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AN INSTITUTIONAL MODEL TO EXPLAIN UTILISATION PROBLEM OF COMMUNITY FOREST PRODUCTS

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Abstract
This study examined utilisation problems of community forest products (firewood and timber quantity harvested, and fodder collection days) on an institutional model. The data for this study were collected from forest user groups of three mid hill districts in Nepal. The results showed that the problems and practices of product utilization were determined by many factors of forest user group institutions. This study identified that the forest product utilisation is a double hurdle decision process. The first hurdle is to decide whether or not to utilize the products. The second hurdle is how much to utilize for those who decide to utilize. Some factors played a positive role in the first decision step and for some products and a negative role in the second decision step and for other products, or vice versa. Some institutional factors exhibited endogenous roles in determining the outcomes of other institutional factors. The findings imply that improvement of institutional factors can increase in some extent, the rural households' access to forest products in Nepal. Improvements of the determinants for better utilization of the forest products require technical supports specific to the conditions of each decision step.

Keywords: *institution, product utilisation, selection, outcome decision model, double hurdle, Nepal.*

Introduction

Problem of community forest development has been shifted from forest protection to product utilization. The problem is more critical in Nepal, where rural people have faced forest resource scarcities, even though forest resource stocks are increasing and under utilized (Thomas 2008, Khanal 2003). Studies

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showed that poorer households are least advantaged by the community managed forest (Adhikari *et al.* 2004) and worse off in current forest management (Dhakal *et al.* 2007, Timilsina 2003). These emerging problems are driving practitioners and researchers to understand what factors determining utilization of community forest products.

Scholars have different opinions to explain the problems of product utilization of community forests. For example, Thomas (2008) stated that the problem of the forest product utilization result from poor technical support of service providers including government officials. Maskey et al (2005) showed that the problem associated with poor participation of needy people in decision making. Shrestha and McManus (2007) pointed to the problem of 'elite capture' in decision making. Dhakal et al. (2007) demonstrated that government policies constrained the utilization of the resources of community forests. However, effects of institutional elements of forest user groups are not well studied. The studies so far done at forest user group level are based on qualitative analysis (Varughese 2000, Agrawal 2000). The problems at community level are not empirically examined. Our study is based on a quantitative analysis and attempted to fill the knowledge gaps. This study looked at problems associated with three major products (firewood, fodder and timber).

This study used an institutional framework to examine the problem of forest product utilization in community forests. According to North (1990), institutions are the relatively enduring constraints, restrictive or enabling, that direct human behaviour in social, political and economic exchanges. These comprise the formal and informal rules or practices that, with their respective enforcement characteristics, create a set of incentives that guide human behaviour and consequently, determine outcome performance. The institutions structure interactions and behaviours of members of the society. That means the institutional arrangements restrain one group and release others, and regulate the flow of economic goods and services. The regulative arrangements determine access to, and control over, resources, and are a disadvantage to some people while disadvantaging others. Organisations (e.g. forest user group and district forest office) are formal bodies that are established to enforce, facilitate or improve those institutions (Bromley 1989). The organizations consist of resources, authorities and operating procedures, including rules to enforce the institutions. This study examined elements of community forest institutions determining forest product utilization.

Community forestry is a management approach in which local users manage public forests in collective efforts under the government policy guidelines and external supports: the government, NGOs or other aid agencies (Hobley 1996, Master Plan 1988). The collective management body of local people is called a "user group". The user groups are formed and

legalised over different years based on the decisions of the government authority. A policy of regulated forest user groups has been in effect in Nepal since the late 1980s, as the Government faced a forest policy failure to regulate forest traditionally managed by communities. In this approach, the Government has devolved some user rights and management responsibilities of communal forest for an organised body of the forest users, which is termed a "user group" (Hobley 1996).

Some organization mechanisms are developed to operate or enforce community institutions. The executive committee of the user group prepares a constitution and forest management plan, often with the support of aid agencies, and receives approval from a general assembly of user households and government authority. The committee is a body composed of representatives elected from general assembly. It consists of a chairperson, secretary, treasurers and general members. They are assigned some authority to make decisions, and to implement decisions passed in the general assemblies. The user group generates a fund from various sources, including forest product sales for managing the forest, and other development activities. The committee can hire a forest watcher to look after the forest.

This study evaluates how the above all institutional arrangements determine utilization of main products and services of community forests. Forest user group level data are used to examine the causal relationships between the institutional factors and the forest product utilization. The theoretical and empirical models applied to analyse the research problems are described in next sections consecutively. Then the following section explained the research sites, information collection methods and data characteristics. The section is followed by presentation of results and description of findings. The conclusions and policy implications are presented in the final section. The descriptive results of the data are given in annex.

Economic Model of Forest User Group

The theoretical model is based on the behaviour of an agrarian community, consisting of many households to share the production and consumption of products from a communal forest. In the community, household utility is a function of consumption of goods and services, produced or purchased using income derived from firewood, fodder and timber produced in community forest, on private land and traded in the market. However, households use some of the products of community forests only in the face of the scarcity of alternative products or services. These products have no explicit market price. The households often have to pay a nominal amount to community funding in return for getting forest products from their community forest. In markets outside the members' households, the user group (a collective body of community), not an individual

household, sells forest products if there is any surplus beyond the needs of the community. Therefore, in an economic sense, the market prices of forest products in the community are imperfect.

The household has an opportunity to use its labour for the collection of community products, private land production and off-farm employment. The rural communities are characterised by underemployed households' labour and limited capacity on accessing to forest products and services of markets. It is assumed that all members' households behave similarly with regard to the use of the forest resources in the community. This means the effect of variation in individual household behaviours on institutional arrangements and products utilization are not considered to overcome complexity in analysis. In this situation, the utility of the forest products sourced from their community forest is considered a horizontal summation of all household utilities. The forest user group is considered as a single production and consumption unit due to similarity of production and consumption behaviour of the member households in the community. Its utility function is based on the agricultural household model described by Amacher *et al.* (1996). It is assumed that the community utility function is twice differentiable and concave in arguments (Jumbe & Angelsen 2007, Chen *et al.* 2006, Bardhan & Urdy 1999).

