PROPERTY RIGHTS AND CHOICE OF FUEL WOOD SOURCES IN RURAL ETHIOPIA

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Abstract

This study tries to examine the determinants of the choice of fuel wood sources in rural Ethiopia. Survey data collected from a sample of rural households in the East Gojam and South Wollo zones of the Amhara region of the country were used for the analysis. A discrete choice model has been employed to address the question of whether household's socioeconomic, environment and institutional variables affect the choice of fuel wood source in rural Ethiopia. We found that active local level institutions reduce dependency on community forests but positively correlated with the decision to collect from open access areas. The impact of tenure security was also included and found that it does not have any impact on household's decision to collect from private sources. Other household characteristics such as education, land size, number of livestock, and distance to forest were also included to examine their effect on the choice of fuel wood sources. Regional variation also matters for the choice of fuel wood sources which suggests that promotion of tree planting as a source of fuel wood should be accompanied by strong local level institutions. The study also conclude that that there is a need to bring the open access forests under the management of the community and increase the awareness of the locals (through education) on the use and importance of forests conservation.

Key words*: property rights, institutions, fuel wood, rural, Ethiopia.*

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I. INTRODUCTION

Like many other developing countries biomass resources such as fuel wood, dung and agricultural residues are the most important energy sources in both rural and urban Ethiopia. Over 90 percent of the country's total energy for household cooking is derived from biomass fuels, of which wood provides 78 percent (WBISPP, 2004). Rural household use of woody and other traditional biomass resources such as animal dung and agricultural residues accounts for almost 99.9 percent of the total rural population (FDRE, 1998).

The heavy reliance on biomass as energy source has resulted in serious degradation of natural resources such as forests. The deforestation rate in the period 1990 to 2000 was 40,000 ha per year (FAO, 2008). Fuel wood collection together with land clearing for agriculture, overgrazing and other factors such as fire contribute to the unsustainable and misuse of forests in Ethiopia. A shift to other alternative types of biomass energy resources will reduce pressure on forests and hence degradation of forests and forest resources. However, the use of dung and crop residues as a source of energy can reduce agricultural production and productivity, because agricultural residue and dung can also be used as fertilizer (Mekonnen, 1998; IEA, 2004).

In Ethiopia all the major forests are state owned, either at federal or regional states. However, governments in low-income countries including Ethiopia have neither the capacity nor the incentives to engage in reasonable levels of regulation, particularly when forests produce goods used mainly by local villagers (Mekonnen and Bluffstone, 2007). This implies that a de facto open access situation is created which will in turn aggravate the degradation and deforestation problems in the country. Recognizing the problem, there is a keen interest by the government to increase forest cover in Ethiopia. Federal level forest development, conservation and utilization policy and strategy have been approved in April 2007 (MoARD, 2007). One of the strategies mentioned in the document is to assist the farming community by providing seedlings, and grant certificates guaranteeing ownership to lands designated for forest development. Provision

of seedlings is part of the supply side strategies that the current government is using to reduce the pressure on forests and minimize problem of land degradation and its negative socioeconomic impacts particularly on women and children. However, this requires us to understand whether households reduce their demand for fuel wood from forests (especially open access forests) when private sources are available.

Another policy instrument to reduce environmental degradation in general and forest degradation and deforestation in particular, is to give tenure security to farmers. This is because land tenure insecurity will make small farmers uncertain about their own investments and promote unsustainable use of forests. For instance, the Ethiopian government started land certification program in the country's main regions in 2003 with the objective of reducing widespread tenure insecurity and its negative impact on investment (Deininger et al., 2007). Though mixed empirical evidences are available on the effect of this program on farmers' long term investment decision, little has been done on forestry issues.

There are different sources of fuel wood in the rural parts of the country. Private trees or farm forestry, forests (state or community), and market are the major sources of fuel wood and other forest products. The wood supply from trees outside forests is mainly fuel wood for the rural population, and wood for fencing and construction. Forests owned by the state are mostly operating as a *de facto* open access situation. We observe that there are some kind of efforts by the government to involve the local people in the management and use of forest and forests resources in some parts of the study areas. It is known as community forests which is the fourth alternative source of fuel wood for rural households. Thus, for the government to achieve its objectives of increasing the contribution of forests to the economic development of the country, maintaining the ecological balance and conserving and enhancing biodiversity through the sustainable utilization and development of forest resources, it is necessary to examine and understand the factors that drive rural households to collect fuel wood from a given source.

