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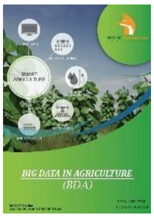

RESEARCH ARTICLE

UNLOCKING THE POTENTIAL OF AGROFORESTRY: UNDERSTANDING ADOPTION FACTORS IN ALETA WENDO DISTRICT, SOUTHERN ETHIOPIA

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ABSTRACT

This study aimed to address the knowledge gap among farmers of the Aleta Wendo district of southern Ethiopia about agroforestry practices. The study used a multi-stage sampling technique and collected primary data from 257 respondents. Quantitative analysis was conducted on the collected data using multiple statistical techniques, which included percentage, mean, frequency, and Chi-square tests. The Tobit model was also employed to identify the factors that affect the adoption of agroforestry practices. The results of the study showed that home garden was the most widely adopted agroforestry practice in the study area, followed by windbreak, woodlot, multipurpose tree, alley cropping, and parkland agroforestry. Among the 15 independent variables expected to affect the adoption of agroforestry practices, only six variables were found to have significant and positive influence, including farming experience, access to credit, labor availability, livestock holding, annual income, and contact with development agents. The study's findings suggest that encouraging farmers to save money, obtain credit, and diversify income sources could help to promote the adoption of agroforestry practices in the study area. The study also highlights the importance of daily communication between farmers and development agents, and the need to take into consideration the major determinants affecting the adoption of agroforestry practices. Overall, the study highlights the potential of agroforestry practices to provide multiple benefits and the need for targeted interventions to promote their adoption in the Aleta Wendo district.

KEYWORDS

Agroforestry, Adoption, Ethiopia, Home garden, Variables.

1. INTRODUCTION

Ethiopia's economy heavily relies on the agriculture sector, which constitutes a significant portion of the country's gross domestic product (GDP) and employs a large population. However, land degradation caused by various factors such as rapid population growth, severe soil loss, deforestation, low vegetative cover, unbalanced crop and livestock production, free grazing system, inappropriate land-use systems and land-tenure policies, desertification, and loss of agro-biodiversity have reduced soil fertility, decreased agricultural productivity, and led to food insecurity (Franzel et al., 2003; Tsegaye and Bekele 2016; Torquebiau 2001; Young 2008). Agroforestry, a land use management system that integrates trees or shrubs with crops or pastureland, has the potential to address these challenges. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land use systems (Arnold 2003; Oram 2001).

It has the potential to contribute to rural livelihood improvement, farm production and income enhancement, and agricultural environment protection. Trees and shrubs grown on farms provide fruit, timber, resins, fuel wood, and livestock fodder, improve soil fertility, regulate water supplies, and help farmers adapt to changing climatic conditions (Rain tree 2000; Beeker 2003). The implementation of agroforestry practices can have a noteworthy impact on enhancing agricultural productivity by promoting nutrient cycling, mitigating soil erosion, and enhancing soil fertility while enhancing farm income compared to conventional crop production (CIMMYT 1993; Neupane and Thapa 2001). Agroforestry can also potentially reduce deforestation while increasing food, fodder, and fuelwood production and creates environmental and management synergies (Nair 2007).

Despite the potential benefits of agroforestry, the adoption of agroforestry practices in Ethiopia's rural areas has been slow due to various factors. These include inadequate awareness of the benefits of agroforestry practices among farmers, high costs of production associated with monocropping, and insufficient empirical information on the determinants of farmers' adoption of agroforestry practices (Million and Belay 2004; Pattanayak et al., 2003). The Aleta Wendo District, located in the Sidama region of Southern Ethiopia, is known for its traditional agroforestry practices, which integrate multipurpose trees with crops and livestock in intimate association, such as coffee shade-based systems, scattered trees on farmlands, home gardens, woodlots, farm boundary trees, grazing lands with trees, and various fruits and root/tuber products (AWDBoA 2017).

