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Determinants of Income from Moringa Tree based Agroforestry Practice in Konso, Southern Ethiopia

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Abstract
Agroforestry is praised for its benefit in balancing economic and environmental goals although its income differs from house hold to house hold. This study was carried out to examine determinants of income from Moringa tree based agroforestry practice. The study employed focus group discussion, key informants interview, and household survey for data collection. The data obtained via these techniques were analyzed by using descriptive statistics and econometric analysis. The result of econometric analysis indicates that six variables (farm size, family size, access to extension service, number of livestock kept, experience of farmers and species diversity) are positively and significantly related to the income earned from moringa tree based agroforestry practice. Therefore, it is recommended that the government and other responsible bodies should give due attention on accessing extension service; managing lands which farmers have because of the land can't be stretched; encouraging the household heads who have better farm experience to make use Moringa Tree Based Agroforestry Practice; enabling the households hold higher quality and quantity livestock; and increasing environmentally friendly farm tree species owned by farmers.
Keywords: Smallholders, livelihood, benefits, sensitivity analysis, and cost benefit analysis

1. Introduction

It is very common to see different types of small and big trees (which imply agroforestry practice) inside and around the farm land of Konso woreda. The best example in the area is the cabbage tree Moringa Stenopetala (locally also called to be Moringa). Other tree species in the area are: *Terminaliabrowenii, Juniperusprocera, Euphorbia, Oleaafricana, Ficussori, Cordiaafricana, Sterculiaafricana, Acacia Abysinica* and others. They harvest variety of crops mixed with these tree species throughout the year. Among the crops, cereals mainly sorghum followed by maize which are intercropped with pulses (beans and peas varieties), tuber and root crops (yam, cassava, sweet potato and yam), oil crops, fibers, citrus plantations, stimulant crops (coffee, chat and tobacco) are very common. These unique mixed agriculture practices enabled them to cope up the climate change impacts during unpredictable environmental conditions (Forch, 2003).

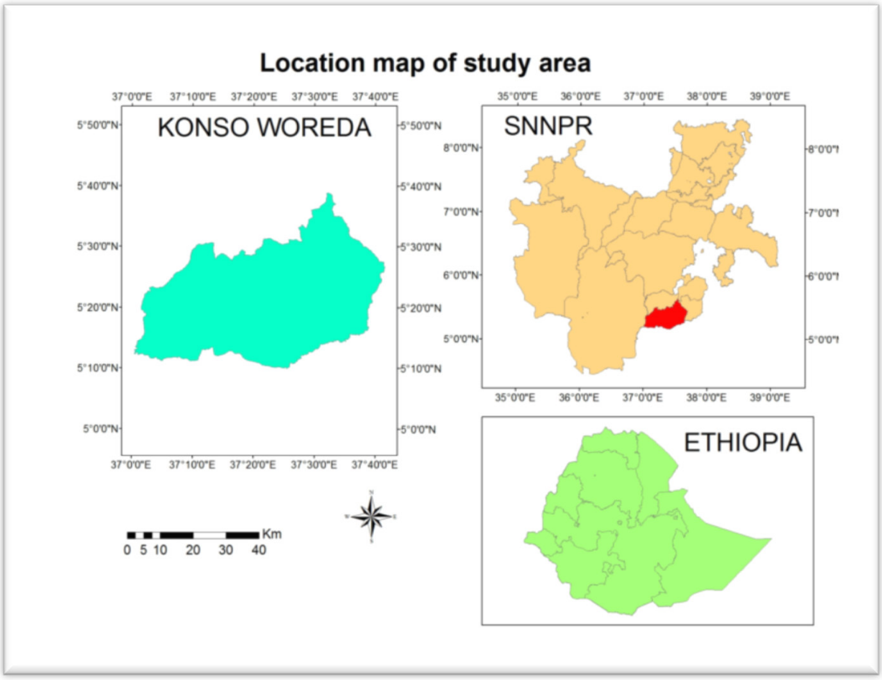
In Konso, moringa is multipurpose tree used to fill gaps associated to drought impacts; used for shade; and it has a very high nutritional advantage. Its leaves are served as the main diet as well as medicine for various diseases. It is seen as an important insurance against crop failure. Culturally the tree is taken as a dowry or measure of wealth as how many of these trees the bridge groom has in the garden or nearby farmland to feed his/her family.