The Representative Forest User Group

A typical forest user group consumes community forest products (C), leisure ($L_{leisure}$), and other goods and services (X), subject to its budget and labour constraints. The utility function of the community can be written as:

$$MaxU(C, X, L_{leisure} : G) \quad (1)$$

The term G is a vector of forest user group institutions and other factors important to community forest product utilisation. The forest products or services (q_j) are intermediate inputs, and production technologies (ψ_c) transfer them into goods or services, providing direct utility for the community.

$$C = \Gamma(q_j, \Psi_c) \quad (2)$$

The quantities of forest products depend on the size of the forest area (A_{cf}), characteristics of forest management institutions (I_n), forest specific factors (F_{attri}), rival products (R_{ival}) and external technical advise (D_{is}). In addition it can depend on labour endowment available for forest product collection (L_{cf}) and its production technologies (ψ_h). Collection of private land resources (q^{ag}) competes for the labour available for community forest product utilisation.

$$q_j^{cf} = h(A_{cf}, q^{ag}, I_n, L_{cf}, \psi_h, F_{attrib}, R_{ival}, D_{is}) \quad (3)$$

Institutions are comprised of many factors. The most important factors include executive meeting frequency (M_{freq}), meeting time (M_{time}), ratio of household to executive members (E_{no}), common fund (F_{und}) and forest watcher (W_{atch}). It also includes gender participation level in the general assembly (W_{assem}) and the representation of women in the executive committee (W_{ec}). The other factors include the chairperson's characteristics including ethnicity (C_{eth}), experience (C_{exp}), and affiliation with other organizations (C_h).

There are many challenges to manage community forestry resources and institutions. Social backgrounds determine people's capacity to take leaderships and address the challenges. Some factors can determine community to make selection decision of a leader from particular social group and address those challenges. For instant the choice of chairperson of forest user group from a particular ethnic group can be determined by total numbers of households in the forest group (HH_{no}) , forest related attributes, size of forest, years of the group functioning (G_{age}), external technical support (D_{is}) and access to private resources.

$$C_{eth} = C_{eth}(A_{cf}, q^{ag}, HH_{no}, F_{attrib}, G_{age}, D_{is}) \quad (4)$$

Forest products are more related to the daily activities of rural woman. Higher participation of women in decision making is expected to result in higher utilisation of forest products. The number of women members in the executive committee (W_{ec}) depends on participation of females in the general assembly (W_{assem}), group age, external technical support, and number of household in group. The size of the community fund, forest related characteristics, forest size, numbers of executive members in the committee (E_{no}) and chairperson's attributes also contributes to the number of women members in the executive committee.

$$W_{ec} = W_{ec}(W_{assem}, E_no, I_a, HH_{no}, A_{cf}, F_{attrib}, G_{age}, D_{is}) \quad (5)$$

Female participation in the general assembly is a function of female members in the executive committee and number of households in the group. Additional factors include, size of community fund, forest related characteristics, forest size, group age, external support, numbers of executive members in the committee (E_n) and chairperson attributes.

$$W_{assem} = W_{assem}(W_{ec}, E_{no}, I_a, HH_{no}, A_{cf}, F_{attrib}, G_{age}, D_{is}) \quad (6)$$

The role of executive members is to collect problems or opinions of households or different social groups in the community and make community forest management decision accordingly. The members can play facilitative roles in harvesting or collection of forest product and enhance utilization. This means the lower the number of households per executive member is the better the forest product utilization The number (E_{no}) can depend on female members in the executive committee, number of household in group, size of the community fund, forest relater characteristics, forest size and group age. Other factors that can contribute include external support, numbers of executive members in the committee and chairperson's attributes.

$$E_{no} = E_{no}(W_{ec}, I_a, HH_{no}, A_{cf}, F_{attrib}, G_{age}, D_{is}) \quad (7)$$

The chance of making decisions on forest product utilisation can be higher in the executive committee which has held a greater number of committee meetings. The number of meetings (M_f) is a function developed from the chairperson's attributes including gender influence, forest related factors, numbers of households, group age, and external technical support.

$$M_f = M_f(I_a, W_{ec}, F_n, H_n, G_{age}, D_{is}) \quad (8)$$

The chance of making decisions on forest product utilisation can be higher in the executive committee when enough time is applied. The meeting time of the executive committee (M_{time}) is deprived from functions from the chairperson attributes including gender influence and forest related factors. The attributes may also depend on numbers of households, group age and external technical support.

$$M_{time} = M_{time}(I_a, W_{ec}, F_{attrib}, HH_{no}, G_{age}, D_{is}) \quad (9)$$

The chance of making decisions on forest product utilisation can also be higher in the groups which spend enough time in assemblies. Time taken in general assembly (A_{time}) is obtained from the functions of chairperson's attributes including gender influence and forest related factors. That can also be a function of numbers of households, group age, and external technical support.

$$A_{time} = A_{time}(I_a, W_{ec}, F_{attrib}, HH_{no}, G_{age}, D_{is}) \quad (10)$$

The forest watcher regulates the misuse of forest products, and can contribute to forest product utilisation. Employing a watcher (W) to take care

of misuse can depend on the funds in the group, chairperson attributes, gender influence and forest related factors. Other factors affecting the employment of a watcher include the numbers of households, forest size and group age.

$$W = W(I_a, W_{ec}, F_{attrib}, HH_{no}, G_{age}, A_{cf}, F_{und}) \quad (11)$$

Saving can strengthen the forest user group capability, and enhance forest product utilisation. Saving of a fund by the group (F_{und}) can be a function of forest attributes, forest size, chairperson attributes and gender influence. Other factors include external support, numbers of households, and group age.

$$F_{und} = g(C_h, W_{ec}, F_{attrib}, HH_{no}, G_{age}, D_{is}, A_{cf}) \quad (12)$$

