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COLLECTIVE ACTION, PROPERTY RIGHTS AND BAMBOO DEFORESTATION IN BENISHANGUL-GUMUZ REGION, ETHIOPIA

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ABSTRACT

Benishangul-Gumuz Region is known as the land of lowland bamboo accounting for about 56 percent of bamboo forest in Ethiopia. However, bamboo deforestation has become a serious problem threatening the biodiversity and the people who depend on bamboo income. The purpose of this study is, therefore, to examine perceptions of smallholder farmers toward bamboo deforestation, identify the driving forces behind bamboo deforestation and evaluate the roles of collective action and property rights in overcoming the problem. Data were obtained from a sample of 384 households selected using multistage stratified random sampling techniques. Factor analysis, descriptive statistics and econometric were employed to estimate households' perception, interdependence of perceived effects of bamboo deforestation, intensity of deforestation and participation in collective action, respectively. The study revealed that farmers in the study area participate in three types of collective forest management initiatives: participation in conservation of the forest, participation in hazard management and joint participation in bamboo conservation and hazard management. These strategies were found to be helpful in reducing the rate of deforestation. The factor analysis identified 3-latent factors (perceived economic, environmental and social effects) of bamboo deforestation and illustrated that an array of impact indicators exist. The SUR model estimation results of households' perception showed that economic, environmental and social effects of bamboo deforestation were positivity interdependent, and influenced by four common underlying variables. Tobit regression results indicated that proximity from bamboo area, duration in the study area, knowledge of the resource condition and participation in collective action played positive role in curbing the intensity of bamboo deforestation. Multinomial probit model results revealed that age of the household heads, household size, settlement condition, access to *information, strength of social capital and networking, and secure property right positively influence households participation decision in collective action. Analysis of bamboo property rights change and effects of the change on bamboo forest revealed the existence of intensive competition between large-scale investors, government organizations, bamboo smugglers and the local communities over bamboo forest. The result showed that political factors seem to be the main driving force behind property rights change. Transferring traditional bamboo use rights from local community to the private investors have undergone some adverse effects including ownership disputes, occurrence of frequent bushfire and bamboo forest degradation. The findings generally indicate the need to strengthen forest tenure rights and collective action institutions to manage local bamboo resources effectively.*

Keywords: Bamboo deforestation, household perception, collective action, property rights, Ethiopia.

1. INTRODUCTION

Ethiopia stands first in bamboo potential in Africa comprising 67 percent of the continent's bamboo forest area (LUSO Consult, 1997; Kassahun, 2003). Bamboo is linked with Ethiopian rural people's life for centuries. It plays important roles in improving the livelihood of both rural and urban population. Particularly, rural and poor people depend on bamboo as major sources for food, medicine, fodder, fiber, household utensils, furniture, and fencing and construction materials. Bamboo provides off-farm income to a large part of the rural population in Ethiopia and accounts for a large share of household income. In the context of Benishangul Gumuz Region, bamboo is a historic economic commodity. The region accounts for about 55 percent of the lowland bamboo in the country. Yigardu (2014) indicated that the household contribution of lowland bamboo including both consumption and sale is more than 10,000 ETB for the year 2014. Bamboo is used for housing, fencing, kitchen utensils, baskets, mats, and agricultural implements and shoots for food (Ensermu *et al.*, 2000; Kassahun, 2000; Million, 2009; Demissew *et al.*, 2011; and Kibwage and Misreave, 2011).
However, as part of deforestation and land degradation are still pressing issues in Africa, massive bamboo depletion has been taking place in many parts of Ethiopia. For example, in the 1960s, the total area of bamboo in Ethiopia was estimated at 1.5 million hectares, which include 1 million hectares of lowland bamboo and 0.5 million hectares of highland bamboo. In 1997, global forest resources assessment attested that Ethiopia possessed only about 0.8 million hectares of bamboo resources (FOA, 2010). At present, approximalty less than 0.83 million hectras of lowland bamboo have remained in the country (INBAR, 2011).

