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Determinants of Apple Based Agroforestry Technology Adoption in Lay Gayint District Northwestern Ethiopia

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ABSTRACT

Integration of fruit trees to the farm land is one of the options for ecological and economical resilience by contributing both products and important ecological services in rural livelihoods via agroforestry farming system and are being introduced for adoption by farmers. However, despite this fact, they are inadequately studied in the world wide. This study aimed at investigating the adoption of Apple based agroforestry technology in Lay Gayint District, Northwestern Ethiopia. Thus, two kebeles practicing the technology, namely, Akabit and Moseb-Terara were purposively selected, and then four villages (two from each kebele) were randomly selected. Then, households in each selected villages were stratified in to adopters and non-adopters of the technology. Subsequently, both adopter and non-adopter households were further stratified based on wealth categories using Key informants (KIs). Accordingly, a total of 103 HHs (35 poor, 37 medium and 31 rich) were selected randomly. The data was collected through Key informants' interview, households' interview and focus group discussion. The results showed that year of adoption of apple fruit tree were significantly associated with wealth categories (p< 0.001). Thus, adoption year of the respondents was ranged from 2006-2011years for rich and 2012-2016 for medium and poor HHs. Out of 11 explanatory variables that were expected to affect farmers' decision to adopt the technology or not, access to training, social position, land tenure; gender and age of the household head were positively and significantly affected, while, access to off-farm income affects negatively. Based on the findings, it was concluded that adoption rate of the technology was varied among wealth categories and correspondingly adoption of the technology was influenced by different factors.

Keywords: *Adoption rate, Determinant Factors, Adopter, Wealth category, ORDA, Ethiopia*

INTRODUCTION

Background

The major challenge confronting most of developing countries such as Ethiopia are environmental degradation, improving rural as well as urban food security and rapid population growth(Mesfin, 2005).Thus, there is an ever increasing concern that it is becoming more and more difficult to achieve and sustain the needed increase in agricultural production based on intensification, because there are limited opportunities for area expansion but even poor farmers are forced to expand their cultivation to hilly and marginal areas(Kang and Akinnifesi, 2000).

Lay Gayint district where this study was conducted is the one where rain fed agriculture has expanded to marginal areas and farmers are forced to cultivate steeper slopes often without the application of effective conservation measures. Thus, agricultural activities are not able to feed the growing population let alone savings. As a result, a considerable number of poor households are dependent on food aid, making the district one of the largest beneficiaries of the government safety net program (GWAO, 2016).

Thus, the adoption of more efficient farming practices and technologies that enhance agricultural productivity and improve environmental sustainability is instrumental for achieving economic growth, food security and poverty alleviation. Accordingly, fruits are one of the potential candidate worth high consideration to curb the extant malnutrition and mitigate poverty by contributing both products and important ecological services. Moreover, in recent times, there is a move to include fruit trees with the potential to generate cash for farmers and the integration of trees to the farm land that generate products holds a substantial potential in terms of economic, ecological feasibility, as well as social acceptability and could enormously enhance household food security situations through improved and sustainable production (Garrity, 2004).

Currently, several fruit tree species are being introduced to agroforestry system. Thus, introduction of apple trees as an agroforestry technology has been taken as one of the strategy to diversify the farmland and then improve family nutrition in the study area, such practice also play a role to mitigate land degradation through better land husbandry (Ashebiret al., 2010) However, In spite of the efforts made by NGOs to introduce apple trees to individual farmers this technology development still does not address through all the farmers due to different factors.Therefore, this study is believed to produce empirical evidences on the determinants for the adoption of Apple based agroforestry technology in Lay Gayint district Northwestern Ethiopia.

General Objective

The overall objective of this study was to investigate the determinants for adoption of Apple based agroforestry technology in Lay Gayint District, Northwestern Ethiopia.

Specific Objectives

To determine the adoption rate of Apple based agroforestry technology across wealth categories in the study area.To assess the socioeconomic factors influencing the rate of adoption of Apple fruit based agroforestry technology as compared to non-adopters.

MATERIALS AND METHODS

Description of the study Area

This study was conducted in Lay Gayint district, which is found in South Gonder Zone (SGZ), Amhara National Regional State (ANRS), North western Ethiopia between 110 35’ to 120 12’ N latitude and 380 12’ to 380 48’East longitudinal lines. The capital city of the woreda Nefas Mewchia which is 740 Km northwest away from Addis Ababa, 175 km east of Bahirdar and 75km from zonal city of Debretabore. It is delimited by Ebinat Woreda and Bugina of North Wollo in the north, Simada, Tach Gayint and Estie of SGZ in the South , Mekete of North Wollo zone in the east and Farta woreda of SGZ in the west. It comprises 32 Keble administrations of which 29 rural & 3 Urban Keble administrations (GWAO, 2016).