The community faces constraints of its labour to utilise different opportunities. It allocates its total labour (L) to leisure ($L_{leisure}$), contribution for community forest management to secure its utilisation rights ($L_{community}$) and collection of community forest products (L_{cf}). In addition, the community can use private land activities (L_{ag}) and earning wages from participating in off farm income activities.

$$L = L_{j\,cf} + L_{community} + L_{ag} + L_{wage} + L_{leisure} \quad (13)$$

The community also faces a budget (Y) constraint. The budget limit is the sum of income from (*j)* forest products, private land production, wages developed from off-farm work from labour and other exogenous sources from (n) to (N) households. The community also generates a communal fund from forest product sale for forest management and other community development. We assume that the group does not generate income other than from its forest products.

$$Y = [\sum_{j=1}^{J}\sum_{n=1}^{N} p_j \cdot q^{ag}{}_{jn} + \sum_{j=1}^{J}\sum_{n=1}^{N} P_j \cdot q^{cf}{}_{jn} + w\sum_{n=1}^{N} L_{wage} + \sum_{n=1}^{N} E + \sum_{j=1}^{J} P_j q^{cf} \ ] \quad (14)$$

Where p is price of farm products, P is price of community forest product, w is market wage rate and E is other exogenous income.

It is assumed that the labour available for different activities, production from community and private lands, income and other goods and services cannot be negative.

$$L_{j_{cf}}, L_{wage}, L_{ag}, L_{leisure}, q_p, q_{j_{cf}}, Y, X \geq 0 \quad (15)$$

In the user groups, some factors can be deliberately changed, while others cannot be changed. The factors that can be changed by user group efforts are called endogenous or literally institutional factors (y_i). The fixed factors are termed exogenous factors (x_i). Therefore, utilisation of forestry product j is a function of both factors.

From equation (1) to (15) the LaGrange for Kuhn-Tucker problem (Chen et al 2007; Jumbe and Angelsen 2007) can be formulated as:

$$\ell = U(C,X,L;G) - \lambda_1[q_j^{cf} - g(A_f, I_n, L_{cf}, \psi_{cf}, F_n)] - \lambda_2[q^p - h(L_{ag}, A_p, \psi_p)] + \lambda_3[L - L_{j_{cf}} + L_{community} + L_{ag} + L_{wage} + L_{leisure}] + \lambda_4[\sum_j (P_{j_{cf}} q_{j_{cf}}) + P_p q_p + w L_{wage} + E - Y] \quad (16)$$

The first order (necessary) conditions are as follows:

$$\frac{\partial \ell}{\partial X} = \frac{\partial U}{\partial X} - \lambda_4 P_x = 0 \quad (17)$$

$$\frac{\partial \ell}{L_{leisure}} = \frac{\partial U}{\partial L_{leisure}} - \lambda_3 w = 0 \quad (18)$$

$$\frac{\partial \ell}{\partial C} = -\frac{\partial U}{\partial \Gamma}\frac{\partial \Gamma}{\partial q_j^{cf}} - \lambda_4 P_j^{cf} = 0 \quad (19)$$

The above conditions can be rewritten as follows:

$$\frac{\partial U}{\partial L_{leisure}} = \frac{\partial U}{\partial x}\frac{Pq^p{}_j}{p_x}\frac{\partial h}{\partial L_{ag}} = \frac{\partial U}{\partial \Gamma}\frac{\partial \Gamma}{\partial g}\frac{\partial g}{\partial L_j} = \frac{\partial U}{\partial x}\frac{w}{P_x} - \lambda_4 \quad (20)$$

$$\frac{\partial U}{\partial L_{leisure}} \div \frac{\partial U}{\partial \Gamma}\frac{\partial \Gamma}{\partial q^m{}_j} \geq w = P_j q_j^{cf} \leq p_j^{ag} q_j^{ag} = \frac{U_{Leasure}}{U_{Cf-product-use}} = \frac{\lambda_3}{\lambda_4} \quad (21)$$

The first equation above indicates the optimum way to allocate the community workforce time between economic activities (off-farm earning, agriculture and community forest product utilisation) and leisure in order to maximise community utility. The marginal utilities of labour in agricultural production, off-farm employment and community forest product collection are equal to the marginal utility of leisure. The second equation implies that the community, in the optimum labour allocation condition, utilizes

community forest products to the point where the marginal rate of substitution between income and leisure is equal to the value of marginal product of collection.

Exogenous factors include size of the community forest area, number of household members in the group and private land holdings in the community. It also depends on the chairperson's attributes, which include education years, ethnicity, experience of community forest use group (CFUG) leadership and affiliation in other organisations. It is difficult to change some forest characteristics in the short term by user groups or the measurement of some characteristics changes that are very complex. These attributes are also considered as exogenous factors. They include forest species, forest regeneration type and proportion of particular forest age class (harvestable timber, pole sized and very young).

This study looked at factors determining utilisation of the main products of community forests. Those products include timber, firewood and fodder. The reduced form of the equations can be written as,

$$\left.\begin{matrix} FW \\ Tim \\ Fod \end{matrix}\right\} = f\left(\begin{matrix} A_{cf}, A_p, C_{eth}, C_{org}, C_{edu}, C_{\exp}, HH_{no}, G_{age}, D_{is}, W_{ec}, \\ W_{assem}, E_{no}, M_{freq}, M_{time}, W_{atcher}, F_{und}, F_{attri}, R_{ival} \end{matrix}\right) \qquad (22)$$

The model with logarithmic transformation of forest product quantities (dependent variables) could give better result. However, the dependent variables of our data contained a significant numbers of zero cases which made problem to do logarithmic transformation. Hickmans' method could not be appropriate to address the problem of logarithmic transformation because signs for some variables were different between probit model and ordinary least square model[3]. We therefore tested the relationships of explanatory variables with dependent variables in non-logarithmic form. Some explanatory variables are hypothesized to be depended on other variables, as explained above. The functional relationship indicates that the model will have structural equation problems. Therefore the research problems are analysed in multiple step models. In addition to them, this model excluded variation in the form of different technologies to utilise the forest products due to there being no observed variation in the group.

