experience have a better knowledge about the potential of the new innovated technologies than short experienced farm communities. Moreover, farmers with longer farming experiences will have a cumulative knowledge of agroforestry farming. Having long year of experience enables the farmers to expand and adopt the existing and/or newly innovated fruit based agroforestry system that those with lower experience (Ashenafi, 2011). In this study, this variable was hypothesized to be positively associated with fruit-tree based agroforestry system.

Family labor (X_6): This is a continuous variable and expected to have a positive effect on the practice of AFPs. Although labor is the only resource that women in many parts of Africa have at their disposal, female headed households are disadvantaged in that they face greater difficulty obtaining male labor needed to carry out different activities like land preparations and tree planting and pruning (Swinkels et al, 2002). In many parts of Africa, men have claim over women's labor, but women do not have similar claim over men's labor; in fact females in male-headed households as indicated in the findings of (Abbas, 1997)in certain parts of Africa are obligated females are enforced to work on male-ownedfarm fields which take superiority over their own farm fields. A household with large labor force can promote the practice of AFPs more than a household with small number of labor force. And also the study done by (Alavalapati, 2002) on agroforestry adoption and practicing in southern Malawi revealed that a positive relationship between agroforestry practicing and the number of active labour in the household that are engaged for farm work.

Availability of extension services (X_7): It is a dummy variable with value of one if a household head has access to extension and zero otherwise. Extension is assumed to have positive contribution to promote AFPs. There are several studies that have shown women were less exposed to extension services as compared to men. In Malawi as indicated in the findings of (Abbas, 1997) almost 19% of women had low access to different extension services delivered by extension workers compared to 81% of men household. In Ethiopia, the figures were 20% for women compared to 27% for men. In Uganda, women had 1.13% contacts with extension compared to men's 2.03% (Katungi *et al*, 2008).

Different to technical information on the management of natural resources between men and woman in Senegal indicates that communication with extension service providers improves skill and knowledge of farmers on innovated technologies (Moore *et al.,* 2001).

Gender (X_8): This is dummy variable that takes a value of one if the household head is male and zero otherwise. The practice of AFPs could also change the social material of a community by cutting down on the opportunities for group work and the chance for talking that goes with them. In most of the literature indicated that female headed households have low admittance to newly improved or innovated technologies (Green, 1993).

Knowledge for Management (X_9): This is a dummy variable taking value of 1 if the farmers have the knowledge to manage AFPs and zero (0) otherwise. It is assumed to have positive impact on the practice of AFPs. The change in management skills, extension services and knowledge brings change in production system. The study carried out on contributions of agroforestry practice in Ondo State, Nigeria, to environmental sustainability and sustainable agricultural production that state the highest proportion (70%) of the farmers in the rural communities lack formal education (Adekunle, 2009).

Access to market information (X_{10}): This is a dummy variable taking value of 1 if the farmers have access to market information and zero otherwise. It is assumed to have positive impact on the practice of AFPs. The better information farmers have the more likely they participate in AFPs. Therefore, it is believed that farmers who have access to market and up-to-date market information are more responsive to agroforestry technologies than those who have no access to market information. Hence, access to market information was hypothesized to influence agroforestry practices and it has a positive correlation with the practicing of agroforestry practices.

Livestock (X_{11}): It is a continuous variable. Livestock is a key element of certain agroforestry practices. Size of livestock was estimated based on tropical livestock Unit (TLU). Agroforestry adoption and practicing of these practices study in different countries indicated that livestock ownership positively influenced adoption and practice of agroforestry (Neupane et al., 2002, Zeleke, 2008). Thus, livestock is included in the model to positively affect adoption of agroforestry.

