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Research Article

Analysis of Adoption of Carbon Trade Project among Smallholder Farmers in Humbo District, Wolaita Zone, Snnprs, Ethiopia

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ABSTRACT

Rejoice Tsheko, Department of Agricultural Engineering and Land P. This study set out to assess farmer's decision to adopt Clean Development Mechanism practices within the existing socioeconomic and institutional arrangements. The study was conducted in Humbo district. Two-stage sampling procedure was used to select 150 small-scale farmers from three Kebeles in the District. Primary data were gathered through interviews and group discussion using a semi-structured questionnaire. Secondary data were collected from different literatures, publications and unpublished office documents. Simple descriptive statistics and econometric models (ordinal logit model and the double hurdle model) were used for data analysis, aided by SPSS and STATA software. The results showed that 26.67% of the farmers practiced tree planting/agro-forestry as the voluntary Clean Development Mechanism practice; 32% of the farmers were not aware of the project; 19% were having correct awareness and; 48% of the farmers were aware about the project but wrongly, showing the existence ofwareness of the project but they understood wrongly and hence might affect the adoption. In this regard, age, and house hold size negatively influenced households' adoption of Clean Development Mechanism while land size, land tenure, farm income, education level and availability of voluntary Clean Development Mechanism had positive influence. Therefore there is urgent need to incorporate the issue of climate change in the countries extension system to enhance the farmer's participation in the adoption for environmental issues such as Clean Development Mechanism.

Keywords: Clean Development Mechanism; carbon trade; adoption; extent of adoption

INTRODUCTION

It is now widely recognized that the global climate is in a state of change. In its fifth assessment report, the Intergovernmental Panel on Climate Change (IPCC, 2014) concluded that climate change is already happening with multifaceted effects on human society and the environment. There is now unequivocal evidence that the earth's climate system is warming, very likely due to anthropogenic greenhouse gas (GHG) emissions. In the absence of effective mitigation strategies, the IPCC predicts that the earth's air temperature will increase by 2.0 to 4.5 degrees by the end of the century, resulting in a sea level rise of at least 18 to 58 cm. Predicted temperature increases in the Arctic are even more extreme; they are projected to rise 5 to 7 degrees by 2099. These variations of the temperature and the sea level rise from the normal conditions will especially affect the lives of the developing nations such as Ethiopia [1].

Carbon trade projects are one of climate change initiatives being implemented in developing countries with the major aim of reducing impacts of climate change and alleviating poverty. As a result global climate variability, problems related to food insecurity have increased considerably over the years in Humbo District. In cognizance of this, voluntary clean development mechanism projects, as one of the ways of addressing the problems arising from climate change, were implemented in Humbo District. However, it is not clear why the farmers in the district have been engaged themselves in these projects to address these problems [2].

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The CDM projects increase the carbon sinks and provide income through purchase of carbon credits. It is not clear why the farmers in the district are engaging themselves in these projects which are implemented on communal land. Therefore, there is need to assess their decision in taking up such a project initiative.

In other words the decision to adopt CDM practices within the existing socioeconomic and institutional arrangements. The main focus of this study is to see level of awareness and adoption CDM projects among smallholder farmers, how the community of the Humbo district area benefited from the carbon project and how they bear the climate change that is happening in their area [3].

METHODOLOGY

Description of the Study Area

Humbo District is one of the 13 districts of Wolaita Zone, which is found under SNNPR fo Ethiopia.

It is located in the Great Rift Valley and bordered on the south by Sidama region, on the southwest by the Gamo Gofa Zone, on the west by Offa district, on the north by Sodo Zuria district, on the northeast by Damot Weyde district, and on the east by the Bilate River.

The administrative center of Humbo is Tebela. Humbo is located in about 18 kilometers far from the Zonal administrative town Soddo to south direction along the main road to Arba Minch.

Geographically, it is located 6044'0"N latitude and 37045'0"E longitude and elevation ranges from 1100-2335 meters above sea level.

The highest and the lowest temperature of the District are 290c and 150c respectively and the highest and the lowest rainfall are 843 mm and 1403mm respectively.

It has 43 smaller administrative Kebeles (including two urban kebeles) form which 19 Kebeles are in Woina dega and the rest 24 are in Kola agro-climate, thus the District agro-climatic condition is 56%Kola and 44% Woina dega[4].

According to Central Statistical Agency (CSA), this district has an estimated total population of 137,252, of whom 68,639 are men and 68,613 are women; 5,009 or 3.65% of its population are urban dwellers, which is less than the Zone average of 8.5%.

With an estimated area of 846.57 square kilometers, Humbo has an estimated population density of 162.1 people per square kilometer, which is greater than the Zone average of 156.5. The figure below shows administrative map of Humbo district [5].