[3] Heckman (Heckit) suggested to calculate an instrumental variable in probit model and use the estimated value in ordinary least square (OLS) model to overcome selection biases problem associated with zero cases dependent variable. Readers are advised to read some econometrics books to understand details of construction of the Hickman's model.

Empirical Model

Many types of estimation methods were applied to examine the analysis models as determined by the problems to be analysed, the characteristics of the data in dependent variables and the distributions of error terms of research models. The Double Hurdle model was used to disaggregate problems associated with selection and outcome decision steps. The double hurdle model consists of two equations (Moffatt 2005). In the context of this study, the equations include, (i) a selection model -a regression model to estimate whether to utilise the forest products (Y_P), and, (ii) an outcome model- a regression model to estimate the amount to utilize (Y_A).

$$Y_P = \beta X_i + e_i \quad (23)$$

$$Y_A = \alpha Z_i + u_i \quad (24)$$

$$\begin{pmatrix} e_i \\ u_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right]$$

where,

- X is a vector of explanatory variables for the utilize/not utilize (collect) decision
- β is a vector of coefficients of the utilize/not utilize variables
- Z is a vector of explanatory variables for the extent of forest product utilisation
- α is a vector of coefficients of variables for the extent of forest product utilisation
- u_i, e_i independently distributed, normal random error terms with mean 0 and variance σ^2

In the case of double hurdle models, the error terms are assumed to be normally distributed and independent (Moffatt 2005, Reynolds 1990). Since Y_P is a binary decision (0 or 1) it is appropriate to use a probit model for Y_P. Since Y_A has both continuous values and zero values it is appropriate to use a truncated model for Y_A.

Equation 23 is a probit model that examines the probability that the i^{th} forest user group would make a decision to utilize the forest products. The model can be written as,

$$Y_P = 1 = Y_P^* = \beta X_i + e_i \quad \text{if } Y_P^* > \tau_P \quad (25)$$

$$Y_P = 0 \quad \text{otherwise}$$

where,

- Y_P a latent variable (1 if planted, 0 otherwise)
- Y_P^* $\alpha+\beta_{j1}x_{ij1}+\beta_{j2}x_{ij2}+.....+\beta_{jk}x_{ijk} + e_i$

x_{ijk} individual *i*'s evaluation of alternative *j* with respect to attribute *k*
β_{jk} parameters
τ_P is the cut off point for having forest utilisation
e_i is an independent and normally distributed random error term with mean 0 and variance 1

Since τ_P is a threshold point, if $Y_P^* \leq \tau_P$ then $Y_P = 0$. If Y_P^* crosses the threshold τ_P, then $Y_P = 1$. In this case no utilisation means $Y_P = 0$.

In firewood and timber cases, Equation 24 is a truncated regression model to examine the extent of forest product utilisation. The model can be written as,

$$Y_A = Y_A^* = \alpha Z_i + u_i \qquad if\ Y_A^* > \tau_A \qquad (26)$$
$$Y_A = 0 \qquad \text{otherwise}$$

where,

Y_A a latent variable (continuous values for observed cases, 0 otherwise)
Y_A^* observed cases or outcome of decision (the extent of product utilisation)
τ_A cut-off point for product utilisation amount
u_i independent and normally distributed random error term with mean 0 and variance σ^2

Ordered Probit

When data do not fit into hurdle truncated or count data model, Equation 24 can be evaluated in an ordered probit model. This is the problem to examine factors determining the numbers of days open for forest fodder collection or grazing. The model is useful to analyse selection and outcome problems for the data, which can be categorised into hierarchical order (Wooldridge, 2001). In a latent variable case, the ordered probit model can be formulated as,

$$y = \beta' z_i + \varepsilon_i \qquad (27)$$
$$\varepsilon_i \sim N[0,1]$$

Where y is a latent dependent variable, β′ is a vector of coefficients and z_i is a matrix of explanatory variables for fodder utilisation. It is assumed that the error term (ε_i) has normal distribution. The observed counterpart of y is y_i which takes different values. If the cut off points for observed values of y are μ_0 and μ_1, the order model can be described as,

$$y_i = 0 \quad if \quad y \leq \mu_0 \qquad (28)$$

$$= 1 \quad if \quad \mu_0 < y < \mu_1$$

$$y_i = 2 \quad if \quad y \geq \mu_1$$

The data and its collection method to fit into the models are described below:

Study Site and Data

This study was based on Nepal's three mid hill districts: Dolakha, Kavre and Nuwakot. These districts lie at altitudes ranging from 400 to 28,000 meters. Due to support of international aid agencies, the levels of technical support for forest user groups were substantially different between the districts. It was too costly to collect a large sample data representing all important attributes of forest user groups in the districts, so only 64 forest user groups were surveyed. To reduce errors associated small sample and extreme distribution of data, we applied a bootstrapped sampling method and generated 961 samples from the 64 original samples.

The user groups in the original samples were almost equal from each district. The forest user groups were selected from stratified random sampling methods. The strata were representative of forest characteristics, altitude, household size and years officially handed over to local communities. Information was collected from interviewing representatives of executive committees and their official records (minute books and forest operational plan). We used district average household landholding size as an instrumental variable of average private landholding of the groups. The data for women in executive committees was retrieved from the national database of forest user group. Similarly a district dummy was used as a measure to examine the effect of technical support on product utilization at community level.

Results

The objective of the study was to determine factors influencing forest product collection. Table 1 provides a description of variables examined in the above models. The descriptive statistics of the forest user groups are given in the appendix. A chi-square test for log likelihood ratio was applied to determine the variable fit in the models. The variables redundant in the model as determined by the test were deleted from the model. White-heteroscedasticity consistent estimator (Wooldridge 2001) was used to obtain robust standard errors in the model. Tobit model was tested for all products and found not valid. Simultaneous model effect was also tested for some variables. The results showed no evidence of simultaneous effect between proportion of female participation in general assemblies and in executive committees. The effect did not hold between forest products. However, there

was a one way effect. The results of the endogenous models and Tobit models will be available upon request.

