Determinants of sustainability of exclosure establishment and management practices in Tigray Region, Ethiopia.

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Abstract- Converting degraded free grazing lands into exclosures is one option to promote natural regeneration of plants and to restore degraded ecosystems in Ethiopia. The present study was initiated with the objective of assessing the determinants that affect the sustainability of exclosure establishment and management practices at the household level. A total of 180 households were systematically selected and a structured questionnaire was provided to these households to collect their perception. Ten in-depth interviews with key informants 9 FGDs were also carried out. Determinants of farmers' sustainability of exclosure establishment and management practices were assessed. The empirical results from binary logistic regression model showed age, tenure, and off-farm activity were positive and significant predictors of sustainability of exclosure establishment and management practices while household size, farm size, distance and number of livestock have a negative effect on exclosure establishment and management practices in the study area and they were not significant except livestock number. These findings strengthen the fact that in order to achieve sustainable exclosure establishment and management practices, institutional and economic factors should be given special attention. In conclusion, there is a need for sensitization of farmers to form groups to benefit formal training of all community in the exclosures and soil and water conservation technologies and capacity building of farmers in other livelihoods areas to reduce the burden on natural resources.

Index Terms- Exclosure, Management, Sustainability, Tigray (Ethiopia)

I. INTRODUCTION

For exclosures to continue playing their environmental conservation role, socio-economic needs of local people are very important. A sustainable and socially fair harvesting system of the wood resources or a rotational grazing system initiates local people to have a positive attitude towards exclosure (Descheemaeker *et al.,* 2006). The vegetation in the exclosures most useful to the communities are mainly the herbaceous and woody plants, specifically grass, tree and shrub species (Betru *et al.,* 2005).

Natural resources, such as forests are among the primary sources of livelihoods of poor people by providing food, fodder, and fuelwood. In the northern highlands of Ethiopia, forest resources are major sources of livelihoods and comprise 27 % of the total household income (Bedru *et al.,* 2009). Similarly, 34 % of the household per capita income in Bale mountains, southern Ethiopia (Yemiru *et al.,* 2011) and 39 % of the average household income in Dendi district, Ethiopia (Mamo *et al.,* 2007) is generated from forest resources. However, the forest resources in Ethiopia and many developing countries have been deteriorating over time (Sunderlin *et al.,* 2005; Bedru *et al.,* 2009). Deforestation and overexploitation of forests in Ethiopia resulted in reductions in forest and food products and aggravated poverty and malnutrition (Mulugeta *et al.,* 2005). For example, Reusing (1998) estimated the rate of deforestation of 163, 600 ha yr^{-1} in the highlands of Ethiopia. Moreover, owing to overgrazing, the natural vegetation in the northern highlands of Ethiopia has virtually disappeared; leaving degraded free grazing lands devoid of vegetation (Betru *et al.,* 2005). For that reason, efforts to rehabilitate degraded natural resources could become a potential strategy for livelihood improvement (Taddese, 2001; Kebrom, 2001; Shylendra, 2002).

- In response to the degradation of land resources, "*Baito"* (a system of political leadership and administration at the "*Tabia"* or *Wereda* level and development agents of the Bureau of Agriculture and Rural Development (BoARD) in collaboration with the communities in Tigray, Northern Ethiopia, established exclosures on degraded free grazing lands to combat forest degradation (Wolde *et al.,* 2010).

More than 80, 000 ha of hillsides were closed to foster regeneration of indigenous tree species during 1985 to 1990. However, most of the exclosures were harvested or destroyed by 1995 and the experience with exclosures in Ethiopia was disappointing (Hoben, 1995). Most importantly, inadequate scientific and technical knowledge, the use of a standardized approach without regard to local agro-ecological conditions, and top-down authoritarian and politicized approaches followed in the implementation of establishing exclosures, disregard of the views and interests of the local communities whom the program was intended to serve contributed to the poor performance of exclosures in the "*Derg"* regime (Berhanu *et al.,* 2003). The experience with exclosures in Tigray was limited in the "*Derg"* regime but increased since 1991. The area covered by exclosures in Tigray increased from 143,000 ha in 1996 to 262,000 ha in 2005 (TFAP, 1996; RLUPD, 2000; Betru *et al.,* 2005), and has further increased 575, 217 in 2010 and to 875, 230 ha in 2014 (Personal communication with the expert of implementation of natural resources management in Tigray, 10th May, 2015). The size of an exclosure ranges from as small as 1 ha to 700 ha.

In Tigray, the priority areas for establishing exclosures are normally identified as a joint initiative of local communities, Governmental and Non-Governmental Organisations

(Descheemaeker *et al.,* 2006). Most importantly, development agents of BoARD and the "*Baito"* are involved in identifying areas to be closed. The final decision was made at a general meeting of the community. Farmer's mobilization for establishing exclosure and devising rules for managing exclosures in Tigray is deeply rooted in the political struggle of the Tigray People Liberation Front (TPLF) and follows participatory process in most cases (Chisholm, 1998; Berhanu *et al.,* 2003). The negative experiences in managing exclosures using top-down approaches in the "*Derg*" regime and the encouragement of TPLF towards empowering local governance contributed to the more participatory approaches in managing exclosures with locally devised rules. However, Segers *et al.,* (2008) pointed out that the mobilization of farmers in central Tigray tends towards convincing farmers to implement the development programs of the government in central Tigray and was not participatory.

There is an ongoing debate in the literature of communal resources management regarding the more relevant institutional arrangements for improving rural livelihoods using the available communal resources (Ostrom, 1990). The debate encompasses views that romanticise the effectiveness of village rules and considering village rules as solutions to most problems in managing communal resources at low transaction costs. On the contrary, there are views that undermine the effectiveness of village rules in facilitating users to have common goals towards managing communal resources in a sustainable manner (Campbell *et al.,* 2001; Makepe, 2006). Neither of these extreme views could contribute to solving the challenges in the management of exclosures on its own under the rural context of Tigray, Ethiopia. There is a general consensus among researchers on the need of effective village rules such as taboos to manage forest resources and to enhance socio-ecological benefits (Chisholm, 1998; Betru *et al.,* 2005). This need becomes so critical, because of the built-up weakness of village rules in Tigray owing to a long history of war, political uncertainty, and government interventions (Yohannes and Waters-Bayer, 2007).
Most of these studies documented positive environmental and socio-economic outcomes from the establishment of exclosures on degraded free grazing lands. In particular, Nyssen *et al.,* (2009) found that the natural resources in northern Ethiopia was very degraded in 1868, but has shown a remarkable improvement since then as an outcome of the large-scale implementation of afforestation and terracing activities. Exclosures were also implemented as part of this large-scale land rehabilitation works and contribute to the improved forest resources. We suppose that such positive outcomes could result from the village rules that are used in managing the exclosures. However, studies are lacking on the relevant institutional arrangements that ensure the sustainable management of exclosures. This lack of evidence exists despite the fact that more than three decades have passed since the establishment of most of the exclosures in Tigray. Particularly, the effectiveness of village rules with the goal of promoting sustainable management of exclosures was ignored and not explored well because most of the researchers were emphasizing on the biophysical impacts of exclosures. This information is, however, critical for managing exclosures in Tigray in a sustainable manner.