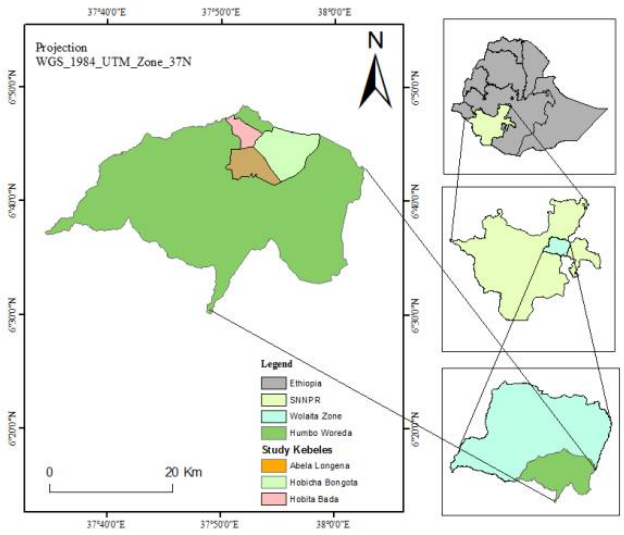

Figure1: Map of the study area Sampling Technique.

There are 43 kebeles in Humbo district. But 7 kebles were kebeles where CDM was being practices. Two stage sampling procedure was used to select the respondents. In the first stage, 3 out of 7 kebeles, where the carbon trade project was being implemented were selected randomly. The kebeles were Gamo Laluwa, Woito and Ada. In the second stage, simple random sampling was employed to select sample HHs from each of the three Kebeles. The numbers of households to be selected in each village were determined in proportion to the total number of households (Anderson et al., 2007). The respondents were selected based on the ith number of house counted in the village. The "i" is calculated using the assigned number of questionnaires and the total number of households in the area [6].

$n=PqZ2/E2$ .... (3)

Where; n=Sample size; Z= confidence level (α=0.05); p = proportion of the population containing the major interest q = 1-p E= allowable error.

The proportion of the population p=0.5, q= 1-0.5=0.5, Z= 1.96 and E = 0.08.

A list of 2805 farmers in the three kebeles who participated in the carbon project was taken from the carbon project cooperatives office.

Consequently, a total of 150 sampled farmers were selected from these 2805 farmers. Of this amount, 35.3% (53) were from A/L Gamo Laluwa mountain forest development and protection, 33.9% (51) were from H/B Woito mountain forest development and protection, and rest 30.8% (46) were from H/Bon Ada mountain forest development and protection. The sample size from each kebele was decided based on proportion of CDM participants within the population of the three kebeles [7].

Method of the Data Collection

This study employed both primary and secondary data collection. The primary data was gathered through interviews, focus group discussions and key informants personal interview with the help of semi-structured questionnaire, FGD guide questions and KII questions respectively. The main data

collected were the voluntary CDM participation of farmers, factors that influence the level of awareness of carbon project, the level of carbon trade initiatives in the area and the socioeconomic and institutional factors that influence the decision to participate in carbon trade project by the small holder farmers [8].

The focus group discussion was conducted to have clear understanding about the overall situation of the carbon project and to capture those data which couldn't be captured by HH interview. The KII was conducted with the World Vision project worker, with each of the three members of the cooperative management committee. Four experts of NRM in Humbo district, who have adequate knowledge on the issue at hand. Secondary data was collected regarding to the members of the forest cooperatives and about the general context of Humbo carbon project from the Kebeles cooperatives and from World vision carbon project for the sake of triangulating and cross validating the primary data [9].

Method of Data Analysis

Descriptive statistical analyses including percentages, tables, graphs and mean were used to describe the voluntary carbon trade project activities present in the farming system at the time of the study. In addition, logit model was employed to identify the socio-economic and demographic variables having an effect on the awareness of the carbon trade initiatives among small-scale farmers. According to Melissa and Bryman (2004) ordered logit model is modeled as follows;

This model is advantageous in terms of removing the restriction of parallel regression by allowing varying for each of the J-1 comparisons. It is exemplified as follows:

To determine the socio-economic and demographic variables that affects the awareness of the carbon trade projects among small-scale farmers. The empirical model used to estimate is;

yi =α+β1 Locfarm+ β2Grumemb +β3Age +β4Educ+ β5Exten +β6 Sex + β7Soinfo + β8Extrefarm+ε ..... (eq)

Where yi,- is the level of awareness measured in a likert scale of 1 = not aware, 2 = aware but wrong, 3 = aware and correct,

Double-hurdle model was used to determine the factors that influence decision to adopt and the extent of adoption of carbon trade project in order to identify areas of intervention. The model allows for the application of the empirical model to study :(i) whether or not a farmer is willing to participate in the carbon project (a dichotomous choice), and (ii) the extent the farmer is willing to convert land to the project (a continuous variable). In the study it was not expected that all households will be willing to participate in the project thereby resulting in some observations being zero [10].

The double-hurdle model will assume that farmers will make two sequential decisions with regard to decision to participate and the extent to which they are willing to participate in the project. Each of the two hurdles will be conditioned by the household's socio-economic characteristics and variety-specific farmers' characteristics. Different latent variables were used to model each decision process in the double-hurdle model, with the Probit model determining the probability that a household will be willing to participate in the project and a Tobit model will determine the extent of adoption, as conveniently adopted or not. The empirical model is shown as below:

Discrete choice model (Probit)

PART (yes/no) = β0 + β1 (EDU) i + β2 (FSIZE) i + β3 (AGE) i + β4 (SEX) i + β5 (HHSIZE) i + β6 (LANDTEN) i + β7 (FARMINC) i +β8 (NONFARMINC) i +β9 (EXTEN) i + β10 (VOLUCDM) i + β11 (AWANESS) i + β12 (GRUMEMB) i +β13 (PERCE) i + β14 (ATTISK) 1+ε

Outcome equation (Tobit)

Enroll share = β0 + β1 (EDU) i + β2 (FSIZE) i + β3 (AGE) i + β4 (SEX) i + β5 (HHSIZE) i+ β6 (LANDTEN) i + β7 (FARMINC) i +β8 (NONFARMINC) i + β9 (EXTEN) i + β10 (VOLUCDM) i + β11 (AWANESS) i + β12 (GRUMEMB) i + β13 (PERCE i + β14 (ATTISK) i + ε .