Table 1: Description of independent variables used in the model

№	Variables	Description of variables	Variable type	Expected signs or outputs
1	AGE	Age	Continuous	Positive (+)
2	GEN	Sex / Gender	Dummy (male = 1, female = 2)	Positive (+)
3	FaRs	Farm size	Continuous	Positive (+)
4	Edu.	Education	continuous	Positive (+)
5	FAREX.	Farming experience	Continuous	Positive (+)
6	SOINS	Sources of Income	Continuous	Positive (+)
7	AOESs	Availability of extension services	Dummy (yes=1, no=0)	Positive (+)
8	FLs	Family Labor size	Continuous	Positive (+)
9	AcTMIN	Access to market information	Dummy (yes=1, no=0)	Positive (+)
10	KOTMOTPs	Knowledge for the management of the practices	Dummy (yes=1, no=0)	Positive (+)
11	TLU	Value of livestock in TLU	Continuous	Positive (+)

RESULT AND DISCUSSION

Benefit of agroforestry

In order to get better insight on the benefit of agroforestry comparison of respondents who already have been practicing agroforestry (hereafter practitioners) and those who do not practice agroforestry (hereafter non-practitioners) is presented in this section.

Farmers' perception

In the study site respondents were alerted of the benefits of Agroforestry practices (i.e., economic and environmental) and had a constructive approach towards those practices. The results of the study indicate that most of the respondents approve Agroforestry practices increases soil fertility and that increases income of farm communities and reduces loss of crop (Table 2).

On study site, most of the products are sold at the farm gate or to the middlemen that travel around. In this study all practitioners of AF obtain foods, fuel-wood, animal feeds, and animal products from AFPs (Table 2 and 3). About 75% respondent practitioners also obtained construction materials and about 56% of them got medicine from AFPs. All respondent practitioners of AF got an animal feed from their Agroforestry practice. The study done by (Franzel and Tuwei, 2003) in the highlands of central Kenya and by (Bosma et al., 2003) in Cagayan de Oro, Philippines, support this finding.

All the respondents who planted Eucalyptus in boundaries form have realized its economic benefits. All Respondents have planted Eucalyptus and use for pole, construction material and firewood and it is also commonly used for charcoal.

Table 2: Number of practitioner and products obtained from Agroforestry Practices (N = 80) at the study site.

AF benefits	Frequency	%
Food	80	100
Fuel wood	80	100
Construction materials	60	75
Reduceprobabilities of total crop failure	75	93.75
Animal feed	80	100
Medicine	45	56.25
Animal products	80	100
Increased soil fertility	80	100

Table 3: Number of practitioner respondents and type of output of Agroforestry used for consumption and income generation (n= 80)

Products from AFPs	Total no. of respondents	Number of respondents	
		used for consumption (frequency)	used for income (frequency)
Fire wood	80	80	80
Timber	42	12	30
Home implements	80	80	31
Fruits	65	65	47
Construction materials	80	80	59

According to the respondents the firewood and charcoal activities from their AF practices are important for cooking food because both produce energy. (FAO (2008) asserted that the availability and contribution fire wood is crucial for the survival and well-being of rural community, enabling them to cook food to make it palatable and safe for consumption.

As respondents stated AFP contribute not only provision of firewood, but also has other positive impacts such as less wood fuel needs to be purchased by them, there is a low dependence of collecting fuel woods from natural stands, which indicates there is less time for fuel collection. This implies that household saves more time for income generating activities, especially for women, who are usually the major firewood collectors. Access to cooking-fuel enhances the farm a community with more flexibility that requires more energy to cook and to have better eating habit with a better nutritional profile.

Cordia Africana is the most popular tree species mainly for timber and expensive tree in the area as well as in the country. It has multiple economic benefits and environmental services.*Grevillea robusta* is the most common planted trees (95%) among the respondents due to its multi-purpose use (Table 4). About 62.5% of the respondents have realized the benefits of *Grevillea robusta* species, while 37.5% have not yet benefited because the trees have not matured to be sold or used as timber or poles or have not reached pruning time to get firewood. *Albizia gummifera, Croton macrostachyus* and *Acacia Obadiah* was planted by 81.25%, 72.5%, and 88.75% of the respondents respectively. However, during the study period, about 28.75%, 40% and 56.25% of the respondents have realized the economic benefits (Table 4).