The sizes of bamboo forests have been shrinking due to human influences that have gradually contributed to degradation of lowland bamboo. The bamboo resources of the region are depleted because of several factors. These factors include bamboo clearing for crop production purposes, forest fires, absence of secure land use policy, effects of agricultural expansion and intensive resettlement programs (BGRFSSR, 2004), land use changes. Socio-economic factors are contributing to resource scarcity and conflicts on bamboo resource. In addition, th lowland bamboo has been under high pressure due to lack of knowlege on resource use. Yet, its effect on farmers' livelihood is actually not well understood. This demands raising the awarness of local communites, managers and policy makers for efficient utilization and conservation of the exsiting natural resource endowment. Scholars identified two broader causes of deforestation: underlying causes of deforestation (direct causes) and immediate causes of deforestation (indirect causes) (Angelsen and Kaimowitz, 1999). The underlying causes of deforestation include population growth, economic growth, income level, technology, foreign debt and trade liberalization and devaluation. The immediate causes of deforestation comprises factors such as agricultural output prices, agricultural input prices, off-farm wage and employment, credit availability, property rights, land tenure security, timber price and forest fire. In a similar way, Kant and Redantz (1997) classify the causes of tropical deforestation into two categorical levels: the first-level (direct) causes and second-level (indirect) causes.

On the other hand, Angelsen and Kaimowitz (1999) argue that the varied relationship between deforestation and multiple causal factors without any distinct pattern. For instance, consumption and exports of forest products and changes in land use for cropland and pasture are independent (Zikri, 2009). Geist and Lambin (2000) further grouped direct causes of tropical deforestation into three aggregate forms (agricultural expansion, wood extraction, expansion of infrastructure) and five broad categories of underlying driving. Dolisca (2005) identified commercial logging, illegal export, infrastructure and industrial development and population growth and rural poverty as causes of forest degradation. They refer to these underlying factors as demographic factors (human population dynamics, sometimes referred to as population “pressure“ (Kant and Redantz, 1997), economic factors such as commercialization, development, economic growth or change (Yiridoe and Nanang, 2001, Susandi, 2004), technological factors (technological change or progress), policy and institutional factors such as change or impact of political-economic institutions, institutional change (Amin and Chipika, 1995), and a complex of socio-political or cultural factors (values, public attitudes, beliefs, and individual or household behavior).

Despite the fact that bamboo offer extensive products and services, there is scanty information on the socio-economic and institutional factors driving human disturbances in the bamboo forest. Technical and mechanical characteristics bamboo tree have been adequately studied in Ethiopia (INBAR, 2011). These studies indicate that, there is a knowledge gap on the anthropogenic factors that are causing deforestation. This study analyses the factors influencing deforestation in Bebishangul Gumuz Region. Hence, the information presented in this paper is relevant for future bamboo researchers and decision makers dealing with sustainable management of natural bamboo resources

2. RESEARCH METHODOLOGY

2.1. Description of the Study Area

Benishangul-Gumuz National Regional State (BGNRS) is one of the nine regional states established in 1995 by the new constitution of Ethiopia that created a federal system of governance. Previously the southern part of BGNRS belonged to Wollega while the area above the Abay River was under Gojjam province. The region is located in the western part of the country between 09.17^0-2.06^0 North latitude and 34.10^0-37.04^0 East longitude. The region has international boundary with the Sudan and south Sudan in the West and is bordered by the Amhara region in the North and Northeast, Oromiya in the Southeast and South. The regional capital, Asossa is located at a distance of 687 km west of Addis Ababa, the capital city of Ethiopia. The region has a total area of approximately 50,380 km^2 with altitude ranging from 580 to 2,731 meters above sea level (m.a.s.l.). BGR is divided into 3 administrative zones and 21 '*Woderas*'. Based on projected data, the current total population of the region is about 975,988 people in 2013 (CSA, 2013). Population density is sparse with a regional average of 14 people per square kilometer. The smallest population density is estimated at 3 persons per square kilometer and recorded in Guba, Yaso, Dangur and Sirba Abay *woredas* while the largest population density is estimated at 62 people per square kilometers, which are recorded at Assosa, Mandura, Bambasi and Pawi districts (CSA, 2007). Agricultural land is abundant with a mean land holding size of 3.7 hectare a household.