RESULTS AND DISCUSSION

Farm and Farmer Characteristics

Age of the Respondents: The characteristics of study farmers and their farm are presented in Table 4. As indicated in this table the mean age of potential adopters was at the average of 40.67 years while the mean age for those who were not willing to adopt was 51.93 years (Table 4). The youngest and the oldest age were 21 & 80 years for the potential adopters consecutively however those who were unwilling to adopt was 21 & 90.The age of the household head plays a crucial role in the uptake of new technologies. This may be attributed to the failure of the older farmers to embrace new ways of doing things and thus still continue to embrace the old ways of doing things (Langyintuo and Mulugetta). Amsalu and De Jan further argues that younger farmers have a longer planning horizon and are likely to undertake agro-environmental measures.

Household Size: The mean of the household size was found to be 4.74 members for those who were not willing to adopt and 4.19 members for those who were willing to adopt. Overall, the mean household size was 4.35; which is slightly below both national and regional rural average household size, which is 4.9 and 4.9 respectively (CSA). The smallest household size had 1 member and the highest had 10 members. Further, the results designate that though those who were not willing to adopt had a bigger household size compared to potential adopters, a household size was not significantly affect the adoption of CDM. Unlike this study, a household size has been linked to the availability of "own" farm labour in adoption studies. Amsalu and De Jan found out that household size had a significant and positive effect among the determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed.

The argument was that larger households have the capacity to relax the labor constraints required during the introduction of new technologies.

Table1: Farm and farmer characteristics by decision to adopt.

Decision to adopt CDM	Variables	N	Min	Max	Mean	Std. Deviation
No	Age of Respondents	43	21	90	51.93	20.111
	Household Size	43	1	9	4.74	2.310
	Total land size (in Hectare)	43	1	4	1.86	0.774
	Total Livestock Unit (TLU)	43	0	13	3.83	3.110
	Amount outstanding	38	1880	9000	4196.6	1777.913
	Contacts with the Extension Service	43	5	9	7.56	1.201
Yes	Age of Respondents	107	21	80	40.67	14.889
	Household Size	107	1	10	4.19	2.348
	Total land size (in Hectare)	107	1	5	2.42	1.010
	Total Livestock Unit	107	0	27	4.71	3.849
	Amount outstanding	98	1880	12500	5857.7	2422.852
	Contacts with the Extension Service	107	7	9	7.95	0.805
Overall	Age of Respondents	150	21	90	43.9	17.257
	Household Size	150	1	10	4.35	2.343
	Total land size (in Hectare)	150	1	5	2.26	0.979
	Total Livestock Unit	150	0	27	4.46	3.664
	Amount outstanding	136	1880	12500	5393.59	2375.684
	Contacts with the Extension Services	150	5	9	7.84	0.949

Source: Own field survey, May 2015

Total land size (in hectare): Land size had an overall mean of 2.26 hectares with the farmer having the smallest size of land owing 1 hectare and the highest owing 5 hectares as indicated in Table 4. The potential adopters had relatively bigger size of land indicated by the mean of 2.42 hectares compared to potential non-adopters which is 1.86 hectares. The effect of land size on adoption of conservation agriculture in past studies has showed that small sizes of land hinder adoption since farmers fear loss of agricultural land and large tracts of land encourages adoption due to the larger capacity in terms of resource base (Gebremedhin and Swinton).

Number of contacts with the Extension Service Provider: According to the innovation diffusion theory, the frequency of extension service contributes to the awareness and subsequent adoption of the innovation (Dolisca). In this study, the potential adopters were found to have the mean of 7.95 contacts with a minimum of 7contacts and a maximum of 9 with extension officers as depicted in Table 4. The potential non adopters had a mean of 7.56 with a minimum of 5 contacts and a maximum of again 9 contacts with extension officers. Generally, the mean was 7.84 contacts with a minimum of 5 contacts and maximum of 9 contacts. Based on statistical result, even if the number of contacts with extension officers was a proxy for access to information, it was not seen as a significant variable in the study area.

Total Livestock Unit (TLU): The total livestock unit based analysis showed that the minimum livestock unit for potential adopters was 0 and maximum of 27. Whereas, the mean of potential adopters were 4.71 unit while the none adopters were 3.83 units. The statistical result also indicated that the existence of livestock unit affects the farmer's potential adoption of CDM practices.

Amount outstanding: As the study result indicated; the minimum amount outstanding was 1880 and maximum were

9000 for those respondents who were under the category of not willing to adopt CDM practices. Those respondents who were willing to adopt were scored as a minimum of 1880 and maximum of 12500 with the overall mean result of 5393.59.

