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Expansion of Eucalypt Woodlot and Its Factors in Cheha District, Southern Ethiopia

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ABSTRACT

Growing eucalypts at a farm level in the form of woodlot has become popular among rural household in Ethiopia. Households in the study area establish mainly eucalypts woodlot as a component of livelihood portfolio both for meeting household wood consumption and generating cash income. However, there were no sufficient information on the extent of eucalypts woodlot, and factors influencing the household decision on their establishment on the individual farm lands. This study was conducted in Cheha Districts in Guraghe zone with the aims of assessing the magnitude of eucalypts woodlots and factors influencing their establishment at household level. The data was collected by employing formal survey using structured questionnaire and Woodlot inventory. The latest version of Stata, version 13 and Microsoft excel were used to analyze the data. The result of the study revealed that some 58% (n = 61) of the sampled farmers in the study area had eucalypts woodlot, and among these 27% and 24% are those farmers who have converted their crop and grazing lands to eucalypts woodlots targeting either to earn more income or to increase the productivity of the land which has denied to grow cereal crops and pastures. Most of the farmers considered eucalypts as one of the major sources of income and risk aversion. The study is concluding that different socioeconomic factors, family size, crop income and accessibility of road had significant negative effect whereas total land holding and education level of the household heads had significant positive effects on the household's decision for the allocation of land and establishment of eucalypts woodlot on the farm lands. Further studies are needed to compare the return from Eucalyptus with other crops in terms of economic and environmental benefits and finally management aspect of eucalypts needed further research for the productivity of allocated land.

***Keywords*:** Eucalypts, Eucalypts woodlot, Expansion, Management, Rural households, wealth status

1. INTRODUCTION

Eucalypts is one of the diverse genuses of flowering plants in the world. It belongs to the Family *Myrtaceae* (subfamily *Myrtoideae*) and comprises about 800 species. The term eucalypts is derived from the two Greek words, "eu" meaning "well," and "kaluptos" meaning covered. Thus, eucalypts means true cover, well-covered (Luis *et. al,* 2010).

In Ethiopia, the planting of *eucalypts* has a long history dating back to extensive plantations surrounding urban centers in the late 1800s (Jagger and Pender, 2000). *Eucalypts* was widely introduced in Ethiopia since 1895, with the objectives of meeting the ever increasing demand for construction poles and firewood in Addis Ababa, the then seat of King Menelik II (Yetebitu Moges, 2010). Since then, eucalypts has expanded over large parts of Ethiopia, becoming an integral part of most of the Ethiopian farming system and one of the Ethiopian most important tree resources (Pohjonen and Pukkala, 1988, 1990).

The ability of eucalypts to grow in all types of soil has an advantage for rural farmers since it can help them to get benefit from land that is unproductive for agricultural crop production and from which crop yield harvested is variable and may not be sustainable in supporting the daily livelihoods (Biruk Ketsela, 2012).

Jagger and Pender (2000) also pointed out that the planting of e*ucalypts* trees in Ethiopia has expanded from State owned plantations to community woodlots, and households suffering from severe wood shortages, water scarcity, erosion and land degradation. The fast growing and resilient eucalypts species perform well than most indigenous woodland and forest tree species and most crops.

In Ethiopia, growing eucalypts helps local communities to diversify and increase their farm income, and hence, farmers prefer to plant eucalypts for household use (construction, firewood, farm implements), sell, soil conservation and gully stabilization, to drain marshy land, and ensure land tenure security (Gessesse Dessie and Teklu Erkossa, 2011).

Eucalypts has become popular among smallholder farmers in rural parts of Ethiopia and they grow eucalypts as an important land use option at the farm level, contributing up 50% of household income relative to major agricultural crops (Zerihun Kebebew and Gazahegn Ayele, 2010). Kaleb Kelemu (2004) and Wubalem Tadesse (2010) also revealed that in the Northern part of Ethiopia, eucalypts provides 20% of household income to rural small holders excluding its value for household consumption.

In fact, the planting of large areas of fast growing spp. (Eucalyptus) has sparked bitter controversies, and today two classes of opinion exist: - Pro and against (Dereje Jembere, 2009).

However, despite the ongoing debate among the scientific community, smallholder farmers have never ceased planting *Eucalypts,* on their homesteads, farm boundaries, farm lands grazing lands, open communal lands and other available spaces in different parts of Ethiopia (*e.g.* Zenebe, 2006).

Likewise, farmers in Guraghe highlands, where the present study was carried out, have been expanding eucalypts planting as a major tree species on their farm lands. In spite of this expansion there was no study undertaken in the area in relation to its major factors that determine farmer's decision in establishment and land allocation of eucalypts plantations.