However, the adoption of agroforestry practices by farmers in the area is similarly hindered by different factors. Despite the potential benefits of agroforestry, its adoption is still limited. The reasons behind this limited adoption are not well understood, which hinders the development of effective strategies to promote agroforestry practices among farmers in the area. Thus, this study was conducted with the intention of investigating the factors limiting the adoption of agroforestry practices in Aleta Wendo District, Southern Ethiopia, and to develop effective strategies to promote the adoption of agroforestry among farmers in the area.

Moreover, to promote sustainable agriculture and forest management practices, alleviate poverty, and ensure food security in the region, a

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comprehensive study is necessary to identify the socio-economic, cultural, institutional, and environmental factors that affect farmers' adoption of agroforestry practices in the Aleta Wendo District. The study can provide valuable insights into the determinants of agroforestry practices adoption in the study area, inform policies and interventions, and recommend awareness creation among farmers regarding the benefits of agroforestry practices, such as increasing farm production and income, enhancing rural livelihoods, and protecting the agricultural environment.

2. METHODOLOGY

2.1 Description of the Study Area

The research was conducted in the Aleta-wondo woreda, located in the Sidama Regional state, 64km and 337km from the regional capital city of Hawassa and Ethiopia's capital city, Addis Ababa, respectively. The woreda has a total area of 27,823 hectares, which is divided into 27 administrative kebeles. Its geographical location is between 6°31'30''N and 6°40'30''N latitude and 38°21'0''E and 38°32'0''E longitudes (Figure 1), and latitude ranges from 1700 to 2500 meters above sea level. The woreda has a land area of 640 km^2 and an estimated population of 188,976 (CSA 2007). Aleta-wondo shares its borders with Dara Woreda to the south, Chuko to the west, Dale and Wonsho to the north, and Bursa to the east. The annual rainfall in the area ranges from 900 to 1400mm, and the min and max temperatures are approximately between 10°C to 24°C (AWDFEDO 2012). The woreda has 27 kebeles, with two agroecologies, highland 'Dega' (14.9%) and 'WoyinaDega' (85.1%), and two rainy seasons, namely Belg and Meher. Belg is the short rainy season that lasts between February and April, while Meher starts in May and ends in September.

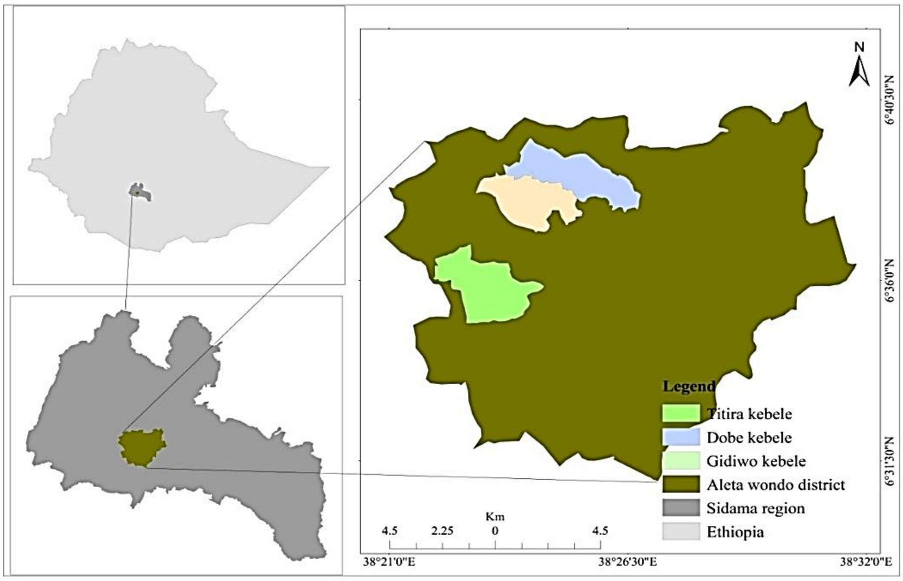

Figure 1: Map of the study area

2.2 Sample Size and Sampling Techniques

Selecting an appropriate sample size is an important decision when adopting a sampling technique, which depends on various factors such as research cost, time, degree of accuracy desired, and others related to the subject under investigation (Rangaswamy et al., 2000). For this study, factors such as research cost, time, and accessibility were considered when determining the sample size.