There exist some empirical evidences on the relationship between biomass production and property right regimes in developing countries. Some studies show a high correlation between specific attributes of fuel wood collection source such as area, species, distance to the forest, etc. and household's choice of fuel wood collection source (Jumbe and Angelsen, 2006). In Linde-Rahr (2003) study on Vietnam, there are four types of fuel wood sources: market, open access, plantation and natural forest. Linde-Rahr (2003), though his analysis did not consider the sources of fuel wood from private sources, found a strong substitution between open access and plantations forests as a source of fuel wood. Among the three types of fuel wood sources: customary, plantation and forest reserves, in Jumbe and Angelsen (2006) study, customary forests and forest reserves are substitutes, while substitution is more limited between plantation forests and forest reserves. The paper by Jumbe and Angelsen (2006) is written in contexts where the household extracts only from the forest. The role of private sources and market were not incorporated in to their analysis. The role of private trees, for instance, is examined by Heltberg e al. (2000), and Mekonnen (1998) in India and Ethiopia, respectively. Heltberg et al. (2000) found evidence in favor of the substitution between forest fuel wood and private energy (like dung, residues and trees from homestead). Based on the findings from India, Nepal, and Ethiopia, Cooke et al. (2008) indicate that private trees and trees in common forests substitutes in the production of fuel wood for rural households, at least for households with land.

The empirical evidences on this area are still scanty. To our knowledge, we found no empirical evidences that try to link households' socioeconomic and environmental factors to the choice of fuel wood sources in Africa (exception Jumbe and Angelsen, 2006) in general and rural Ethiopia in particular. Therefore, the purpose of this study is to get empirical evidences on the determinants of household's choice of fuel wood sources with a focus on tenure insecurity and local level institutions. The study contributes to the limited literature in Africa in general and Ethiopia in particular. Moreover, it tries to address the impact of land certification and local level institutions on the choice of fuel wood sources and its policy implication regarding the management and conservation of forests.

The next section of the paper deals with the analytical framework. The nature of the model used for the empirical analysis is discussed in this section. Section three discusses the data source and sampling methods. The descriptive statistics are also discussed in this section. In section four the result of the findings are discussed. The last part of the paper is the conclusions and guide to future work.

II. ANALYTICAL APPROACHES

The analytical framework followed is that of multinomial Logit model that is applied to different household choice of fuel sources. Multinomial logit is a regression technique used to assess factors associated with households' choice among mutually exclusive groups. We have five different groups: Private, community, market, open access and multiple sources. Unordered choice models can be motivated by a random utility model (RUM). Individuals are assumed to select the fuel source that maximizes the expected utility. For the i'^{th} household faced with J choices, we can write the utility of choice j as:

$$U_{ij} = X_{ij}^{'} \beta + \varepsilon_{ij}$$

Where U_{ij} is the utility derived from the choice of j's source of fuel wood, X_{ij} is a vector of explanatory variables that affect the choice of fuel wood source and ε_{ij} is the disturbance term. β is the vector of parameter to be estimated. The individual chooses a fuel source based on his preferences and thus this particular choice maximizes his utility. Hence, the statistical model is driven by the probability that choice *j* is made.

$$\Pr(U_{ij} \succ U_{ih}), \ for \ all \ other \quad h \neq j$$

This means, the option with the highest utility is chosen. Depending on the choice of the distributional assumptions of the disturbances, the probit or logit model can be used. Because of the need to evaluate multiple integrals of the normal distribution, the probit model has found rather limited use in this setting (Greene, 2003). The logit model, in contrast, has been widely used in many empirical works.