2. MATERIALS AND METHODS

2. 1. Description of the study area

The study was conducted in Cheha District, Guraghe Zone, Southern Nation Nationalities and People Regional State. It is about 186 km Southwest of Addis Ababa and 30km from the Zonal capital town, Wolkete.

The District town is Emdibir. Altitude of the District ranges from 1500-2800 m a.s.l (District Office of Agriculture and Rural Development, 2005).

The landscape varies from undulating alongside the highlands to gentle gradients and plains in the areas adjacent to the lowlands. The mid-altitude zone offers a unique climatic opportunity for the cultivation of a wide variety of crops. As the moisture and other climatic requirements of different types of crops vary, abnormal conditions do not damage all crops to the same extent, which decreases the vulnerability of the zone to climatic hazards (District Office of Agriculture and Rural Development, 2005).

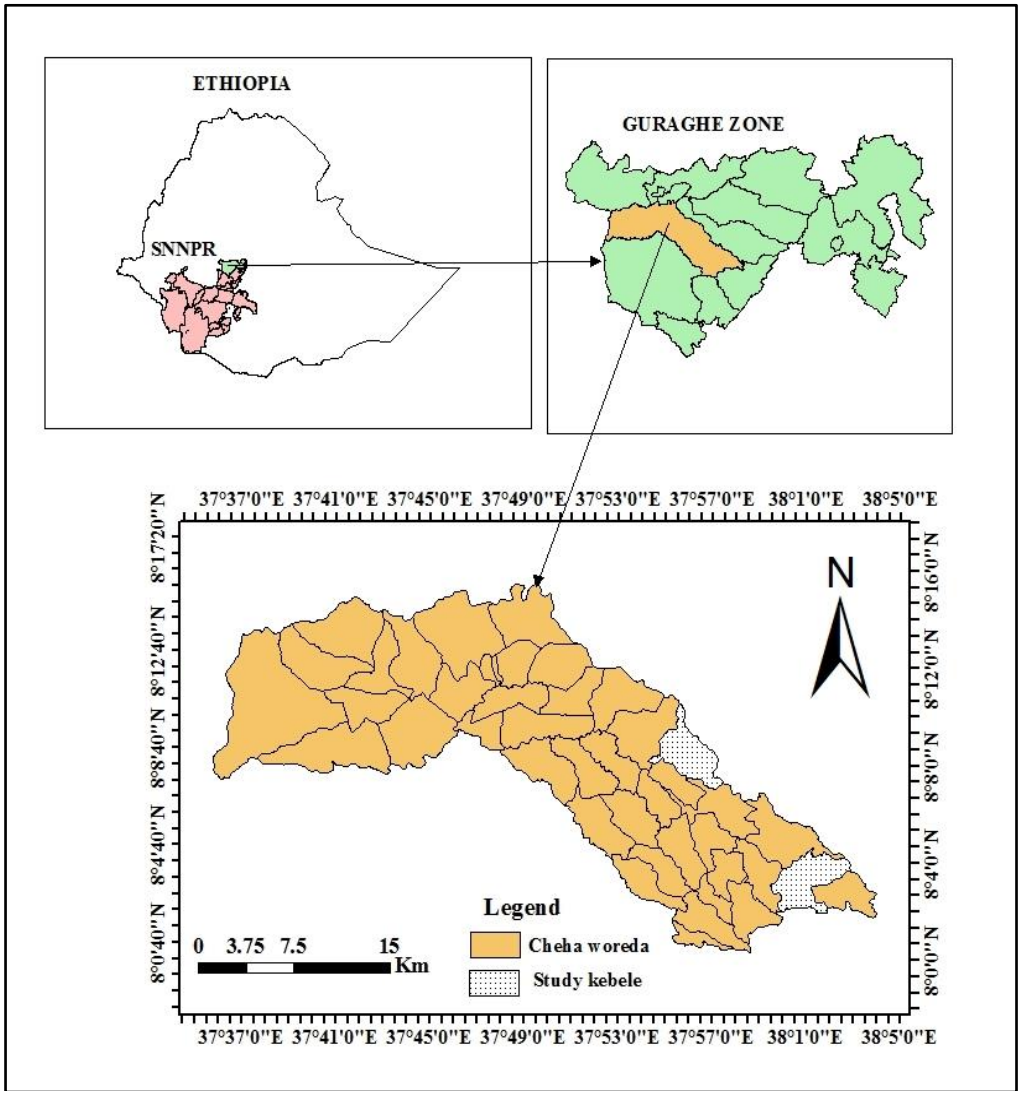

Figure 1. Map of the study area

2. 2. Methods of sampling and Data Collection

2. 2. 1. Preliminary survey

The preliminary survey conducted included reconnaissance of the study sites and informal discussions with farmers, rural development agents, kebele leaders, forestry and agricultural personnel. Through the survey, major socioeconomic activities were identified including the existing farming systems, eucalypts plantation activities, and market and livelihood strategies of the farm households in the context of their specific biophysical, social, and cultural settings.