A multi-stage sampling procedure was employed to select rural kebeles and sample respondents. Firstly, the district was purposively selected due to its favorable conditions for practicing agroforestry technology. Secondly, three kebeles were randomly selected from the 27 kebeles using simple random sampling techniques. Finally, 257 farmers were selected using systematic random sampling with probability proportional to size from the selected kebeles. The number of respondents was determined using a formula developed by Yamane (1967) for a required sample size at the 6% level of precision. To elaborate, the formula used was $n = N/(1+N(e)^2)$, where n is the sample size, N is the total number of population (total population in the three selected kebeles, which is 3400), and e is the level of precision (6% or 0.06). Thus, $n = 3400/(1+3400(0.06)^2) = 257$.

A sample of 110, 80, and 67 respondents were selected from the three kebeles, namely Gidiwo, Dobe, and Titra respectively, using systematic sampling. The details are presented in the Table below.

Table 1: Sample size of respondents in three kebeles

No	Sample selected kebeles	Number of total HH	Total sample size
1	Gidiwo	1455x257/3400	110
2	Dobe	1058x257/3400	80
3	Titra	887x257/3400	67
Total		3400	257

2.2 Data Collection Methods and Tools

Both quantitative and qualitative methods of data collection was used in connection with all the information needed to answer the research questions. A structured interview was conducted using a structured questionnaire with both open and closed ended questions. Key informants interviews was done using a checklist of items for discussion with District Agricultural Officers of different places in the study area, and they have given information on adoption of agroforestry technology and practices. Enumerators who are familiar with the existing social settings and can communicate with thelocal language was recruited. They were given training and briefings on the objective, contents of the interview schedule and were also acquainted with the basic techniques of data gathering and interviewing techniques and how to approach farmers. Two focus groups composed of elders, youths, mens and womens were organized from each kebeles for the discussion. The group consists of 8 to 12 members. The purpose of the discussion was to gain indepth information about the areas and other issues that may not have been adequately captured by the household questionnaires.

2.3 Data Analysis

2.3.1 Descriptive Statistics

Descriptive statistics such as mean, standard deviation (SD), frequencies, and percentages were used to describe the demographic and socio-economic features of the respondents. Furthermore, cross tabulation were used to identify the influence of demographic and socio-economic factors on farmers' adoption of agroforestry technology practices in the study area.The Quantitative data was analyzed and presented by using descriptive and inferential statistics such as frequency distribution, measures of central tendency, percentage and Chi-square test and F-test respectively.

2.3.2 *Definition of dependent variable and independent variables*

The dependent variable is the variable being studied and influenced by independent variables. Independent variables are expected to have an impact on the dependent variable. Table 2 summarizes the expected direction of the influence of each independent variable on the dependent variable, helping to understand the relationship between the variables.

Table 2: Expected relationship between adoption of technologies and demographic factors

Description of Variables	Expected Sign	Rationale
Age of household	+	Younger farmers are more likely to adopt new technologies (Hailu, 2008).
Sex of household	+	Male farmers have greater access to information due to socio-cultural values and norms (Taha, 2007; Mesfin, 2005).
Farming experience of household	+	Farmers with more experience and knowledge are better able to evaluate and adopt new technologies (Chilot, 1994).
Education level of household	+	Farmers with higher levels of education possess superior capacity to comprehend and analyze information and thus, are more efficient in selecting suitable technologies (Getahun, 2000).
Farm size of household	+	Farmers with larger farms are more likely to adopt new technologies compared to those with small farms (Belay, 2003).
Total farm income	+	Farm income has a positive effect on household's adoption decision (Degnet et al., 2001; Leggese, 1998).
Access to credit	+	Farmers without cash and no access to credit will find it difficult to adopt new technologies (Million and Belay, 2004).
Number of livestock in TLU	+	Livestock ownership is expected to positively influence adoption/intensity of adoption (Habtemariam, 2004).
Participation in off-farm activities	+	Additional income earned from non-agricultural activities increases the farmers' financial capacity to invest in new technologies (Techane, 2006).
Contact to extension agents	+	Extension agents have a positive influence on the adoption of improved technologies (Hailu, 2008).
Participation in on-farm activities	+	Participation in on-farm demonstration is expected to positively influence the adoption of new technologies (Techane, 2006).
Participation in training	+	Participation in training is expected to positively influence farmers to adopt new technologies (Belay, 2003).
Labor availability	+	Household's labor availability has a positive effect on adoption (Million and Belay, 2004).