Consequently, in-depth analysis of the effectiveness of village rules in managing exclosures becomes crucial for reinforcing sustainability outcomes such as preventing forest degradation and achieving equal benefit sharing among users. We considered forest degradation, conflicts among users over natural resource use, and meeting high expectations of users to realize economic benefits from exclosures as important challenges in the management of exclosures and evaluated the effectiveness of village rules by examining their roles in addressing those challenges. Therefore the following project was initiated with the objective of assessing the determinants that affect the sustainability of exclosure establishment and management practices at the household level.

II. Material and Methods

2.1. Study area

Tigray Region has five administrative zones, which are further sub-divided into 35 *Woredas* (districts). The study was conducted in three *Woredas*/districts of Tigray (12° - 15° N latitude and 36° 30' - 40° 30' E longitude), the northernmost region of Ethiopia (Figure 1). The specific study area was selected based on criteria's from the list of districts of the region that have had greater than twenty-five years age area exclosures with different management and utilization system. The wide variety of altitude (range between 1400 and 2900), the age of exclosures (vary between 1 and 25 years), size of exclosures (differ from 8 to 125 hectares), proportion of exclosure, and distance from residence (vary in the range 0.5 to 9 kilometers). Fair accessibility is also under consideration.

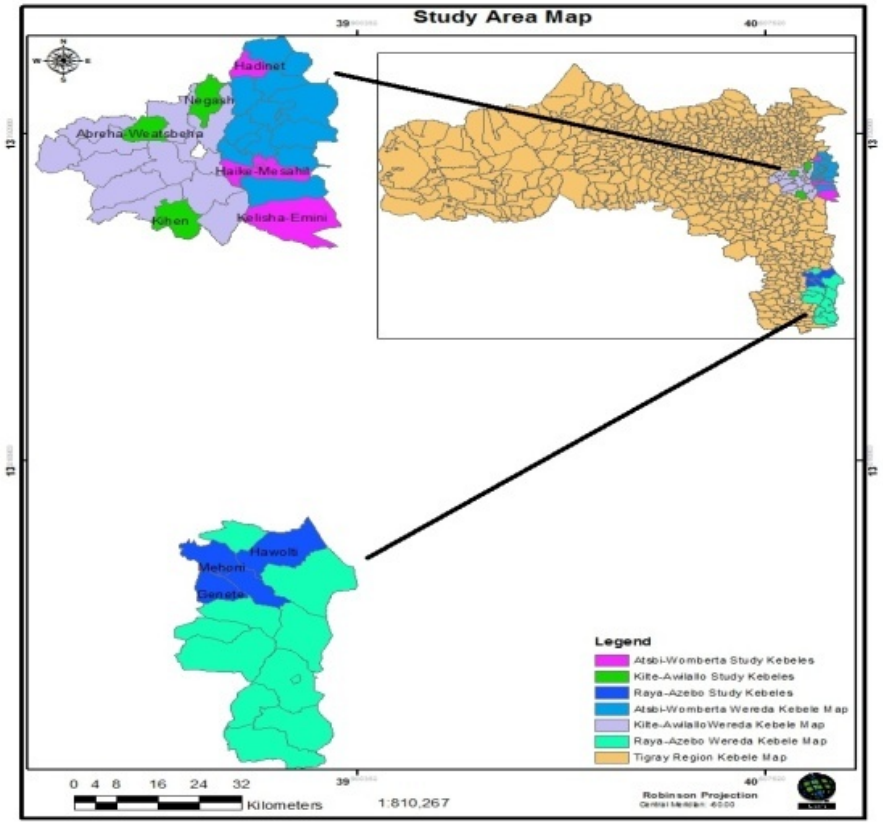

Figure 1. Map of Selected *Kebeles* of the Study areas.

2.2. Topography

The topography of the areas comprises several forms from high slope to flat, ragged and deep gorges and gullies. Most of the areas were characterized by cleared forest and considered as the most degraded and eroded area in the previous time. The topography of Tigray contains the three main traditional divisions of arable Ethiopia: the *Kolla* – lowlands (c1400-1800 meters above sea level) with relatively low rainfall and high temperatures; the *Woina dega* – middle highlands (c1800-2400 m.a.s.l.) with medium rainfall and medium temperatures; *Dega* – highlands (c2400-3400 m.a.s.l.) with somewhat higher rainfall and cooler temperatures.

2.3. Climate

Analysis of the meteorological data showed that the mean annual temperature for Raya Azebo was 20.8 ^{0}C and the mean minimum and maximum were 11.8 and 33.5^{0}C respectively. The hottest months are April and June, while coldness is from September to December. The mean annual rainfall is 604 mm, which varied greatly from year to year. Generally, the study area has bimodal rainfall pattern, with low rainfall from February to May and the main rainy season (June – September). Kilite Awulaelo *Woreda* average daily air temperature of the area ranges between 8^{0}C and 30.1^{0}C with a mean of 19.7^{0}C. The mean annual rainfall of the area is about 610 mm. Kilite Awulaelo *Woreda* has unimodal rainfall pattern.

2.4. Site Selection

The study was conducted in Raya Azebo *Woreda* (Genete, Hawelti, Mehoni *Kebeles*), Atsbi Womberta *Woreda*-(Hadinet, Kelesha Emene, Haikmeshal *Kebeles*), and Kilte Awelaelo *Woreda*-Kihen, Negash, Abreha We Atsbeha *Kebeles*) located in Southern and Eastern parts of Tigray region (Figure 1). The *Kebeles* demonstrate degraded vegetation and soils and differ in elevation, rainfall, agro-ecology, access to the main road, distance to regional capital, population distribution and density and lithology.

2.5. Population and economic activities

Mixed crop-livestock farming is the dominant farming system of the *Woredas*. The main livestock in Raya Azebo are cattle, sheep, goats, and camel. Livestock provides draught power, transport, food, and income. Pasture is available in free grazing lands. Crop residue (mainly the stalk of maize and sorghum and straw from *teff* and barley) and chopped cactus are used to feed cattle whenever there is a severe shortage of feed during the dry season. The total population of the Raya Azebo *Woreda* was 161, 394 of which 80, 193 (49.7%) were males and 81, 201 (50.3%) were females. With regard to farm households, the number of male-headed households (MHHs) and female-headed households (FHHs) were 18,201 and 18,334, respectively and a total of 36,541 (*WoFED* report, 2016).

Distribution of land was done based on the fertility status of the soil (fertile, less fertile, moderately fertile), and the functional category of the plot (field plot and backyard plot). Concerning the landholding size in the area, it is estimated that a household

has 0.84 ha on average. Crops are produced in rain-fed agriculture mainly for subsistence purpose.

Even in some areas the prevalence of a bimodal rainfall pattern is common, the system of double cropping (production of two crops on the same plots of land in a year) is not practiced both on the highlands and lowlands except in irrigated land. Manuring and crop rotation are practiced very rarely. Diversion of floods and water harvesting mechanisms are also practiced, especially in the lowlands where rainfall is relatively scarce.

Livestock husbandry is an integral part of the mixed farming system in the study area. Among the various livestock reared, cattle constitute the highest proportion (61.5%) (Zenebe *et al.*, 1998). Other important domestic animals next to cattle in the order of quantity and importance are sheep (20.3%) and goats (10.5%). Donkeys, horse, mules, and camels are the most important means of transport for the rural households. In general, the livelihood of the livestock family depends on natural vegetation and crop residues. The use of tree parts as fodder is very limited in the study area. “Hizaeti” and “Mewaya” or “Mewcha” are the two most practiced traditional systems of grazing in the area. These are common pool natural resources management systems or a common grazing place designated particularly for oxen and cattle other than oxen respectively.