2. 2. 2. Key Informant selection

Key informants were selected based on the level of expected knowledge about the local conditions, livelihoods and their long residence in the local area. The individuals who are active and knowledgeable of their localities were selected.

2. 2. 3. Focus Group Selection

For focus group discussions individuals who are knowledgeable persons to discuss on the eucalypts plantation activities and contribution, reasons for expansion of eucalypts plantation on farm land and conversion of crop land to eucalypts woodlot were selected. Two separate focus group discussions were conducted in each kebele, one with agricultural office experts and another with farmers and each group included six up to eight members. The discussions were guided by facilitator during which group members were encouraged to talk freely on a certain topic.

2. 2. 4. Sample household selection

In order to represent the population with sufficient accuracy and to infer the sample results to the population, the target sample households were selected in a multi-stage sampling process. In the first stage, from thirty nine kebele, two rural kebeles from Cheha district were purposively selected. The basis for selection was intensive expansion of eucalypts woodlots on agricultural land.

In the second stage, the households in the selected kebeles were stratified into wealth categories. The sampling strategy employed was stratified random sampling based on wealth status as it influences the eucalypts woodlot plantation activities. The base for the classification of the wealth class was developed from key informants and/or kebele leaders in the local situation. Based on the sample frame population the simplified formula (Amissalu, Milkias, 2013 citing Adugna, 2008) was used to determine the sample size of respondents for questionnaire distribution at 95% confidence level, degree of variability = 0.5 and level of precision = 9% (0.09):

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

where n is the sample size, N is the population size (total household heads size), and e is the level of precision. Accordingly, sample households from each kebele were randomly selected.

Table 1. Selected kebeles and number of households sampled for the study.

Household	Selected kebeles		Total number of households
	Yefersye	Moche	
Agro ecology	Midland	Highland	
Total HH per kebele	500	540	1040
Sampled HH	50	54	104

2. 2. 5. Household survey

Household survey data were collected using structured and semi structured questionnaire. The household questionnaire consisted questions on demographic and socio-economic conditions, the livelihood strategies and eucalypts woodlot plantation activities. Enumerators were trained prior to the household survey. The questionnaire was also pretested prior to the real survey to get feedback from enumerators and correction has been made based on the information received.

2. 3. Data analysis

2. 3. 1. Descriptive statistics

The survey data were analyzed using both descriptive statistics and econometrics models. The data collected were analyzed using Statistical Package for Social Sciences (SPSS) version 20 and STATA Statistical Software version 13. Descriptive statistics such as mean, percentage, and frequency etc. were employed.

2. 3. 2. Econometrics model

An econometric model, in particular binary logit regression was used to examine the effect of different socio-economic and institutional factors on the farmer's decision to establish eucalypts woodlot and allocation of land to eucalypts woodlot. According to Gujarati (2004), binary logistic regression is used to identify the determinants of dependent variable. Therefore, in estimating the binary logit model, the dependent variable was eucalypts woodlot owners which took value of 1 if the household had eucalypts woodlot and 0 otherwise.

The logistic distribution function the specification of the logit model (Hosmer and Lemshew, 1989) for identification of the woodlot owners and non-woodlot owner's farmers can be defined as:

$$P_i = \frac{1}{1 + e^{-z_i}} \quad \text{---------- (1)}$$

where Pi is the probability of being wood lot owners for the i^{th} farmer and Zi is a function of *m* explanatory variables (Xi) (discussed below at section 3.3.5), and expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + - - - + \beta_m X_m \text{ ---------- (2)}$$

where β_0 is the intercept and β_i are the slope parameters in the model. The slope tells how the log-odds in favor of being woodlot owners change as independent variables change.

Since the conditional distribution of the outcome variable follows a binomial distribution with a probability given by the conditional mean P_i, interpretation of the coefficient will be understandable if the logistic model can be rewritten in terms of the odds and log of the odds, (Gujarati, 2004).

The odds to be used can be defined as the ratio of the probability that a farmer will be woodlot owner (Pi) to the probability that he/she will not (1-Pi).

But:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \text{ ---------- (3)}$$

Therefore

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \text{ ---------- (4)}$$

and

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{\beta_0 + \sum_{i=1}^{m} \beta_i X_i} \text{ ---------- (5)}$$

Taking the natural logarithm of the odds ratio of equation (5) will result in what is known as the logit model as indicated below:

$$Ln\left[\frac{P_i}{1 - P_i}\right] = Ln\left[e^{\beta_0 + \sum_{i=1}^{m} \beta_i X_i}\right] = e^{Z_i} \text{ ---------- (6)}$$

If the disturbance term Ui is taken into account the logit model becomes:

$$Z_i = \beta_0 + \sum \beta_i X_i + U_i \text{ ---------- (7)}$$

Hence, the above econometric model was used in this study and was treated against potential variables assumed to affect the farmers' decision to establish eucalypts woodlot.

2. 3. 3. Multi colleniarity test

Prior to using the models multicollinearity (degrees of association) among independent variables was checked as it affects the parameter estimate. Therefore, the problems of multicillinearity are tested by computing Variance Inflation Factor (VIF) and Contingency Coefficient (CC). Accordingly, a method of Variance Inflation Factor (VIF) was employed to detect the problem of multicollinearity between continuous variables and contingency coefficients were undertaken to check the presence of association between dummy variables. According to Gujarati (2004), Variance Inflation Factor (VIF) computed as:

$$\text{VIF } (x_i) = \frac{1}{1 - R_i^2}$$

As a rule, large value of VIF (exceeds 10) indicated that there is strong multicollinarity between variables. The VIF values have shown that all the continuous independent variables have no multicollinearity problem.

Similarly, the contingency coefficient (CC) was computed as:

$$C = \sqrt{\frac{X^2}{N + X^2}}$$

where C = Coefficient of contingency
X^2 = Chi-square random variable and
N = Total sample size

The decision rule for contingency coefficients is that when its value approaches 1, there is a problem of association between the discrete variables. The contingency coefficients also showed that there is no problem of multicollinearity between variables

3. RESULTS

3. 1. Household and Socio-Economic Characteristics

3. 1. 1. Household Characteristics

Among the total sampled respondents, about 85% and 86% were male and 14.8% and 14% were female household heads in the midland and highland respectively (Table 2). The average family size of the respondents was 5.91 and 5.74 for the midlands and highlands, respectively, while the respective average age of the household heads was 43.72 and 43.62 years.

The average family sizes of the productive age group (15 – 64 years old) of household members were 4.3 and 4.2 in the midlands and highlands, respectively. About 61% of the respondents in the midland and 38.9% in the highland were illiterate and the rest attended primary, secondary and preparatory schools or formal education.

Table 2. Household characteristics of the sample households

Household characteristics	Highland (n = 54)				Midland (n = 50)				
	Min	Max	Mean	Std.	Min	Max	Mean	St.d.	p-value
Age in years	20	65	43.72	8.45	28	60	43.62	8.64	0.95
Family size(number)	3	10	5.91	2.01	3	11	5.74	1.64	0.84
Members b/n age of 15and 64 in years	1	9	4.2	1.89	2	8	4.30	1.50	0.95
Education (year)	0	12+2	3.57	4.45	0	12	3.12	3.35	0.85

Dummy Variables	Frequency	Percent	Frequency	Percent	Person chi-square	
					χ^2	p-value
Sex					1.235	0.539
Male	46	85.2	43	86.0		
Female	8	14.8	7	14.0		
Off-farm work engagement					3.343	0.068*
No	9	36	16	64		
Yes	45	57	34	43		

Note: *statistically significance at 10% significance level

3. 1. 2. Tangible assets

3. 1. 2. 1. Land holding

The landholding of sample households varied between 0.38 and 3 ha in the highlands and 0.56 and 3ha in the midlands. The average land sizes vary between agro-ecologies, being 1.01 ha in the highlands and 1.23 in the midlands. The average land sizes also varied among wealth categories of the midland households with 0.78 ha for the poor, 1.12 ha for the medium and 1.93 for the rich while in the highland the poor owned 0.69 ha, while the medium and rich households' had 1.08ha and 1.95 ha of land, respectively.

3. 1. 2. 2. Livestock

Livestock were also other important assets of farm households in the study area. The number of livestock in the sample households estimated to be 2.41 and 3.88 in the highland and midland agro ecology, respectively in terms of tropical livestock unit (TLU), (Table 3).

Table 3. Land holding, TLU and proximity to the main road of the sample households.