2.3.3 *Econometric Model*

To examine the impact of various explanatory variables on the dependent variable, a Tobit model was employed.This model was chosen due to its advantage over other analytical models, as it can reveal both the probability of technology adoption and its intensity (Maddala, 1992; Johnston and Dandiro, 1997). The utilization and adoption of technology can have a notable effect on the production and productivity of farm households. Farmers may choose to adopt only some of the recommended practices and implement them on varying percentages of their farms, making the Tobit model more suitable for providing reliable outputs for both discrete and continuous variable combinations.

The Tobit model specification, which tests the factors affecting the incidence and determinants of adoption, can be expressed as follows, based on McDonald and Moffitt (1980) and Maddala (1983): $AI_i^* = B_0 + B_iX_i + U_i$

$$AI_i = AI_i^* \text{ if } B_0 + B_iX_i + U_i > 0 \quad (1)$$

$=0$, if $B_0 + B_iX_i + U_i \leq 0$, Where:

The latent variable AI_i^* represents the solution to the utility maximization problem of adoption, subject to a set of household constraints and conditional on exceeding a certain threshold. The adoption index for the ith farmer is denoted by AI_i, while X_i is a vector of factors that affect adoption. B_i is a vector of unknown parameters, and U_i is the error term that follows a normal distribution with a mean of 0. To estimate the model parameters, the Tobit likelihood function is maximized, which takes the following form (Maddala, 1992). In order to determine the relative influence of various explanatory variables on the dependent variable, a Tobit model was utilized. This model was preferred due to its ability to reveal both the probability and intensity of technology adoption, which is essential for the production and productivity of farm households. Farmers may adopt only certain recommended practices and implement them on different portions of their farms, making the Tobit model more appropriate for providing reliable outputs for both discrete and continuous variable combinations (Maddala 1992; Johnston and Dandiro 1997).

The Tobit model used in this study was specified based on (McDonald and Moffitt, 1980; Maddala, 1983). To analyze the data, the Tobit model was utilized with the aid of the STATA software. It should be noted, however, that the interpretation of coefficients in a Tobit model differs from that of an uncensored linear model (Johnston and Dinardo 1997). To estimate the effects of changes in the explanatory variables, the derivatives of the Tobit model were calculated. Prior to running the Tobit model, multicollinearity was checked for all hypothesized explanatory variables. The Variance Inflation Factor (VIF) was used for continuous explanatory variables, while contingency coefficients were used for dummy variables. Variables with a VIF value exceeding 10 were considered highly collinear, while those with a contingency coefficient greater than 0.75 were also considered collinear (Gujarati 1995).

2.4 Estimation of the Adoption index

Before examining the determinants of adoption, it is necessary to evaluate the extent of adoption for each farm household. To assess the level of adoption, a sample of agroforestry technology practices should be taken. Out of the many agroforestry technology practices, only six were selected for this study, namely home garden, windbreak/shelter belt, multipurpose tree, woodlot, parkland agroforestry, and alley cropping. Tree planting as live fences and boundary delimitation were not considered for both adopters and non-adopters, as they are common practices.