The average number of family members of a household in the region is 6.7. Of the total population, 92.2 percent lives in the rural areas and 7.8 percent is urban population (BGRFSS, 2004). Diverse ethnic groups inhabit in the region, five of which are indigenous. Based on their languages, "the five indigenous[1]" ethnic groups in their order of population number are Berta (26.7 percent), Gumuz (23.4 percent), Shinasha (7.0 percent), Mao (0.6 percent) and Komo (0.2 percent). Significant numbers of Amhara (22.2 percent), Oromo (12.8 percent) and others (7.1

5Indigenous ethnic groups refer to the five ethnic groups in the region. Berta, Gumuz, Shinasha, Mao and Komo people. According to the Ethiopian 1995 new constitutions, the responsibility to manage the region was given to these ethnic groups.

percent) also reside in the region. The religious affiliation of the population of the region constitutes Muslims (44.1 percent), Orthodox Christian (34.8 percent), traditional religions (13.1 percent), Protestant Christian (5.8 percent), Catholic (0.5 percent) and others (1.5 percent).

Agro-ecologically, it is classified into *Kolla* about 75 percent (lowlands below 1500 m.a.s.l.), *Woina Dega* about 24 percent (midland between 1,500-2,500 m.a.s.l), and *Dega* about 1 percent (highland above 2,500 m.a.s.l.). The region is characterized by a monomodal rainfall. According to the classification of rainfall regimes given by the National Meteorological Service Agency, Benishangul-Gumuz region is characterized by a wet season from April to October. Annual rainfall varies from 800 to 2000 mm. The temperature reaches a daily maximum of 20^0C to 25^0C in the rainy season and rises to 35^0C to 40^0C in the dry season. The minimum daily temperature ranges from 12^0C to 20^0C, depending on season and altitude. The hottest period is from February to April.

Benishagul-Gumz region is endowed with fertile land suitable for high value crops, livestock, apiculture, fishery, minerals like gold and marble, and economically important trees like bamboo and incense. Livestock production is important means of livelihood in the region next to crop production. It is important sources of food, cash income, and assets to buffer against shocks. In general, a mixed farming system, involving both crop production and livestock rearing activities, is the dominant type of production system. According to the CSA (2007), agricultural survey, the region had about 0.4 million cattle, 0.3 million goats, 0.1 million sheep, and nearly one million poultry.

In terms of land-use patterns, the region's landmass is predominantly comprised of bushes and shrubs that constitute 77.4 percent while forestland constitutes about 11.4 percent. Further, cultivated land, grazing land and marginal land constitutes about 5.3 percent, 3.2 percent and 2.3 percent, respectively. The vegetation in the area is classified into eight types, namely: dense forest, riverine forest, broad-leaved deciduous wood lands, acacia woodland, bush land, shrub lands, boswellia wood land and bamboo thickets (INBAR, 2010). About 0.2 hectare (89 percent) of the total land of the region is covered with vegetation. Evidences in the region revealed that the lowland bamboo forest grows between 1000 and 1800 m.a.s.l and on poor soil in dry vegetation formation (LUSO CONSULT, 1997). It also tolerates poor rocky soil, in erratic annual rainfall even down to about 600 mm and in high temperature of above 35°C. The highland bamboo grows in altitudes from 2.200-3.500 m.a.s.l and the lowland bamboo between 700-1800 m.a.s.l (Liese, 1989).