The total area is 1,519 km2 with a total population of 201787 of which 102109 male while 99678 are females. Among the total population 4446 are urban dwellers while 197341 are living in rural areas (GWAO, 2016). Ecologically 45.39% of Lay Gayint is Dega, 2.71% Wurch, 39.4% Woinadega and 12.5% Kolla. The lowest and highest altitude of the district is 1500 to 4230 M.a.s.l respectively. The topography of the district is 5% mountainous, 75% plain with steep slope, 8% rift valley, 10 % bush land and 2% is covered by water. Annual rainfall is marked with erratic distribution, varying from 900mm to 1100mm; June, July and August are the rainy months. The mean annual temperature ranges from 4°C (on top of Guna Mountains) to 28°C (near Tekeze river valley); the dominant soil types are Vertic Cambisols. Regarding the land use patterns 28% is cultivated land, 13 % grazing land, 5% forest & bush and out of total size other types constitute 54% (Birhanu, 2009). The livelihood of the district mainly depends on Small scale mixed agriculture (crop and livestock production) characterized by subsistence production and it is the dominant source of livelihood to the local peoples. Beer barely, wheat andteff are the principal crops and from the livestock cattle, sheep and goats are dominant. In addition to crop production they are also involved in different economic activities such as politery and hen breeding, the area is also suitable to grow different root crops such as potatoes, gingers and garlic (GWAO, 2016).

Sampling Techniques

Selection of Study Sites

Multistage sampling techniques were used to select the sample area. First, Lay Gayint district was selected purposively based on the presence of apple based agroforestry. Of the 32 kebeles in Lay Gayint district Apple fruit trees were introduced to 10 kebeles. Secondly, two of ten kebeles namely, Akabet and Moseb-Terara were purposively selected, considering extensive presence of the technology, time of introduction and ease of accessibility.

Then, two villages for each Kebeles; Gobgob and Bekcho from Moseb-Terara, Wuha-Midir and Yitva from Akabet were randomly selected for this study.

Household Sampling Technique

Stratified random sampling technique was used for the HH survey. Thus, the HHs from each selected villages were stratified in to adopters and non-adopters of the technology from the list in the agricultural office and by the help of village leaders. Hence, wealth is one important socio-economic criterion by which farmers may be grouped, in order to understand their differing needs and capabilities in adopting new technology and to have a representative sample. As a result, wealth and adoption were used as a stratum in order to assess the variations in adoption of the technology. Accordingly, both adopter and non-adopter farmers from each sampled villages were further stratified into different wealth categories by using KIs and local criteria (for being poor, medium and rich according to their locally accepted criteria for wealth classification such as:- land size, livestock ownership and house status).The KIs for this purpose was selected based on snowball method. Thus, all the farmers from each sampled villages were stratified into three wealth categories using KIs. Then, random sampling technique was applied to select the respondents from each wealth strata. Accordingly, a total of 103HHs were randomly selected for this study comprising 15% from adopters and 5% from non-adopter farmers from each wealth strata.