Table 4: Number of practitioner respondents mentioning economic benefits of major tree species of AFPs (N = 80)

Tree/shrub species	Number of respondents that have these tree species		Number or respondents that realize economic benefit		Major uses type
	Frequency	%	Frequency	%	
Eucalyptus Spp.	80	100%	80	100%	1,2,3,
Grevillea robusta	76	95%	50	62.5%	1, 2,3,4
Cordia Africana	80	100	80	100	2, 3, 4, 5, 6
Albizia gummifera	65	81.25	23	28.75	3, 4
Croton macrostachyus	58	72.5	32	40	2, 3
Acacia albedia	71	88.75	45	56.25	2, 3

1= pole; 2= construction material; 3= fire wood; 4=timber; 5 =farm implements; 6=post

Comparison of income

In this section the benefits of Agroforestry, other land use system (especially, mono-cropping system) and off-farm activities were estimated based the net output gained (net income) from each land use. The benefit analysis of both systems requires the output data (net income) of two systems and off-farm activities. As it can be seen from table 5 practitioners and non-practitioners have different sources of income. For all practitioners of AF the major source of income was from Agroforestry products, followed by income from off-farm activities (54.3% households) and from other land use system (especially mono-cropping). Contrary to this for non-practitioner respondents the major means of income from other land use systems (43% households) followed by off-farm activities (31.4% households) (Table 5).

With regard to gross annual cash income, the result of this study revealed that practitioners obtain significantly higher gross annual cash income than non-practitioner respondents (Table 6). Animal products and trees and tree products are the major sources of income for the households in the study site. The overall mean income earned by practitioners from crops, livestock sales and products, trees and trees product sales 2009 E.C., production year was 4014.36 ETB (Table 6). On overall income obtained by non-practitioners were 2610.15 ETB on the same production year. This implies that practitioners obtain more income (65%) than non-practitioners which probably encouraged them to practice and expand AFPs better than non-practitioners and fulfill all the needs of their households better than non-practitioners. The income difference might result from the significant difference in land holding between practitioners and non-practitioners. The difference might also be due to the diversified benefits earned from the Agroforestry practices. Income difference of both practitioners and non-practitioners at the three KA was in the order of Lalo-Hadaro>Lesho>Mugunja (Table 6). Therefore, Agroforestry practices could enhance the livelihood of farmers at the study sites. The result of study is in line with the findings of (Neupane and Thapa, 2001) in Nepal who found that with the intervention of Agroforestry the mean annual net income of farm communities from Agroforestry was estimated $1582/ha compared to $804/ha ‘without’ Agroforestry intervention.

Table 5: Major means of income of respondents (i.e., both practitioners and non-practitioners) in the study site (N = 140)

Means of income	Practitioners Frequency (n=80)	Non-practitioners Frequency (n=60)
Agroforestry practices	80	-
Others land use system	58	60
Off-farm activities	76	44

Table 6: Mean annual on-farm net income obtained by the respondents in ETB (N = 140)

Kebeles	Practitioners	Non-practitioners
	Mean ±Std.	Mean ±Std.
Lalo Hadaro	4765.78^{a} ± 168.45	3048.26^{b} ± 133.97
Lesho	4017.58^{a} ± 98.49	2754.72^{b} ± 110.07
Mugunja	3259.72^{a} ± 109.67	2027.48^{b} ± 96.76
Overall mean	4014.36^{a} ± 125.54	2610.15^{b} ± 113.60

*Values having the different letter above are significantly different from each other (P<0.01) among practitioners and non-practitioners