Let Y be the dependent variable with J nominal outcomes. The categories are numbered 0 through J, but are not assumed to be ordered. The model for choice of fuel wood sources can be given as follows:

$$\Pr\left(Y_i = j\right) = \frac{\exp\left(\beta_j' X_i\right)}{\sum_{k=0}^{J} \exp\left(\beta_k' X_i\right)}, \qquad for \quad j = 0, 1, 2, - - - 4$$

The estimated equations provide a set of probabilities for the J +1 choices for a decision maker with characteristics X_i. In order to remove an indeterminacy in the model, a convenient normalization that solves the problem is $\beta_0 = 0$. Therefore, the probabilities are

$$\Pr\left(Y_i = j \,/\, x_i\right) = \frac{\exp\left(\beta_j' X_i\right)}{1 + \sum_{k=1}^{J} \exp\left(\beta_k' X_i\right)}, \qquad for \quad j > 1$$

The model implies that we can compute J log-odds ratios

$$\ln\left[\frac{P_{ij}}{P_{ik}}\right] = x_i'\left(\beta_j - \beta_k\right) = x_i'\beta_j \qquad if \quad k = 0$$

The MNL coefficients are difficult to interpret, and associating the β_j with the j^{th} outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as (Greene, 2003)[1]:

$$\delta_j = \frac{\partial P_j}{\partial x_i} = P_j\left[\beta_j - \sum_{k=0}^{J} P_k \beta_k\right] = P_j\left[\beta_j - \overline{\beta}\right]$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Greene, 2003). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

[1]The expression is obtained by differentiating the multinomial logit model above.

III. DATA SOURCE AND DESCRIPTIVE STATSITICS

3.1. Nature and source of data

In this section we present the nature and sources of data used for the empirical analysis. We used the data collected in the year 2007 from a sample of rural households in the East Gojam and South Wollo zones of the Amhara region of Ethiopia. This data is part of a longitudinal survey conducted through a collaborative research project of the economics departments at Addis Ababa University and the University of Gothenburg and financed by Sida/SAREC. The selection of the sites was deliberate to ensure variation in the characteristics of the sites, including agro-ecology and vegetative cover. Households from each site were then selected randomly. A total of 1760 households from 14 sites were interviewed in the survey. The data include various information on household characteristics, household's perception on land certification and registration, energy collection and consumption, assets, credit, off-farm activities, nature and type of forests, etc. Community surveys were also conducted which enabled us to use some of the information in our empirical analysis.

3.2. Descriptive Statistics

Table 1 presents the definition and summary of the descriptive statistics of sample households. Both household and community level variables were included.

Table 1 : Summary of Descriptive Statistics (N=1545)

Variable Description	Mean	S.D.	Min	Max
Household characteristics				
AGEHH (Age of the household head)	51.35	14.75	15.00	97.00
SEXHH (Sex of the household head)	0.82	0.38	0.00	1.00
EDUCATION (If the head has attended any type of education 1and, 0 otherwise)	0.48	0.50	0.00	1.00
FAMILYSSIZE (Family size of the HH)	6.61	2.42	1.00	20.00
CREDITOPP (A dummy 1 is assigned if any member from the HH has credit opportunity from any source)	0.87	0.34	0.00	1.00
LANDSIZEHA (Size of land in hectare)	1.32	0.93	0.04	6.72
DISTTOWN (Distance from nearest town in hours)	1.23	0.90	0.00	4.67
DUMMYSTOVE (Dummy for stove, 1 If stove with three stone, open fire, and 0 otherwise)	0.78	0.41	0.00	1.00
LIVSTOCK_TLU (Number of livestock owned in TLU)	3.83	3.02	0.00	31.59
DLANDCERT (Dummy variable for land certification)	0.80	0.40	0.00	1.00
Community characteristics				
DREGION (Dummy for region 1 if East Gojam and 0 for South Wollo)	0.48	0.50	0.00	1.00
DISFOREST (Average distance of the kebele[2] to the forest in Hours (two ways))	2.45	2.13	0.74	9.85
DUMMINST (Dummy for institutions (1 for strong institutions and 0 for weak ins)	0.52	0.50	0.00	1.00

In the study areas there are different types of fuel wood collection sources: For this study we considered five types of fuel wood sources. These are community, market, private, open access and multiple sources. It is observed that some households collect and use fuel wood from more than one source. Hence we considered additional choice, those who collect fuel from two or more sources[3]. Therefore, we have five choices. We could not find a significant number of households collecting fuel wood only from two sources. Table 2 presents average number of households who participated in collection of fuel wood from each source.