Farm income: Farm income can have influence on decision to adopt the CDM practices was also considered and the results are presented in Table 5. Among the potential non adopters, many of them were under the income range of 501-1000 which was 44.2%, and 1001-2000 (25.6%). Whereas, potential adopters were in the category of 1001-2000 with 21.5%, and 3001-4000 which was 18.7 % of adopters? From the overall result, 22.7% were under the income range of 501-1000 and 1001-2000 per year.

Table2: Farm income and decision to adopt the CDM practices.

Decision to adopt CDM	Farm Income	Frequency	Percent
	501-1000	19	44.2
	1001-2000	11	25.6
	2001-3000	4	9.3
	3001-4000	4	9.3
	>5000	2	4.7
	Total	43	100
Yes	Less than 500	5	4.7
	501-1000	15	14.0
	1001-2000	23	21.5
	2001-3000	16	15.0
	3001-4000	20	18.7
	4001-5000	9	8.4
	>5000	19	17.8
	Total	107	100
Overall	Less than 500	8	5.3
	501-1000	34	22.7
	1001-2000	34	22.7
	2001-3000	20	13.3
	3001-4000	24	16.0
	4001-5000	9	6.0
	>5000	21	14.0
	Total	150	100

The level of education: Table 6 presents the result of the level of education of the household heads in the study area. From the total potential non-adopters, only 25.6 % of the respondents did not go to school, this indicates that 74.4 % of the respondents accessed formal education. On the other hand, majority of them attained primary and secondary education while very few attained tertiary and university level education. Among the potential adopters, those who attained no formal education, primary and secondary were 12.1%, 31.8% and 43.9% consecutively, whereas those who attained college and university education were 8.4 % and 3.7% respectively. on the conversely, 25.6% of the potential non-adopters attained no formal education,48.8% primary,23.3% secondary,2.3% college and finally 0% attained university education. The low percentage of farmers had tertiary education and university education and this can be ascribed to the fact that farmers with higher levels of education have a tendency of involving themselves in other off-farm activities as their education level increases. Concluded that low education level is the most limiting factor in the uptake of innovation among small holder farmers.

Table3: Education level of the household head.

Decision to adopt CDM		Education level of the household head					Total
		Not gone to school	Primary	Secondary	College	University	
No	Frequency	11	21	10	1	0	43
	Percent	25.6	48.8	23.3	2.3	0	100
Yes:	Frequency	13	34	47	9	4	107
	Percent	12.1	31.8	43.9	8.4	3.7	100.
Total Frequency		24	55	57	10	4	150
		16.0	36.7	38.	6.7	2.7	100

Sex: As it is depicted on Table 7, sex had the potential to influence the decision on adoptance and adoption. The result shows that among the potential non-adopter, 53.5% were male and 46.5% were female. On the other hand the potential adopter comprised of 54.2% male and 45.8% female. In both cases since male farmers participated in CDM practices, the male-headed households were none adopters and the potential adopters themselves. Support for participation in the project initiative is stronger among male farmers. Similar results were found by who found that female-headed households usually see the forest activities as a means of meeting basic needs like fuel wood and as a support mechanism for increasing self-reliance at

the same time on the opposite male-headed households observe the forest activities as a source of income creation and earning power.

Table4: Sex-wise distribution of the respondents.

Decision to adopt CDM		Frequency	Percent
No	Male	23	53.5
	Female	20	46.5
	Total	43	100.0
Yes	Male	58	54.2
	Female	49	45.8
	Total	107	100

Group membership: Another institutional support on participation in the project which was considered in this study was group membership. Among the potential adopters 67.4 % of them did not engage themselves in group activities compared to 32.6% who did (Table 8). Among the potential non-adopters 66.4% of the respondents did not engage themselves in group activities while 33.6 % were involved. Though, organizational membership has a role in generating support to under take new innovation is via information sharing, resource mobilization and higher market bargaining power (Shiferaw), the participation of potential adopters on group activities slightly lower than potential non-adopters.

Table5: Group Membership.

Decision to adopt voluntary CDM		Frequency	Percent
Yes/No	yes	14	32.6
	No	29	67.4
	Total	43	100.0
	yes	36	33.6
	No	71	66.4
	Total	107	100.0

Off-farm income: The off-farm income was considered to have an influence on decision to adopt the CDM project. The results are presented in Table 9. It can be inferred that 44.2%, 11.6%, 30.2%, 7.0 and 7.0% of the respondents earned less than 100, 101-500, 501-1000, 1001-2000 and greater than 2001 ETB per month respectively among the potential non-adopters. Out of them the potential adopters 47.7% had less than 100, 26.2% had 101-500, 10.3 % had 501-1000, 9.3 % had 1001-2000 and 6.5 % had greater than 2001 ETB per month. Although, the difference is not that much significant the proportion of potential non-adopters (7%), whose monthly income is greater than 2001 ETB is slightly higher than potential adopters (6.5%). This is due to that; respondents with higher income gives more focus and priority on investing various income generating activities with short-term benefit like trade, livestock fattening, than engaging on such CDM projects characterized by medium to long-term benefits. Farmers with higher income are reluctant to adopt and invest on new conservation based technologies, as they have the financial capacity and opportunity to invest on familiar activities whose benefits are harvested easily and quickly. On contrary, Amsalu and De Jan, argued that off-farm income has an influence on adoption of new technologies is derived with the fact that income earned can be used to finance the uptake of new innovation.