According to Valdivia et al (1996), agroforestry practice yield environmental, economic, and scenic beauty benefits in the area. But the income, which is a basic economic benefit of the practice differs from house hold to house hold due the practice is affected by many factors. In line to this fact the income of rural communities, which is heavily dependent on MTBAFP, seen differing from household to households level in Konso also. That's the income obtained from the practice vary from household to household in the area, but the detailed study, hard facts and figures which examined and shown the determining factors in a way which can help to narrow this income variance gap were not available. Thus, without a formal study, hard facts and figures, the variance in income from the practice from household to household may remain unknown. Therefore, this study, which has targeted at filling this gap in the area, was required. That is why this study examined and shown the significant determining factors of income from Moringa Tree Based Agroforestry Practice (MTBAFP).

Therefore, the objective of this study was to examine the determinants of income from Moringa tree based agroforestry practice in Konso woreda of Southern Ethiopia.

2. Research Methodology

Konso woreda is one of the woredas in Segen Hizbcoh zone in the Southern Nations, Nationalities, and Peoples Region (SNNPR) of Ethiopia and covering the area of 202,286 hectare. The distance from Addis Ababa to Konso woreda is 595 km to South (CSA, 2007).



Konso woreda was selected purposively based on the presence of Moringa-tree based agroforestry practice. From the woreda, three kebeles namely, Goc'ha, Macholo and Gamole kebeles were selected purposively based on the potential of Moringa-tree based agroforestry practice after discussion with the woreda agricultural office experts. Before selecting sample households from these three kebeles the whole population have been differentiated for their being MTBAFP users. The sample size for this study was determined based on the rule of thumb method that is N ≥ 50 + 8 m, where N is the minimum required number of households and "m" is explanatory variables (Green, 1991). Based on this rule sample size was 155, (155 ≥ 50 + 8 *13=154); because the number of expected explanatory variables for this study was 13. The households were selected by following simple random sampling[1] techniques.

In the study both primary and secondary data were used. Primary data like the production costs and total revenues which can build the foundation for the calculation of income from MTBAFP were collected through a household survey, focus group discussions, key informant interview, field observation, and biophysical resource and market assessment methods. Secondary data like the number of households in the kebeles and socio-economic information were again taken from the agricultural office of Konso woreda. Different offices and personal contacts were also made to obtain additional information for achieving the objective.

Finally, for achieving the research's objective, the econometric analysis, which is the result of a certain outlook on the role of economics; consist of the application of mathematical statistics to economic data to give empirical support to the models constructed by mathematical economics and to obtain numerical results (Guajarati, 1998), was used. In using the econometric analysis for achieving this objective, there are two variables, namely income from MTBAFP which is dependent variable and determinants of income from MTBAFP which are independent variables. The multiple linear regression or ordinary least square (OLS) econometric model was used to analyze factors affecting income earned from the practice. Hence, the relationship between a dependent variable income from MTBAFP and one or more independent variables which were expected to affect the income was studied by using the multiple linear regression model.

The multiple linear regression model formulated for income from MTBAFP function and its determining factors for this study is given as:

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

Where, Y is the dependent variable income from MTBAFP and $X_1 \ldots X_k$ are the independent/ explanatory variables age, experience, education, family size, land size, access to extension service, distance from market, price of inputs, gender, number of livestock, involvement in off farm activities, species richness or diversity in moringa tree based agroforestry practicing households' plot of land, credit accessibility and "ε" is the error term. The equation can be written as:

Income from MTBAFP = $\beta_0 + \beta_1 Age + \beta_2 Sex + \beta_3 Exp + \beta_4 Famsize + \beta_5 Farmsize + \beta_6 Ext + \beta 7 Dmkt + \beta_8 Lvstcksize + \beta_9 Educ + \beta_{10} OfFaAct + \beta_{11} Inptprice + \beta_{12} Sprchns + \beta_{13} AcsCrdt + \varepsilon$

[1] Sampling refers to drawing a sample or selecting a subset of elements from a population

Regression coefficients $\beta 1$, $\beta 2$ and…. B_{13} are known as partial regression or partial slope coefficients. β_n measures the change in the mean value of Y, $E(Y)$, per unit change in X_n holding the value of all other explanatory variables constant. And β_0 is intercept of the model.

Definition of Variables

Different variables were expected to affect the income from the moringa tree based agroforestry practice in the study area. The attempt here was to identify why some farmers get more income and others less income from moringa based agroforestry practice.

Income: the gross income[2] earned from moringa tree based agroforestry practice which is the dependent variable. The multiple linear regression analysis/Ordinary Least Square (OLS) estimation was used to capture the cause and effect relationship between the dependent variable, gross income from moringa tree based agroforestry practice and the independent variables. The expected factors or the independent variables were discussed below:

Experience: It is a continuous variable. Farmers having a longer farming experience were in a better position to get income from moringa tree based agroforestry system than farmers with shorter farming experience. Moreover, farmers with longer farming experiences have a cumulative knowledge of expanding moringa agroforestry practice and could diversify its components. This in turn enables them to get higher income from moringa agroforestry system than farmers with short farming experience (Nkamleu and Manyong, 2005). In this study, it was hypothesized to be positively associated with the income earned from moringa agroforestry practice.