[2]Kebele is the lowest administrative unit in the country.

[3]The numbers of households who collect from more than two sources are very few in the sample.

Table 2: Average number of households by sources of fuel wood

SOURCE	Mean	Std. Dev.
PRIVATE	0.723	0.448
COMMUNITY	0.077	0.267
MARKET	0.073	0.260
OPEN_ACCESS	0.086	0.281
MULTIPLE SOURCE	0.041	0.198

The majority of the households (72%) collect fuel wood from private source. While 7.7 % of the sample households collect from community forest, 8.6 % of the sample households collect from open access (OA) areas. Some households satisfy their fuel wood demand from the market (7.3%). Most of the households who buy fuel wood from the market are those who do not have land at all or too small to plant trees in addition to crops grown for their livelihood (see the table 3 below).

The number and characteristics of households who participated in collection of fuel wood from each source and the characteristics of the community are presented in table 3 below. We can see that some of the variables are different across fuel wood sources. Age of the household head and gender are more or less the same across the different sources except that it is lower for those who depend on market. Education level of the household heads is lower for households who are highly dependent on OA sources compared with other sources of fuel wood. This is because households with less-educated household heads are likely to have fewer outside labor opportunities, and are therefore more likely to choose collecting from OA forests. Similarly, household's wealth is expected to be correlated with choice of fuel wood sources. Those households with more number of livestock are relatively rich and hence may depend more on private sources (4.12 TLU) and less on other sources such as market (1.86 TLU). According to Van'tVeld et al. (2006), households with more land and more livestock (as measured by the size of land and number of livestock in TLU, respectively) are less likely to collect from forests, as the

opportunity cost of time spent collecting rather than working the farm is likely higher for such households.

Around 87 percent of the sample households have access to credit opportunity and there is no significant variation among the different sources. Credit is expected to reduce household's dependency on the commons. A dummy variable for possession of improved biomass stoves shows that few households (22%) have adopted some kind of improved cook stoves. Given the importance of improved biomass cook stoves in saving fuels and relieving pressure on forests, we expect households using traditional (three stone stoves) to depend more on forests and less on other sources.

The proportions of households who have land certificate are relatively low (67 %) in the case of market and OA users. It, however, ranges from 80% to 87 % for those households who depend on private, community and multiple sources. The purpose of land certification is to assure the household about their holdings so that they can make long term investment, of which trees and permanent crops are the ones which contribute to the income of the household. Moreover, they are used to satisfy their energy demand and demand for construction and fencing.

Table 3: Summary of Descriptive statistics of variables by sources of fuel wood

	PRIVATE (N=1117)		COMM (N=119)		MARKET (N=113)		OA (N=133)		MULTIPLE SOURCE (N=63)	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
AGEHH	52.43	14.46	50.36	15.84	43.35	12.44	50.57	16.17	50.06	14.16
SEXHH	0.84	0.37	0.79	0.41	0.71	0.46	0.73	0.45	0.87	0.34
EDUCATION	0.50	0.50	0.41	0.49	0.56	0.50	0.35	0.48	0.44	0.50
FAMILYSSIZE	6.75	2.37	6.45	2.67	5.49	2.46	6.29	2.40	7.13	2.29
CREDITOPP	0.86	0.35	0.91	0.29	0.88	0.32	0.88	0.33	0.87	0.34
LANDSIZEHA	1.35	0.91	1.64	1.19	0.82	0.59	1.04	0.63	1.60	1.20
DISTTOWN	1.21	0.88	1.18	0.70	0.93	1.08	1.64	0.95	1.31	0.83
DUMMYSTOVE	0.80	0.40	0.82	0.39	0.81	0.39	0.68	0.47	0.67	0.48
LIVSTOCK_TLU	4.12	3.04	3.77	2.90	1.86	2.31	3.03	2.69	3.98	3.07
DLANDCERT	0.82	0.39	0.80	0.40	0.67	0.47	0.67	0.47	0.87	0.34
DREGION	0.44	0.50	0.78	0.41	0.48	0.50	0.53	0.50	0.60	0.49
DISFOREST	2.44	2.18	2.10	1.94	2.67	2.23	2.84	1.94	2.07	1.74
DUMMINST	0.54	0.50	0.25	0.44	0.61	0.49	0.56	0.50	0.49	0.50