The total population of the Kilte Awelaelo *Woreda* is estimated at 164, 743 of these 80, 943 (49.1%) are male and 83, 800 (50.9%) are female in the year 2015 (*WoFED* report, 2016). Out of the total population, about 90.46% of the population is living in rural areas and 9.54% is living in urban areas. Average family size is five and population density of the district is 87.4 people per square kilometer. Like in the other drought-prone areas of the region, agriculture in Kilte Awelaelo is only subsistence, which is unable to secure adequate food supply, and cash for the farm households` yearly expenditures. Farmers grow different food and cash crops and rear livestock including beekeeping and poultry. The dominant crops grown in the area include *Triticum aestivum* (wheat), *Hordeum vulgare* (barley), hanfets (wheat and barley mixture) and *Eragrostis tef* (teff).

According to the recent *Woreda* population reports, the estimated total number household heads in the Atsbi Wemberta *Woreda* was 24, 398, with total population of 156, 632 of which 74, 238 (47.4%) male and 82, 394 (52.6%) female in 2015 (*WoFED,* 2016). Under normal conditions, rain starts around the last days of June. As a result of all these, Atsbi Wemberta is one of the drought-prone *Woredas* in the Tigray region. The area receives bimodal rainfall: *Belg* (short rains) from Mach to April and *Meher* (long rainy season) from June to August. The short rainy season is not reliable enough for crop production except for growing grass for livestock. Nearly all the cereals and legumes are planted during the main rain.

Despite the large population of livestock, livestock productivity is low as in many other parts of Tigray. The population of livestock in Atsbi Womberta *Woreda* is 61, 429; 83, 870; 22, 266 and 20, 771 heads of cattle, sheep, goats, and equines, respectively. The number of poultry is estimated at about 58, 085. Out of the cattle population, there are an estimated 16, 319 drought oxen. On the other hand, there are 7, 739 beehives of which 3, 986 are modern ones. The population of livestock in Raya Azebo is 165, 655; 22, 180; 22, 931 and 28, 102 heads of cattle, sheep, goats, and equines respectively. The number of poultry is estimated at about 65, 475. On the other hand, there are 9, 411 beehives of which 4,314 are modern ones. The population of livestock in Kilte Awelaelo is 86, 645; 33, 947; 27, 202 and 14, 568 heads of cattle, sheep, goats, and equines, respectively. The number of poultry is estimated at about 49, 043. On the other hand, there are 5, 822 beehives of which 2, 142 are modern ones (*WoFED*, 2016).

Mixed crop-livestock farming is the backbone of the livelihoods of households in all the study sites. Major cultivated crops include *Triticum aestivum* (wheat), *Hordeum vulgare* (barley), *Vicia faba* (faba bean), *Sorghum bicolor* (Sorghum) and *Eragrostis tef* (teff). The villages are characterized by low and erratic rainfall, drought, and land degradation, as are most other parts of Tigray. Like more than 85% of the Ethiopian population, the residents of the study area live in rural areas and depend on land resources including forests and grazing lands for their livelihoods (CSA, 2008).

2.6. Sampling of respondents for the socio-economic study and considerations in group discussions.

Reconnaissance field survey was made to obtain an overview of the study sites, followed by a detailed preliminary survey. The data for the study was collected from primary sources. The main source of primary data was a household survey that was conducted from May 2016 to July 2016 using a structured survey questionnaire. The respondents for individual interviews were chosen by using purposive sampling technique, as suggested by Patton (2002), in order to select specific elements of a population that are believed to represent the range of variation expected in a population. Purposive sampling technique methods were used to select both study sites and households. Observation and structured questionnaire were employed to collect information related to households’ perception of the role of exclosures.

The criteria we used for selecting the respondents were: villagers who were involved in the decision-making process for instance in demarcating the area to establish exclosures, who have first-hand information about the establishment of rules and enforcing rules in managing exclosures. Moreover, we included villagers that live near and far from the exclosures, and also farmers in the neighboring villages. For the purpose of this study, the heads of the selected households (usually the household head is implicitly assumed to be the decision maker in sustainability studies) were interviewed using a structured questionnaire which covers a broad range of personal, social, economical, institutional, and plot level issues relevant to the process of sustainability exclosure establishment and management practices or the instruments including questions related to the background information of the households such as socio-economic variables to determine the key predictors that differentiate household’s strategy choice and choice of natural resource management and conservation.

Two initial meetings, 10 in-depth interviews with key informants including village administrators and guards of exclosures were conducted. In addition, 9 focus group discussions with men and women subgroups, ranging in size from five to seven participants, were carried out. Besides, the performances of area exclosures on biophysical qualities of the areas were noticed and recorded by observation. Furthermore, for

focus group discussion, we used a random sampling technique to select men and women participants from a list of dwellers in the villages. Separate men and women subgroups were organized so that both women's and men's perceptions are equally represented and members in the subgroups could feel comfortable discussing the issues. The discussions focused on the management of exclosures and how the village rules addressed the challenges in the management of exclosures. We encouraged all participants to speak and we gave participants equal chances to contribute to the discussion in the facilitation to reduce the dominance of conversation by few members of the focus groups. Interviews were conducted by the first author with the help of a translator whose first language is Tigrigna, the local language spoken in the study areas. We used participatory appraisal tools in the group discussions, for instance, we used scoring exercises to compare the importance of different communal resources to the livelihoods of villagers.

In addition, transect walks following the altitudinal gradients of the sites were used to get an impression of the conditions of the exclosures. Observations and informal discussions with villagers were used to get information on how villagers refer to community rules and challenges, and how villagers manage the exclosures. Moreover, secondary data on socio-economic settings were collected from literature and local organizations including BoANRD.

2.6. Data Analysis

A total of 180 households were systematically selected from the list of local community members received from the Village administration. A structured questionnaire was provided to these households to collect their perception of area exclosure and benefits gained from it. Respondents were included using a statistical formula as follows:

i.e. $n = \frac{Z^2 * p * q * N}{Nd^2 + Z^2 pq}$

Where, n= sample size
N= total population of households in all sites
Z^2= confidence interval (1.96, constant)
d^2= margin of error
p= proportion of population (0.5, constant)
q= 1- p
Assumption: let d= 0.05 and q= 0.5

$$n = \frac{(1.96)^2 * 0.5 * 0.5 * 339}{(339)(0.05)^2 + (1.96)^2(0.5)(0.5)}$$

n = 180

Hence the data was stratified into three sites, the number of households in each site was calculated as:

$$n1 = \frac{n * N1}{N}$$

Where n1= sample size on the first site
n= number of households in the first site
N1= total number of households included in the study
N= total number of households in all sites

$$n1 = \frac{113 * 180}{339}$$

n1=60

Similarly,

$$n2 = \frac{n * N1}{N}$$

Where n2= sample size on the second site
n= number of households in the second site
N1= total number of households included in the study
N= total number of households in all sites

$$n2 = \frac{109 * 180}{339}$$

n2=58

and

$$n3 = \frac{n * N1}{N}$$

Where n3= sample size on the third site
n= number of households in the third site
N1= total number of households included in the study
N= total number of households in all sites (Daniel, 1995)

$$n3 = \frac{117 * 180}{339}$$

n3= 62

The complexity of the interdependence among different factors made it difficult to take a separate examination of each factor under consideration. However, generally, the hypothesis is that if individual households can earn significant contribution from the outcome of exclosure establishment (on livestock production and productivity, apiculture, vegetable production and better ecosystem and climate); these households manage sustainably to perpetuate these benefits; otherwise the reverse is true other things remained constant. Hence, as hypothesized in various studies this study test the following major factors (table 1).

