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Household Production and Time Allocation Behaviour to Climate Change of Nepal

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Abstract

This study investigates empirically how forest resources production and time allocation's behavior links with climate change issues by using a household survey in a mid-hill village of Nepal. We use Cobb Douglas's production function theory to develop a household production function econometric model. We use two-character households: unemployed and forest-dependent population for observation of time allocation behavior for household production. In addition, we use poverty and illiteracy of household characters for understanding its effect on household decision behavior and production behavior. In outcomes of the study, household production behavior of rural people results in higher dependency on forest biomass and its consequence-climate change cause issue.

Key words: Household production, forest, time allocation & climate change.

Introduction

Climate change is a greater concern and attentive issue in the world, particularly in the developing world (IPCC, 2021). IPCC (2021) mentions the range of total human-caused global surface temperature increase from 1850-1900 to 2010-2019 from 0.8^oc to 1.3^oc with the best estimate of 1.07^oc. This average temperature rising is a powerful variable to increase destabilize ice, ocean, land, forest, and atmosphere of the world. WWF (2021) has recorded a 10 percent declining ice in Antarctica per decade. Further, WWF (2021) has predicted that more than a third of the world's remaining glaciers will melt before the year 2100. Thus this temperature rising can cause the growth rate of ice melting and glacier bursting induced big and small multiple natural disasters. Its outcomes would be unexpectedly huge and intolerable. Similarly, fire as a common hazard is frequently in the forest areas during the summer with the rate of 70000 per annum due to the temperature

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rising by the National Interagency Fire Center (NIFC) (<https://www.iii.org> › [fact-statistic](#) › [facts-statistics-wildfires](#)). It is a threat to forest wealth and biodiversity and a driver of GHG emissions and climate change. Furthermore, the effect of climate change falls more than 90 percent on the ocean than land. In the ocean, ocean acidification and deoxygenation, leading to changes in oceanic circulation and chemistry, rising sea levels, increased storm intensity, as well as changes in the diversity and abundance of marine species (IUCN, 2021). The IPCC projects the global mean sea level to increase by 0.40 [0.26–0.55] m for 2081–2100 compared with 1986–2005 for a low emission scenario, and by 0.63 [0.45–0.82] m for a high emission scenario. Extreme El Niño events are predicted to increase in frequency due to rising GHG emissions (IUCN, 2021). In climate change literature, change in land that is deforestation is a major casualty of carbon emission led atmospheric greenhouse gases (GHG), and temperature rising (Bista, 2018 & IPCC, 2021). Despite the worldwide scale of forestation, reforestation, and afforestation action, campaign, and activities, change in the land as deforestation is due to two major drivers: natural shocks and anthropogenic human activities. In natural shocks, natural fire is a major driver due to global warming. Its annual deforestation in the world is approximately 16 percent only but about 84 percent fire is due to human activities. Its loss is approximately 2 billion USD per annum in the world (<https://www.smithsonianmag.com> › [smart-news](#) › [study...](#)) In addition, in human-induced deforestation, humans cut down trees mainly for their livelihood and economic activity for their income, energy, timber, employment, settlement, and industrial activities. Deforestation per day is 80000 acres of forest land in the world. Every year from 2011 to 2015 about 20 million hectares of forest was cut down (<https://www.theworldcounts.com> › [forests-and-deserts](#)). Thus, the natural deforestation rate is less than human-induced deforestation. Deforestation alone contributes 18-25% carbon emission more than the global transportation system (IPCC, 2001, Stern, 2007, UNFCCC, 2007, Eldis, 2012, and IPCC, 2021) and the damage cost of climate change will be huge in terms of deaths, scarcity, diseases, malnutrition and GDP losses (IPCC, 2001, Stern, 2007, Eldis, 2012 and Bista, 2018). Therefore, deforestation is a major accelerator factor to climate change.

We cannot ignore that 240 million rural poor population of the developing countries of the world depend on forest resources for their livelihood (<https://www.grida.no> › [resources](#)). It means forest resources-based production function of rural poor households for their basic need livelihood and survival. In another word, the time allocation behavior of the rural poor households in the household production function concentrates on the forest. This production function maintains directly household livelihood as the opportunity cost of the forest resources as GHG emission and climate change. At the household level,

cut down trees is an individual household's behavior to operate household production but at the aggregate level, it has the power to deforest large and large forests. At the household level, its impact may be small to destabilize climate but at the aggregate level, its impact may be big to destabilize the climate. Therefore, this relationship between household production and household time allocation behavior is a big query at a micro-level and a macro level from a climate perspective as well as academic perspective, when the scientific literature (IPCC, 2001, Ali, Riaz and Iqbal, 2014, Bista, 2018 & IPCC, 2021) have established deforestation as a major cause of climate change. In the literature, there are three schools of thought to observe this issue: a) pro-active (conservation and preservation of forest) and b) reactive (i) reforestation and (ii) afforestation, c) market mechanism (REDD and CDM). They argue to save trees and stabilize the climate. Its logic is to encourage the developing world to conserve and preserve the forestland in whatever aid and trade mechanism incentives for stabilizing climate change under the property right mechanism. Additionally, the developed world has economic arguments of incentive to the poor rural population for their alternatives and benefits because of the opportunity cost of labor, land, time in the developing world less than the developed world.