Another important variable is the strength of local level institutions in the area. We hypothesize that the strength of institutions i.e. the rules and regulations on how to use and manage the forest affects the choice of fuel wood sources. For example, if the local institutions are relatively strong then households will be forced to depend less on forests and use more from either private sources or market. Establishment and enforcement of appropriate rules and regulations are found to be important in the natural resource use and management. The descriptive statistics shows that the local level institutions are relatively strong in the south Wollo region compared with East Gojam region. This may suggest that there is a need to increase the perception and awareness of households regarding the forest use and management in the East Gojam Zone.

IV. RESULTS OF ECONOMETRIC ANALYSIS

The results of the multinomial logit estimation are presented in Table 4. As discussed earlier, the coefficients of the multinomial logit estimates are difficult to interpret. Hence we present the marginal effects for all sources. The base category is private source. We have checked that the results are not sensitive to the choice of the base category. The likelihood ratio test indicates that the regressors are jointly statistically significant at the 0.01 level. We have also estimated the robust model to check if there is any kind of misspecification because of heteroscedasticity problem. We found that the results are the same.

Table 4: The marginal effects from estimates of Multinomial logit model

	PRIVATE			COMMUNITY			MARKET			OPEN ACESS			MULTIPLE		
variable	dy/dx	S.E.	P>z	dy/dx	S. E.	P>z	dy/dx	S. E.	P>z	dy/dx	S. E.	P>z	dy/dx	S.E.	P>z
AGEHH	0.003	0.00	0.001	-0.000	0.00	0.546	-0.001	0.00	0.000	-0.001	0.00	0.142	-0.001	0.00	0.119
SEXHH*	0.027	0.03	0.355	-0.013	0.02	0.462	-0.007	0.01	0.525	-0.019	0.02	0.296	0.012	0.01	0.306
EDUCATION*	0.060	0.02	0.005	-0.016	0.01	0.193	0.011	0.01	0.179	-0.041	0.01	0.002	-0.014	0.01	0.173
FAMILYSIZE	-0.002	0.00	0.647	-0.003	0.00	0.258	-0.001	0.00	0.414	0.004	0.00	0.198	0.003	0.00	0.140
CREDITOPP*	-0.051	0.03	0.057	0.034	0.01	0.006	0.004	0.01	0.737	0.014	0.02	0.378	-0.002	0.01	0.907
LANDSIZEHA	0.039	0.01	0.009	0.005	0.01	0.499	-0.029	0.01	0.000	-0.023	0.01	0.034	0.008	0.01	0.158
DISTTOWN	-0.005	0.01	0.717	-0.017	0.01	0.023	-0.018	0.01	0.001	0.035	0.01	0.000	0.005	0.01	0.361
DUMMYSTOVE*	0.086	0.03	0.002	0.000	0.01	0.996	0.001	0.01	0.938	-0.053	0.02	0.004	-0.034	0.02	0.025
LIVSTOCK_TLU	0.022	0.00	0.000	-0.002	0.00	0.406	-0.011	0.00	0.000	-0.007	0.00	0.019	-0.003	0.00	0.139
DLANDCERT*	0.021	0.03	0.495	-0.005	0.02	0.810	-0.002	0.01	0.842	-0.037	0.02	0.069	0.023	0.01	0.031
DREGION*	-0.154	0.03	0.000	0.068	0.02	0.001	0.034	0.01	0.007	0.019	0.02	0.261	0.033	0.01	0.024
DISFOREST	0.001	0.01	0.854	-0.005	0.00	0.190	0.003	0.00	0.070	0.003	0.00	0.421	-0.002	0.00	0.482
DUMMINST*	-0.019	0.03	0.504	-0.057	0.02	0.003	0.009	0.01	0.374	0.047	0.02	0.004	0.019	0.01	0.118

(*) dy/dx is for discrete change of dummy variable from 0 to 1.
Using the correlation matrix and the VIF (found to be less than 5), we found no severe multicollinearity problem.