Household Livelihood Strategy (Sources of Income)

- The impact of those households with off-farm livelihood strategies those are completely independent of exclosure like trade cannot be determined *apriori*.

Household Human Capital:

- Farmers who are older experienced more exclosures than younger; thus, age is expected to have a positive relationship with exclosure establishment.
- Higher levels of literacy, training and secured land tenure are hypothesized to have a positive association with exclosure establishment.
- Two opposing relationships are expected between exclosure establishment and household size. On the one hand, the larger the size of the household, the higher the subsistence consumption needs, and given a fixed benefits, the lower the willing of the farmer to participate in the management of exclosure. On the other hand, larger household size is the source of labor which is an important input to participate in the exclosure soil and water conservation practices, because it requires more labor. Hence cannot be determined *apriori*.
- Regarding sex of household head, female-headed households are expected to be less likely to participate in the management of exclosure, maybe because of their

less exposure to the external environment and new technology.

Household Physical Capital:

- Household physical capital endowment – land and oxen–is expected to have a positive or negative relationship with its investment decision on exclosure establishment. So, cannot be determined *apriori.*

Household Financial Capital:

- Household's endowment of financial capital (e.g. household saving and access to credit service), is obviously expected to have a positive relationship with a farm household's investment decision and exclosure establishment.

Farmland factors:

With respect to the influence of the characteristics of exclosure on the households, exclosure distance near to their home, lower catchment flat slope farm plots, and infertile plots are expected to increase management and establishment of exclosures.

Table 1. Definitions of Variables Used in the Regression Analyses

Explanatory Variables	Definitions
Expected direction of the relation between HHHS characteristics and decision to exclosure establishment	
AGE(+)	Age of the household head in years
SEXDMY(+)	Sex of respondent; male= 1, Else=0
HHSIZE(+/-)	Total number of household size
HHLIT(+)	Literacy status of household head 1=literate, 0= otherwise
TENURE(+)	Whether a farmer perceives a risk of loss of land in the future; 1 if he/she perceives 0 otherwise
FMSIZE (+/-)	The size of the farm, in hectares
DISTANCE (+)	Distance of nearest exclosure from homestead, in km
SLOPE_CAT(+)	Slope category of majority of household head land; flat and mid slope=1, Else=0
TRAINING(+)	Whether training about soil conservation received by the farmer; 1 if a farmer got training and 0 otherwise
CREDIT(+)	Credit access of household head; Yes=1, Else=0
OFF_FARM(+/-)	Whether a farmer engaged in off-farm employment; 1 if a farmer has off-farm employment and 0 otherwise
PERCEIVE(+)	Whether a farmer perceives land degradation as a problem; 1 if farmer had perceived erosion as a problem and 0 otherwise
LIVESTOCK(+/-)	Livestock holding (in TLU)
SOIL_FERTI(+)	Soil fertility category of majority of household head land; infertile=1, Else=0

Note:

Dependent variable- decision to exclosure establishment

signs (+/-), in braces, indicate the expected sign of coefficients of the specified variable to exclosure establishment

The study heavily depends on the quantitative method of data analysis. The study used descriptive statistics (averages, cross-tabulation, and percentages) as well as econometric models (Binary Logistic Regression). Frequency tables were generated for general information, t-tests were applied to compare the mean differences, chi-square tests were applied to analyze categorical data, and binary logistic regression was applied to find out the degree of relationship between independent and dependent variables influencing the sustainability of exclosure establishment and management practices. All other socio-economic and questionnaire survey data were analyzed and interpreted with appropriate statistical tools using SPSS software V.20. Finally, the data analyzed and interpretations were conducted by including data from observations that were recorded in the field.

III. Results

3.1. Socio-Economic Characteristics of Farmers used for logistic regression.

In this section, the general household characteristics are presented and selected variables were used for logistic regression analysis in section 3.2. In addition to the tabular presentation and description of variables, all variables under consideration were tested to see their statistical significance.

Mean age of respondents were 38.4 years. Statistically significant differences (P= 0.001) were found in age. This means age may be important in influencing exclosure establishment and management. Sex is not significant and may not be important in exclosure establishment and management.

Household size is significant only at 10% therefore it may not be major determinant in exclosure establishment but when we see with respect to poor resource farmers who depend solely on family labour to maintain their farms it may have an influence but it has also implication on resource share from the exclosure and public works on the area. As shown in table 2 the average household size is also more or less 6 persons rounding to the nearest whole number.

More literate farmers are assumed to increase the ability to obtain process and use of information relevant to the use of new adoption technology. In addition, high rate of literacy increases the capacity and ability to obtain and apply relevant information concerning the use of exclosures. The survey result shows variation statistically significant at less than 5 percent level. Thus, literacy could have a contribution in exclosure establishment and management in the area.

Table 2. Description and summary statistics (mean and percentage) of the variables used in the binary logistic model (n = 180).

Variable	Description		Sig
Dependent/ Constant	decision to exclosure establishment		
Age [x]	Mean Age of the household head in years	38.41	0.0001***
Sex[y]	Sex of respondent		0 .108
	Male (%)	84.4	
	Female (%)	15.6	
Household size [x]	Total number of household members	6.3	0.072*
Literacy[y]	Literacy status of household head (%)		0.04**
	Literate (%)	40.56	
	Illiterate (%)	59.44	
Tenure[y]	Farmer's perception towards tenure (%)		0.0001***
	Yes (%)	94.4	
	No (%)	5.6	
Farm size [x]	The size of the farm, in hectares	0.84	0.02**
Distance [x]	Average distance of nearest exc. from homestead, in km	3.04	0.001***
Slope[y]	slope category of the majority of household land		0.77
	Flat and Gentle slope (%)	57	
	Others (%)	43	
Training[y]	Training about SWC received by the farmer		0.0001***
	Yes (%)	97.8	
	No (%)	2.2	
Credit[y]	Credit access household (%)		0.01**
	Yes (%)	60	
	No (%)	40	
	A farmer engaged in off-farm employment (%)		0.001***
Off-farm[y]	Yes (%)	85	
	No (%)	15	
Perceive[y]	A farmer perceives land degradation as a problem (%)		0.02**
	Yes (%)	99.4	
	No (%)	0.6	
Livestock[x]	Livestock holding (in TLU)	3.11	0.003***
	Soil fertility category of majority of household land (%)		0.01**
Soil fertility[y]	Infertile (%)	60	
	Fertile (%)	40	

Source: Survey data, 2016
Note: n = number of respondents [x] Continuous variable and use t-test
[Y] Dummy variables and use χ^2 test * significant at 10%, **significant at 5%, ***significant at 1%

Farmers' perception of land degradation and recognizing it as a problem is an important factor that influences the exclosure establishment and management practices. Table 2 showed significant differences were observed on the level of perception regarding the causes of land degradation. Similarly, chi-square tests showed that the use of credit, training about SWC techniques, a farmer engaged in off-farm employment and soil fertility categories of the majority of households land were statistically significant differences and could have contribution and influence in exclosure establishment and management in the area.