Besides, the basic principles of the Kuznets curve advocate the lower per capita income as a cause of resource depletion, particularly deforestation (Todaro, 2017). It shows the relationship between poverty and forest resources. In the developing world, the household production of the poor is more dependent on forest resources for their livelihood (Godoy and Bawa 1993; Reddy and Chakravarty 1999). In the study, Amacher et. al. (1996) argues subsistence households as a leading source of deforestation because of their fuelwood consumption. Like Amacher et. al. (1996), Adhikary (2003) considers a higher forest-dependent population if they are rural poor. Similarly Angelsen, and Wunder, (2003) mention forests as a potential for poverty alleviation with possible roles as safety nets, poverty traps, and pathways out of poverty. Khuc et. al. (2020) finds a trade-off between forest cover change and household livelihoods. From this literature, rural household depends more on forest resources for livelihood objectives for household welfare. However, its externality outcome (indirect relationship) establishes the relationship between forest household production and climate change issues.

In household production, economic methods are general in this literature. Amachar et.al. (1999) and Edmunds (2001) have used the household production model for analyzing household fuelwood demand and supply and welfare. Ahikary et. al. (2003) has used an econometric model to analyze household dependency on the forest. Pattanayak et. al. (2003) has used the C-D production function. However, the relationship is not traced

out in Nepal because of different geographical variables and socio-economic variables. In the context of Nepal, still, the relationship between forest household production, labor time allocation, and climate change is a query. Thus, this paper investigates the relationship between forest households and labor time allocation in the period 2018 and what are variables behind forest household production in the static conditions. For this first investigation, the C-D production function regression model is applied.

Methodology and Data

Model

To test the relationship between household production of forest (Q_f) and time allocation for fuelwood biomass collection that is labor allocation for fuelwood biomass collection (L), Cobb- Douglas production function can be expressed as

$$Q_f = f(L_f)^\beta \text{-----(1)}$$

There are other qualitative independent variables which are a household character (h_c) and household literacy (h_e) influences household. Therefore, the Cobb-Douglas production function's econometric model is developed as follows.

$$\ln Q_f = \alpha + \beta \ln L_f + \beta_1 h_p + \beta_2 h_e + e \text{-----(2)}$$

Where, α , β , β_1 , β_2 , β_3 , β_4 and β_5 are parameters which are

$$\alpha > 1, 0 < \beta < 1, 0 < \beta_1 < 1, \text{ and } 0 < \beta_2 < 1$$

e = error term which is a random variable.

Study Area

The data set, which was used here, was collected from a household survey conducted in Kalimati Village, Lamjung District, Gandaki Province of Nepal in 2019. The study area, Kalimati Village that was remote and rural areas of Lamjung District located in trans Himalayan geo ecological belts (Mid Hill) areas in the altitude range from 300 ft to 6500 ft from the sea level and approximately 150 kilometers far west north of Kathmandu Centre. This beautiful trans Himalayan village, one of the Gouda Village Development Committee (Gouda Rural Municipality), Lamjung was selected for the household survey because the poor rural households had experimented with the contract forestry model to conserve the forest resources and to generate resources, income, and employment for their livelihood security and safety for their poverty reduction and welfare.

Sample Selection and Sample size

The study area, Kalimati village was selected purposively based on the performance of leasehold forest, year of leasehold, and progress report of the leasehold forest. In the study area, almost all households that were 476 were active members of the Kalimati leasehold forest.

Based on income groups, caste, communities, and sex, there were made four clusters so that all caste and income groups could represent proportionally. In general, a 10 percent sample size is considered a representative sample. This golden rule was followed but the sample size was 9 % (42 households) because of the error of questionnaire fill up (table -1).

The lottery method was employed to select sample households by generating random numbers by using excels sheets. Its detail is in the table below.

Table 1: Sample of leasehold forest

District	VDC	No of LF	HH	Sample No	Sample Village	Sample Ward	Sample HH
Lamjung	Gouda	6	476	1	Kalimati	3	42
Total		6	476	1			42

Source: Field Survey, 2019

Data Collection Method

The data set of the study was collected from a household questionnaire survey in Kalimati Village. PRA method was used, along with case study method and interview method so that quantitative and qualitative data could be collected from 42 sample households. For supplementary, we collected secondary data sources such as a minute book, the procedure of decision making, structure and function of the Bhangeri Pakha Leasehold Forestry Program reports and also *Ninth Plan*, *Tenth Plan*, *Economic Survey*, *Web Browsing of Research report related to Leasehold Forestry in Midhill areas*, reports of DEPROSC, *Fifteen Plan*, etc

Household characters were homogeneity in terms of food sufficiency, literacy, social security, and caste. Average household size was also like of national household size (approximately 5 household members). The primary income, employment, and livelihood source of almost all households was agriculture. In addition, fuelwood and

other forest products were perceived as supplementary sources of income, employment, and livelihood. In simple, forest dependency was just like in other rural areas of Nepal was extremely higher because of leisure time, traditional social-economic activities, and absence of alternatives.