Table 1: Descriptions of Variables

Name of variable	Description of the variable
Constant	Constant term
TIM_{qt}	Timber quantity utilized in a year (cubic feet)
FOD_{day}	Allowed days for fodder collection or livestock grazing
FW_{LOD}	Quantity of firewood collected from community forest (average head-loads per household)
LA_{cf}	Community forest area (logarithm of area hectare)
LA^2_{cf}	Square of logarithm value of the forest area
LA^3_{cf}	Cubic of logarithm value of the forest area
LHH_{no}	Logarithm of number of household members in the group
LHH^2_{no}	Square of logarithm value of the household numbers
LHH^3_{no}	Cubic of logarithm value of the household numbers
F_{pinp}	Percentage of pine species in the forest
F_{natur}	Percentage of naturally regenerated forest
F_{bl1020}	Interaction of percentage forest area of pole size and percentage broad leaf forest
F_{20y}	Percentage of forest covered by trees suitable for timber product
F_{brod}	Percentage of broadleaf species in the forest
Fsal	Percentage of Sal (Sorea) species in the forest
W_{ec}	Proportion of women in the executive committee
W_{assem}	Proportion of female participants in annual general assembly
C_{org}	If chairperson of executive committee affiliated in any other formal organization 1, otherwise 0.
C_{expr}	Years of experience of the chairperson in the executive committee
C_{eth}	Ethnicity of chairperson, if the chairperson is Brahmin, Chhetri and Newar 1, otherwise 0.
G_{age}	Forest user officially registered period (group age) in a year
E_{no}	Average number of households per executive member
M_{freq}	Number of executive meetings in a year
M_{hrs}	Average hours per meeting
W_{atch}	If the user group had watcher to look after forest 1, otherwise 0
D_{is1}	If the district is Kavre 1, otherwise 0.
D_{is2}	If the district is Nuwakot 1, otherwise 0.
D_{is3}	If the district is Dolakha 1, otherwise 0.
A^P	District average size of private land holding per household
F_{und}	Amount of income saving in group

Timber Utilisation

Table 2 shows the result of timber utilization. The coefficients of the factors determining whether or not to harvest timber each year were estimated on the probit model. The coefficients of the factors determining how much to harvest were estimated on truncated models. In both models, numbers of female members in executive committees and average household numbers per executive committee were endogenous variables.

Table 2. Institutional Factors Determining Timber Utilisation

	Whether or not to utilize (Selection model)		How much total amount to utilize (Outcome model)	
Variable	Coefficient	Z Statistic	Coefficient	Z Statistic
CONSTANT	-247.6	-8.72**	29625.99	5.97**
A^P	346.3	6.95**	-61372.92	-5.39**
D_{is1}	-3.99	-4.38**	4413.85	7.74**
LA_{cf}	-24.74	-7.44**	15018.76	10.85**
LA^2_{cf}	1.86	7.58**	-1063.82	-7.83**
LHH_{no}	78.63	7.21**	-20201.06	-11.63**
LHH^2_{no}	-12.51	-6.11**	1564.28	9.3**
LHH^3_{no}	0.53	4.22**	x	x
E_{no}	0.27#	7.83**	298.15#	4.48**
W_{ec}	-212.9#	-6.89**	43778.88#	5.18**
F_{20Y}	x	x	52.79	13.82**
F_{pinp}	-0.02	-6.06**	-4.02	-1.53
W_{assem}	0 .95	9.51**	6491.17	14.57**
M_{freq}	x	x	232.4	8.6**
M_{hrs}	x	x	152.74	3.1
C_{eduyr}	x	x	-56.75	-3.64
C_{eth}	-2.33	-7.26**	1421.58	6.83**
G_{age}	0 .60	6.71**	x	x
F_{natur}	x	x	x	x
Sigma	-	-	490.52	22.1**
Log likelihood	-335.67		-3619.85	
Pseudo R-Sqr	0.48		x	
Predicted % correct	92		x	

#= estimated using endogenous variables. ** & * significance at 1 % and 5 % respectively. Sigma = factor estimating marginal effect

The differences of some variables and signs of some other variables between the probit and truncated model indicated that timber utilisation is a

double hurdle decision problem. The variables with sign difference include private landholding (A^P), Kavre district (D_{is1}), forest area (LA_{cf}), household size (LHH_{no}) and female members in executive committees (W_{ec}). The variables important only for determining the extent of the timber utilisation include percentage of forest area with harvestable age (F_{20Y}), meeting frequency (M_{freq}), meeting hours (M_{hrs}), education years of chairperson (C_{edyr}) and percent of naturally regenerated forest area (F_{natur}). The variables exhibiting the same type of significant relationships across both models include number of households per executive committee member (E_{no}), female participation in the general assembly (W_{assem}) and percentage of pine forest (F_{pinp}). The signs of constant terms are also different.

All variables except percentage of pine forest (F_{pinp}) are significant in all models. The F_{pinp} is significant only for making choice of utilisation. The variables forest area (LA_{cf}), Kavre district (D_{is1}), female members in an executive committee (W_{ec}), percentage of pine forest (F_{pinp}) and ethnicity of chairperson (C_{eth}) were negatively related to the probability of forest harvesting for timber. The positively related variables include numbers of households (LHH_{no}), number of households per executive committee member (E_{no}), proportion of female member who participated in general assembly (W_{assem}) and years of forest officially handed over (G_{age}). The relationship of the household size variable was log linear for per hectare basis but non-linear for choice for harvest and extent of total product harvest in the group. The variables expressing differences between per hectare harvest and total harvest bases include ethnicity of chairperson (C_{eth}), years of forest officially handed over (G_{age}), meeting hours (M_{hrs}) and percentage of naturally regenerated forest area (F_{natur}).