3.2. Results of Logistic Regression Model

This section of the study is devoted to testing the relative effect of the variables under consideration towards exclosure establishment and management in the study area. Table 3 presents the logit estimates of the determinants of the likelihood of exclosure establishment and management practices sustainability. A chi-square test which measures the goodness of fit of the model is found to be significant at 1 percent level; signifying a good fit i.e., the model is adequate.

The logistic regression model result shows that, though not significant, sex and educational status of the household heads has a positive coefficient which implies that male headed and literate households have a higher probability of acceptance of exclosure establishment and management than female-headed and illiterate households. In the same manner, training, the perception of land degradation, and slope of farmland are not significant in the model result but their positive coefficient indicates their positive contribution to acceptance of exclosure establishment and management in the area.

Table 3. Factors that affect the sustainability of exclosure establishment and management (logit model).

Variables in the Equation						
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
AGE	.095	.046	4.267	1	.039	1.100
SEX	1.576	.928	2.883	1	.090	4.838
HHSIZE	-.146	.142	1.064	1	.302	.864
HHLIT	.447	.768	.339	1	.560	1.564
TENURE	2.867	1.059	7.333	1	.007	17.592
FMSIZE	-.949	.535	3.148	1	.076	.387
DISTANCE	-.299	.246	1.467	1	.226	.742
SLOPE_CAT	.109	.733	.022	1	.882	1.115
TRAINNING	24.044	15094.772	.000	1	.999	27677757192.712
CREDIT	1.342	.734	3.345	1	.067	3.828
OFF_FARM	2.861	.832	11.824	1	.001	17.478
PERCEIVE	20.141	40192.963	.000	1	1.000	558369624.960
LIVESTOCK	-.323	.154	4.412	1	.036	.724
SOIL_FERTI	.676	.740	.835	1	.361	1.966
Constant	-48.695	42933.975	.000	1	.999	.000
-2Log likelihood 63.886						
Model chi-square 88.29						
Correctly predicted Positive attitude % 96.7						
Correctly predicted other attitude % 70.4						
Overall cases correctly predicted% 92.8						

Source: Model output

IV. DISCUSSION

4.1. Determinants of sustainability of exclosure establishment and influencing factors for its management practices

Empirical studies have considered a broad range of factors such as credit constraint, limited access to information, farm size, socioeconomic and institutional factors to assess exclosure establishment and management practices by farmers. Yet, not all factors are equally important in different areas and for farmers with different socio-economic situations. This means the decision to accept or not a particular measure exclosure establishment and management practices varies depending on the age of farmer, educational level of household size, landholding size, livestock ownership and other factors that indicate also the wealth status of farmers.

With regard to the age of the household head, previous researchers reveal that the direction of the influence of this variable is either way. Farmer's age is negatively related to the

adoption of soil and water conservation practices (Bekele and Holden, (1998) and Paulos *et al.,* (2004) for Ethiopia, and Krishna *et al.,* (2008) for Nepal). On the other hand, Aklilu (2006) for Ethiopia reported that farmer's age is positively related to the adoption of soil and water conservation practices. As table 2 shows, the average age of household heads was high, this was about 38.4 years. In this study, age variable has a positive coefficient and significant at 0.001 levels, signifying a strong impact on the decision to exclosure establishment and management practices. This can be explained by the fact that older farmers have longer farming experience and relate to the use of exclosure establishment and management practices as compared to the younger counterparts. The result shows that keeping other variables in the model constant, as the age of the household heads increases by one unit sustainability or acceptance of exclosure establishment and management increase by a factor of 1.1. This implies older farmers accept more exclosure establishment and management than the younger counterparts do.

As observed by Bekele and Holden (1998), the effect of household size on the adoption of soil and water conservation practices may be either positive or negative. Larger households are able to provide the labor that is required for establishing and maintaining selected conservation structures and smaller ones may face labor problems which may hinder adoption and sustained use of certain practices. However, Abera (2003) found out that if a family is larger, there will be more demand for land to meet subsistence needs. Hence, members may not adopt soil and water conservation practices. The result from the logistic regression shows that household size and acceptance of exclosure establishment and management has a negative association, but not significant at 10 percent level. It signifies that household size was not an important factor to influence the acceptance of exclosure establishment and management in the area.

To test this hypothesis a literacy status dummy was included in the logit model. The variables literacy status of household head was positively related to acceptance of exclosure establishment and management, but the result was not strong enough to support the idea since it is not significant.

The relationships between farm size, soil and water conservation practices differ from place to place. Farm size is found to have mixed effects on the sustainability of soil and water conservation practices. While various studies (Wagayehu and Lars, 2003; Ersado *et al.,* 2004; Aklilu, 2006) indicated positive relation between adoption of soil and water conservation practices and farm size, Pender and Kerr (1998) find differential effects of farm size on soil and water conservation practices across the three villages they studied in India. However, in this study, farm size was found to influence acceptance of exclosure establishment and management negatively and significant at 10 percent level. The result implies all other variables remaining constant, increase in a unit of cultivated farm size would result in a decrease in the acceptance of exclosure establishment and management by the factor of 0.387. The negative influence might be explained that a large proportion of farmers with larger farm sizes tend to use soil and water conservation practices on any of their plots than the exclosure.

Land tenure as an important predictor was also assessed and the result shows, as expected, a positive and significant relationship at 1 percent level, signifying a strong impact on the decision to acceptance of exclosure establishment and management practices. Thus, farmers that have access to land secured they cultivate through inherited or obtained from the *Tabias* administration are more likely to accept exclosure establishment and management practices than their counterparts that are living with renting or sharecropping.

The value that inherited land acceptance of exclosure establishment and management practices is 17.59 times that are accessed for renting, sharecropping or others. This can be explained by the fact that farmers cultivating their own lands are more secured compared to those rented. The possible explanation is that land ownership has some influence on acceptance of exclosure establishment and management practices. Most farmers feel secure under the current land tenure system, and tenure is not a constraint in most cases. However, a few farm groups who rent land mainly young people and new landless regard insecure tenure as a constraint in the acceptance of exclosure establishment and management practices.

As expected of this study, the coefficient of the distance of an exclosure from homestead was found to be negative but not significant. This should have given them the opportunity to pay more attention to nearby exclosures with less care to distant ones. This can be attributed to the fact that farmers give more attention to nearby exclosures and the care given to distant areas is low. Therefore, the greater distance of an exclosure from homestead (As distance increases), and the long-term and immediate benefits of the exclosures may have discouraged farmers from giving the emphasis and management of exclosures. This finding is not in agreement with (Wagayehu and Lars, 2003) who found significant but similarity with negative correlation between no conservation decision and distance of a parcel from the residence but positive correlation between distance of the plot and adopting conservation decision in Ethiopia (Kessler, 2006) also found out that farmers invest more in soil and water conservation in fields situated near to residences.