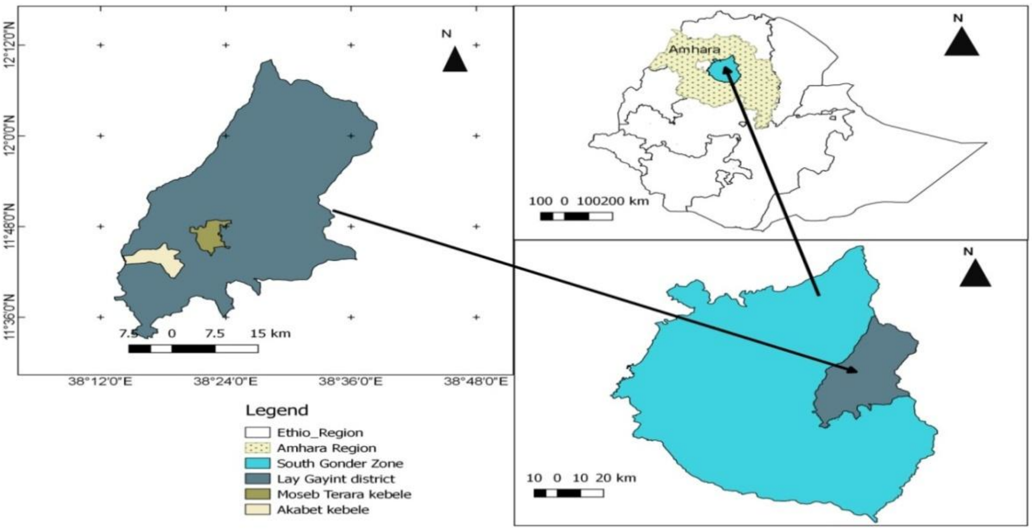

Fig1. *Location map of the study sites*

Method of Data Collection

Both primary and secondary data sources were used for the purpose of this study. The primary data was collected through reconnaissance survey, key informant interview; structured questionnaire and focus group discussions so as to collect detailed information on the determinants for adoption of a pple based agroforestry in the study area. And Archival search was also used to supplement and cross check the primary data obtained. This includes data from the departments in the district (Such as; annual reports, censuses records), Published Journals, books and from unpublished documents, which deal with adoption of agroforestry issues and the specific study area.

Method of Data Analysis

The data obtained from HH survey through the structured questionnaire was analyzed using Statistical Package for Social sciences (SPSS) version 20 and STATA version 12. Binary logistic regression model was also used to identify the factors determining for adopting Apple fruit production.

Table1. *Definition of dependent and independent variables expected outcomes and their sign*

Notation	Definition	Types of variables	Unit of measurement	Expected sign
Dependent variable				
ADOPTION	Adoption of apple based agroforestry	Dummy	1=adopter 0= non-adopter	

Independent variables				
GENDER	Sex of the household head	Dummy	1=male 0 = female	+/-
AGE	Age of the household head	Continuous	Years	+
EDUCL	Educational level of the household head	Categorical	1 = unable to read and write 2=can read and write 3=primary school 4=secondary school	+
OFFFARM	Access to off farm income	Dummy	0= no 1= yes	+
HHSIZE	Family size of the HH	Continuous	Number	+
FRMSIZE	The total land holding size of the respondent	Continuous	Hectare	+
SOCIALPOS	Social position	Dummy	1= yes , 0= no	+
INCOME	Total HH income	Continuous	Birr	+
TENUR	Land tenure	Categorical	1=inheritance 2= given by the government 3= rent 4= share	+
ACSEXTEN	Extension contact of the household head	Categorical	1 = limited contact	+
			2 = good contact 3= no contact	

Results And Discussion

Adoption of Apple Based Agroforestry

Trend of Adoption of Apple Based Agroforestry Technology in Lay Gayint District

Trend of adoption of Apple fruits in the past sixteen years across the two studied kebeles are presented in Table 2. Accordingly to reduce young class age effect on this finding the KIs were used instead of using HH respondents for gathering information about Apple tree adoption trends over time. Thus, the majority of KIs in the study sites confirmed the presence of difference between past and present status of technology adoption in the studied sites. According to the KIs Apple tree was introduced to the study sites in 1995.

However, based on the KIs, even if it is introduced in the above mentioned year at that time only model farmers had an opportunity to adopt. While, formally Apple fruit tree was known by farmers after the year 2000; therefore based on this information the trend was assessed after 2000 up to 2016. According to the response of the KIs in the study areas, there were many factors and reasons for cause of these changes in the tree density over time. These include:- population growth, land degradation, failure of agricultural crops, expansion of food insecurity, increase in fruit demand and higher market price for apple fruit, farmers training and extension work were among the reasons mentioned by the KIs.

Majority of KIs, 75% from Akabit and 62.5% from Moseb-Terara kebeles revealed that, the trend of Apple tree adoption was remained the same from the year 2000-2005 in the two studied sites. According to the KIs discussion and interview fixed number of farmers were got the seedling each year from the NGOs for the seek of trial. However 87.5% of the KIs from Akabit reported that in five year time 2006 – 2010 there was slight increase in Apple fruit tree adoption due to the fellow farmer's experience, high fruit demand in the market and training. On the other side, the same proportion (87.5%) of KIs from Moseb-Terara indicates that there was rapid increase in the trend of Apple fruit. This rapid increase was attributed to deliberate release of huge number of seedling and promotion of the technology by Organization for Rehabilitation and Development in Amhara Region (ORDA).

Recently after five years starting 2011 – 2016, surprisingly 100% of KIs from both study sites confirmed that Apple fruit tree adoption was rapidly increased in the studied sites as compared to the past years. The KIs put high market price of the fruit and successive training of farmers as the main reason (factor) for increasing pattern of Apple tree adoption. However, it does not mean Apple tree adoption is 100% increasing, but the KIs claimed that Apple tree adoption is increasing from year to year when they compare the past trend with the current.

The findings of the result comparable with Mary (2013) who reported that high adoption rates of agroforestry was probably due to increased awareness of the communities on agroforestry in contributing to poverty alleviation as the majority of the population in kasulu district, Tanzania; depended entirely on farming for their livelihood.