Education: It is a continuous variable and refers to the number of years of schooling of the household head. Education enhances farmers' skill to observe, respond to new technologies of farming and easily solve problems that face during farming seasons. Education was expected to increase the income of farmers from the moringa tree based agroforestry practice positively (Adekunle, 2009).

Family labour: It is a continuous variable which is measured in terms of man-equivalent and it is the active labour force the household owns. A household with large family labour force can practice the moringa tree based agroforestry practice more than a household with small number of family labor force (Getahun, 2012). Therefore, family labor was expected to influence income earned from moringa tree based agroforestry practice positively.

Livestock: It is a continuous variable. Size of livestock is estimated based on TLU. Those farmers with large livestock can get more income than farmers who have small livestock's (Muhammad, 2005). Thus, livestock was expected to influence income earned from moringa tree based agroforestry practice positively.

Distance to market: It is a continuous variable. Farmers who are near to market will have up-to-date information than farmers who are far from market. And farmers who have up-to-date market information are more responsive to newly introduced agricultural technologies than those who have no access to market information which is associated with distance from market. Therefore, the longer the distance from the market farmers will be discouraged to adopt moringa tree based agroforestry practice. Thus, income from moringa tree based agroforestry is negatively correlated with distance from market (Ashenafi, 2011; Getahun, 2012).

Off-farm activity: It is a dummy variable with value of one if a household head participates in off farm activity and zero otherwise. And involvement in off-farm activity produces additional income. Hence, a farmer who participates in off-farm activity will be reluctant to work on the farm activity (Ashenafi, 2011). Thus, off-farm activity was expected to influence income negatively from moringa tree based agroforestry system.

Farm size: It is a continuous variable. Sufficient size of land holding is the basic requirement for adoption of improved agricultural technologies. A farmer with more land is more able and willing to experiment with a new technology (Zeleke, 2008; Ashenafi, 2011). It was thus expected that the farmers who have larger farm size would have got higher income from the practice than those of small farm size.

Access to extension service: Extension is a dummy variable with value of one if a household head has access to extension service and zero otherwise. It has positive correlation with income from agroforestry system. Extension contact creates farmers' awareness about new technologies. The presence or absence of extension support of moringa tree based agroforestry determines farmers' access to improved technologies/practices (Zeleke, 2008). If there is open access of extension service for farmers it cannot be difficult to adopt new technologies that improve the farming style and this will increase the income from farming in general and moringa tree based agroforestry system in particular.

Age: It is a continuous variable**.** The agroforestry practice has long time dimension to recognize its benefit; thus, farmers with old age have better practice to recognize this benefit earlier than young aged farmers (Pattanayak, *et al.*, 2003). Thus age of a farmer was expected to have a positive effect on income from moringa tree based agroforestry practice.

Sex: It is a dummy variable with value of one if a household head is male and zero otherwise. The gender

[2] The gross income from agroforestry practice was calculated by summing up all incomes; that is the estimated income of consumed and saved products at home level in monetary terms and income from sold products at market.
Income from all components of Moringa tree based agroforestry practice was calculated and summed up.

variable is measured by proportion of males in the household. Households with a higher proportion of males are more likely to adopt agroforestry technologies (Mesele, 2002). Hence in this study it was expected to positively affect adoption of moringa tree based agroforestry which increases income from the practice.

Input Price: It is a continuous variable that was expected to affect income earned from agroforestry practice positively. When the price of inputs increases the total cost of production will also increase and reduces benefit from farming. Monocropping system needs more inputs than agroforestry practice. Therefore, when the price of input increase farmers ignore monocropping system due to high cost of input (e.g. fertilizer) and shift to agroforestry practice which need less input than monocropping system. The ignorance of fertilizer use reduces productivity of the monocropping system and would have increased gross agroforestry income (Place *et al.*, 2005). Thus the increase in input price for monocropping system in the area expected to affect income from moringa tree based agroforestry practice positively.

Species richness: It is a continuous variable measured in number and it is expected to affect income from agroforestry practice positively. When the species existing in certain plot of land allotted to agroforestry practice is high, it is expected that the yield gained from the practice is high and hence it affects the income from moringa tree based agroforestry practice positively.

Access to Credit (ACSCRDT): This is a dummy variable and will be measured with 1 for those farmers who took credit for the agroforestry practice and 0, otherwise. Access to credit would enhance the financial capacity of the farmers to purchase the necessary inputs for the production. Therefore, it was hypothesized that credit use for agroforestry practice would have positive influence on income from agroforestry practice.