2.2. Sampling Technique

This study employed both purposive and stratified multistage random-sampling technique in selecting 384 sample households. In the first stage, all the 21 *woredas* in the region were categorized into two groups: *woredas* with bamboo forest (13 *woredas*) and without bamboo forest (the remaining 8 *woredas*). *Woredas* with bamboo resources were also classified into two as *woredas* with lowland bamboo and with highland bamboo based on bamboo species found in their respective *woreas*. Study conducted by INBAR (2010) identified two bamboo species as lowland bamboo (*Oxytenanthera abyssinica*) and highland bamboo (*Arundinaria alpina*) in the region. Based on this, lowland bamboo forest is identified in 11 *woredas*. The districts with lowland bamboo resources situated in two agroecologies *lowland* and *midland* were considered. The rationale for stratifying *woredas* based on agroecology is attributed to differences in terms of bamboo resource endowments owing to human and natural factors. Consequently, Assosa and Bambasi were selected from midland and Homosha and Guba *woredas* from lowland agroecologies. In the second stage, *kebeles* (the lowest administrative unit) were classified into two groups: *kebeles* with and without bamboo resources. Subsequently, a total of 11 *kebeles* having bamboo resources were purposively selected. The selection of *kebeles in Assosa and Bambasi* was done by taking into consideration the fact that these sample *kebeles* possess wider bamboo forest, but are known for high population pressure and high bamboo deforestation. Moreover, experts, NGOs, and regional authorities' opinions were considered in selecting the *kebeles*. Accordingly, three *kebeles from* Assosa *woreda* and three *kebeles* from the Bamabasi *woreda* were purposively selected. Finally, three *kebeles* from the *Homosha wored* and two *kebeles* from Guba *woreda* were purposively selected. The selection took into consideration illegal bamboo export and high rate of bamboo degradation. Thus, a total of eleven *kebeles* were purposively selected. In each *kebeles*, sample households were selected by considering probability proportionate to size of the population. Accordingly, a total of 384 sample respondents were selected in this study.

2.3. Measurement and definition of variables

The annual bamboo forest area cleared in hectare per household within five-year (2008/9-2012/13) time periods was estimated using proxy variable. The estimation relies on the difference between household's farm size measured in 2009 and 2013, respectively. This is because agricultural land expansion is estimated to be the proximate driver for around 80 percent of deforestation worldwide (Kissinger *et al.*, 2012). The last five year time period was used as a reference because of two reasons: (1) in the last five years, Ethiopia has achieved substantial and sustained economic growth and development (MOFED, 2011) which might have played a significant role in increased deforestation (Wolfersberger *et al*., 2013). (2) Since the five year time period is reasonably short, it helped the respondents easily remind their previous land holding (*e.g* plot size) with no difficulty. In a related study, Wyman and Stein (2010) used a five year data (2000-2004) to estimate deforestation using remote sensing and household survey data in community Baboon Sanctuary of Belize.

In this study, socioeconomic, demographic and institutional factors that influence bamboo deforestation were estimated using Tobit model. As noted in Tobit analysis, the regressand can assume a value of zero. This is assumed because some farmers actually do not deforest any forestland during the five years study periods. Thus, compelling application of Tobit regression. The stochastic model underlying Tobit is expressed as follows.

$$y_i^* = X_i \beta + \mu_i = 1, 2, 3, ., n \qquad (2)$$

$$y_i = \begin{cases} 1 & if\ y_i^* > 0 \\ 0 & if\ y_i^* \leq 0 \end{cases} \qquad (3)$$

where, n is the number of observations, μ_i is assumed to be independent and normally distributed with $N\ (0,\delta^2)$ and β is a vector of unknown coefficient parameters to be estimated. y_i is annual forest area cleared in hectares as a proxy for rate of bamboo deforestation, y_i^* is unobservable latent variable and X_i are vectors of explanatory variables.