Farmers who did not practice any of the selected sample practices of agroforestry were classified as non-adopters, while those who practiced one of the selected sample practices were considered adopters. All practices were given equal weight, with 1 assigned to adopters and 0 to non-adopters. An adoption index score was computed by adding up the number of practices adopted by each respondent from the selected sample practices and dividing it by the total number of selected sample agroforestry practices for each respondent. A person who did not practice any of the practices was considered a non-adopter, while those who practiced one or two practices were considered low adopters, those who practiced three or four practices were considered medium adopters, and those who practiced five or six practices were considered high adopters.

$$AIi = \frac{HG + WB + MPT + WL + PLAF + AC}{NP}$$

AI_i = Adoption index of the i^{th} farmer

HG = Home garden for the i^{th} farmer

WB = Wind break/Shelter belt for the i^{th} farmer

MPT= Multi purpose tree for the i^{th} farmer

WL=Woodlot of the farmer for the i^{th} farmer

PLAF= Parkland agroforestry for the i^{th} farmer

AC= Alley cropping for the i^{th} farmer

NP= Number of total selected sample practices(6) of agroforestry technology.

Thus, the adoption index was used to categorize adopter ranging from zero to one. Zero indicates no adoption and 1 indicates full adoption. Once the adoption index was calculated, respondent farmers were classified into three categories, viz., low, medium, and high adopter (Adoption index formula sample adopted from (Scherrs 1995). The actual adoption index score ranges from 0 to 1. The level of adoption of agroforestry technology practices by farmers may vary depending on demographic and socioeconomic variables, although institutional and environmental factors in which the household operates also influence level of adoption.

3. Results and Discussion

3.1 The status of Agroforestry technology practices in the study area

The study area examined different agroforestry technology practices, which were categorized into six to distinguish low, medium, and high adopters. However, beyond these six practices, other agroforestry technology practices were observed in the woreda. The selected technologies identified in the study area include home gardens, alley cropping, multipurpose trees, woodlots, shelterbelts/windbreaks, and parkland agroforestry. It was evident that some farmers raised their own seedlings, while others obtained seedlings from institutions that support agroforestry. Various tree species were identified in the area, including Gravilla, Moringa, Birbira, Grava, Eucalyptus, Nimi, Sycamore, and Maple tree species, which were grown with crops. Boundary planting and live fences were found to be popular among smallholder farmers in the woreda. Figure 2 illustrates the status of the selected agroforestry technology practices in the woreda.

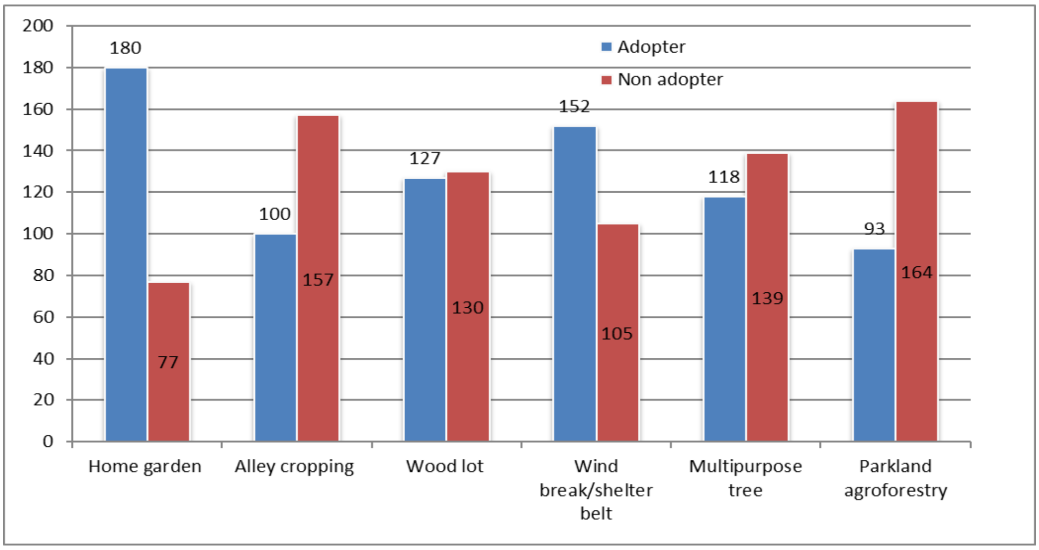

Figure 2: Adoption status of agroforestry technologies practices by household

The bar chart illustrates that home gardening has the greatest number of adopters among the six agroforestry practices, with a total of 180 farmers adopting this practice. Windbreak/shelter belt is the second most adopted practice, with 152 adopters. However, for all other practices, the number of non-adopters is higher than the number of adopters, with woodlot having 130 non-adopters and parkland agroforestry having 164 non-adopters. This suggests that a considerable proportion of farmers in the study area have not yet adopted these agroforestry practices.