Table: 1 Definition of variables and hypothesis

Variables	Descriptions	Expected sign
Age	Age of the household head in years	+
Education	Number of Years of schooling of the household head	+
Farm size	Total farm size of household head in hectare	+
Farming experience	Year of farmers stay at farming	+
Livestock number	Total numbers of livestock Unit(TLU) kept	+
Off-farm activities	1 if participated 0 if not participated	-
Access to extension service	1 if have access 0 if no access	+
Distance from market	Number of Hours to arrive market center	
Price	Input price in ETB	+
family size	Number of labor force who participated in farming (in terms of adult/men equivalent	+
Species diversity/richness	Number of tree species in farm land per each household in number	+

Normality test

There are different methods used to test normality of the model. One of this is visual examination of residuals. A number of residual plots are worth examining and are easily accessible in SPSS. In this study the researcher used normal probability plot of residuals to test normal distribution of error term. Normal probability plot of residuals, it is one way of visually testing for normality. Normally distributed errors will lie in a straight line along the diagonal. Non-linearity not captured by the model and other misspecifications may cause the residuals to deviate from this line (Baker, 2006).

Multicollinearity test

Multicollinearity occurs when two or more predictors in the model are correlated and provide redundant information about the response. That means multicollinearity is a situation where explanatory variables are highly correlated. It is violation of assumption of no exact linear relationship among explanatory variables (Gujarati, 1999; Baker, 2006). Therefore, it is important to check multicollinearity problem for continuous and dummy variables before estimating/regressing, presenting, interpreting and discussion of the result. The existence of multicollinearity in this study was tested by using the methods of variance inflation factor, Tolerance (TOL) and contingency coefficients (CC).

Variance Inflation Factor (VIF): it was used to test the existence of multicollinearity among the continuous variables. The presence of collinearity among explanatory variables can increases value of VIF (Rj^2). As Rj^2 increase towards one, means the collinearity of explanatory variable with the other explanatory variable increase. The larger the value of VIF, the more collinear is the variable Xj. If the VIF greater than 10, which will happen if

Rj^2 is greater than 0.90, that variable is said to be highly collinear. If the VIF less than 10 the variable is said to be less collinear (Gujarati, 2004). Tolerance (TOL) can also be used to detect multicollinearity. TOL is one if X_i is not correlated with the other regressors, whereas it is zero if it is perfectly related to other regressors (Gujarati, 1998). Statistical package for Social Science (SPSS) 20 was used to compute VIF.

Contingency coefficient (CC): this was used to check multicollinearity between discrete variables. It is a symmetric measure which indicates the co-linearity and significance of 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 variables (Gujarati, 2004). Statistical package for Social Science (SPSS) 20 was used to compute CC.

Hetroscedasticty test

One of the assumptions of the classical linear regression analysis is that there is forgiven *X*'s, the variance of $\mathcal{E}_i$ (error term) is constant or homoscedasiticity among the explanatory variables. That means, the variance of the unobservable error term, conditional on the 'x's,'' is constant, i.e. Var ($\mathcal{E}$/x) = δ^2. The Violation of homoscedasiticity assumption is known as heteroscedasticity. It is important to check heteroscedasticity problem before presenting, interpreting and discussion of the result of regression. There are different methods to check existence of heteroscedasticity problem in the model. But in this study Breusch-Pagan Test approach was used (Gujarati, 2004; Baker, 2006).

Heteroscedasticity was tested using Breusch-Pagan test based on the following procedure.

1. The original equation was estimated by using OLS method and the least square residuals were obtained .i.e. $y = \beta 0 + \beta 1x_1 + \beta x_2 + \beta x_3 +$ ------ $\beta_{13}x_{13} + \mathcal{E}_i$,
2. Then the least square residuals were regressed on all the independent variables. i.e.
   $\mathcal{E}^2 = \delta 0 + \delta 1X1 + \ldots \delta_{13}x_{13} + u$ where, δi=parameters
   $\hat{e}^2$ is independent variable
3. The R-square of this regression was obtained.
   - The null of no heteroscedasticity is then:

$H_0 = \delta_1 = \delta_2 = \delta_k$

$\mathbf{H_1}: = \delta_{1\#}\ \delta_{2\,\#}\ \delta_k$

$$F = \frac{R2\ddot{\varepsilon}2/K}{(1-R2\ddot{\varepsilon}2)/(n-k-1)}$$

If F-calculated is less than F-tabulated, the null hypothesis is accepted which says there is homoscedasiticity in the model.