The slope of a plot was included as an explanatory variable. Considering the assumption of the higher the slope category of a land, the greater will be the severity of soil erosion. This means that on sloping lands the impact of soil erosion would be more visible to the farmers and force them to take remedial actions. This is because the slope is an indicator of soil and water loss from the farmland or other lands. Thus, farmers cultivating sloping fields perceive the threat of soil loss better than farmers who cultivate gentle or level sloping fields. This is also true on exclosures and free grazing lands. This implies that farmers cultivating vulnerable fields are more likely to adopt soil and water conservation practices on their farms than those cultivating less vulnerable lands. It implies slope of plots is positively related to the sustainability of soil and water conservation holding other factors constant. The finding supports to that of (Bekele and Holden, 1998; Wagayehu and Lars, 2003; Berhanu and Swinton, 2003; Aklilu, 2006). As per the same authors, the conclusion was that a positive and not significant effect of the slope of a plot on the decision to adopt soil and water conservation practices.

Another important factor analyzed in the model is the level of off-farm income. Off-farm employment does not necessarily lead to more sustainable land use. Rather, better access to off-

farm activities especially in the exclosure community works will increase income and farmers' incentives to invest in soil and water conservation practices. It has a positive sign and highly significant. The association is strong since exclosures are managed by FFW and PSNP programs too but unrelated findings also reported by (Pender and Kerr, 1998; Berhanu and Swinton, 2003; Tenge *et al.,* 2004; Aklilu, 2006). They reported off-farm income on farmers' had a negative association with the sustainability of soil and water conservation practices.

However, it was hypothesized that the more the farmer earns off-farm income the less liquidity problem he/she faces so that he/she is more likely to accept exclosure establishment and management practices even in the absence of credit access. It has a positive sign but significant at 10 percent level.

The positive influence might be explained that farm income is low and the farmers cannot rely on agriculture. The low annual farm income has probably forced some of the sample households to engage in off-farm activities. Household's survival depends on the ability to generate off-farm income so as to smooth their consumption as means of risk management. A major reason could be that majority of the households rely on non-farm activities as they have very small and fragmented farm size. The implication is that farmers are discouraged to rely on farming, which in turn, may result in farmer's to under-invest on their farmlands.

A substantial number of households in the Tigray region participates in food-for-work (FFW) activities which involve labour contribution to public works such as road construction or maintenance, soil and water conservation activities, and forest rehabilitation and receiving food in return for their labour services and this results supports a trend reported by other authors who found, that (Berhanu and Swinton, 2003; Fitsum *et al.,* 1999).

The effect of soil fertility on acceptance of exclosure establishment and management was found to have a positive association, but not significant at 10 percent level. Plots with both fertile and infertile soils positively influenced farmers' acceptance of exclosure establishment and management but the difference s insignificant possibly the majority of the farmers assume their farmland is different from the exclosure and the farmland fertility is not associated with the exclosure management and them did look only short-term economic benefits of their farmland or they did not see the negative effects of erosion on their plots in the long term.

Access to credit and acceptance of exclosure establishment and management practices is given much emphasis in many empirical studies. In the same way in this study, the effects of credit were assessed. The result showed, as expected, a positive and significant at 10 percent level, signifying an impact on the decision to acceptance of exclosure establishment and management. This implies that households with better access to credit are more likely to have a higher probability of acceptance of exclosure establishment and management than those without access.

Regarding the credit access, the stipulation of interpreting this result is that farmers who did not take credit may not necessarily mean they had no access to it. This means that use of credit may not clearly distinguish between farmers who chose not to use available credit and farmers who did not have access to credit. For instance, farmers may not take credit if it is not affordable, or if they perceived it is associated with some risks, though there is access (availability).

This means rationale farmers will use credit if it is profitable. Profitability, in turn, depends on the cost of credit and the potential returns on investment. Moreover, from the FGD respondents replied the main microfinance institute in the study areas is Dedebit Credit and Saving Institution (DECSI). DECSI was established in response to the work done by REST in providing credit services to the poor, and since it was officially registered in 1997, much of DECSI's work has continued to focus on the provision of credit services for the poor in the rural areas of Tigray.

The multipurpose cooperative operating in the areas is another major source of credit. The cooperative provides credit in kind (main inputs such as improved seed, chemical fertilizer, etc) interest-free. Informal credit sources such as friends, relatives, and neighbors also play an important role in providing cash credit when individuals are in urgent need of money.

These Cooperatives or Credit and saving associations (CSA) groups can borrow during a given loan disbursement cycle. In order to borrow, a member will present a proposal to the group, outlining what they intend to use the loan for, and how they will be able to repay it. For example, members might use the loan for agricultural production (Fertilizer or Improved seed purchase), to invest in petty trading or other income-generating activities. In principle, members will select the person with the most convincing proposal. However, it is also not uncommon for loans to be given to the person who appears to need it most, for example, to cover medical expenses, as long as the members are confident that the person can repay the loan. Penalties are imposed on members who fail to repay their loans within the specified time period, which is usually between 1-3 months typically meet twice a month, and each member will contribute a specified amount of money to a savings pool, and a smaller amount to a social fund. After a certain amount of capital has accumulated in the savings fund, members can take out loans, which they are obliged to repay with interest within a certain time period. Group members will collectively agree upon the contribution amounts, interest rates and repayment periods. However, the approach is meant to be flexible and in principle, individuals can contribute whatever amount they can afford. In such cases, the amount they can borrow is proportional to their accumulated savings.

In some cases, a group may also decide not to disburse loans on an individual basis, but to collectively invest their savings in a group business venture and then share the profits. After a certain period, usually between 9-12 months, the group will share the savings and any interest accrued with all the members. As such Village Savings and Loan Associations (VSLA) members can earn dividends on their savings whether they borrow from their group fund or not.

The challenges involved in providing microfinance for the poor are related to low demand, particularly in areas where potential clients are unfamiliar and suspicious of the microfinance products being introduced. There are also challenges relating to the cost of providing financial services to the poor, given that transaction costs are high in comparison to the returns that can be expected from poor clients. Essentially

MFI's have to be financially viable, and there is little incentive for them to invest in the poor and the Raya Azebo *Woreda* also 30% Muslim population and religiously use of this MFI is limited.

The logistic regression model result also shows that, though not significant, sex and educational status of the household heads has a positive coefficient which implies that male headed and literate households have a higher probability of acceptance of exclosure establishment and management than female-headed and illiterate households. In the same manner, training, the perception of land degradation, and slope of farmland are not significant in the model result but their positive coefficient indicates their positive contribution to acceptance of exclosure establishment and management in the area.

The number of livestock on acceptance of exclosure establishment and management was found to have a negative association, and significant at 0.05 level. The result implies all other variables remaining constant; increase in a unit of livestock would result in a decrease in the acceptance of exclosure establishment and management by the factor of 0.72. The negative influence might be explained that a large number of livestock needs a larger proportion of grazing lands than exclosures and farmers with a high number of livestock want to have a larger size of free grazing lands than that of exclosure.

Land degradation is sometimes taken as synonymous with soil degradation. Soil degradation commonly manifests itself through soil erosion and soil fertility decline (Alemneh *et al.*, 1997). In the strict sense of the word, however, land degradation is more than degradation of the soil (Woldeamlak, 2003). Likewise, farmers in the study perceive land degradation in its broader sense. These include soil erosion, soil fertility decline, and loss of vegetation cover and transformation of farmland to rocky bare land. Soil erosion causes a reduction in infiltration and water holding capacity of the soil as well as a loss of plant nutrients which ultimately results in low productivity (Carucci, 2003).