Table 3: Adoption Rates of Agroforestry Practices in Gidiwo, Dobe, and Titra Kebeles

Agroforestry practices	Gidiwo		Dobe		Titra	
	Adopters (%)	Non adopters (%)	Adopters (%)	Non adopters (%)	Adopters (%)	Non adopters (%)
Home garden	76.7%	23.3%	67.56%	32.44%	63.83%	36.17%
Alley cropping	36.7%	63.3%	43.24%	56.76%	38.30%	61.70%
Wood lot	46.7%	53.3%	51.35%	48.65%	51.06%	48.94%
Wind break	80%	20%	54.05%	45.95%	36.17%	63.83%
Multi purpose	53.3%	46.7%	37.84%	62.16%	42.55%	57.45%
Park land AF	33.3%	66.7%	35.13%	64.87%	40.43%	59.57%

The table shows the adoption rates of six different agroforestry practices in three different kebeles (Gidiwo, Dobe, and Titra) in Aleta wendo woreda. For each agroforestry practice, the percentage of adopter and non-adopters is presented for each kebele. The highest adoption rates were observed for home gardening in all three kebeles, with the adoption rates ranging from 63.83% to 76.7%. Windbreak/shelter belt was also popular among farmers in Gidiwo and Dobe, with an adoption rate of 80% and 54.05%, respectively. The adoption rates of other agroforestry practices, such as alley cropping, woodlot, and multi-purpose tree, were more variable across the kebeles. The adoption rates for alley cropping ranged from 36.7% in Gidiwo to 56.76% in Dobe, while the adoption rates for woodlot ranged from 46.7% in Gidiwo to 51.35% in Dobe.

The adoption rates for multi-purpose tree ranged from 37.84% in Dobe to 53.3% in Gidiwo. The lowest adoption rates were observed for parkland agroforestry in all three kebeles, with the adoption rates ranging from 33.3% to 40.43%. This suggests that farmers in the study area may face challenges in adopting this particular agroforestry practice. Overall, the results suggest that certain agroforestry practices, such as home gardening and windbreak/shelter belt, are more popular among farmers in the study area, while the adoption rates of other practices are more variable. It is important to note that the adoption rates may be influenced by various factors, including access to information, availability of resources, and socio-economic factors. Further research is needed to identify the specific factors that influence farmers' adoption decisions and to develop appropriate interventions to promote the adoption of agroforestry practices in the study area.

Table 4: Mean square for between groups and with in groups for agroforestry						
ANOVA						
Agroforestry practices		Sum of Squares	Df	Mean Square	F	Sig.
Home garden	Between Groups	.155	1	.155	.732	.000***
	Within Groups	30.005	255	.211		
	Total	30.160	256			
Alley cropping	Between Groups	.356	1	.356	1.494	.000***
	Within Groups	33.866	255	.238		
	Total	34.222	256			
Wood lot	Between Groups	.048	1	.048	.189	.021***
	Within Groups	35.945	255	.253		
	Total	35.993	256			
Wind break/shelter belt	Between Groups	.087	1	.087	.355	.010***
	Within Groups	34.740	255	.245		
	Total	34.826	256			
Multi purpose tree	Between Groups	.456	1	.456	1.834	.128***
	Within Groups	35.294	255	.249		
	Total	35.750	256			
Park land agroforestry	Between Groups	.212	1	.212	.911	.213
	Within Groups	33.010	255	.232		
	Total	33.222	256			

*** Signifcant at less than 1% and ** is 5% significance level

3.2 Catagorizing adopters by adoption index

Table 5: Distribution of respondents by level of adoption of agroforestry technology practices			
Adopter Index			
Category	N	Percent (%)	Score
Non	77	30	0
Low	23	9	0.10-0.33
Medium	64	25	0.34 - 0.66
High	93	36	0.67 - 1.00
Total	257	100	0.00-1.00