3. RESULTS AND DISCUSSION

3.1. Socio Economic Characteristics of the Respondents

The socio-economic and demographic characteristics of sample households are summarized and presented in the following tables.

Table: 2. Descriptive statistics of categorical variables

Variables	**Category**	**Participation in MTBAFP and Monocrop.**		
		MTBAFP (N=155) (N& %)	Monocroping (N=77) (N& %)	Total (N=232) (N& %)
Sex	Female	33 (20.0)	13(17.0)	46(20.0)
	Male	122 (80.0)	64(83.0)	186(71.3)
Education status	Illiterate	84(54.2)	42(55.3)	126(54.2)
	Literate	71(45.8)	35(44.7)	106(45.8)
Marital status	Unmarried	17(10.9)	8(10.4)	25(10.9)
	Married	138(89.1)	69(89.6)	207(89.1)
Being Native		155(100.0)	77(100.0)	232 (100.0)

Source: own survey (2014)

Table: 3 Descriptive statistics of continuous variables

Variables	Participation in MTBAFP	Mean	Standard Deviation
Age of respondent	MTBAFP (155)	39.30	6.115
	Monocropping (77)	38.85	7.130
	Total (232)	39.34	7.343
Household size	MTBAFP (155)	7. 3	3.215
	Monocropping (77)	7.4	6.120
	Total (232)	7.3	8.953
Distance from market	MTBAFP (155)	7.4	2.170
	Monocropping (77)	7.4	2.170
	Total (232)	7.4	2.170
Land Holding	MTBAFP (155)	0.125	14.728
	Monocropping (77)	0.120	14.330
	Total (232)	0.125	14.728
Livestock Holding	MTBAFP (155)	11.156	1.5920
	Monocropping (77)	8.632	2.42821
	Total (232)	11.102	2.9157
Tree species	MTBAFP (155)	8.535	1.7281
	Total (232)	8.535	1.7281

Source: own survey (2014)

It can be seen from the result that about four-fifth of respondents were male and the remaining one-fifth of the respondents were female with respect to the gender. This means that the highest proportion of respondents were men (80%) while only 20% were women (Table 2). With respect to marital status the respondents belong to diverse categories. Out of the total sampled household heads, the majority (89.1%) were married, 7% were widowed, 2.6% were single and the remaining 1.3 %, were divorced. Regarding to the education level, the households fall in to various categories ranging from those who did not attend any formal education to those who completed grade 12 (Table 2). The categories include those who did not attend formal education; those who attended primary education (grade 1-4); those who attended secondary education (grade 5-8); those who attended high school education (9-10) and above high school level (11-12). The result shows that almost more than half of respondents (54.2%) did not attend any formal education. The household heads who attended junior secondary level (5-8) education were more than one-fifth (22.6) of the total respondents. The households who completed primary level (1-4), high school (9-10) and (11-12) were respectively 16.1%, 5.2 and 1.9 (Table 6). The study result shows that the majority of the respondents did not attend formal education, which is a typical characteristic of country side farmers. This might be due to the absence of the education facilities in the past decades. Also the age of the sample households varies from 27 year to 57 year, with the average age being 42 years. All sampled household heads (100%) were found in the age group of 18-64 years (Table8). This age composition show that all respondents are in the productive age category.

Regarding to family size, the average family size of respondents was 7 persons although it ranges between 2 to 17 persons with standard deviation of 2.70. The result in table 8 shows that family size of respondents is characterized categorizing them in to three groups. More than half (54.84%) of respondents have family size of greater than 7 person's (large family size) category and 38.71% of respondents have a family size of 4 to 6 persons (medium family size). The remaining respondents (6.45%) have a family size of the category 1 to 3 persons (low family size). This shows that the household heads in the study area are mostly incorporated in large family size (54.84%) category followed by medium family size which is 38.71%. The result show that majority of respondents have family size of more than seven family members, which is large family size.

The size of the land owned by the respondents varies from a minimum of 0.125 hectare to a maximum of 3 hectares with the average land holding of 0.1 hectares. There is low supply relative to the large family size of households in the study area. It is also important to note that 47.70% of the respondents owned less than 1 hectare of land and those households who own 1ha, 1.5ha, and 2-3 hectares of land are 24.53, 12.82, and 14.95% respectively. This shows around half of the respondents own less than one hectare of land (Table 3). According to FGD the principal reason for the low average land holding was the increase in population in the area and topographic problem of the unique land creature of Konso. The shortage of land is basic problem in Konso to maximize agricultural production. The minimum and a maximum farm land sizes covered by agroforestry practice was 0.125 hectare and 3 hectare respectively. The minimum and maximum land covered by monocropping system was 0.0625 hectare and 2 hectare respectively. The result shows that the land which is covered by agroforestry was slightly greater than land covered by monocropping. Currently the farmers prefer more land for agroforestry practice rather than monocropping, because of the agroforestry practice is traditional, cultural, climate change resisting, sustainable and more profitable than monocropping in the study area.