Table2. *Trend of adoption of apple fruits across the two studied kebeles according to the KIs n=16*

Year	Sample kebele's	KIs responses (%) of trend of adoption					
		RI	RD	SI	SD	RS	Total %
2000 –2005	Akabit	-	-	25	-	75	100
	Mosebterara	-	-	37.5	-	62.5	100
2006 –2010	Akabit	-	-	87.5	12.5	-	100
	Mosebterara	87.5	12.5	-	-	-	100
2011 –2016	Akabit	100	-	-	-	-	100
	Mosebterara	100	-	-	-	-	100
Note: RI= rapidly increase ,RD= rapidly decrease ,SI=slightly increase , SD slightly decrease =, RS=remain the same							

The adoption rate for the three wealth categories is presented in Table 3. Thus, year of adoption of Apple fruit tree was significantly associated with wealth categories (p<0.001).

Thus, adoption year of the respondents was ranged from 2006-2011 years for rich and 2012-2016 for medium and poor HHs. As depicted by Table 3, 55 % of poor and 59% of medium HHs were started adoption from 2012-2016 years; however, majority of the HHs (83%) from rich wealth categories were adopted early than the latter two wealth categories.

This difference in year of adoption within wealth category could be due to income difference and farm size of the respondents.

Table3. *Adoption year of the respondents across wealth categories in the studied sites n=56*

Year of adoption	Wealth categories						x^2	P-value
	Rich n=23		Medium n=22		Poor n=11			
	Freq.	%	Freq.	%	Freq.	%		
1999-2005	8	35	4	18	0	0	33.5	0.000***
2006-2011	11	48	5	23	5	46		
2012-2016	4	17	13	59	6	55		

**** Statistically different at p<0.05*

Factors Influence Adoption of Apple Based Agroforestry

Factors Encourage Adoption of Apple Based Agroforestry

Table 4 shows different motives for adopting the technology by farmers in the studied sites. When farmers were asked on the motive factors that make them to adopt Apple fruit trees approximately 82.1% of the respondents mentioned that they were adopt mainly because of the assistance by way of incentives given by the NGOs. As indicated by the respondents ORDA and GTZ were the most driving factors that initiate 95.7% of rich, 81.8% medium and 54.5% of poor HHs, while, 75.5% of the respondents site other farmer's experience. Although, 66.1% of the respondents were attracted by higher market value for Apple fruit. Whilst, 62.5 %, 58.9%,

23.2% of the respondents blamed that Extension support, nutritional vs. medicinal value of the fruit and ease of growing respectively were the other reasons to adopt ABAF. The Chi-square test proved that training and advertisement of NGOs, Other farmers experience, Market value and Nutritional vs. medicinal value of the fruit were significantly (p< 0.05) enhanced adoption of apple fruit trees across the three wealth categories (Table 4). As expected, (100 %, 90.9%, 72.7%,) of poor HHs and 86.4%, 81.8% 68.2% of medium HHs blamed that high market value of the fruit , other farmers experience and Nutritional vs. medicinal value of the fruit were attract them to adopt apple based agroforestry respectively. While, 95.7%, 69.6% 43.5% of rich HHs were attracted by the intensives given by the NGOs, extension support and nutritional vs medicinal value of the fruit respectively.

Table4. *Factors encouraging farmers to adopt Apple based agroforestry n=56*

Factors	Wealth categories	Total (%)	X^2	P-value

	Rich (%) n=23	Medium (%) n=22	Poor (%) n=11			
Training and advertisement of NGOs	95.7	81.8	54.5	82.1	8.58	0.000**
Other farmers experience	60.9	81.8	90.9	75.0	4.48	0.04**
Market value	30.4	86.4	100.0	66.1	22.72	0.00**
Extension support	69.6	59.1	54.5	62.5	0.90	0.23
Ease of growing	26.1	31.8	0	23.2	4.35	0.18^{ns}
** Significant different at p ≤ 0.05, ns= not significant at p≤0.05						

Disfavoring Factors to Adopt Apple Based Agroforestry

Adoption of ABAF in the surveyed sites was limited by a number of technical factors as shown in Table 5.Thus, Lack of germ plasm, lack of extension support, technology takes long time, lack of land, shortage of water, high initial cost, technology takes long time, lack of knowledge and lack of interest were the factors reported by the respondents. Where, majority of the respondents (85.1%) cited that Lack of germ plasm as the major factor limiting the adoption of ABAF in the studied sites followed by Lack of extension support (74.5%); Technology takes long time(61.7%) and Lack of land (56.9). This result is in line with Stephen, 2007: Mary, 2013,showed that shortage of land was a major limiting factor for AF technology adoption in Tanzania.