The above estimation result shows that the choice of fuel wood source by a household is affected by many socioeconomic and environmental factors. Household characteristics such as age, gender, and education of the household head affect the choice of fuel wood source differently. Age and education of the head have a significant and positive effect on the probability of fuel wood collection from own source. Education is negatively correlated with the probability of collecting fuel wood from open access (OA) forests. It reduces the probability of collecting from OA areas by 4.1 percent. The reason might be that educated heads are more aware of the importance of forest conservation and its use in maintaining the soil fertility of the land as well as mitigating the climate change. Age and gender reduces the probability of fuel wood purchase from the market, though the latter is not significant. We found that gender is not significant in the choice of fuel wood sources. Contrary to Jumbe and Angelsen (2006), household's family size has no significant influence on the choice of fuel wood source. However, Heltberg et al. (2000) explains the ambiguity of the sign of this variable on the collection of fuel wood.

Household wealth indicators such as land size and livestock ownership were included in the analysis. Household assets affect production capabilities and preferences, and many studies include some measure of household wealth, such as landholdings (Edmunds, 2002) and livestock ownership. Whatever is considered as a measure of wealth, most poor households cannot afford to buy fuel wood from market. They are also too land-poor to invest in tree planting due to land shortage. We therefore expect them to depend more on forests owned by government (de facto open access) or community forests in order to satisfy their energy demand. The results of the estimation show that an increase in land size by 1 hectare reduces the probability of fuel wood collection from OA forests and market by 3.4 and 2.9 percent, respectively. On the other hand land size has a positive and significant effect on the probability of fuel wood collection from own source. An increase in land holdings by one hectare increases the probability of fuel wood collection from own source by 3.9 percent. Similar conclusions were drawn by Heltberg et al. (2000) in India. They found that larger landowners collect less from commons and produce more fuel wood privately. Cook et al. (2008) also argued that households with little or no land

have much less ability to produce fuel wood themselves. We found that the effect of livestock is consistent with land size.

Location variables such as distance to town and distance to forest were also included in the analysis. Distance to town negatively affects fuel wood purchase from the market. As most markets are located in or near the town, this result is not surprising. And it is positively correlated with the probability of choosing OA forests. Distance to forest has a positive and significant effect on the decision to buy fuel wood from the market. The physical scarcity of the forest has no effect on the probability of fuel wood collection from other sources. The reason might be because people tend to use other sources of energy when forests become inaccessible. We could not find any substitution between forests and private sources as claimed by some studies. This result may also suggest that policies designed to increase the supply of fuel wood will reduce additional expenditure by poor households as these part of the population are the ones who depend on the market.

What is the effect of land tenure insecurity on the choice of fuel wood source? So far no study has considered this factor as a determinant of choice of fuel wood source and fuel wood collection. Many studies (see for example, Mekonnen, 2009; Deninger et al., 2007) have shown the relationship between tenure insecurity and long term investment in developing countries in general and Ethiopia in particular. It is generally believed that a more secure tenure system provide the necessary incentives for farmers to better manage their land and invest on land improvement such as soil and water conservation or terracing, crop rotation and tree planting. In this study households were asked the question whether they have a land certification or not. In contrast to our expectation, the results of our econometric estimates show that tenure security does not have a significant impact on the probability of fuel wood collection from market, private, and community forests. It is, however, negatively related to the probability of collecting from OA forests. While the effect of land certificates on OA is expected, its effect on collection from private source (though positive) is unexpected. One possible explanation is the effect of land certificate on household's decision to collect from private source will be realized in

the long-run. The second reason might be because land certificate program did not have any impact on farmers long term investment decision (such as tree planting) which will in turn be used a source of fuel wood. Poverty and high discount rates (not considered in this paper) might be more important factors than tenure security (land certification) in affecting farmer's decision regarding resource use from different sources. However, additional empirical researches on the role of land certification and farmers perception on their long term investment decisions may be required to supplement these findings.