According to FGD, farmers give due attention for AFP than monocropping. This is because AFP requires lower input costs and hardly any use of modern inputs like fertilizer. The other finding from survey result was shortage of grazing land. Due to lack of enough land size, there is no grazing land left for livestock.

Farmers in the study area rear different type of livestock, such as cattle, shoat and poultry but never pack animals like donkeys. As it is indicated in table14, the highest number of livestock holding in TLU among the livestock types dominant in the study area were goat and sheep (65.13TLU and 64.61 respectively); there are no horse, donkey and mule. Farm animals have an important role in rural economy of the area.

The dominant source of income in the study area is from agricultural activities, such as crop production and livestock production whereas marginal farmers obtained their income additionally from off-farm activities. Off-farm activities have a great potential to provide additional incomes during the slack season to rural households in the area. The result shows that from the whole sampled household heads about one third (36.77%) were involved in off farm activities and more than half (63.23%) were dependent on agricultural income only (Table 3).

3.2. Determinants of Household's Income from MTBAFP

In this section factors that determine the income of households from MTBAFP are discussed. The statistically significant variables that were estimated using the ordinary least square (OLS) were interpreted and discussed by linking with other studies. Before estimation, interpretation and discussion of the regression result, muliticollinality and hetroscedasticty test was conducted. From the test, it is assured that there is no problem of muliticollinality and hetroscedasticty in the model (see appendix 1). The model was also tested for its normality by normal probability plot of residuals and the test shows that there is no problem of non normality in the model (see appendix 2). The regression model explained 64% of the variations in the factors affecting the household's income as indicated by the adjusted R^2 (table 2).

The explanatory variables estimated to see their impact on the household's income from MTBAFP practice were: age, sex, education level, family size, farm size, farming experience, number of livestock, AFP species diversity, extension service access, credit access, involvement in off-farm activities, output price and distance from market. From the regression result in table 3 it has been observed that the above mentioned factors have explained the household's level of income from the agroforestry practice.

Table 3. Regression result of the determinants of HH'S income from MTBAFP

Variables	Beta coefficients	Std. Error	T	p.value.
AGE	0.175	0.40	0.57	0.57
SEX	1.5605	3.27	0.44	0.63
EDU.	0.3220	0.49	0.62	0.53
F.SIZE	4.1424 ***	1.03	4.76	0.00
FRM. SIZE	6.570 **	3.55	2.34	0.02
FRM. EXP	1.0258 **	0.41	2.47	0.03
TLU	1.235 *	0.37	1.71	0.07
SPEC.DIVERS	1.965***	1.02	5.67	0.00
EXT.SERV	3.1005 ***	0.23	12.62	0.00
CRDT.ACS	1.7402	2.97	0.45	0.66
OFF	-1.7872	3.27	-0.51	0.59
OP.PRICE	3.0878	3.28	0.76	0.38
DIST.FMKT	-0.675	1.72	-0.44	0.64
Constant		19.14	-2.13	0.01

Source: own survey (2014)

***represents less than 1% significance level, ** represents less than 5% significance level, and * represents less than 10% significance level. Adjusted R^2 = 90.5%, n = 155

The result shows that six of the thirteen explanatory variables included in the analysis such as the family size, farm size, farming experience, species diversity, number of livestock and extension service were statistically significant. This shows that a change in size of these explanatory variables will bring about a change in the household's annual gross income at magnitudes indicated by their respective coefficients. It was expected that determinants such as age of house hold head, sex of household head, educational level of household head, family size, farm size, farming experience of household head, number of livestock by household head, output price of products from AFP, species diversity of AFP, extension service availability to household head, credit access to household head, have positive relationship with the dependent variable while, involvement in off farm activity and distance from market have negative relationship with the dependent variable. The relationship between the explanatory variables and the dependent variable was as it was expected.

According to the result in table 3, the three variables family size, species diversity and extension service were highly significant, at less than 1% significance level. This means the three variables highly influence the amount of income from the moringa tree based agroforestry system. The two other variables farm size and farming experience were significant at less than 5% significance level and number of livestock is significant at less than 10% significance level. Other variables such as education, price of output, involvement in off- farm activities, and distance to market, gender, and age of household head were found to be statistically not significant.