Socio economic characteristics	Highland (n = 54)				Midland (n = 50)				
	Min	Max	Mean	Std.	Min	Max	Mean	St.d.	p-value
Total land holding	0.38	3.00	1.01	0.48	0.56	3.00	1.23	0.52	0.021**
Live stock in TLU	0	11.70	2.41	2.69	0	9.85	3.88	2.45	0.54
Distance from accessible road	0.50	10.00	3.63	2.55	0.5	7.00	2.70	1.56	0.54

Note: ** Statistically significance at 5% significance level

3. 1. 3. Land allocation for eucalypts woodlots

The area of land allocated for eucalypts woodlot differed along wealth categories and agroecologies. Farmers in the midlands allocated slightly larger portion of their farm (mean, 12.21%) to woodlots as compared to those in the highlands (mean 9.10%) (Table 4). Regarding wealth status, rich households allocated relatively larger areas to eucalypts woodlot as compared with middle and poor ones. In the highlands, poor households have slightly larger portion than middle households (8.61% vs 7.41%). This is because poor households in the highlands tend to reduce production area of labour-intensive annual crops and engage in off-farm activities for their subsistence, than other groups. The mean comparison at $\alpha = 0.05$ significance level showed a significant difference in the two agroecologies. Among wealth categories rich households in both agro ecologies had significantly larger woodlots as compared with the other groups (poor and medium) (Table 4).

Table 4. The extent of Eucalypts woodlots (ha) and their distribution among wealth classes and agro ecologies.

Agroecology	Wealth status	Eucalypts woodlot size (ha)	Aggregate mean	Share (%)	Aggregate share (%)
		Mean	Mean ±SE		
Highland	Poor	0.06±0.03^{b}		8.61	
	Medium	0.09±0.03^{b}	**0.09±0.02^{b}**	7.41	**9.10**
	Rich	0.22±0.05^{a}		11.28	
Midland	Poor	0.07±0.04^{b}		8.97	
	Medium	0.13±0.03^{b}	**0.17±0.02^{a}**	11.61	**12.21**
	Rich	0.31±0.04^{a}		16.06	

Note: Different letters following vertical mean values indicate significant difference between wealth categories and similarly across agroecology ($P < 0.05$) at the study area

3. 1. 4. Conversion of other land use to Eucalypts woodlot

Focus group discussants revealed that the majority of households in the study area had converted parts of their agricultural lands into eucalypts woodlots for different reasons: (i) when crop yields decline, (ii) when cost of fertilizer is not affordable, (iii) due to influence of neighbor households who have woodlots and (iv) when annual and perennial crops (coffee and potato) fail to give reasonable yield due to diseases and pests. Generally, as discussants revealed the need for high management inputs and low price of agricultural crops and livestock and high market demand with lower production cost of eucalyptus woodlot have been forcing households to convert their crop and grazing land to eucalypts woodlot.

In most cases households established their eucalypts woodlots by converting other land use types. In the highlands higher percentage of households converted other land use types to eucalypts woodlot when compared to households in the midlands. This indicated that in the highland agro ecology eucalypts was the only cash crop for household income. Even for the poor households who are faced with land shortage, more than half of their eucalypts woodlots were converted from other land use type, particularly grazing land.

Table 5. Number of households who converted other land use type to Eucalypts woodlot across wealth categories in the midland and highland agro ecology (N = 61).

Agro ecology	Wealth status	Converted land use type									
		Cereal crops		Grazing		Cereals &grazing		Coffee		Coffee ,cereals &grazing	
		F	%	F	%	F	%	0	0	0	0
Highland	Poor	2	40	3	60	0	0	0	0	0	0
	Medium	2	33	3	50	1	20	0	0	0	0
	Rich	0	0	4	80	1	20	0	0	0	0
	Total	**4**	**25**	**10**	**62**	**2**	**12.5**	**0**	**0**	**0**	**0**
Midland	Poor	3	60	0	0	1	20	1	20	0	0
	Medium	6	50	4	33.3	2	16.7	0	0	0	0
	Rich	2	22.2	2	22.2	4	44.4	0	0	1	11.1
	Total	**11**	**42.3**	**6**	**23.1**	**7**	**26.9**	**1**	**3.8**	**1**	**3.8**

Note: & = and, F = frequency, and % = percent

The survey results showed that most eucalypts woodlot had previously been grazing land followed by cereal crop land. In the highland, about 60%, 25%, and 12.5% households established their eucalypts woodlot by converting grazing land, cereal crop land and both cereal and grazing land use types, respectively. In the midland about 42.3, 23.1, 26.9, 3.8 and 3.8 percent woodlot owners established woodlot by converting cereal crop land, grazing land, both cereal and grazing land, coffee, and cereal, grazing and coffee respectively (Table 5).