Table 1. The definition and measurement of all explanatory variables

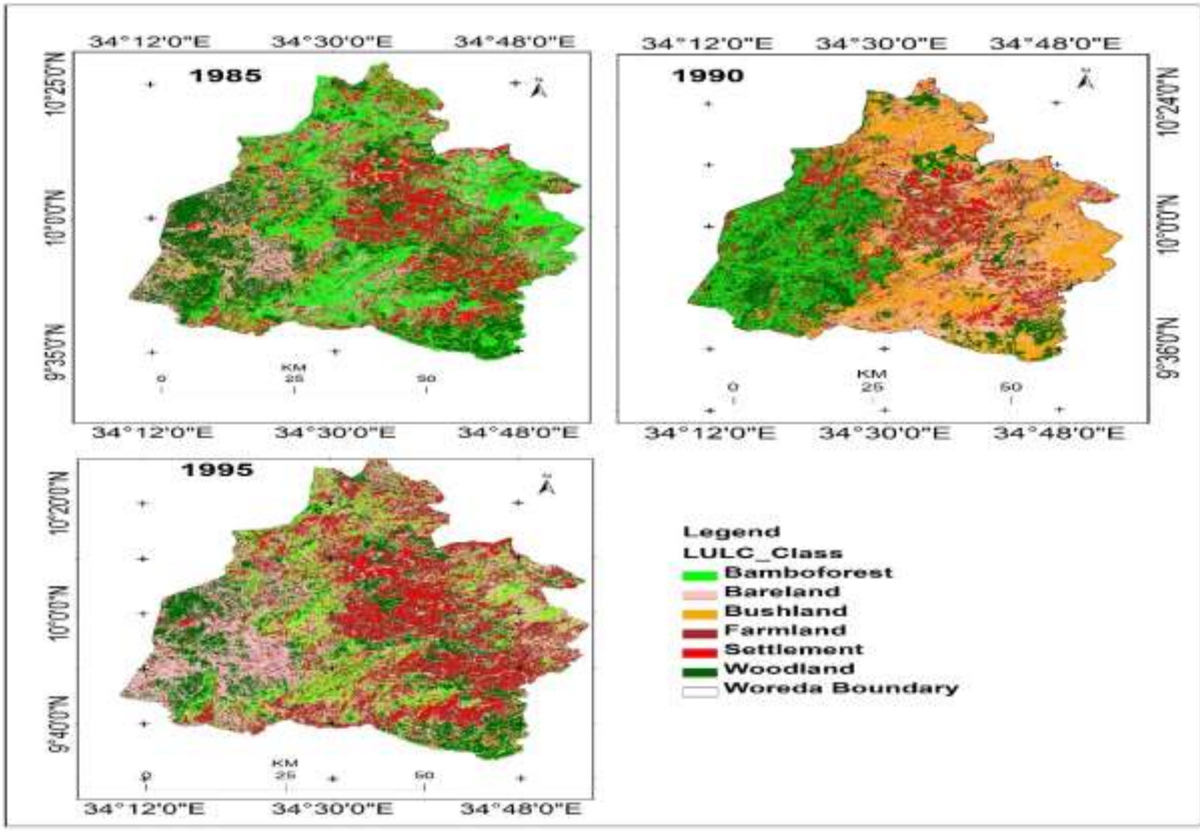
Varables	Definition and measurements	Expected sign
Sex of the heads	Sex of the household head (1=male, 0=female)	-
Age	Age of the household head (years)	+
Household size	The total number of household (continuous).	+