According to the respondents seed availability of insufficient amount limits the extensive adoption of ABAF.

Hence, the introduction of Apple fruit trees in the studied sites was started with NGOs (GTZ and then ORDA) by distributing seeds to the interested farmers. However, the availability of seed is very limited, since; the NGOs were give the Apple seedlings for the interested farmers as a gift for the sake of promotion.

Farmers in the study area have not an experience of producing grafted seedling and buying Apple seedlings , since they mainly need to be given by the NGOs as their colleagues, however it is impossible to give Apple seedling for all farmers as a gift, unless the development of nursery sites for Apples in the studied sites.

This result is comparable with Stephen, 2007 who found that seedling availability was a constraint for their adoption in morogoro district, Tanzania for further development of AF practices. Similarly, Mugure, 2009:Weston, 2015 also showed that lack of seed was the factor limit adoption of AF practice.

The second technical factor limit adoption of ABAF was lack of extension support.

Since AF is new to the studied sites, and according to FGD and HH interview agricultural extension workers were not sufficiently trained in ABAF and lack exposure to the technology to enable them to confidently promote them amongst the farming families as a result the farmers have not got sufficient technical knowledge about ABAF Hence, extension services were available for food crops and cattle farming, but not for intercropping of Apple trees with agricultural crops.

(Kabwe, 2001: Mugure, 2013: Reyes, 2008: Weston, 2015: Mary, 2013) reported that some of the extension workers were not confident in disseminating AF technologies since they had not any other training in AF apart from what they had at college yet college curricula did not keep abreast of AF innovations in the field. And as a result, hinders farmers to adopt AF practices.

The Chi-square test showed that land shortage, shortage of water, high initial cost ,technology takes long time and lack of interest were significantly ($p < 0.05$) affected adoption of ABAF across the three wealth categories (Table 5). As expected, major proportion of poor HHs (91.7 %) and 40% of medium HHs mentioned shortage of land as the major constraints to adopt ABAFT.

Mainly the youth farmers, unless they got from their parents by inherent or gift they cannot get land.

This study shows that land shortage was the first factor for poor HHs. Simultaneously, shortage of water, high initial cost and technology takes long time were discourage 87.5 54.2%,79.2% of poor HHs respectively.

The result could be due to their lower income than the former two wealth categories. This result is in line with Mugure, 2009 who report that farmers' decision to adopt AF practices in Nambale division were influenced by lack of land, lack knowledge and lack interest.

Table5. *Factors limiting the adoption of Apple based agroforestry n=47*

Factors	Wealth categories					
	Rich (%) n=8	Medium(%) n=15	Poor (%) n=24	Total (%)	x^2	P-value
Lack of land	0	40	91.7	59.6	24.44	0.000**
Shortage of water	12.5	33.3	87.5	31.9	15.55	0.000**
Lack of germ plasm	62.5	93.3	87.5	85.1	4.14	0.11
High initial cost	0	20	54.2	34	9.78	0.000**
Lack of knowledge	12.5	13.3	16.7	14.9	0.12	0.43^{ns}
Lack of extension support	75	66.7	79.2	74.5	0.76	0.36^{ns}
Technology takes long time	37.5	46.7	79.2	61.7	6.52	0.02**
Lack of interest	62.5	13.3	16.7	23.4	8.23	0.02**
*** Significant different at p ≤ 0.05, ns= not significant p≤0.05*						

Socioeconomic and Institutional Factors Determining Adoption

Out of 11 explanatory variables that were expected to affect farmers' decision to adopt ABAFT or not, six of them were found statistically significant. As portrayed by Table 6, these significant predictors for adoption of ABAFT include:-Access to training, social position, land tenure; gender and age of the HH head were positively and significantly affect adoption of ABAFT. While, access to off-farm income affects negatively. However, extension contact, farm size, education, family size and total income of the HH were not significant factors to adopt ABAFT.

Table6. *Socioeconomic and institutional factors affecting adoption of Apple based agroforestry*

Variables	Coef	Std. Err.	Z	P > [z]	dy/dx (mf)
Gender	2.817	0.285	1.66	0.097*	0.47
Age	0.281	0.039	1.82	0.069*	0.07
Educational status	0.016	0.224	0.64	0.986	0.003
Family size	0.759	0.117	1.63	0.104	0.039
Social position	3.360	0.261	2.63	0.008***	0.69
Access to off-farm income	-3.063	0.278	-2.04	0.017**	-0.64
Farm size	0.019	0.465	1.62	0.105	0.057
Land tenure	3.046	0.841	2.09	0.036**	0.36
Extension contact	0.726	0.348	0.52	0.602	0.18
Training	5.53	0.104	8.44	0.000***	0.88
Total income	0.0002	.000	1.43	0.154	0.001
Cons	9.313	5.31	1.75	0.079	
(***,**,*) significant at 1,5,10% respectively, dy/dx is for discrete change of dummy variable from 0 to 1					
y = Pr(adoption) = .483					