3. 1. 5. The Determinants of households to the decision to establishing Eucalypts woodlot

3.1.5.1. Goodness-of-fit of the model

Goodness-of-fit of the models were measured using pseudo-R^2. The pseudo-R^2 was computed 0.3274. Converting the models final pseudo R^2 ratio into a percentage showed that 32.74 % of the variance of the dependent variables (establishment and land allocation of eucalypts) was accounted for by the logit model regression equation. That is, about 32.74 % of the variation was explained by the respective logit models. These pseudo R-squares estimated in this study were above the minimum of R- square of at least 0.15 which was in agreement with Mitchell and Carson (1989). Thus, the goodness of fit of the logit model used was adequate.

3. 1. 5. 2. Binary logit model result

As indicated under the second column of the logit estimate in table 6 below, out of the total nine explanatory variables hypothesized, two explanatory variables have positively and three explanatory variables negatively significantly effects on probably of household decision in establishment of eucalypts woodlots and the remaining four explanatory variables were found to be insignificant.

3. 1. 5. 3. Marginal effect of the binary logit model estimates

The coefficients of the logit model do not indicate the marginal effects of explanatory variables on the dependent variable. That is, in the binary logit model only the signs (not the magnitudes) of the coefficients of independent variables are important. In order to analyze the effects of each explanatory variable on the probability that farmers decision to establish eucalypts woodlot or not established, the partial derivatives of explanatory variables with respect to discrete responses must be taken (Greene, 1993, Bamlaku, 2013). The interpretation of the marginal effect measures the change in probability (likelihood of occurrence) of an event to a unit change in the continuous explanatory variables and the change of dummy variables from 0 to 1 for discrete response. The marginal effects of the logit model estimation results are reported in the table 6.

Table 6. Factors affecting decision of households in establishment and land allocation to Eucalypts woodlot, the binary logit model regression results.

Explanatory variables	Coef.	Robust Std. Err	p>/z/	Marginal effect	
				Dy/dx	Std.Err
SEX	1.041119	0.7886611	0.187	0.251779	0.19004
AGE	0.0248639	0.340722	0.466	0.0057095	0.00788
FAMSIZ	-0.3628092	0.1876934	0.053*	-0.083312	0.04336
EDU	1.07232	0.5718342	0.061*	0.2405007	0.12263
CROP INCOME	-0.0000571	0.0000673	0.096*	-0.00013	0.00002

TLANDHOL	2.341518	0.7972318	0.003**	0.5376804	0.17806
LIVTLU	-0.0230599	0.1089358	0.832	-0.005295	0.02501
OFF-WORK	0.4375292	0.7269461	0.547	0.1031257	0.17447
ROADDIST	-0.3796447	0.1088515	0.001***	-0.087177	0.02658
Constant	-0.4910398	2.075829	0.813	-	-

Number of obs = 104 Y = pr (planting eucalypts) (predict)
Log likelihood = -47.429753 Wald chi^2 (9) = 26.46
Prob > 0.0017 pseudo R^2 = 0.3274
Note: ***, ** and* significant at 1%, 5% and 10% probability level respectively.

Family size (FAMSIZ): As hypothesized, similar to the prior prediction, the model result shows that the family size of the households was statistically significant ($p < 0.1$) and has negative relation to households' decision in land allocation and the establishment of eucalypts woodlots. The marginal effect of the estimates ((dy/dx) 0.0833) indicated that, other factors held constant, if a household increase the total family size by a unit, the probability of the household's decision in the establishment and land allocation of eucalypts woodlot will decrease by 8.33% in the study area.

Total land holding (TLANDHOL): The total land holding of the household displayed statistically significant ($p < 0.05$) and had positive relationship to farmer decision in establishment and land allocation for eucalypts woodlots. Keeping other factors constant, the estimated marginal effect shows that, increase in total land holding of households by a unit hectare, increases the probability of farmer decision for establishment and land allocation of eucalypts woodlots by 53.76%.

Education level (EDU): Education level of household head showed statistically significant ($p < 0.1$) and positive relation to households decision in establishment and land allocation for eucalypts woodlot. The marginal effect estimate indicates that if the other factors are kept constant, the improvement in households literacy increase the probability of their decision in establishment and land allocation to eucalypts woodlots increased by 24%.

Income from crop production (CROPINCOME): The relation between crop production and households decision in establishment and land allocation for eucalypts woodlot was negative and statistically significant ($p < 0.1$). As observed from the model result, the marginal effect estimates showed that all other factors kept constant households' income from crop production may decrease, the probability of farmer's decision in establishment and land allocation of eucalypts woodlot increased by 0.013% in the study area.