Table6: Off farm Income Percentage Distribution per Month.

Decision to adopt CDM	Off-farm Income	Frequency	Percent
No	Less than 100	19	44.2
	101-500	5	11.6
	501-1000	13	30.2
	1001-2000	3	7.0
	>2001	3	7.0
	Total	43	100.0
Yes	Less than 100	51	47.7
	101-500	28	26.2
	501-1000	11	10.3
	1001-2000	10	9.3
	>2001	7	6.5
	Total	107	100.0

Location of the farm from the market

The results in Table 10 points out that majority of the households (53.5%) of potential non-adopters and (62.6%) of potential adopters were located at a distance to the nearest trading center of 1-5 km. There were more potential adopters located at distance of 1-5 km compared to potential non - adopters. On the contrary, among the potential non-adopters and adopters few respondents were located < 1km from the nearest trading center since those within 1 km are more influenced by commercial (business) inclination than carbon trade. Location from the trading center here plays a role of a proxy for information access and the potential market for the purchase of farm inputs as well as tree seeds and tree seedlings.

Decision to adopt CDM	Distance from the Market	Frequency	Percent
No	<1km	5	11.6
	1-5Km	23	53.5
	>5Km	15	34.9
	Total	43	100
Yes	<1Km	22	20.6
	1-5Km	67	62.6
	>5Km	18	16.8
	Total	107	100

Risk Attitude: Results of farmer's attitude towards risk are depicted in Table 11. In case of potential adopters, majority farmers were risk neutral (42.1%), risk takers (31.8%) and risk adverse farmers (26.2%) consecutively. Most of the potential non-adopters were risk averse, which were 51.2% while risk neutral and risk takers accounts 32.6% and16.3% respectively. Risk aversion champion farmers to reluctantly adopt new innovations on trial basis, unlike the risk taking farmers who would adopt the new innovation on much more greater scales (Baidu-Forson, 1999).

Table7: Percentage distribution of the respondents by risk attitude.

Decision to adopt CDM		Frequency	Percent
No	risk averse	22	51.2
	risk neutral	14	32.6
	risk taking	7	16.3
	Total	43	100.0
Yes	risk averse	28	26.2
	risk neutral	45	42.1
	risk taking	34	31.8
	Total	107	100.0

Land tenure: Land tenure plays a significant role in agro-environmental initiatives and the results are depicted in Table 12. Most of the potential non-adopters held land with title deed (97.7%) and the remaining 2.3% of them having without title deeds. Similarly, 88.8% of the potential adopters also held land with title deeds with only 11.2 % without the title deed. Land tenure provides the farmers with ownership and user rights which are necessary in long term projects and collateral which allows the farmer to access credit facilities to fund the investment (Mwirigi). Despite this, Neo-classical economic theory confirms this by suggesting that, ceteris paribus, reduced risk and longer planning horizons would enhance expected returns and encourage more investment. Land tenure security and stability personify both of these attributes hence would enhance the extent of adoption of the carbon tree trade project (Arellanes and Lee,). Brännlund, argued that higher level of land use right security favors investments in forest conservation because of the future profit for the farmer and his family.

Table8: Land tenure percentage distribution.

Decision to adopt CDM	Land tenure	Frequency	Percent
No	With title deed	42	97.7
	Without title deed	1	2.3
	Total	43	100
Yes	With title deed	95	88.8
	Without title deed	12	11.2
	Total	107	100

Small-holder FarmersVoluntary CDMs Practice

The results indicated that, majority of the farmers (26.67%) practiced tree planting/ agro forestry (Table 13). The reason for this is mainly due to the farmer experience of integrating trees in their farms as a source of fuel wood and timber products for both home consumption and sale.

Secondly, the application of manure was applied by 21.67% of the farmers and in order to increase soil fertility and to cut down expensive inorganic fertilizers. Strip cropping was practiced by 17.78% of the farmers mainly to reduce the effects of soil erosion. Terracing was practiced by 10% of the farmers where they planted Napier and Elephant grass on the terraces for the purposes of livestock feed and to help control soil erosion. Water conservation and harvesting was practiced by 9.44% of farmers to supply water for domestic use and irrigation during dry seasons. Zero tillage was practiced by 6.11%. Mulching was practiced by 5.27% of farmers to improve the moisture content of the soil during the seasons of inadequate rainfall and dry seasons. Cover cropping was practiced by 2.22% of farmers. The reason for the low adoption of cover cropping practices may be due to the limited availability and insufficient knowledge of the cover crops in the study area.

Table9: Distribution of voluntary CDM practiced by farmers.

CDM Practices	Voluntary practice	Frequency	Percent
Tree planting/ Agroforestry	Yes	96	64.0

	No	54	36
Strip Cropping	Yes	64	42.7
	No	86	57.3
Zero Tillage	Yes	22	14.7
	No	128	85.3
Terracing	Yes	39	26
	No	111	74
Mulching	Yes	19	12.7
	No	131	87.3
Cover Cropping	Yes	8	5.3
	No	142	94.7
Application of Manure	Yes	78	52.0
	No	72	48.0
Water Conservation and harvesting	Yes	34	22.7
	No	116	77.3
Total	Yes	360	30
	No	840	70
			100

The respondents were also asked to rank the top three trees in terms of numbers in the farm.