The study used an adoption index score to classify respondents as non-adopters, low, medium, and high adopters, with score ranges of 0, 0.1-0.33, 0.34-0.66, and 0.67-1.00, respectively. The results showed that 77 respondents (30%) were non-adopters, 23 (9%) were low adopters, 64 (25%) were medium adopters, and 93 (36%) were high adopters. Table 3 displays the distribution of respondents based on their level of adoption of agroforestry practices. The adoption index score ranges from 0 to 1, with 0 indicating non-adoption and 1 indicating full adoption according to the recommended practice (as shown in Table 5).

3.3 Summary of Results of Descriptive Statistics

The study utilized descriptive statistics to analyze demographic, socioeconomic, and institutional variables. The F-test and Chi-square test were used to evaluate differences between adoption categories for continuous and discrete variables. Significant associations were found among variables such as household head age ($p < 0.01$), education level ($p < 0.05$), labor availability ($p < 0.01$), and access to credit ($p < 0.05$). Tables 6 and 7 provide a summary of the overall findings, including the level of significance for each variable. The significant associations found between adoption categories and variables such as family size, social participation, and cosmopolitanism are also presented in these tables, with their respective level of significance.

Table 6: Summary of result of continuous variables					
	Non	**Low**	**Medium**	**High**	**F**
AGEOHHH	65.80	58.94	53.96	51.83	3.594***
EDUCHHH	1.53	1.67	2.69	3.29	7.745***
EXPHH	17.93	20.93	21.98	22.76	1.131**
LABOURAV	4.13	3.00	5.00	7.89	4.298***
FAMILYSIZE	3.80	3.94	6.35	8.76	2.379 ***
SOCIALPT	0.33	.67	0.89	0.94	7.008 ***
COSMOPOT	0.27	0.39	0.71	0.90	24.137 ***
LIVESTOCK	2.47	9.67	13.77	14.33	2.399 ***
ANINCOME	9760.00	21,218.89	22,902.08	29,664.29	19.740 ***
FARMSIZE	0.4553	0.4667	0.7679	1.2306	33.405 ***
DACONTACT	0.53	1.28	2.15	2.41	5.324 ***

Note: F-values are shown with their respective levels of significance. *** indicates $p < 0.001$, ** indicates $p < 0.01$.

Table 7: Summary of result of discrete/dummy explanatory variables						
		Non	**Low**	**Medium**	**High**	**χ2 value**
ACCESSCR	Yes	26	15	40	60	6.324 ***
	No	51	8	24	33	
RADIO	Yes	17	15	51	76	24.562***
	No	60	8	13	17	
ACCESSTRA	Yes	32	16	45	88	37.248***
	No	45	7	19	5	
SEXHH	Male	38	14	46	77	**23.021*** **
	Female	39	9	18	16	

Note: χ2 values are shown with their respective levels of significance. *** indicates $p < 0.001$.

3.4 Determinants of Adoption of Agroforestry Practices

Description of the sample respondents and test of the existence of association between the dependent and explanatory variables alone is not enough to stimulate policy actions unless the relative influence of each factor is known for priority based intervention. Thus, fifteen explanatory variables were included into the econometric model and out of which only six variables were found to significantly influence the adoption of agroforestry practices. These include farming experience, labor availability, livestock holding in TLU, annual income, accesses to credit and frequency of contact to extension service.(Table 8):

Table 8: Maximum Likelihood Estimates of Tobit Model				
Variable	**Coef.**	**Std. Err.**	**t**	**P>|t|**
AGEHH	0.0199	.00557	-3.58	0.350
SEXHH	0.0144	.03795	0.38	0.703
FEXPHH	0.0096	.00435	2.21***	0.029
EDUCHHH	0.0015	.01791	0.09	0.931
FAMLSZ	0.0084	.00814	1.04	0.301
RADIOLH	0 .0634	.03766	1.69	0.293
LABRAV	0.0239	.0070	3.41***	0.001
SOCIALPT	0.0401	.04701	0.85	0.394
COSMOPOT	0.0151	.04201	0.36	0.718
LIVESTOCK	0.0181	.00366	4.95***	0.000
ANINCOME	5.90e-06	1.81e-06	3.26***	0.001
FARMSIZE	.0361	.05764	0.63	0.531
ACCESSTRA	0.0359	.04234	0.85	0.398
ACCESSCR	0.0846	.03451	2.45***	0.015
CONTACT	0.0255	.00657	3.88***	0.000