Distance of accessible road (ROADDIST): Distance of households from the nearest accessible road was negatively ($p < 0.01$) related with household decision to establish and land allocation to eucalypts woodlot. The model result indicated that households that are located far away from accessible road were less likely to establish and allocate land for eucalypts woodlot. The estimates of the marginal effect showed that all other factors kept the same; a unit kilometer increase of the distance of households' location from an accessible road, the probability of the household to establish eucalypts woodlot would be decreased by 8.72%.

4. DISCUSSION

4. 1. Status of Eucalypts woodlot

The decline of wood resources, growing demand for wood products and its high income contribution of wood products are encouraging the rapid expansion of eucalypts woodlots by rural household in Ethiopia, including the Guraghe administrative zone of Southern Ethiopia. Based on the information from key informants eucalypts *species* was introduced to the Guraghe regions by the Amahra settlers during 1950s (Nigussie, 2004). The survey result showed that, involvement of smallholder households in eucalypts planting as a woodlot increased in the two consecutive decades from 1981 to 1990 and 1990 to 2000 years in response to the increasing market demand. However eucalypts planting by smallholder households showed decreasing trend from 2001 to 2005 following the advise of agricultural extension workers to reduce its expansion due to its alleged ecological effects.

Households in the midlands allocated significantly larger portion of their farm land to eucalypts woodlots as compared to those in the highlands this is because in the midland agro ecology households have better access to land and market as compared to the highlanders. Regarding wealth status, rich households allocated relatively larger areas to eucalypts woodlot as compared with middle and poor households. However, in terms of percentage in the highland, poor households have slightly larger portion than medium households. This is because poor households in the highlands tend to reduce production area of input and labour-intensive annual crops and engage in off-farm activities for their subsistence, than other groups. This is in line with Selamyhun Kidanu et al. (2004) who reported that, in spite of low stand density and long pay off period the *eucalypts* – wheat system achieve return to land 1.3-1.7 times and return to labor 1.2-1.5 times greater than sole wheat cropping.

Increased land allocation for the production of eucalypts is one of the indicators for increased importance of eucalypts for rural small holder's livelihoods. Focus group discussion revealed that the majority of households in the study area converted parts of their agricultural lands into eucalypts woodlots. Cereal crop and grazing lands were mainly converted to eucalypts woodlots. This is probably due to smallholder households' preference to depend on perennial crops as sources of income rather than labour and input intensive annual crops. They depend on, enset for household consumption (stable food) and chat, coffee and eucalypts for cash income. Obviously, production of annual crops requires high management and input costs. Thus the higher outputs of eucalypts with a given input and less initial investment cost are attractive to households. Similar findings were also reported by Mesele Negash (2002) in Sidama Zone of SNNPRS.

Whereas in the highland agroecology the less income diversification and low output of livestock and crop production, and high market value of eucalypts products are the major factor that leads households to plant *Eucalypts* on their agricultural farm land. This result is also in agreement with the study at Wondo Genet by Tolla Gemechu (2010) who indicates that, most households began to plant eucalypts woodlot around homesteads and gradually expand to agricultural lands close to homesteads and some households converted crop lands that have lost crop production potential.

4. 2. Determinants of households decision to plant eucalypts

Households' decisions to plant and allocate land to eucalypts woodlot are affected by several household socioeconomic, physical and institutional factors. Factors that showed

significant effect in farmer's decision to plant eucalypts woodlot were, family size, education level, land holding size, income from crop production and distance of the household from the accessible road. However, age and sex of household head, and off-farm employment had no significant effect but they were positively correlated. On the other hand Livestock holding (TLU) had no significant effect but it was negatively correlated.

Family size of the household significantly and negatively affected household decision in planting and land allocation of eucalypts woodlot. The results showed that household with large family size were less likely to plant eucalypts woodlot. One possible reason for such negative relation between total family size and household decision in planting and land allocation for eucalypts woodlot could be that households used their land for crop production instead of planting eucalypts to feed their large family. This result agrees with Dereje Jembere (2009) who noted that in large family size that include especially males aged 18 and above share land from their parents and use it to produce cops for their own subsistence, and this might limit the area for eucalypts plantations. The other possible reason could be availability of sufficient household labour force in large families to engage in intensive crop production activities.

Education level of the household head was positively and significantly correlated with households' decision to plant eucalypts woodlot. Likewise, Nigussie (2004) point out that more educated household heads slightly enhanced propensity towards establishing additional eucalypts woodlot. Knowledge about forest plantation plays a key role in forest plantation development. It is likely that better educated households will be more aware of the potential benefits to be derived from smallholder forest plantation than households who are illiterate. Households cannot be expected to exhibit positive attitudes towards smallholder forest plantation if they are unaware of the benefits and costs associated with their establishment and management (Bernard *et al.* 2005). In line with this result Selamyhun (2004) has reported that farming experience and educational background are the most important determinant factors that affect the adoption of boundary planting of eucalypts.