The comprehensive results are presented in Appendix 2 while the graphical representation as shown in Figure 4.

The results indicated that the tree that was highly ranked as number one was Eucalyptus sp by 55.3% of the respondents and was followed by Cordia Africana (38%) and Grevillea robusta (4.7%).

The most common tree ranked as number two was still Cordia Africana (46.7%) of the respondents and was followed by Accacia sailgna and Eucalyptus sp by 31.3% and 13.3% respectively by the respondents.

Eucalyptus sp was ranked as the most common in rank three by 26.7% followed by Ballanites aegiptica and Grevillea robusta by 26% and 24% consecutively by the farmers.

The top most three trees in the study area are Eucalyptus, Cordia Africana and Eucalyptus sp.

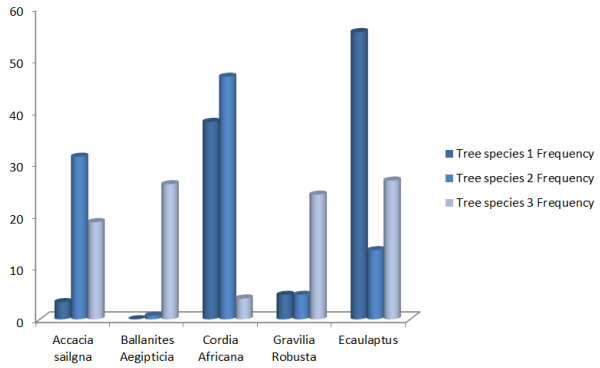

Figure2: Top three trees in the study area

Factors Influencing adoption and the Extent of Adoption of Tree Carbon Trade Project

Factors affecting adoption of Tree Carbon Trade Project

To identify the factors influencing the decision to adopt the project the probit model was estimated and the results are depicted in Table 15. The Probit model estimated using the random effect maximum likelihood estimation method (random effect models have an assumption that individual effect is uncorrelated with all other explanatory variables). The results of the maximum Likelihood estimation are depicted in Table 14 and reveals that three variables were significant at 1%, four variables were significant at less than 5% and one variable was significant at less than 10%. The log likelihood for the fitted model was -55.151148 and the log likelihood $\chi 2$ value of 64.87 indicates that all parameters are jointly significant at 1%. Pseudo R2 of 0.3687% was also above the statistical threshold of 20% confirming that the decision to adopt carbon tree trade project were attributed to the covariates considered in the model.

Table10: First hurdle econometric results.

Variable	Marginal	Standard error	P>|z|
Age	-0.00364	0.015355	0.04**
HHS	-0.02265	0.109944	0.070*
Sex	0.011194	0.7367	0.893
Perception on new tech	0.017685	0.200578	0.444
Treefarm	-0.08149	0.600165	0.232
Awaness	-0.00815	0.367688	0.845
EdLHH	0.083751	0.356211	0.038**
Total Land Size	0.116513	0.328506	0.002***
LanTenur	0.350587	1.181897	0.009***
TLU	0.023649	0.099853	0.037**
FarmInco	0.03531	0.156329	0.047**

OffIncoR	-0.02217	0.216859	0.368
AmtOusta	1.44E-05	0.000102	0.213
AttRisk	-0.00577	0.349101	0.884
VolnCDMP	0.046774	0.147249	0.005***
GruMebsh	-0.00263	0.727009	0.975
ExtenSer	0.001835	0.929862	0.986
_cons		3.707271	0.079

Age of the household head: In contrary to the expectation, age of the household head had a negative and significant influence on the decision to adopt the carbon tree trade project. Based on the result obtained, other things remain constant, a 1% increase in age of the household head the probability of adopting the project decreases by 0.36%. These designate that, older farmer's lack receptivity towards newly introduced technologies and thus, they are more satisfied with their old ways of doing things. Similar argument was advanced by Langyintuo and Mulugetta in their study to model agricultural technology adoption. The justification here is that younger household heads would be more willing to search and have greater mobility thus will have a positive influence on the project than older household heads. This implies, that two different programmes could be established to target the young household heads and the older household heads as the two group depict different level of awareness and would probably require different modes of information dissemination

Total land size: The effect of total land size was found to be positive and significant. The result shows that, a 1% increase in land size increases the probability of adopting the project by 11.65%. And this suggests that, the larger the land size, the more likely the farmer is willing to adopt the tree carbon trade project. The interpretation for this is that the larger the land size, the more the farmer flexibility in their decision making, more opportunity to use new practices on a trial basis and more ability to deal with risk. This also offers the farmer greater access to discretionary resources. In addition, technologies related with tree plantation are dependent on farm size as it takes agricultural space which could have been used to grow crops. Similar results were found by Nowak (1987) who stated that the smaller farms have lower levels of diversification of land use, as competition and conflicts arise since there is a limitation to the number of uses applicable on the piece of land unless the uses are complementary.

Household size: In line with prior expectations, the household size has a significant and negative effect on decision to adopt tree carbon trade projects. The result shows that, with a1% increase in household size the decision to adopt the project decreases by 2.26%, all else held constant.