In fact, only a few farmers named a disadvantage of the soil and water conservation practices and exclosure establishment and the top cited reasons for negative impacts are the following. This was mainly due to the problem of time and labor for its maintenance. The regular maintenance of soil and water conservation is problematic; as they only have limited time and labor to do such work. Thus, they stopped applying soil and water conservation practices at some portions and only kept the area from any interference. Finally, few farmers had totally had a negative perception because the structures of soil and water conservation are a source of rodents for their farmland in the areas. Due to the very small number of answers, general statements cannot be made.

Due to exclosure establishment, the advantages most often mentioned are decreasing in soil erosion; increase crop production/yield and soil fertility; and no expansion of farmland towards conservation areas. The advantage, soil erosion decreasing was mentioned by farmers by almost 93%. Further, the soil fertility and the crop production/yield are connected directly; this can be stated that after making the soil more fertile, the harvest will increase. So may be in few years, even more farmers would say that the harvest increased through the restoration of degraded lands since its implementation. The soil erosion decrease advantage mentioned by them also help one can assume that the management practices and exclosure establishments in the watersheds were successful. Without increasing the grazing land size livestock production is going with fodder and grass supply products were also a sign of the success of the exclosure management.

The most frequently quoted reason of exclosure establishment is to reduce soil erosion. In fact, this is the most mentioned reason for sustainability of exclosure establishment and management practices at all levels. Some respondents have believed that exclosure in the watersheds will improve the soil moisture of their farm's plots in the leveled grounds of the lower catchments. Others were influenced by increased both yield and soil fertility. The reasons behind the adoption of soil and water conservation measures were similar with the mentioned expectations of sustainability of exclosure establishment and management practices. Still, reduced soil erosion and improvement of soil fertility were the two major expectations in adopting of soil and water conservation and sustainability of exclosure establishment and management practices.

On the other hand, farmers expected that sustainability of exclosure establishment and management practices could help their farms to generate more variation or sources of livelihood. It was observed that most of the expectations mentioned can only be acquired within a long-term period of time such as prospects related to developing to bench terrace, soil fertility improvement, soil loss reduction and increase yield. Immediate benefits were not expected that much from the soil and water conservation practices and exclosure establishment. Farmers' expectations of long-term benefits perhaps have motivated them to try and continuously adapt the soil and water conservation and exclosure establishments.

Majority of the respondents claims that exclosures have no damaging effect on their cultivated farms. Perhaps this served as one of their motivation to continuously adapt the soil and water conservation practice at high intensity. Only a few farmers mentioned some negative effects of exclosure establishment. Few reasons mentioned here are that's of wildlife shed after the exclosures have damage on our livestock and farms, and limitation of the free grazing areas.

Nevertheless, despite the problems experienced by local farmers, most were encouraged by restoration of degraded lands by exclosure as well to apply soil and water conservation practices both on exclosures and their farms. Yet for them, the gains are far more worthy than the undesirable characteristics of the soil and water conservation.

Concerning the restoration of grazing lands and exclosure establishment, FGD members said that grazing has "decreasing" and in some areas "no change". Still, there is a difference in the different *Tabias.* For example, in the *Tabia* of Hadinet in Atsbi *Woreda* and Hawelti of Raya Azebo *Woreda* responded that grazing lands are not improving; instead, it is getting lower from time to time. The focus group discussion participants from the *Tabia* of Genete and Kihen confirmed that even though grazing land is small, the area is protected from animal and human intervention and that the people also participated massively in public soil and water conservation. However, the limited sizes of free grazing lands were open usually.

The amount and duration of yearly rainfall was an important factor that determined the duration of opening and closing

periods of the free grazing lands, in Kilte Awelaelo and Atsbi *Woreda* the opening and closing periods of the free grazing lands are during the month of Meskerem (September), while in Raya Azebo *Woreda*, especially the Mehoni Tabia where the grass production was the highest and the topography is plain, so it has five to six opening and six to seven closing months.

Fuelwood is one of the critical problems in all *Tabias* in the study area. People usually use animal dung and few eucalyptus trees grown on their private plots of land. The reason why wood production has decreased, while the number of trees has increased, is that wood distribution from exclosures is yet not allowed and a limited usage is allowed. After soil and water conservation was introduced, at least, the degradation and depletion of the natural resource bases are minimized. All respondents agree that, had it not been for soil and water conservation, conditions would have worsened and hence people and animals would not have survived. The survey results indicated that soil erosion and flooding have decreased.

From the analysis, it was possible to understand that in all *Tabias* communities have a similar perception about the benefits of exclosure establishment and activities on the soil and water conservation. There is a common consensus about the positive benefits of exclosure establishment. For example, one of the study sites named Haikmeshal is found in a lower slope and is surrounded by chains of mountains; it is exposed to flooding but now, thanks to a massive soil and water conservation practices, the area is fully protected from flooding.

Moreover, as participants confirmed, new springs have emerged and a discharge from the existing ones improved, new irrigation schemes have been started to be developed with the availability of water, biodiversity is regenerating and wild animals are emerging, and local-climate around the treated watersheds is improving. This result is supported and has been noted in terms of soil conservation, water infiltration, crop yield, biomass production, groundwater recharge, and flood hazard prevention (Berhanu *et al.,* 2003; Belete, 2003).

This observation is further substantiated by field investigation in Tigray: a photographic record over 30 years, which show the status of natural resources since 1975. The study demonstrates that in Tigray, sheet and rill erosion rates have decreased, infiltration and spring discharge are enhanced, and vegetation cover and crop production have improved. The rehabilitation was due to both the improved vegetation cover and to the implementation of physical conservation structures. Similarly, overall land management has improved in 85 % of the analyzed landscapes (Nyssen *et al.,* 2007). However, maintaining and enhancing farmers' participation is obviously a continuous challenge. Thus, it implies that sustained motivation will determine the success or the failure of any future restoration program in Tigray (Nyssen *et al.,* 2009; Reubens *et al.,* 2011). For this reason, community mobilization for collective action was considered an important intervention aimed at restoring the productive capacity of the land as water was conserved and soil loss was kept minimal.

V. Conclusion and Implications

The purpose of this study was to investigate the factors that influence the sustainability of exclosure establishment and management practices in the highlands of Tigray. The land users' understanding and perception of exclosure establishment and management practices are important when sustainable natural resources management options are considered. A large-scale mass mobilization undertaken for more than three decades in soil and water conservation practices has minimized flooding and thus soil erosion or degradation both in the farmlands and in exclosures, although it was less practiced in on-farm conservation compared to the exclosures.

Results of the study also indicated that perception of farmers towards benefits of conservation attempts in changing and hence important contribution towards livelihoods has been recorded. However, the benefits are not yet adequate. Therefore, if the people of the study areas are to continue with the community-based soil and water conservation practices, they have to realize tangible net benefits in terms of production and income as well as environmental improvements. The study revealed that the landless people have tackled not only land degradation by applying various hillside conservation methods such as soil/stone bunds, trenches, and tree plantation but also, creating alternative income through different activities such as the sales of honey production and growing vegetables.