Total land holding and household's decision to plant and allocate land for eucalypts woodlot were positively correlated; this could be due to the fact that, land availability is a critical factor in household tree planting. This result agrees with Zeleke Ewnetu (2008), who reported that tree growing on farm components needs agricultural spaces, thus adoption of on-farm tree growing depends on availability of land. He further explanained that households that have bigger landholding provides enough space to produce food and more trees and the capacity to take risks for diversifying farm crops including long-term crops such as trees. Analysis of the survey results agree with several findings in different parts of Ethiopia (Dereje Jembere, 2009; Mind Teshome, 2004; Amare Getahun, 2002; Asaye Asnake, 2002; Mesele Negash, 2002), who identified land shortage as the major factor that hinders the expansion of eucalypts plantations.

The outcome of focus group discussions and key informant interviews indicated that rapid population growth influenced the size of land holdings of households to be fragmented. Consequently, households are suffering critically with land shortage for the establishment of eucalypts woodlot in the study area. In line with the results, Zubair (2005) concluded that the availability of land is the major encouraging factor contributing toward the performance of farm forestry in Pakistan. Moreover, Nigussie Achalu (2004) from Ethiopia highland also reported that the land holding sizes is claimed to be insufficient for about two-thirds of the

household to establish woodlots. This will continue to fragment with further redistribution among descendants of the households.

Crop productivity and farmer's decision to allocate land and plant eucalypts woodlot were negatively correlated, one possible reason is that households in the study area may change their farm lands when the productivity of land start to decline since they cannot afford to invest agricultural inputs to improve the productivity of the land as well as when the family food security is at risk. This result agreed with Amisalu Milkias's (2013) findings; most households can get high yield from annual crops by applying high amount of fertilizers due to the decline of soil productivity but they cannot afford it. Therefore, planting eucalypts is an alternative to households to invest low money but the return is attractive without any fertilizer application. Similarly Tolla Gemechu (2010) concluded that some households converted crop lands to woodlots that lost crop production potential around Wondo Genet area. Biruk Ketsela (2012) also revealed that the major reason for the expansion of eucalypts woodlot in the central highland of Ethiopia was the decline of crop productivity of the farmland. Whereas, Zeleke Ewnetu's (2008) findings also describes that better farms can be safety nets for food security and other agricultural products on relatively small sizes of land and can those have some extra land which they can devote for growing trees. Generally households have already begun to convert unproductive farmlands with trees (especially eucalypts trees) as trees demand less nutrients and due to economic reasons.

Proxy of households to accessible road and households' decision to allocate land and plant eucalypts woodlot is negatively correlated. This is due to the fact that household's distance to accessible roads is an advantage for easier supply of seedlings and sale of woodlot products without household's high transaction cost. This result is in line with Maru Shete (2010) and stated that those farm households that are located near to the main road facility will go for monoculture plantation of eucalypts spp. for the reason that households get better market value as fuel wood and construction poles. In addition Bernard (2005) from Gahna and Asaye Asnake (2002) from highland of Ethiopia concluded that the availability of market is one of an important factors influencing household decision to engage in forest plantation development. This result also agrees with Zeleke Ewnetu (2008), he described that households 'distance to accessible road was negatively and significantly associated with the number of trees grown per household, that's why improving rural road network is crucial for households to make a well informed production decisions and to exploit the market opportunities of tree production.

5. CONCLUSION AND RECOMMENDATION

The livelihoods of households in the study area depend on portfolio of activities in which eucalypts production is one of the major role players. Eucalypts is the most economical important tree species established as woodlot by rural households. Rural household considered eucalypts woodlot as a form of financial security against any sort of unforeseen financial problems.

Furthermore, in the study area households' decision to allocate land and plant eucalypts woodlots was positively determined by socio-economic and institutional (road access) related arbitrating factors, including household head's education level and total land holding. Whereas, family size, crop productivity and households distance to the nearest accessible road

were found to be affecting negatively. From this, it is possible to conclude that household socio-economic characteristics and institutional factors can enhance or hinder the decision of rural household‘s eucalypts woodlot establishment. As long as growing eucalypts is a potential financial income sources and contributes highly to the livelihood of the farming households, restricting and hindering the growing of eucalypts without considering the existing benefit should be avoided. Therefore policy makers should take the right and careful decision by assessing the overall socioeconomic and ecological aspects of eucalypts based on the interest of the community.

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