Log likelihood = -10.14 PseudoR^2 = 0.857 LR chi^2(11) =121.73

Access to Training

Farmers may obtain information from different source and may learn also from DAs through extension programs. However, unless they obtain required skill through training they may face some difficulties to understand and apply new agricultural technologies. Therefore, it is very important aspect of disseminating a given agricultural technology. To this regard in the study area there are efforts made by NGOs to give training to the farmers about ABAF. In the present study, adoption of ABAFT was significantly affected by training (p< 0.001) at 1% significant level and positively (ß = 5.53). Meaning that, holding other factors constant; as the head of the HH receive training, probability of adopting the technology had increased by 88% as compared to those that did not got training.

The result is comparable with Agena and Amare (2016) showed that keeping other factors constant, when household heads tendency to get training in natural resource management /agriculture is increased, they could have 11.48

more likely to practice AF implying that training is being one of the incentives. i.e, the authors stated that training influence positively and significantly at Fogera district, Northwestern Ethiopia for practicing AF. Similarly, Quang (2000) also showed that training was significantly correlated to the adoption of fertilizer use, improved maize and hedgerow technologies in Black river watershed, Northwest of Vietnam.

Social Position

Was significantly affect adoption of ABAFT (p<0.001) at 1% significant level and positively (ß = 3.360). As the head of the HH had social position in the community the chance of adopting ABAFT had increased by 69% as compared to those that did not have social position holding other factors constant. In the studied sites, having social position in the community increases the possibility to have access to information, training and to have good contact with extension agents than the latter one, Since, the information from NGOs were also directly goes to them than other farmers who did not have social position, then as a result helps to adopt faster than the latter ones.

Gender of the Household Head

Gender of respondent (being male) is positively (ß= 2.817) and significantly (p<0.1) related with adoption of ABAFT at 10% significant level. This indicates that male headed HHs were better to adopt ABAFT than female headed HHs. A unit change from being headed by female to male increases the probability of adopting ABAF by 47% holding other factors constant. The possible reason for this result could be male headed HHs were better to get information about new agricultural technologies than female headed households. Since, women are normally responsible for providing water, fire wood and cooked food for their HHs. As a result, women spent their much time on searching firewood, water, food and the like rather than participating in any of adoption issues. The result is comparable with kebede, 2012 who reported that the gender type of farmers indicates the poor involvement of women in agroforestry, it can be said that women are mostly interested in planting and cultivating vegetables to meet household consumption needs rather than tree crops. Adesinaet al., 2000 also showed that women adoption potential of new technology is less likely than males because of either lack of rights to grow trees or secured land rights. Similarly, a study in south-western Ethiopia by Sisay (2016) showed that female-headed farmers are less likely to adopt intra-row spacing than male-headed HHs. However, the current result is contradict with the Mulatuet al. (2014) the authors showed that being a male-headed family reduces the likelihood of adopting AF technologies by 0.535 units at 5% level of significance, holding other factors constant in Eastern Cape Province, South Africa.

Access to off-Farm Income

Off-farm income represents the amount of income the farmers earn in the year on other than on-farm activity. Involvement in non-farm jobs is common in the study area. Some are engaged in handicrafts, guarding, daily labor work, cattle fattening, selling of firewood, petty trading and brewing local beverages (“Arake” and “Tela”) especially female headed HHs. These off-farm activities have served farmers as sources of additional income to purchase food crops mainly during the scarcity of agricultural products. In the present study, involvements in these off-farm activities have negative effect on the adoption of ABAFT. Thus, adoption of ABAFT was significant (p<0.005) at 5% level of significance and negatively (ß = -3.063). Consequently, as the head of the HH involved in off-farm activities the chance of adopting ABAFT had decreased by 64% as compared to those that did not access to off-farm income. This could be due to the nature of the technology is labor intensive and have negative impact on their off-farm activities. The result is comparable with Goodwin and Mishra (2004) they reported the pursuit of off-farm income by farmers may undermine their adoption of modern technology by reducing the amount of HH labor allocated to farming enterprises.

But, the current result contradicts with Mbugua (2009) who report that positive relationship between off-farm income and adoption of the entire package implies that, farmers with off-farm income expect to realize high returns from investing it in the farm and therefore use part of it to improve farming practices.