Education	1 if households head literate ; otherwise,0	-
Ethnicity	Ethnicity of household head (1 if Berta; 0, otherwise).	+
Credit	1 if the household head obtained credit, 0 otherwise (dummy)	-
Income	Households' annual income per capita (ETB)	-/+
Land holding	Total land holding in hectare	+
Off-farm income	Total income from non-agriculture activities (continuous)	-
Wealth	Welfare index (1 if the is poor, 0 otherwise)	+/-
Livestock	Total number of livestock holding in terms of TLU.	+
Factory establish	Households' attitude towards of bamboo PLC (1 if support, 0 otherwise)	+/-
Benefit	Perceived bamboo forest benefits by households head (Ranked on scale)	+
Price of bamboo	The value of a bamboo stand sold at the local market	-/+
Distance	The number of hours a household head has to walk to harvest bamboo.	-
Shifting	Participation in shifting cultivation by HH head (dummy)	-
Fire	Households perception that wildfire is a problem (1=yes,0=no)	-
Settlement	Household's settlement condition (1=native ; 0= settlers)	-
Property right	Households perceive secure forest tenure rights (1=yes, 0=no)	+/-
Heterogeneity	Households' receptions that income heterogeneity is a problem (1 =yes, 0=no)	+/-
Group size	Perceptions that large group size a problem (1 =yes, 0=no)	-
Trust	The overall trust index (ranked on scale 1 to 4)	+
Network	Relation of bamboo users (1 positive, 0, otherwise)	+
External support	Receive technical assistance from NGOs (1 if available, 0, otherwise).	+

3. RESULTS and DISCUSSIONS

The GIS result shows general decline in the natural forest cover for last two decades. The study has made use of three sequential satellite images (1985, 1990, and 1995) and GIS technologies in combination with ground verification. The analysis detected six major land use types in bamboo forest. These classifications were: woodland, bamboo forest, bush land, bare land, farmland and settlement. Previously bamboo forests occupy the highest estimated areas. Bamboo forest is found to be the most shrinking land use type in the area. It reduced by 53.9 percent between 1985 to 1995. It shrank at the rate of 9.07 percent per year from 1985 to 1990 and 1999 to 1995, respectively.

Figure1. Land Use land covers change



The results of the Tobit regression analysis for identifying the factors affecting bamboo deforestation are presented in Table 2 below. Prior to model estimation, the nature and distribution of error term for the dependent variable was tested. The standardized normal probability plots for the error term (which capture random influences on the relationship) were found to be linear, indicating constant and normally distributed residual. The result implies that the model passes the test for homoscedastic variance, which is one of the caveat assumptions in cross-sectional survey study. Fourteen explanatory variables that had correlation with the dependent variable were used in the model. The result shows that eight covariates significantly affect the intensity of bamboo deforestation at different significance levels. The predicted intensity of bamboo deforestation was 0.158 hectare, implying that approximately a household deforest about 23.58 percent of his total land size between 2009 and 2013 years, ceteris paribus.

Table 2. Determinates of bamboo deforestation

Variables	Coefficients	Standard error	Marginal Effects
Sex of a household head	0.190*	0.059	-0.109

Educational status	-0.032	0.052	0.031
Household size	0.004*	0.002	0.004
Access to ox	0.110*	0.059	0.110
Distance to bamboo	-0.010*	0.006	-0.010
Duration in a resident	-0.105**	0.053	-0.105
Off-farm income	0.027	0.021	0.027
Poverty status	-0.117	0.088	-0.118
Experience in shifting cultivation	0.167***	0.039	0.167
Perceived bamboo deforestation	0.016*	0.009	0.016
Collective action	-0.032*	0.017	-0.033
Property rights	-0.125	0.089	-0.125
Knowledge on resource condition	0.093	0.061	-0.105
Dependence on bamboo	0.115	0.109	0.115
Constant	0.119	0.307	
Sigma	0.462	0.018	

Source: Model output

The relationship between sex of the household heads and bamboo deforestation was found to be positive and significant at 10 percent level of significance. It was also consistent with priori hypothesis. A positive sign indicates that male-headed farmers clear more forest for various purposes as compared to their female counterparts. Our experiences show that male-headed households play many livelihood activities that lead to deforestation than the female. These include harvesting of bamboo culm for firewood, expanding farmland, collecting bamboo for construction material and the like. Keeping all other variables constant, the marginal effect result shows that male-headed households increase the intensity of bamboo deforestation by 10.9 percent. A study that explored the causes of deforestation in Sumatara has reported similar result (Suyanto and Ostuka, 2001).