Factors influencing expansion of AFPs

Table 7: Logistic Regression Result of determinant factors

Explanatory variables	Coefficient (B)	S.E	Wald	Sig.	Odd ratio [EXP(B)]
Age	.125	.081	2.370	.124	1.133
Farm size	2.909	1.017	8.185	.004	18.338***
Source of income	2.108	1.160	3.302	.0449	8.228*
Farming experience	1.586	.489	10.496	.001	4.883***
Family labor size	-.5575	.226221	.018	0.014	.5727**
Access to extension	2.101	1.472	2.037	.154	.122
Education	.102	.358	.081	.000	3.646***
Gender	1.790	1.082	2.736	.398	5.992
Knowledge for mgt	5.899	1.633	13.042	.776	1.107
Access to market information	.332	1.137	.085	.770	1.394
TLU	-.158	.174	.824	.364	.854
Constant	22.827	6.317	13.059	.000	.000
N = 140					
Pseudo R^2= 0.681					
Log pseudo likelihood = 31.440[a]					

***represents less than 1% significance level, ** represents less than 5% significance level, and * represents less than 10% significance level

The regression result shows that three variables, namely as farm size, farming experience and education were highly significant (at less than 1% probability level of significance) in influencing the probability of practicing AFPs (Table 7). The size of farm size influences expansion Agroforestry practices positively and this result is in line with the previous expectation. Therefore, those who have minimum farm size were limited to, practice Agroforestry practices as compared to those who have large farm size. The odd ratio of 18.338 indicated that, other factors held constant, the likelihood of a household in favor of practicing the AFPs increases by a factor of 18.338 over those who have small farm size. The regression result showed that as the size of land owned by an individual increases, the probability that an individual to practice the AFPs would increase. This could be explained by the fact that the main components of the agro-forestry system take longer to bear fruit, that it requires patience and financial stability. Therefore, those who have relatively larger land holding are likely to be patient enough and financially secured to enjoy the later benefit of the Agroforestry practice. These findings complies with the finding by (Chitere, 1985), indicated that farmers were unwilling or reluctant to plant trees on their farms because trees shade on crops and their farms were small and the farm size influences the practices. Tree species, crops grown, farm size and local planting practices were found to influence Agroforestry practice in Western Kenya (Kimwe and Noordin, 1994). Therefore, from this we can understand that there is a positive relation between Agroforestry practice expansion and the farm size; i.e., as the size of farm increases the farmers got the chance to practice agroforestry practices.

Farming experience was found to have a positive effect at a level of significance less than 1% on the practice of AFPs. The odd ratio of 4.883 indicated that, other factors held constant, the likelihood of a household in favor practicing the AFPs increases by a factor of 4.883 over those who are practicing other land use system. (Gibreel and Bauer, 2007) carried out the research and revealed that there is a positive effect of farming experience on adoption of at the level of 1% significant. (Nkamleu and Manyong, 2005) carried the research in Cameroon and revealed that experience of farmers affects the adoption of Agroforestry practices (like, improved fallow) positively and significantly and recommended that having high levels of farming experience improves the likelihoods of farmers which uses improve fallow.

Education was found to have a positive effect at less than 1% significance level on the practicing of AFPs. The odd ratio of 3.64592 indicated that, other factors held constant, the likelihood of a household in favor practicing the AFPs increases by a factor of 3.64592 over those who are not practicing AFPs. (Misiko, 1976) noted that, level of education as a socio-economic factor in the adoption or expansion of Agroforestry development and production system has been controversial and further noted that the relationship between a farmers level of education and farm practices is indirect except where persons learn new practices otherwise education prompts them to prefer better and well-paying jobs at the expense of their farms. This is further supported by Ragland and (Lal, 1993), they noted that education enhances one’s ability to receive and understand information but affects adoption behavior. However, (Amudavi, 1993;Nair, 1993) in their respective studies found that education was a significant factor in facilitating awareness and adoption of agricultural technologies.