Age of the Household Head

Age of the HH head was found to be positively (ß = 0.281) associated with adoption of ABAFT and significantly (p<0.1) at 10% level of significance. The logit output showed that as the age of the HH head increase adoption of

ABAFT increase, i.e a unit change from being headed by younger to older increases the probability of adopting ABAFT by 7% holding other factors constant. This might be due to the fact that older farmers had more knowledge from the previous experience and resources that would allow them to adopt than younger farmers. Therefore, older farmers were more likelihood to be adopter of the technology than younger one in the study area.

The current result is in line with Lemlem et al.(2013), showed that the probability of the HH being adopter of ABAFT was increased as age of the household head increased due to the accumulated experience of older farmers that helps them to make early adoption decision. Kweka (2004); Sisay (2016) also showed that older farmers with more experience were adopting improved technologies than young farmers. Similar result was also reported by Eneteet al.(2010) showed that as woman gets older, the more her opinion is respected and sought after in decision making in the farming system. Correspondingly, a study by Zenebeet al. (2010) in Tigray region also showed the positive relation between the age of the HH head with tree adoption.

On the other hand, this result was contradict with the finding of Agena and Amare (2016) they report that as the age of farmers increase by one year, AF practicing tendency decreases by a factor of 0.87. This may be because younger farmers are often better disposed to devote in long term investments like AF and have lower risk aversion and longer planning horizons to justify investments in tree-based technologies. Similarly, the study done by Motamed and Singh (2003); Muneer (2008); and kebede (2012) revealed that young farmers have been found to be more innovative and more flexible in deciding for the adoption of new technologies and more schooling than older generation.

Land Tenure

Influences adoption of ABAFT positively (ß= 3.046) and significantly ($p< 0.005$). This indicates that as farmers feel land tenure securities, they have more probability to adopt ABAFT. Accordingly, the current result revealed that HH that had secure land tenure right had 36% chance of adopting ABAFT as compared to those that did not have secure land tenure right at 5% level of significance. The result is comparable with Agena and Amare (2016); Soita (2012) showed that as farmers feel land tenure securities, they have more probability to devote on AF practices. Since, secure tenure provides proper incentives for farmers to make investments in the long term productivity of their land.

CONCLUSION

In general, the findings of the study revealed that adoption of apple based agroforestry technology increases rapidly due to high market value of Apple fruit and successive training of farmers. Correspondingly, the years of adoption and mean stem number of Apple fruits planted at the first time were significantly associated and differed among wealth categories. As a result, wealthy farmers were more likely to adopt the technology early and plant higher number of Apple tree in their farm land than medium and poor households due to their higher annual income and larger farm size they have in the study area. Accordingly, training and advertisement of NGOs, other farmers experience, Market value and Nutritional vs. medicinal value of the fruit were significantly enhanced Apple fruit tree adoption across wealth categories. However, adoption of Apple fruit tree was limited by the following technical factors in the study area. Such as: - Lack of germ plasm, lack of extension support, technology takes long time and lack of land. Ultimately, other socioeconomic and institutional factors such as:- access to training, social position, land tenure; gender and age were positively affect Apple fruit tree adoption while access to off-farm income were affects negatively in the studied sites.

RECOMMENDATIONS

Based on the findings and personal observations the following are forwarded

- Supply of Apple seedlings can do better in prompting the technology adoption.
- Policies designed to promote and develop adoption of new technologies should give due attention and be pertinent to household characteristics as wells different socioeconomic categories.
- Since, only the rate of adoption and determinant factors were evaluated in this study, further research should focus on; identifying the best and optimum silvicultural practices for the management of Apple trees in order to improve its economic and environmental values

including spacing and arrangement of planting, interaction with other agricultural crops and soil and effective methods of propagation.

REFERENCES

[1] Adesina, A., Mbila, D., Nkamleu, G. and Endamana, D. (2000): Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon .Agriculture, Ecosystems & Environment 80: 255-265.

[2] AgenaAnjulo and AmareMezgebu, (2016): Determinants of Agroforestry Practicing at Fogera district, Northwestern Ethiopia, International Journal of Agriculture and Ecology Research, 9(4): 1-14, 2016.

[3] Ashebir, D., Deckers, T., Nyssen, J., Bihon, W., Tsegay, A., Tekie, H., Poesen, J., Haile, M.,

[4] Wondumagegneheu, F., Raes, D., Behailu, M. &Deckers, J., (2010): Growing apple (Malusdomestica) under tropical mountain climate conditions in northern Ethiopia. Experimental Agriculture, 46: 53-65.

[5] Birhanu G, (2009): Delineation of food insecure areas using remote sensing and GIS (food availability analysis); the case of south Gondar zone. Doctoral dissertation,, Addis Ababa University, Ethiopia.