The signs of most of the variables are consistent with expectations. One of the obvious findings is that the larger numbers of household members the higher the probability to decide to distribute the timber product in groups. The user groups with higher numbers of household members have a higher chance of requiring the timber product. The variable showed a negative log non-linear relationship on the extent of distribution of forest products on a per hectare as well as total user group basis. The negative relationship might be due to management complexity for harvesting and distribution for those larger groups. The forest area showed negative log non-linear relationship with the probability to decide to harvest and positive log non-linear relationship with the extent of harvest. It is obvious that larger forest areas contain more resources for utilisation. The interesting finding is that the larger the forest area, the lesser the probability to decide to utilise the products. Surplus harvest amounts could be a reason. In mountainous regions, many user groups do not sell forest products in the market. The group with the larger forest area is likely to have a surplus harvest in one year and therefore

no need to harvest the following year. The private landholding variable showed negative relationships with the extent of forest product utilisation. The relationship is consistent with expectations that the larger private land holding groups can access substitute product on their own farms. However, the positive relationship of the private landholding factor to choosing to utilise the forest products is surprising. Other unexplained socioeconomic factors might have been associated with this relationship. This was difficult to measure due to the unavailability of average landholding data for individual user groups.

The signs of the variables that differed from expectations were verified using a variable restriction technique (Wooldridge 2001). For example, the sign of the chairperson's years of education variable was negative. A chairperson's presence and decisions are important for timber product utilisation. The higher educated chairpersons are likely to be involved in more activities which might have hampered timber product utilisation. Both Kavre District and the number of female members in the executive committee variables had a negative relationship on choosing to harvest and a positive relationship for the extent of the harvest. Executive committee members need to give a considerable level of effort at the time of forest harvesting. The burden from harvesting management might be a reason for the negative relationship with the decision to harvest. Women members of the executive committee might have more feeling about it. The complexity is more evident in the Kavre district where executive committee members are busy with other private activities. The positive relationship for extent of harvest is obvious in Kavre district where the forests of many user groups are at harvestable stage. The positive sign of the number of households per executive committee member (E_{no}) in all models was against expectation and difficult to explain. This finding needs further study.

Firewood Utilisation

This study used an average amount of green firewood per a household collected from community forest because the firewood was a forest product in daily need. In addition, the product is traded in nominal amounts in many communities. Therefore, we used a double hurdle model to examine factors determining firewood product utilisation from community forest. We tested endogenous problems associated with variables in the models and found strong support for some of them in the choice to utilise the firewood product. The variables include timber quantity utilisation, forest watcher, meeting frequency, meeting hours and households numbers per executive member.

Table 3 depicts the double hurdle model for firewood utilisation. The numbers of variables and signs of some variables' coefficients are different between the truncated and probit model. The variables for forest area (LA_{cf}),

Table 3. Institutional Factors Determining Firewood Utilisation

	Decision on whether or not to utilize every year (Selection model)		Decision on how much to utilize (Outcome model)	
Variable	Coefficient	Z Statistic	Z Statistic	Z Statistic
Constant	32.97	2.31*	-8.046**	-8.046**
LA_{cf},	-0.022	-4.19**	14.29**	14.29**
LA^2_{cf},	11.99	6.33**	-14.03**	-14.03**
FOD_{Day}	-1.68	-6.41**	2.41	2.41
F_{pinp}	-0.01	-5.85**	-7.29**	-7.29**
F_{natur}	0.08	3.59**	5.79**	5.79**
D_{is1}	-0.01	-2.47*	6.60**	6.60**
LHH_{no}	2.01	3.25**	2.91**	2.91**
LHH^2_{no}	-22.73	-3.44	x	x
G_{age}	2.49	3.49**	3.85**	3.85**
D_{is2}			-3.17**	-3.17**
C_{org}			-7.97**	-7.97**
TIM_{qt}	0.01	8.18	2.44*	2.44*
W_{atch}	x	x	-7.51**	-7.51**
W_{assem}	x	x	7.59**	7.59**
E_{no}	x	x	-2.74	-2.74
C_{eth}	x	x	-5.9**	-5.9**
M_{freq}	x	x	2.46*	2.46*
M_{hrs}	x	x	11.32	11.32
W_{ec}	x	x	-6.40**	-6.40**
Sigma	x	x	26.80	26.80
LL value	-121.66	x	x	x
R-sqr	0.68	x	x	x
Predict% Correct	92	x	x	x

#= estimated using endogenous variables. ** & * significance at 1 % and 5 % respectively.
Sigma = factor estimating marginal effect

Kavre district (D_{is1}) and number of days open for fodder collection or livestock grazing (FOD_{Day}) have a positive relationship with the decision concerning the extent of the amount of firewood utilisation and a negative relationship to the probability of deciding for utilisation of firewood product. The household variable was log linearly related to the extent of firewood product utilisation every year. The variable was log non-linearly related to the

probability of choosing the firewood product utilisation decision. The variables determining the amount of firewood product utilisation were chairperson involvement in other organization (C_{org}), forest watcher (W_{atch}), female participation level in general assembly (W_{assem}), number of female members in the executive committee (W_{ec}). The other variable include Nuwakot district, number of household per executive member (E_{no}), ethnicity of chairperson (C_{eth}), meeting frequency (M_{freq}), and meeting hours (M_{hrs}). The sign of the constant terms were also different between the selection (choice to utilize) and outcome (amount utilised) models. This evidence supports the hypothesis that the firewood product utilisation is a two step decision process.

The sings for coefficients of most variables were consistent with expectations. The variables positively related to both deciding for firewood utilisation and the extent of its utilisation include household size (LHH_{no}), group age (G_{age}) percentage of natural forest area (F_{natur}), and utilisation of total timber quantity in the group (TIM_{qt}). Only the percentage of pine species in the forest (F_{pinp}) variable was negatively related in both decisions. The variables positively related to the amount of firewood product utilisation include female participation level in general assembly (W_{assem}), meeting frequency (M_{freq}) and meeting hours (M_{hrs}). The negatively related variables were Nuwakot district (D_{is2}), forest watcher (W_{atch}), chairperson ethnicity (C_{eth}) and the proportion of women in executive committees (W_{ec}). All the variables of both models were significant at a 5 percent probability level.