Household size determines per capita collection and utilization of bamboo culm and, therefore, influences bamboo forest adversely. From the Tobit regression model, household size appears to have a positive effect on bamboo deforestation. This implies that a unit increase in the household size increases the intensity of bamboo deforestation by 0.4 percent. The result also indicates that households with fewer family members are more likely to clear less bamboo forestland and vice versa. This finding deviates from the conclusion of several population theorists (Boserup 1965; Godoy *et al.*, 1998). According to Boserup's view, large households' size is not a threat to deforestation as they carry out intensive agriculture using agricultural technologies. However, our result implies that households with more members are more likely to clear forests for cultivation and put pressure on the bamboo forest. This finding is in line with the study conducted in Uluguru forest in Tanzania by Mtinje *et al.* (2007) who found that household size contributes significantly to degradation of forest resource. Another study conducted in Miombo woodlands in Kenya by Oyugi *et al.* (2007) identified farmland size as a cause for deforestation. Dolisca (2005) reaffirms that households with fewer members are more likely to clear less forestland than large family.

A statistically significant and positive coefficient of oxen implies that owning of oxen exacerbate bamboo deforestation. This may be because households who own oxen usually require a large piece of land to cultivate as compared to traditional hoe based farmers. Although an ox is an important source of livelihood income for rural people (eg. renting and sharecropping), possessation of an ox increases the probability of cultivating forest land. Farmers start to plough more land when they get access or rent ox which in turn facilitates the chance of forest clearance. Moreover, ox ploughed land is often cultivated up to three times, a factor that could completely uproot the bamboo forest. Regeneration of the uprooted bamboo usually took longer time as is the case in several areas of Assosa and Metekel Zones. In the study area, possessation of oxen is also a good indicator of wealth status among farmers. Households who own some oxen could obviously have more herds that directly affect bamboo forest through grazing. Similarly, removal of forest for cattle was reported as the leading cause of deforestation in the Brazilian Amazon. Particularly in Central and South America, expansion of pastures for livestock production has been one of the driving forces of destructions of forest resources (FAO, 2010). Participants of FGDs and the filed visit to some *kebeles* also reaffirmed that farmers who owned oxen and donkey are relatively rich farmers who clear more bamboo. Therefore, this finding tends to argue that having oxen in the study area aggravates bamboo deforestation. However, it should be noted oxen ownership was not necessarily a cause for deforestation as there are farmers who cultivate non forest areas.

Shifting cultivation was identified as one of the principal causes of bamboo deforestation in BGR. The relationship between shifting cultivation and bamboo deforestation was found to be significant at 1 percent. This implies that households who carry out shifting cultivation clear more bamboo than others. The finding validates the hypothesis that shows positive relationship between shifting cultivation and bamboo deforestation. In the study area, small-scale slash-and-burn farmers often clear bamboo forest for growing crops. And these farmers gradually end up with forest degradation and other environmental problems. That is, a unit change in the size of land retained due to shifting cultivation by households would increase the intensity of deforestation by 16.7 percent. Negative correlation between shifting cultivation and deforestation was supported by several studies in Asia, Africa and America (Brown and Schreckenberg, 1998; Brunner *et al.*, 1999; Rahman *et al.*, 2011; Seidenberg *et al.* 2003; Ickowitz, 2006).

Knowledge of bamboo forest contributes to local livelihoods and to rural income is critical to the collective action and becomes incentives for successful local forest management. Households who have adequate knowledge can easily cooperate and contribute to managing the bamboo resources, and hence reduce bamboo deforestation. In this study, perceptions of the household heads whether the natural bamboo forest around their area belongs to common-pool resources influences the bamboo deforestation at 10 percent significance level. The household heads who perceive bamboo forest as common-pool resource harvest more bamboo than those who perceive the natural bamboo as a state or private property.