Family size: Family size is statistically significant at less than 1% significance level. Not different with the prior expectation, it was positively associated with the income from moringa tree based agroforestry practice. The coefficient value of 4.1424 indicated that, other factors held constant, when the family seize increase by one unit the income from MTBAFP will increase by 4.1424 ETB. This positive impact may be due to the nature of farm activity, which is labour intensive that needs more family labour. The household who have more family size can easily or cheaply supply more family labour for farming activity. This will increase income from agroforestry practice. This is consistent with the study carried out by Adekunle (2009) in Ondo State, Nigeria on contributions of agroforestry practice to environmental sustainability and sustainable agricultural production and similar with that of Alemu (2013) in Hadero Tunto Zuria woreda, Kembata Tembaro zone, South Ethiopia, on financial analysis and determinants of income from fruit tree based agroforestry practice. Both studies revealed that large family is desirable to supply family labour which increases income from agroforestry practice. The study conducted by Kebede et al. (2013) in northern Ethiopia also reveals that large family size has positive impact on farm income.

Extension service: this is another explanatory variable that affected income from agroforestry practice. According to the regression result in table 3, the extension service is statistically significant at less than 1% significance level. Consistent with the prior expectation it is positively associated with the income from moringa-tree based agroforestry practice. The coefficient value of 3.1005 indicated that, other factors held constant, the farmers who have access to extension service will get greater income which is greater by 3.1005 than farmers who have no access to extension service. This is because extension service enhances the capacity and knowledge of farmers in implementation of the technology which is important for improving farming activities. In other words it is a means to deliver the message from research center and development agencies at different time. Extension service is also important to expand the knowledge and skills of farmers to increase income. The agricultural extension services offered in the study area are: training, visiting, arranging field days, etc. which have a direct impact on the attitudes and decisions of farm households. The result in this study is in line with study by Alemu and Kebede et al. (2013) who revealed that an increase in extension service in farming system is found to increase income. Likewise, the study by Goitom (2009) stated that membership in an extension service program is positively associated with total crop production. According to his finding extension service extends from the provision of technical advice on farming issues such as what to produce, how to produce and when to produce, for facilitating credit availability and input supplies and even to the provision of market information and capacity building training to farmers.

Farm Size: Consistent with the prior expectation farm size was found to be positively associated with income from agroforestry practice. Therefore, those who have large farm size will get high income than those who have small size. The coefficient value of 6.570 shows that, other factors held constant, when there is increase of farm size by one unit the income generated from MTBAFP will increase by 6.570 ETB. This is because of that with large size of land there will be more diversification of components, which increases income from the system. This finding is consistent with the finding of Rogers (1983) who revealed that farmers, who have larger farm size, will get higher income from agroforestry system than farmers who have small farm size. Additionally the study by Tesfaye (2005), Desta (2012) and Alemu (2013) revealed that the size of farm, which enables the users of agroforestry system to increase diversification of agroforestry, increases income from the system. Similarly, study by Regmi (2003) in Dhading district, Nepal on contribution of agroforestry to rural livelihoods revealed that income from agroforestry is positively related with size of land holding.

Farming experience: As shown in table 3, the regression result indicates that farming experience has a positive effect on income obtained from MTBAFP at less than 5% significance level. The farming experience coefficient 1.0258 indicated that, other factors held constant, when the farm experience of the household head increases by one year, the income from MTBAFP will increased by 1.0258 ETB. This may be because the experience of farming can reduce production cost through long period experience and can contribute in generating income from agroforestry practice. Thus when the farmers are more experienced, they became familiar with the opportunities and constraints and they can adjust their activities accordingly. This finding is in line with that of Nkamleu and Manyong (2005) who revealed that farmers' experience positively influences the adoption of improved fallow and they suggested that farmers who have the higher the level of experience would have the greater the likelihood to get income from improved fallow than farmers who have lower level of experience. Alemu (2013) also revealed that farm experience have positive impact on income from fruit-tree based agroforestry practice.

Number of livestock: Livestock holding by the household as measured by Tropical Livestock Unit (TLU) is also found to influence income from agroforestry practice. The result in table 3 indicates that the possession of livestock positively influences the income from agroforestry practice. In line with the prior expectation, it is positively associated with income from moringa-tree based agroforestry practice. The coefficient value of 1.235 indicated that, other factors held constant, when the number of livestock increases by one unit the income earned from MTBAFP will increase by 1.235 ETB. The explanation for this fact is when there is more livestock; there will be more availability of dung which is the best organic fertilizer for AFP. Thus, farmers who have more livestock can get more dung, which in turn increase soil fertility and this will increase yield of agroforestry practice. Therefore; the number of livestock will have positive impact on income from agroforestry practice. The finding is consistent with the finding of Muhammad (2005) who studied the socio-economic factors affecting the income of small-scale agroforestry farms in hill country areas in Yemen and revealed that number of animals always influence farm income. Similarly, the study conducted by Khanal (2011) on contribution of agroforestry in biodiversity conservation and rural needs fulfillment revealed that 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. The study underlined that the existence of large number of livestock makes large contribution of income than farmers who have small number of livestock. The study by Goitom (2009) and Alemu (2013) which revealed that ownership of oxen, in particular is very important aspect in agricultural production of households given the poor resource endowment. Thus, as an alternative for the lack of modern farm input technology by the rural people, existence of large number of livestock can enjoy higher level of crop production and more likelihood of going commercial than those farmers with small number of livestock.