This implies that, as the family sizes increases the decision to adopt tree carbon trade projects decreases significantly. In other word, households with higher children have less decision to adopt the project than households having few children. Even though tree planting in the farm requires substantial labor and so the farmer decision to adopt such a project may be influenced by the availability of family labor proxies by the house hold size, the qualitative result showed that the project by itself was not labor intensive. The possible reason could be that the larger the family sizes the more a household head uses their land relatively for crop production. For a given land-man-ratios, house hold with larger size may perceive a higher risk of starvation than those with smaller families and such projects may reduce their ability to meet subsistence needs. Therefore, they prefer to use their labor on food crop production to ensure food security. So their adoption is likely to depend more on farm size. Similarly, Teklewold 2004; Yesuf 2004; Ayalew, Dercon, and Gautam).Shiferaw and Holden also found a negative relationship between family size and adoptance of soil and water conservation activities in AnditTid, North Shewa. In contrast, Amsalu and Jande found household size had a significant and positive effect on determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian high land watershed.

Land ownershiprecognized with title deeds provides enhanced la nd tenure security and gives higher protections to the farmers use right, thus creating an incentive to the farmers to adopt new long term and even riskier technologies. Similarly, Arellanes and Lee also concluded that, farmers with secured tenure right were four times likely to adopt and adopt new techniques and technologies. In addition based on nationally representative survey data, Deininger also supports the positive impact of tenure security on adoption of land management technologies and planting of trees.

Availability of voluntary CDM

statistically it was obtained as a positive and highly significant variable and shows that an increase in 1% of voluntary CDM practices, the probability of the decision to adopt the tree trade project increases by 4.67%. The reason behind this was because farmers who have practiced voluntary CDM have the hand on experience and have at least benefited from the various voluntary CDM practices in the farm. The influence of the general perception towards the carbon tree trade technology was found to have a positive and significant effect increasing the probability of the decision to adopt the carbon tree trade project by 2.97% with a 1% change in the perception level, all other factors held constant. Farmers who perceived the trees as an important investment were expected to adopt the tree trade objective as a mitigation measure against climate change since they find it as a positive investment.

Factors affecting the Extent of Adoption

The second stage of the double hurdle model measures extent of adoption among the potential adopters of the carbon tree trade project. The random effect censored regression model (Tobit model) was applied in order to be consistent with the Random effect Probit model. The number of observation that was censored was 1 and the uncensored observations were 149. Results indicate that the log likelihood for the fitted model was -568.7275 and the log likelihood chi-squared of 50.88 showed

that all parameters are jointly significant at 1% (Table 16.). The share which was used as the dependent variable was generated as the ratio between the number of trees the farmer was willing to plant and the farm size. Perception towards the technology and land tenure was significant at 1% level, TLU and Voluntary CDM practices were significant at 5% level.

Perception towards the technology: Perception towards the technology has a positive significance at 1% level influence on the extent of adoption (Table 16.). The reason behind the inclusion of perception here is that technology characteristics within potential user's context model in which the characteristics of the technology underlying land users' agro-ecological, socioeconomic and institutional contexts play an essential role in the extent of adoption decision process. The possible explanation here is that farmers who perceive the technology as beneficial to them would adopt the carbon tree trade project more than those whom their perception is negative or indifferent. Similarly, Dolisca, supports the positive role of Perception of the farmers towards adoption of agro-environmental and conservation initiatives.

Land tenure; land tenure had a positive and significant influence on the extent of adoption. Land tenure has a positive significant influence on both the decision to adopt and the extent of adoption of the carbon tree trade project. This was due to the reason that land tenure provides the farmer with ownership and user rights which are necessary in long term projects like tree farming. The other reason is the land tenure (title deed) provides the farmer with the required collateral and thus can access credit facilities to fund the investment. Credit facilities will meet the initial capital requirement and enable the farmer to increase the number of trees via establishment of tree nurseries, land preparation and the labor requirements. Neoclassical economic theory confirm this by suggesting that, ceteris paribus, reduced risk and longer planning horizons would improve anticipated returns and encourage more long term investment. Land tenure security and stability epitomize both of these attributes hence would boost the extent of adoption of the carbon tree trade project. Similarly, Gebremedhin and Swinton suggested that farmers' perceived land tenure security in Tigray was significantly and positively associated with long-term durable soil conservation and tree planting.

Availability of voluntary CDM: The result also shows that availability of voluntary CDM influences both the decision on decision to adopt and the extent of adoption. The explanation is that farmers who are voluntary to practice any CDM activities would be willing to adopt the project to a larger extent than those who are not yet practiced. The reason behind this was because farmers who have practiced voluntary CDM have the hand on experience and have at least benefited from the various voluntary CDM practices in the farm.

Table11: Second hurdle econometric results.

Variable	Marginal effects	Standard error	P>|t|
Age	-0.02793	0.058389	0.633
HHS	0.335975	0.418237	0.423
Sex	3.678311	2.537569	0.15
PercepNe	6.867053	2.208649	0.002***
Treefarm	2.358194	2.230622	0.292
Awarness	1.526695	1.372331	0.268
EdLHH	-1.45735	1.155678	0.21
ToLS	0.183323	0.918106	0.842
LtWTD	8.501338	2.727815	0.000***
TLU	0.954231	0.371939	0.011**
FarmInco	0.571247	0.538742	0.291
OffIncoR	0.962019	0.84887	0.259
AmtOusta	0.000395	0.000361	0.276
AttRisk	0.119339	1.27184	0.925
VolnCDMP	4.532894	2.022193	0.027**
GroupMem	2.892381	2.56866	0.262
Extension	0.754443	0.743249	0.312
cons		13.5279	0.002

Log likelihood =-568.7275; LR chi2 (17) = 50.88; R2=0.0428; ***, **, * significant at 1%, 5% and 10% probability level respectively.