On the other hand, source of income was found to influence the probability of practicing AFPs at less than 10% significance level. Source of income is one of the 11 explanatory variables regressed and it is statistically significant at less than 10% significance level. In line with the prior expectation, it is positively associated with the practicing of AFPs. The odds ratio 8.228 indicated that, other variables held constant, the probability of the household to practice AFPs will increase by a factor of 8.228 when compared to those who were practicing other land systems. This result complies with the finding (FAO, 1989) in Nigeria, practitioners were older, wealthier farmers who own more than average amounts of land and have different sources of income and obtain more income than non-practitioners. Therefore, in this study, it should be a positive impact, likely income of farmers to practice agroforestry practices. And also the studies undertaken by (Hoekstra, 1985) which revealed that income of the household is a very important factor that affects the expansion AFPs and indicates that high-income farmers (practitioners) may be less risk or unwilling, have more access to information, have a lower reduction rate and longer-term planning horizon, and have greater capacity to mobilize resources in order to practice Agroforestry practices low-income farmers (non-practitioners).

As an important variable, family labour size is statistically significant at less than 5% of the significance level. According to (Abbas, 1997) labor influences the practice of Agroforestry practices positively. A household with large labor force can promote the practice of AFPs more than a household with small number of labor force. However, contrary to the prior expectation, family size was negatively associated with the practicing of AFPs. The reason for the negative association might be due to the presence of the majority of non-practitioners in the age range of the active work force (i.e., from 22 years to 50 years). Thus, the negative association implied other land use systems are relatively labor intensive farming system than AFPs. The odds ratio 0.5727 showed that, other variables held constant, the probability of practicing the AFPs will decrease by 0.572663 than from those who practice the other land systems. Another study carried on western Sudan revealed that there is a negative association between with adoption decision and practicing of Agroforestry and total working days (Gibreel and Bauer, 2007), this result is in line with the result of the present study. On the other side, the research done by (Thangata and Alavalapati, 2003) the adoption of Agroforestry practice in Southern Malawi revealed that there is positive relationship between the number of people in a household that can contribute to farm work and this result is not in line with the finding of the present study.

Other variables such as age, access to extension service, gender, knowledge for the management of the practices, access to market information and total number of livestock were found to be statistically insignificant (Table 7).

CONCLUSIONS

This study was specifically undertaken to assess the contribution of agroforestry to the maintenance of rural livelihoods and the factors affecting their adoption in the Hadero-Tunto district. There are a variety of Agroforestry technologies like homegarden, live fencing, park land, and boundary plantation, which have been commonly adopted in the study area. As the findings of this study indicate, these practices receive different management activities by household members (such as Planting, weeding, and manure and compost application). Activities like pruning, thinning, coppicing, and pollarding were used by farmers in the study area for the management woody or tree species. Farmers in the study area use several criteria including used for construction, increase soil fertility, fast decomposed, used for the shade, palatable leaves by the animals, easy for microorganisms, having low branch, having sparse crown and unpalatable leaves by the animals to prefer and integrate trees in to AFS.

Agroforestry technologies practiced in study area provide many benefits to the farmers including control of floods, fuel energy provision, construction materials, fodder provision, medicine and animal products, soil erosion, and boundary marking.

The outcome of the logit model indicates that four variables are positive and one variable that is negative and important influences the expansion of agroforestry practices. These variables were (farm size, source of income, farming experience, and education influence positively and family labor size influence negatively) have statistically significant influence on the expansion of AFPs in the study area. Generally, the significant variables were consistent with the priority expected sign except family active labor size.

Data Availability

The analyzed data during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no competing interests.

Authors Affiliations and Contributions

Currently we (both authors) are working as Lecturer and Researcher at Wachemo University (Department of Natural Resource Management). **DD** was in charge of the design, approach, formal analysis, inquiry, initial draft writing and presentation. **AA** was involved in the concept, approach, review writing, and editing.

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