There are some results which require deeper explanation. Forest area, for an example, was positively related to the level of firewood quantity utilisation and negative to the probability to be chosen for utilisation. The large size of the forest area is likely to produce a larger quantity of firewood, so user groups are able to utilize larger amounts. The forest user groups with a large size of forest area can harvest the surplus product in one year and utilize the surplus and not harvest in following year. The probability of having a forest watcher has a negative effect on the extent of firewood product utilisation. The hidden reason for the negative relationship is that the user groups with scarcity of forest resources have a higher probability of employing a watcher as supported by the results of endogenous model (see in Appendix). Per household consumption of firewood is higher in ethnicities other than Bahun, Chhetri and Newar (Graner 1997). The consumption behaviours of the chairperson might influence on utilisation practices too. The extent of firewood utilisation is negatively related to the proportion of women represented in executive committees. The negative relationship is based on the fact that the proportion of women members is higher for forests of smaller sizes that produce a lower amount of firewood. This fact is supported by the results of endogenous model (see in appendix). The Nuwakot district had a

lower level of external support for forest product management of the user groups, which might be a reason to utilize lower amounts of firewood. The Kavre district had a greater support, so exhibited a positive relationship.

Fodder Collection or Grazing

Fodder is also a forest product needed daily, which is impractical to store for times of scarcity. Reducing the number of days for collecting fodder products or animal grazing services can affect the number of livestock holdings substantially for some households. These factors mean the service of fodder collection or grazing is desirable for many days. In some community forests, the fodder needs are met by letting livestock graze in the forests. It is impractical to measure the amount of fodder used by those grazing animals. Therefore, we used number of days allowed for fodder collection or grazing in community forestry, as the dependent variable. The survey data indicated that that some groups had not utilized fodder or allowed grazing at all and some groups allowed full access. The dependent variable data were distributed into three distinct groups: not allowed at all (0 days = 159 cases), allowed for some days (2 to 230 days = 330 cases) and allowed all days (365 days = 383 cases) in a year. The data of dependent variable measured in numbers of days had not normal distribution property so the Poisson and negative binomial hurdle models did not fit. The data had rather sporadic categorical distribution property which was suitable to transform into discrete order form and analyse in order probit model. Therefore standard probit method was used to estimate parameters for the first hurdle problem while order probit model was used to estimate the parameters for the second hurdle problem. Some explanatory variables showed endogenous (structural) problem and analysed with multiple step process.

In selection of the model, the endogenous variables included watcher (W_{atch}), meeting hours (M_{hrs}), meeting frequency (M_{freq}), proportion of female members in the executive committees (W_{ec}), number of households per executive member (E_{no}) and quantity of firewood utilisation (FWlod). In the outcome model, only the number of households per executive member (E_{no}) was endogenously determined.

The signs of many variables differed between the selection and outcome models. Many variables were negatively related to the probability of choosing to open the forest and the probability of allowing more days for fodder collection or grazing. Those variables include forest area (LA_{cf}), forest watcher (W_{atch}), chairperson ethnicity (C_{eth}), percentage of forest area naturally regenerated (F_{natur}) and percentage of forest area covered with trees aged 20 years or older (F_{20y}). The chairperson education level (C_{edyr}) was positively related with the probability of opening the forest for fodder collection or grazing and negatively related with the number of days opened. The selection

model also held additional variables, which included quantity of firewood utilisation (FW_{lod}), timber quantity utilisation (Tim_{qt}), females' participation level in general assembly (W_{assem}) and meeting hours (M_{hrs}). The sign of constant terms were also different. The results indicated that the fodder product utilisation is also a two step decision process.

Table 4. Double Hurdle Model of Fodder Collection or Grazing in Forest

	Decision to whether or not to utilize every year (Selection model)		How many days to open (Outcome model)	
	Coefficient	Z Statistic	Coefficient	Z Statistic
Constant	22.66	1.78	-5.24	-2.46*
LA_{cf}	-10.07	-4.11**	0.92	13.73**
Lhh_{no}	6.56	4.29**	1.60	1.70
Lhh^2_{no}	x	x	-0.18	-1.57
W_{atch}	-5.27#	-7.35**	0.63	6.18**
M_{hrs}	0.42#	2.0*	x	x
W_{ec}	-109.99#	-2.57**	-1.43	-6.02**
C_{eth}	-2.27	-5.89**	0.75	6.13**
F_{natur}	-0.03	-6.00**	0.01	4.85**
TIM_{qt}	-0.001	-4.74**	x	x
E_{no}	-0.25#	-2.37*	-0.10#	-3.14**
W_{assem}	-8.18	-5.18**	x	x
M_{freq}	0.71#	7.21**	0.10	3.60**
F_{20y}	-0.13	-6.68**	0.01	2.68**
C_{edyr}	0.50	7.45**	-0.21	-14.66**
FW_{lod}	0.17#	6.66**	x	x
Threshold Parameter Index		x	1.63	23.93
LL		-170.46	x	x
Pseudo R-Square		0.61	0.22	x
Predicted % correct		91	$	x

#= estimated using endogenous variables. ** & * significance at 1 % and 5 % respectively.
$ = Predicted 45 cases for 0 day, 579 cases for >0 to 330 days and 337 cases for 365 days.

The household number variable was log linearly positive in the case of the selection model and log-non linearly positive in the outcome model. The variable meeting frequency was positively related with the probability of the choosing the decision to open the forest and the probability of allowing more days for fodder collection or grazing. The relationship was negative in the case of the proportion of female members in executive committee. The

numbers of households per executive committee member was negative in both models as expected. The quantity of firewood utilisation (FW_{lod}) and meeting hours (M_{hrs}) exhibited a positive relationship whereas timber quantity utilisation (Tim_{qt}) and females' participation level in general assembly (W_{assem}) exhibited a negative relationship with the probability of deciding to open the forest for fodder collection or grazing.