The second stage of the double hurdle model measures extent of adoption among the potential adopters of the carbon tree trade project. The random effect censored regression model (Tobit model) was applied in order to be consistent with the Random effect Probit model. The number of observation that was censored was 43 and the uncensored observations were 107. Results indicate that the log likelihood for the fitted model was -568.7275and the log likelihood chi-squared of 50.88 indicated that all parameters are jointly significant at 5%. R2 of 42.8% was confirming that the extent of decision to adopt the tree carbon project was attributed to the covariates considered in the model. The share which was used as the dependent variable was generated as the ratio between the number of trees the farmer was willing to plant and the farm size. Land tenure with title deed and perception towards the technology was significant at 1% level, total livestock unit and decision to adopt the carbon project was significant at 5% and age, extension and attitude towards risk were significant at the critical 10% level.

Land tenure with title deed and the perception of the household head had a positivesignificant influence with a 1% increase in land tenure a nd perception towards the technology increase the probability of the extent the farmer is willing to adopt the carbon trade project

by 8.50 % and 6.86% respectively. As expected land tenure had a positive significant influence on the extent of adoption. Land tenure has a positive significant influence on both the decision to adopt and the extent of adoption of the Carbon tree trade project. This was due to the reason that land tenure provides the farmer with ownership and user rights which are necessary in long term projects like carbon tree trade projects. The other reason is the land tenure (title deed) provides the farmer with the required collateral and thus can access credit facilities to fund the investment. Credit facilities will meet the initial capital requirement and enable the farmer to increase the number of trees through establishment of tree nurseries, land preparation and the labour requirements. Neoclassical economic theory confirm this by suggesting that, ceteris paribus, reduced risk and longer planning horizons would enhance expected returns and encourage more long term investment. Land tenure security and stability personify both of these attributes hence would enhance the extent of adoption of the carbon tree trade project. Perception towards the technology has a positive significant influence on the extent of adoption. The reason behind the inclusion of perception here is that technology characteristics–within potential user's context model in which the characteristics of the technology underlying land users' agro-ecological, socioeconomic and institutional contexts play a central role in the extent of adoption decision process. The possible explanation here is that farmers who perceive the technology as beneficial to them would adopt the Carbon tree trade project more than those whom their perception is negative or indifferent.

The result also shows that attitude towards risk both influence the decision to adopt and the extent of adoption. The explanation is that farmers who are risk taking would be willing to adopt the project to a larger extent than those who are risk averse. Risk averse farmers would espouse the project reluctantly on trial basis unlike the risk taking farmers who would adopt the new innovation on much more greater scales. The significant risk attitudes on the extent of adoption of conservation technologies are similar with earlier findings of Baidu- Forson, 1999 in Niger .The higher the level of risk aversion the lower the level of potential adoption of carbon tree project. However, the elasticity of attitude towards risk from the Tobit suggests that if the Carbon tree project demonstrated risk reduction characteristics it should be possible to improve the potential intensity of adoption of the project.

CONCLUSION

A prominent problem being faced by human kind is Climate is change mainly due to human activity is the most serious problem seen in the history of mankind. There is now unequivocal evidence that the earth's climate system is warming very highly due to human induced greenhouse gas (GHG) emissions. The problem of climate change can be addressed in a number of ways. One of the way is by addressing climate change problems through the adoption of technologies that enables the farmers to incorporate mitigation methods through the adoption of carbon trade. The main objective of this study is to assess the decision to adopt clean development mechanism projects among small-scale farmers in Humbo district in order to contribute towards understanding farmer's decision making process when adopting CDM project initiatives. Specifically, this study aims to identify and describe the various voluntary CDMs practiced by smallholder farmers, to assess the level of carbon trade initiatives, to assess the factors which influence the level of awareness of carbon project and to assess the factors that influence the decision to adopt and the extent of adoption of carbon trade project.

Primary data was collected through interview with the help of semi-structured questioner, focus group discussion and from key informant and the world vision project worker. Secondary data was collected from Humbo district carbon cooperatives and world vision project office. Two models were used, ordered logit model and double hurdle for the assessment of decision to adopt carbon trade among smallholder farmers.

The results showed that 26.67% of the farmers practiced tree planting/agro-forestry as the voluntary Clean Development Mechanism practice; 32% of the farmers were not aware of the project, 19% were having correct awareness and; 48% of the farmers were aware about the project but wrongly, showing the existence of awareness of the project but they understood wrongly and hence might affect the adoption and subsequent adoption. In this regard, age, land size, house hold size, land tenure, farm income, education level and availability of voluntary Clean Development Mechanisms were found to influence the decision to adopt the project. Among the listed influencing factors only Age and household size affects negatively the decision to adopt Clean Development Mechanism.

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