We have also tried to examine the effect of local institutions on the choice of fuel wood collection source. Here we have tried to come up with some kind of institutional index indicating whether there is some kind of forest management institutions in the village or not. Households were asked to rate questions related to forest rules and regulations on a five point scale, and this is averaged to get an index for the household. This index at household level is aggregated to get the sum at the community level and rescaled to vary between one and five (dividing the sum by the number of observations). A dummy variable 1 is assigned if the average is greater than 3 and zero if it is less showing that the local level institutions is relatively weak, which has implications on the household's decision to collect fuel wood from each source[4]. In this case we expect that households with weak forest management institutions depend more on the forest (either community or OA sources) than other kind of fuel wood sources. The effect of this variable is insignificant in the case of private and market sources. It is significant and negatively correlated with the probability of collecting fuel wood from community forests and positively and significantly related to the choice of OA forests as a source of fuel wood. This is because community forests in study area have some rules and regulations on forest products use which will reduce household's dependency for fuel. Hence households will look for open access forests, the next alternative sources of fuel wood.

[4]The classification of this index into a dummy variable of (1,0) type is subjective judgment.

The implication is that expansion of community forests (with strong local level institutions) will help reduce the depletion and degradation of forests and forest products by diverting households to other sources of fuel wood.

Regional dummy was included to capture differences in agro-ecology and forest conditions in our study sites. The coefficient for the region dummy is negative and significant under private source, while it is positive and significant under market and community forests. That means, households in East Gojam are less dependent on private source and depend more on community and market sources compared with South Wollo regions. In line with the descriptive statistics, this may reflect differences in the strength of the local level institutions between the two regions. This suggests that promotion of tree planting as a source of fuel wood may be more successful in places where the local level institutions are relatively strong.

Other variables such as access to credit opportunity and possession of improved stove were included. Those households with traditional stove collect from own source and less from OA sources. Access to credit opportunity is negatively correlated with the probability of collecting from private source and positively correlated with the decision to collect from community forests.

V. CONCLUSION

In this paper we have tried to examine the determinants of rural household's choice of fuel wood source by using a discrete choice model. A multinomial logit model has been employed to address the question of whether household's socioeconomic, environmental and institutional variables affect the choice of fuel wood source in rural Ethiopia. Household characteristics such as age, gender, and education of the household head affect the choice of fuel wood source differently. We found that education is negatively correlated with the probability of fuel wood collection from open access (OA) forests. This can be used as an effective instrument for conserving forests and reducing households demand for fuel and other forest products from OA areas. The current

extension system has to consider the importance and role of education in forest resource use and conservation to the local people in particular and the country in general.

The impact of local level institutions has been assessed by incorporating a measure for institutional variable. The issue is very important from policy perspective as the current government of Ethiopia and other organizations working on the area of natural resource conservation are promoting the transfer of forests to the local people. The effect of this variable is insignificant in the case of private and market sources. It is significant and negatively correlated with the probability of collecting fuel wood from community forests and positively and significantly related in the case of OA forests. This is because community forests in the study area have some rules and regulations on forest products use which will reduce household's dependency for fuel. Hence households will look for open access forests, the next alternative sources of fuel wood. The policy implication is that there is a need to bring the OA forests under the management of the community and increase the awareness of the locals on the use and importance of forests conservation.

We have seen the impact of tenure security (land certificate) on the choice of fuel wood source. We found that it is negatively correlated to the probability of collecting fuel wood from OA forests. However, it does not have a significant impact on household's decision to collect from private source. The land certificate program may require long period to realize its effect on household's decision on fuel use. The second reason might be because land certificate program did not have any impact on farmers long term investment decision (such as tree planting) which will in turn be used a source of fuel wood. In the short run, the factors mentioned earlier might be more important than tenure security (land certification) in affecting farmer's decision regarding resource use from different sources. Additional empirical researches on the role of land certification and farmers perception on their long term investment decisions may be required to supplement these findings.