Determinants of farmers' sustainability of exclosure establishment and management practices were assessed. Any further improved conservation technology initiative should aim at enabling local farmers to exclosure establishment and management practices conducive to increasing income as well as to enhancing soil conservation. The empirical results from binary logistic regression model showed age, tenure, and off-farm activity were positive and significant predictors of sustainability of exclosure establishment and management practices while household size, farm size, distance and number of livestock have a negative effect on exclosure establishment and management practices in the study area and they were not significant except livestock number. These findings strengthen the fact that in order to achieve sustainable exclosure establishment and management practices, institutional and economic factors should be given special attention.

Thus, in order to achieve sustainable exclosure establishment and management practices, institutional and economic factors should be given special attention. Extension workers or development agents are urgently needed to give education for farmers to maximize public awareness for the effective and sustainable use of soil and water conservation practices, and the availability of credit is not a solution by itself unless it is accompanied by better rearrangement on repayments. Farmers should be given repayment grace period in times of complete crop failure. There is a need for sensitization of farmers to benefit formal training of all community in exclosure establishment and soil and water conservation technologies and capacity building of farmers in other livelihood areas to reduce the burden on natural resources.

It is frequently argued that various personal, economic, socio-institutional and biophysical attributes have influential roles in farmers' decisions about the sustainability of exclosure establishment and management practices in different areas of Ethiopia. From this analysis, the variables age, household size, and literacy status of the household head have variations. Tenure security and credit access were also found to be important as an

explanation for the positive answer shown by most of the farmers.

Exclosure establishment and management are perceived and valued as positive by all farmers. The farmers point out a lot more advantages than disadvantages of exclosure establishment. However, they also expressed concerns about the negative impacts of exclosures such as reduction of fuelwood and shortage of grazing areas for their livestock. These concerns should be addressed because the farming system in the study area is labor intensive and involves the use of livestock traction power, livestock production is an important source of income and wealth, and the local communities use fuelwood to meet their household energy demands. Thus further expansion of exclosures in the near future could face resistance from local communities in case the direct and indirect benefits of exclosures to the local communities will not be transferred into payments for the respective ecosystem services.

The most important advantages of exclosure establishment were soil fertility increase; increase crop production/yield; erosion decrease; increase fodder and grass supply, and decrease flooding. According to the farmers, the most limiting factor in terms of exclosure establishment and management practices are time and labor intensive.

Off-farm income is low (most of them engage as daily labourers and in safety net program) and the farmers dominantly rely on agriculture as means of their livelihood. However, the low annual farm income has forced some of the households to engage in off-farm activities is due to small land size and fragmented plots of land. The implication is that farmers are discouraged to rely on farming, which in turn may result in farmers to under-invest in soil and water conservation practices on their farmlands.

As land degradation is severe in the highlands of Ethiopia, applications of soil and water conservation practices are a must. As a result, there are many efforts made by the government for rehabilitation of natural resources in particular of soil and water conservation practices, such as experience sharing of farmer's field-based, giving of workshops for farmers, and agricultural days. Therefore, to promote conservation efforts, policies should identify social and economic factors with respect to soil and water conservation and integrate them into the plans, according to the results of the analyses the most important are resources availability and household characteristics. Moreover, conservation should, therefore, be linked to subsidies if possible and credit facilities for those poor farm groups for a long duration. Any effort to achieve sustainable exclosure establishment and management practice should enhance both farm and off-farm income in a way that reinforces each other. Moreover, exclosure establishment and management practices should not only be aimed at minimizing soil erosion but should also cover other household objectives, such as the improvement of soil fertility, yield increase and fodder for animals.

Exclosure establishments and SWC practices in Tigray result in multifunctionality of the land and the livelihood of the community, although inadequate compared to the level of the degradation and depletion of natural resources and the low level of the livelihood of the community. There are certain major observable improvements after the implementation of integrated watershed management such as reduced soil erosion and increased soil moisture availability which could be explained by the increase in crop production; increased groundwater recharge; reduced sedimentation and run-off problems in the lower parts of the watershed; stabilized gullies and river banks; rehabilitation of degraded lands and improved ecological balance; and introduction of modern beehives and increase in honey production. However, the benefits are not yet adequate.

Communities of the study areas are facing difficulty with health hazards associated with community work because of the mountainous and hilly nature of topography in Tigray. This is worrying and can affect the contribution of labor to community work. Free grazing is also another major factor causing the destruction of the physical and biological conservation (both stone and soil bunds) works and the conflicts over free grazing lands. Thus, restricted grazing and resolving the conflicts over free grazing lands were critical for the sustainable management of free grazing lands. Thus, the local leaders should provide logistics associated with health care when an accident occurs, give accreditation to informal institutions, in order to empower the local community and minimize the conflicts among the society in relation to free natural resource management. Last, from this study raise policy issues that awareness creation among respective stakeholders would be important in the attempt to implement soil and water conservation practices and community natural resources management in sustainable ways.

Thus, in order to make the existing community natural resources management efficient and self- sustaining, it requires intervention by local administer in the study areas, such as training by extension workers are right away required to change the perception of farmers about the benefits of conservation and give information the present successful existing of exclosures via sitting best models in the study areas as well as in the region, so this can probably be used to obtain support for the local population. The local administer should also provide some logistics associated with health care when accident occurs mainly in a large-scale mass mobilization of soil and water conservation practices, and the local leaders should give accreditation to informal institutions, in order to empower the local community and minimize the conflicts among the society in relation to free natural resources management. Based on the study findings, the following recommendations were drawn.

Focusing on environmentally friend activities - since all economic activities could not affect the natural regeneration, those activities should be carefully studied and encouraged. The activities like beekeeping should be given attention and conditions should be facilitated in order to maximize the economic return. To fulfill this, the traditional way of beekeeping should be replaced by modern honey production. It is by assuming that, if the modern honey production is going to reduce the economic pressure on the population, the degree of impact on the natural forest will be reduced. Therefore, focusing on and encouraging such economic activities which are environmentally benign is very important.

Resource managers, the scientific community, NGO's and local communities need to come together for participatory research and action-oriented management interventions. Also, they need to adopt a paradigm shift in the view of practicing an adaptive as well as a landscape management approach to conservation.

Before expanding the area covered by exclosures, it is crucial to consider forest management options such as enrichment plantation of indigenous woody species that can grow fast in exclosures to address the shortage of fuelwood and improve future ecological and economical benefits of the exclosures. As fuelwood shortages are one of the concerns for the negative impacts of exclosures raised by the local communities, enhancing fuelwood supply from exclosures could reduce resistance from the local communities while planning to expand the area covered by exclosures. Moreover, transferring the direct and indirect benefits of exclosures into payments for the respective ecosystem services could increase the interest of the local communities on exclosures.

Special attention should be given to solve the shortage of grazing land due to exclosure so as to encourage community's interest in expanding and managing exclosure practices in their locality.

In the area due to small farm size and fragmented plots of land households are characterized by food insecurity. Any effort to achieve food security should enhance both farm and off-farm income in a way that reinforces each other, extension workers or development agents are urgently needed to give educate the farmers to maximize public awareness for the effective and sustainable use of exclosures and management practices, and the availability of credit is not a solution by itself unless it is accompanied by better rearrangement on repayments.

Farmers should be given repayment grace period in times of complete crop failure. Credit access should not also associate with the wealth status of farmers such as oxen and landholdings to address the poor to participate in the application of modern technologies.

Finally, there is a need for sensitization of farmers to form groups to benefit formal training of all community in the exclosures and soil and water conservation technologies and capacity building of farmers in other livelihoods areas to reduce the burden on natural resources.

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