Distance from respondents' home to the natural bamboo area has a negative regression coefficient. This implies that a unit increase in distance from the bamboo forest area decreases the likelihood of bamboo deforestation. This can happen because as distance from bamboo forest area increases, it constrains access to and use of the bamboo for the local communities. There is cost implication due distance they traveled to gather bamboo. Similar study conducted in Tanzania on Bereku forest reserve showed positive correlation between distance from homestead and woodland degradation (Giliba *et al.*, 2011). Likewise, a cross-sectional analysis on a highly heterogeneous forest community groups in Nepal evidenced inexorable negative association between proximity to the forest and forest degradation (Sapkota and Oden, 2008).

Duration in a particular residence is associated with less bamboo deforestation. The negative and highly significant coefficient for this variable shows that the longer households have lived in the particular village, the less likely they clear the bamboo forest. This may be because farmers who have lived for a longer period of time may have more secure rights to the natural bamboo forest than farmers who have lived for shorter period of time. Hence, farmers who have lived for longer period tend to keep bamboo for their children for future use. Moreover, farmers who have lived for longer periods in certain locality are more aware about the effects of bamboo deforestation. Those who have lived in a forest area may accumulate experience and knowledge on the causes and effects of bamboo deforestation. Based on their experiences, they can also provide better solution to the problem. During group discussion people who have stayed longer in an area (mainly elders) were found to provide clear historical causes and the multiple consequences of bamboo deforestation in their areas. Nduwamungu (2001) and Kajembe (1994) have observed similar results that people who have stayed longer in an area are likely to provide relatively reliable data on forest cover.

Bamboo deforestation is significantly and negatively influenced by collective action at 10 percent level of significance. The negative coefficient for this variable indicates inverse relationship between collective action and bamboo deforestation. This implies that farmers who participate in collective bamboo forest management are less likely to deforest bamboo as compared to the non-participants. The main reason for this fact was explained by FGD participants. They reported that households who participate in collective action could receive various types of training from NGOs such as INBAR and FARM Africa that might have assisted them to manage and properly utilize the bamboo forest. The marginal value shows that household head participation in collective action decreases the intensity of bamboo deforestation by 3.3 percent, ceteris paribus. This result is consistent with the findings of Berhanu *et al.* (2000) who identified that collective action is an effective means of redressing resource degradation in Tigray, Ethiopia.

It is interesting to note estimation results for certain variables that are not significant in this particular regression but for which strong predictions and arguments have been made in the literature. Despite their importance, education, property rights, income, wealth status and knowledge on resource condition did not significantly affect the pace of bamboo deforestation. Another interesting point is that wealth inequality is statistically insignificant with negative sign in the model estimation, suggesting that wealth heterogeneity across *woredas* had no significant effect on bamboo deforestation. However, income differences across households are found to have a positive effect on bamboo deforestation.

CONCLUSION

In Benishangul Gumuz Region, bamboo is considered as important as cash crop that it serves as immediate source of income for the poor. Despite its importance in farmers' day-to-day livelihood, bamboo forest degradation is a serious problem. Previous studies have examined the causes and processes of deforestation but these studies lack prioritizing and substantiating the effects of variables explaining deforestation. As a result, little is known about factors influencing the intensity of bamboo deforestation. This study, therefore, has estimated and identified driving forces of deforestation using econometric techniques. The result shows bamboo forest depletion is the current serious problem. Unless cautiously managed, the lowland bamboo may vanish in a shorter period of time because of manmade and natural factors. Some of them are related to socioeconomic factors while others are related with institutional variables. Based on the econometric result, we conclude that ownership of the resources livestock like oxen, shifting cultivation, farmers' knowledge on the resource condition cause bamboo forest degradation. Bamboo deforestation is negatively influenced by sex of the household heads, family size, proximity from bamboo forest area, residence duration in the study area, and participation in collective forest management. On the basis of the problem, collective forest management, secure property rights, proper forestry education and extension services should be promoted to minimize bamboo deforestation. Specifically, creating frequent awareness on wildfire protection, modern charcoal preparation and shifting agricultural production system is important. The other important issues are creating knowledge on the resource condition, creating trust and strong social bond among community members for effective and sustainable use of bamboo resources in the region.

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