The choice of fuel wood sources also varies between regions depending on their agro-ecological and strength of local level of institutions. Our result suggests that promotion of

tree planting as a source of fuel wood may be more successful in places where the local level institutions are relatively strong.

Households with large land size and more number of livestock are more likely to collect fuel wood from own source and less likely from OA forests and market. The implication is that interventions on forest conservation in open access areas may target the relatively poor households in the region.

Another conclusion that comes out of this study is that when forests become inaccessible (as measured by the distance to forest) households will tend to buy fuel wood from the market. This result may also suggest that policies designed to increase the supply of fuel wood will enable the rural households especially the poor to reduce their fuel wood expenditure. The physical scarcity of the forest has no effect on the probability of fuel wood collection from other sources.

This study may be considered as one of the valuable inputs for the government's current demand and supply side strategies in addressing rural energy problems and conservation of forests and halting unwise use and exploitation of the resources. Future studies on this area may focus on evaluation of the long term effect of land tenure security (land certification) on farmers' investment decision and the implication of this on rural energy and forest degradation in the region.

REFERENCES

Charles H. Wood and Robert Walker (undated). Land Titles, Tenure Security and Resource use Among Small Farmers in the Brazilian Amazon: Paper in S67: Population and the Environment, Local.

Cooke,P, St. Clair, William F. Hyde, and Gunnar Köhlin (2008). Fuelwood, forests and community management –evidence from household studies. Environment and Development Economics 13: 103–135.

Edmonds, E. (2002). Government Initiated Community Resource Management and Local Resource Extraction from Nepal‘s Forests‘, Journal of Development Economics, 68: 89-115.

FDRE (Federal Democratic Republic of Ethiopia) (1998). National Action Programme to Combat Desertification, Addis Ababa.

Greene, W. (2003), Econometric Analysis. New York: Macmillan, 5th edition.

Heltberg R., A. Arndt, and N.U. Sekhar (2000). Fuel wood Consumption and Forest Degradation: A Household Model for Domestic Energy Consumption in Rural India. Land Economics 76 (2).

IEA (International Energy Agency) (2004), World Energy Outlook 2002, Paris.

Jumbe and Arild (2006). Household’s choice of fuel wood source in Malawi: A multinomial probit analysis, A paper prepared for presentation at the international Association of Agricultural Economics Conference, Gold Coast, Australia.

Klaus Deininger, Daniel Ayalew Ali, Stein Holden, and Jaap Zevenbergen (2007). Rural land certification in Ethiopia: Process, initial impact, and implications for other African countries:

Linde-Rahr, M. (2003). Property Rights and Deforestation: The Choice of Fuelwood Source in Rural Viet Nam. Land Economics, Vol. 79.

Mekonen, A., and R. Bluffstone. (2007). Policies to increase forest cover in Ethiopia: lessons from economics and international experience, in Bane, J., S. Nune, A. Mekonen and R.Bluffstone (Eds), Policies to increase forest cover in Ethiopia, Proceeding of Policy Workshop, Environmental Economics Policy Forum for Ethiopia, Ethiopian Development Research Institute, Addis Ababa, Ethiopia.

Mekonnen, A. (1998). Rural Household Biomass Fuel Production and Consumption in Ethiopia: A Case Study. Journal of Forest Economics 5(1): 69-97.

Mekonen, A. (2009).Tenure Security, Resource Endowments and Tree Growing: Evidence from the Amhara Region of Ethiopia: Land Economics 85(2):292-307.

MoARD (Ministry of Agriculture and Rural Development). 2007. Forest Development, Conservation and Utilization, Policy and Strategy.

Veld, V., Narain, U., Gupta, S., Chopra.,N. and Singh, S. 2006. India’s firewood crises Re-examined. Discussion Paper. Resource for the future. Washington.

WBISPP (Woody Biomass Inventory and Strategic Planning Project) (2004b). Forest Resources of Ethiopia. Addis Ababa, Ethiopia.

Wooldridge, J. M. 2002. Econometric analysis of cross section and panel data, The MIT Press, Cambridge, Massachusetts.