Sigma= .1776835 Log likelihood = 26.570364 ANOVA based fit measure (R^2) = 0.9708

Note: *** significant at 1% and ** at 5% level of significance

Farming experience (FEHH) has a positive and significant effect on the probability of adopting agroforestry practices at a 5% significance level. This implies that an increase in years of farming experience increases the likelihood of adopting agroforestry practices by 0.9. This finding contradicts the results (Mulugeta, 2009).

Labor availability (LABORAVA) was found to have a positive and significantly impacted at a probability level of less than 1%. Households with high labor availability in adult man equivalent are more likely to adopt agroforestry practices than those with low labor availability. A one unit increase in labor availability increases the probability of adopting agroforestry practices by 2.3 units. This result is consistent with the findings of Molla and Tesfaye, who identified labor availability as an important factor for technology adoption (Molla, 2005; Tesfaye, 2003).

Livestock holding was found to have a positive and significant influence on the adoption of agroforestry practices at a 1% significance level. Households with high livestock holdings in Tropical Livestock Units (TLU) are more likely to adopt agroforestry practices than those with low livestock holdings. The probability of adopting agroforestry practices increases by 1.8 as livestock holdings increase by one TLU unit. This finding is consistent with the results that livestock holdings have a positive and significant influence on the adoption of improved agricultural technologies (Yishak, 2005; Tesfaye, 2003; Gebresenbet, 2008).

Annual income was found to be an important factor in determining the adoption of agroforestry practices. It has a positive and significant effect on the probability of adopting agroforestry practices at a 1% significance level. An increase in annual income increases the likelihood of adopting agroforestry practices. This finding is supported by who reported a positive influence of household farm income on the adoption of improved technologies (Taha, 2007; Gebresenbet, 2008; Tadesse, 2008).

Access to credit (ACCESSCR) was found to have a significant influence on the adoption of agroforestry practices at a 5% significance level. Farmers who have access to credit are more likely to adopt new technologies as it requires input costs. Access to credit helps farmers to allocate their limited resources for purchasing agricultural inputs. This finding is consistent with the results (Getahun, 2004; Million and Belay, 2004).

Frequency of contact with extension agents was found to have a significant influence on farmers' decision to adopt agroforestry practices at a p<1% significance level. A one-time increase in the frequency of contact between extension agents and farmers can increase the adoption of agroforestry practices by 2.5. This finding is supported by the results of Hailu (2008), who stated that extension agents have a positive influence on the adoption of improved technologies.

4. Conclusion

This study aimed to understand the factors that limit the adoption of agroforestry practices in Aleta Wendo District, Southern Ethiopia, and to develop effective strategies to promote their adoption. The study identified six selected agroforestry technology practices, including home gardens, alley cropping, multipurpose trees, woodlots, shelterbelts/windbreaks, and parkland agroforestry. The adoption rates of these practices varied across the kebeles, with home gardening and windbreak/shelter belt being more popular among farmers. The study found significant associations between adoption categories and variables such as household head age, education level, labor availability, and access to credit. The econometric model showed that farming experience, labor availability, livestock holding in TLU, annual income, access to credit, and frequency of contact with extension agents were significant determinants of the adoption of agroforestry practices. These findings can inform policymakers and development practitioners to promote the adoption of agroforestry practices in the study area and similar areas, ultimately promoting sustainable agriculture and forest management practices, alleviating poverty, and ensuring food security in the region. It is important to note that further research is needed to identify specific factors that influence farmers' adoption decisions and to develop appropriate interventions to promote the adoption of agroforestry practices.

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Competing Interests

Authors have declared that no competing interests exist.

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