Results of some of the variables need explanation. In rural Nepal, people with higher levels of education are generally involved in public employment and many social activities. The time constraint for considering different aspects of forest user groups might be a reason for a negative relationship between the chairperson's education level and numbers of days opening for fodder collection and grazing. One person needs to provide services for many households where numbers of households per executive committee member are higher. Working in an executive committee is generally a voluntary position. People have limited time to provide voluntary service for many households. The time constraint for monitoring the forest use activities is a possible reason for the negative relationship of numbers of households per executive committee member and the probability of both deciding to open and the number of days to open. In the context of rural households in Nepal, fodder collection and livestock grazing are female related activities. It was expected that higher participation of females in general assembly increases the probability of opening the forest for the fodder and grazing activities. There is a possibility of many other socio-political factors leading to this unexpected finding. This case needs further study.

Conclusions and Policy Implications

The study examined factors determining the utilisation of community forest products in Nepal's mountain region. It is found that deciding for forest product uses and utilization of higher quantity of the products are most likely in the forest user groups with older age, higher frequency of meeting of executive committee and higher hours of the committee meeting. It is least likely in the forest user groups with higher proportion of women presence in executive committee and pine forest. Deciding to utilize forest products is least likely in the groups with presence of forest watcher and number of household per executive committee member. District effect and backgrounds of chairperson of the group have also important role in the product utilization decision. Other important factors include forest age, forest size and regeneration type and household number in the group. The forest size and household number in forest user group has curve linear effect in product utilization decisions. The effects of some factors are vary with types of forest products and decision steps (decision to utilize a particular product and extent of the product utilization). Some factors played a positive role in the

first decision step and a negative role in the second decision step, or vice versa. Therefore improvements of the determinants for better utilization of the forest products require technical supports specific to the conditions of each decision step.

This study also identified some cases where some levels of external interventions could be productive. The forest product utilisation, for example, is low in those groups which have chairperson from the Bahun, Chhetri or Newar ethnic groups. The forest product utilisation could be increased in those user groups provided there is some level of awareness about their behavioural effects. The finding of the negative role of female executive members on both fodder and firewood utilisation is another area of attention. Running forest user group activities is a challenging task and rural women may face many difficulties in this role. Strengthening their capacity for leadership and organisation management could overcome this problem. The level of forest product utilisation was different between Nuwakot and Kavre districts where there is a different level of external support for user groups. Better performance in the Kavre district implies that the enhancement of external support for forest user groups can increase the level of forest product utilisation. Creating a user group environment for regular meetings of executive committees would also increase utilisation of forest products. The result of forest group age indicates that the probability of making distribution decisions and the extent of utilisation may increase in the future. Therefore the external interventions on the institutional factors hindering forest product utilisation could benefit rural people earlier.

Our findings showed that the forest product utilisation in forest user groups is a two step decision process. The group first decide whether to or not to utilize their forest products. Once they decide to distribute the forest products, the amount to utilize or the number of days to open the forest for utilization is another decision step. Some who played positive role in the first decision step have played negative role in the second decision step, or vice versa. This finding implies that the external interventions to facilitate product utilization can be less effective. The support should be specific to the step of the utilization decision process. This study further suggests that how the service providers for community forestry have dealt with the problems of forest user groups differs in the two steps of the product utilization decision.

Some of the factors determining forest product utilisation were endogenously determined. The endogenously institutional factors include number of women in executive committee, meeting frequency of executive committee, employing watcher, meeting hours of executive committee and higher proportion of executive member in the group. The result indicates that improving one institutional factor can contribute to the strengthening of other institutional factors that determine forest product utilisation.

External support is important in those user groups where households are facing resource scarcity on one side, and forest products are underutilized on the other side. The institutional elements, however, change with time. In order to make decisions regarding the external interventions, this type of study needs to be carried out regularly. In addition this study was based on small samples. This study encountered some unexplained findings. Community forestry user groups are functioning under complex socio-political settings which could be the reason why these problems were encountered. Therefore a further study should be done focusing on detailed analysis of the unexplained findings.

This study demonstrated an institutional model to analyse problem of product utilization in community forests but it was not without limitations. The findings are based on small number of forest user groups which potentially have unavoidable errors while estimating the given data. Other better estimation methods could be applied in large sample data. Moreover, most of the determining factors of the forest institution are dynamic in characteristics. Therefore, the finding should be used cautiously in decision making.

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Appendix

Table 1b. Descriptive Statistics of the Variables

	Mean	Standard Deviation	Minimum	Maximum
FW_{lod}	19.27	19.58	0	85
FOD_{day}	167.23	166.93	0	365
A^{p}	0.58	0.07	0.53	0.68
D_{is1}	0.36	0.48	0	1
Dis2	0.33	0.47	0	1
D_{is3}	0.31	0.46	0	1
G_{age}	7.89	2.71	2	14
LHH_{no}	4.94	0.7	3.33	6.35
E_{no}	13.79	8.59	3.08	43.23
W_{ec}	0.2	0.18	0	0.91
F_{20Y}	31.37	27.41	0	90
F_{pinp}	31.94	32.82	0	95
F_{sal}	35.01	37.5	0	96
F_{broad}	57.13	35.82	0	125
F_{natur}	73.94	32.88	0	100
Tim_{qt}	363.55	682.19	0	2600
W_{atch}	0.55	0.5	0	1
F_{und}	26372.31	40821.35	0	200000
W_{assem}	0.41	0.18	0.04	1
M_{freq}	9.27	4.81	0	20
M_{hrs}	2.81	1.21	1	8
C_{edyr}	7.06	3.53	0	16
C_{exp}	4.9	3.21	0	13
C_{org}	0.55	0.5	0	1
C_{eth}	0.82	0.39	0	1
LA_{cf}	4.94	0.7	3.33	6.35