Species diversity: As shown in table 3, in line with the prior expectation, Species diversity is positively associated with income from moringa-tree based agroforestry practice. The regression result indicates that species diversity has a positive effect on income obtained from MTBAFP at less than 5% significance level. The tree species diversity coefficient 1.965 indicated that, other factors held constant, when the farm tree species owned by farmers increased by one the income from MTBAFP will increases by 1.0258 ETB. This may be because different tree species in the area can give different yield in different seasons. The result is similar with the study conducted by Khanal (2011) that revealed the number of tree species per household increased income from agroforestry practice.

4. Conclusion

This study was conducted at Konso woreda in Segen Hizboch zone to examine the determinants of income from Moringa Tree based Agroforestry Practice.

The explanatory variables estimated to see their impact on the household's income from MTBAFP practice in the study were: age, sex, education level, family size, farm size, farming experience, number of livestock, AFP species diversity, extension service access, credit access, involvement in off-farm activities, output price and distance from market. From the regression result in table 2 it has been observed that the above mentioned factors have explained the household's level of income from the agroforestry practice.

The result of the econometric analysis shows that six of the thirteen explanatory variables included in the analysis such as the family size, farm size, farming experience, species diversity, number of livestock and extension service were statistically significant. This shows that a change in size of these explanatory variables will bring about a change in the household's annual gross income at magnitudes indicated by their respective coefficients.

According to the result in table 2, the three variables family size, species diversity and extension service were highly significant, at less than 1% significance level. This means the three variables highly influence the amount of income from the moringa tree based agroforestry system. The two other variables farm size and farming experience were significant at less than 5% significance level and number of livestock is significant at less than 10% significance level. Other variables such as education, price of output, involvement in off- farm activities, and distance to market, gender, and age of household head were found to be statistically not significant.

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Appendix

Appendix 1: Test of heteroscedasticity

Consider the following linear model:

- Null hypothesis is of homoscedasiticity, i.e.

  H_0 Var (Ɛ/X1, X2…..X13) = δ2

- and since we are assuming that Ɛ has a zero conditional expectation we have

  H_0 E $(\mathcal{E}^2/x1, x2.....x13) = \delta^2$

- This equation indicates that in order to test for a violation of homoscedasiticity we need to test whether $\mathcal{E}^2$ is related to one or more of the explanatory variables.

- Breusch-Pagan Test

Heteroscedasticity can be tested using Breusch-Pagan test based on the following procedure.

1. Estimate the original equation using OLS method and obtain the least square residuals

$$y = \beta_0 + \beta_1 x_1 + \beta x_2 + \beta x_3 + \text{------ } \beta_{13} x_{13} + \mathcal{E}_i$$

1. Regress the least square residuals on all the independent variables.

$$\mathcal{E}^2 = \delta_0 + \delta_1 X_1 + \ldots\ldots \delta_k x_k + u$$

3. Obtain the R-square of this regression.

- The null hypothesis of no heteroscedasticity is

  $H_0 = \delta_1 = \delta_2 = \delta_k$ (there is no problem of heteroscedasticity)

- the alternative hypothesis

  $H_1 = \delta_1 \# \delta_2 \# \delta_k$ (there is problem of heteroscedasticity)

Then, based above procedures we can calculate as follow;

$$F=\frac{R2\hat{\varepsilon}2/K}{(1-R2\hat{\varepsilon}2)/(n-k-1)}$$

$$F=\frac{0.905/13}{(1-0.905)/(155-13-1)}$$

$$F=\frac{0.08227}{0.095/141}$$

$$F=\frac{0.08227}{6.737}$$

F=0.0122

The 5% critical value for numerator *df* = 13 and large denominator *df* (infinitive) is 1.62. Since F-calculated is less F-tabulated, the null hypothesis is accepted which says there is homoscedasiticity in the model. Therefore, there is no heteroscedasticity problem in the model

Appendix 2: Normality Test Indicator