[6] GWAO, (2016): Lay Gayint woreda agricultural and rural development Office, annual Report for Gayint Woreda.Kabwe, G., (2010): Uptake of agroforestry technologies among smallholder farmers in Zambia. PhD thesis , Lincoln University, 234pp.

[7] Kang BT, AkinnifesibFK ,(2000): Agroforestry as alternative land-use production systems for the tropics. Natural Resources Forum 24, pp. 137-151.Blackwell Publishing Ltd.

[8] KebedeWoldemedhin, (2012). The contribution of agroforestry based integrated development project in sustaining the rural livelihoods, The case of Tombiya Agroforestry project in Woliso Woreda, West Shewa of Oromiya Regional State, MS.c thesis ,Ethiopia.

[9] Kweka, D., (2004): The Role of Local Knowledge and Institutions in the Conservation of Forest Resources in the East Usambara. Young Scientist Programme, UNESCO, Biosphere. 33pp.

[10] Lemlem Tajebe, AgenaAnjulo, Zeleke Ewnetu, (2013): Apple Based Agro forestry in Dendi Woreda, Oromiya Region: Income Contribution and Determinants for Adoption, Wolaita Sodo University, Ethiopian Journal of Agricultural Sciences, 23(1-2), pp.61-73.

[11] Mary NdengaheChija, 2013: Adoption status and management of agroforestry systems and technologies by communities: a case study of Kasulu District, Kigoma, Tanzania, Doctoral dissertation Sokoine University Of Agriculture. Morogoro, Tanzania.

[12] MbuguaFelistus, 2009: An analysis of factors influencing adoption of the recommended maize technology's package in Makuyu Division, Murang'a South District, Kenya. Doctoral dissertation, Kenyatta University ,Kenya.

[13] MesfinAstatika. (2005) .Analysis of Factors Influencing Adoption of Triticale (X-TriticosecaleWittmack) and Its Impact: The Case of FartaWereda, Msc. Thesis, Haramaya University, Haramaya, Ethiopia.

[14] Motamed, M. and Singh, B., (2003): Correlation of Adoption of Improved Sericulture Practices. Indian Journal of Extension Education.

[15] Mugure Agnes, (2013): Factors influencing adoption of agroforestry practices among rural households in Nambale division, Busia Country, Kenya M.Sc Thesis University of Eldoret Kenya.

[16] MulatuFekadu ,Zerihun, Mammo ,Muchie&ZelekeWorku (2014) : Determinants of agroforestry technology adoption in Eastern Cape Province, South Africa, Development Studies Research, 1:1, 382-394.

[17] Muneer, S., (2008): Factors affecting adoption of agroforestry farming system as a mean for sustainable agricultural development and environment conservation in Arid Areas of Northern Kordofan State, Sudan. Journal of Biological Sciences 15(1),pp.137-145.

[18] Reyes Teija, 2008: Agroforestry systems for sustainable livelihoods and improved land management in the EastUsambara Mountains, Academic Dissertation University of Helsinki, Tanzania.

[19] Quang Tan Nguyen, 2000: Farmers' training and the adoption of upland agricultural Technologies in the black river watershed, Northwest of Vietnam, Doctoral dissertation, university of Arizona.

[20] SisayDebebeKaba, 2016: Agricultural technology adoption, crop diversification and efficiency of maize-dominated smallholder farming system in jimma zone, south-western Ethiopia; PhD dissertation Haramaya University, Haramaya, Ethiopia.

[21] SoitaWafuke, (2012): Adoption of agroforestry technologies among small scale farmers in Nzoia location, Lugari district, Kenya, Doctoral dissertation, Egerton University.

[22] Stephen ManoniMaduka, 2007: Role of agroforestry products in household income and Poverty reduction in semi-arid areas of Misungwi district, Mwanza, Doctoral dissertation, Sokoine University of agriculture, morogoro, Tanzania.

[23] Weston Mwase, AbelSefasi, Joyce Njoloma, Betserai I. Nyoka, DanielManduwa& Jacinta Nyaika,2015: Factors Affecting Adoption of Agroforestry and Evergreen Agriculture in Southern Africa. Environment and Natural Resources Research; Vol. 5, No. 2; p.148.Published by Canadian Center of Science and Education.

[24] Zenebe Gebreegziabher, Alemu Mekonnen, MenaleKassie, and Köhlin Gunnar.(2010): Household Tree Planting in Tigrai, Northern Ethiopia. Tree Species, Purposes, and determinants. Environmental Economics Policy Forum for Ethiopia (EEPFE), Ethiopian Development Research Institute.

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