These characters influence fuelwood collection (fuelwood production) from the contract forest and another open-access forest. These characters were defined as dummy because of qualitative information.

Estimation of C-DHPF

The data set of C-DHPF includes four variables: weekly quantity of forest fuelwood collection and production (q_f), weekly time allocation for household forest production (L_f), and qualitative household character variables such as poverty (h_p) and illiteracy (h_c). When we conducted a household survey, there was curiosity on the relationship between household and forest in open access resource regime because household fuelwood production requires household time allocation as input of production. We had to explore the relationship to understand further household production and time allocation. In the Participatory Rural Appraisal (PRA) survey we got a unanimously positive response, they responded with a statement, “We use forest resources for our livelihood, income, and micro-enterprises”. To test household fuelwood production and labor time allocation of household, we focused on two questions for quantitative and qualitative information such as.

- How much time allocation of households per week from their leisure for weekly fuelwood collection production?
- What are the effect of poverty and illiteracy levels of individuals on household time allocation decisions and household fuelwood production behavior?

We interpreted answers to the first question such as quantitative information of household fuelwood production (q_f) and labor time allocation of household (L_f). Quantitative information of household fuelwood production (q_f) was measured in terms of *Doko* (50 kg weight unit) per week, meanwhile, labor time allocation of household from leisure time was measured in terms of hours unit. In open access regime forest management, labor time allocation of the household was only household fuelwood production but there were household characters variables such as poverty and illiteracy. They influenced labor time allocation decisions and household production behavior but which level of influence, we could get it from qualitative information of poverty and illiteracy.

Results of C-DHPF

Table-1 provides the mean and standard deviation of key variables in C-DHPM estimation samples. In column 1, there are key variables such as Quantity of fuelwood production (dependent variable) and Labor time allocation per week (L_p) (independent variable). In addition, there are two dummy variables (poverty level and literacy). Standard deviation gives no more deviation character of household data from the mean. Thus, the mean of key variables represents proper household data of key variables collected from the household survey.

In addition, more mean household labor time allocation per week on household fuelwood collection production indicates more leisure time, no information, physical inaccessibility, and lack of alternative economic activities in rural areas because of poor development delivery. This household decision and behavior is made rational by evidence of poverty level and illiteracy. Thus, household production in rural areas has labor input only.

Table 2: Mean and standard deviations: C-DHPF estimation sample

Variables	Household sample
Quantity of fuelwood production	0.72(0.140)
Labor time allocation	1.22(0.133)
Poverty level	0.10(0.297)
Illiteracy	0.38(0.492)

Table-2 presents the results of the regression of the dependent variable, Quantity of fuel wood production (Q_p) on one independent variable, weekly household labor time allocation (L_p), and dummy variables such as household poverty level and household illiteracy. There are three coefficients such as β , β_1 , and β_2 . In the results of regression, the coefficient of weekly household labor time allocation(β) indicates how much weekly labor time allocation is the input of fuelwood collection production, so much fuelwood collection output will come if there is open access regime and forest stock of fuel biomass is available. The input-output relationship between household fuelwood production and weekly labor time allocation has a positive relationship. Dummy variables such as poverty and illiteracy also provide evidence of explanation.

Table 3: Results of regressions of quantity of fuelwood production on weekly household labor time allocation, household poverty level, and household illiteracy

Dependent variable: Average Quantity of fuelwood collection & production			
Repressor	1	2	3
Weekly Household Labor Time allocation (L_t)	1.058(0.005)		
Poverty level (h_p)		0.003(0.002)	
Illiteracy (h_e)			0.001(0.001)
Intercept(α)	-0.574 (0.007)		

Discussion, Conclusion and Policy Implication

Considering the above results of C-D HPM, they provide sufficient and necessary evidence on the positive relationship between household fuelwood collection and household labor time allocation. In this relationship, labor time allocation of household on production behavior in rural areas is only in fuelwood production (collection), if the household has a lack of job alternatives (zero opportunity cost), capital deficiency but has leisure time. It provides strong evidence that a large rural family is a source of large labor, the large labor time and large time allocation on fuelwood collection in the study areas. In the model, the R^2 value is 0.99. It means fuelwood collection production is explained by independent variable by 99%, along with dummies. The model is justified.

Poverty level – below the poverty line defined as minimum subsistence level or less than \$ 2 per day earning is massively rural incident by Tenth Five Year Plan (NPC, 2002). In the household, if there is low income, this is a low opportunity to meet basic needs and the lower opportunity cost of labor. It makes needy to the people for utilizing open access resources such as a forest. If households have leisure, no alternative (zero opportunity cost of labor), and livelihood needy, households have a motivation to collect fuelwood for maximizing their livelihood objective, although such activities have destroyed the forest resources of the country. At the rural household level, it is rational from their survival point of view because the poor household prefers for their survival. In addition, the poor people are illiterate -not able to write, read and understand. They are not aware of the roles and importance of forest resources, except for their intuitive decisions. These two rural poor households’ character leads to higher dependency and consumption of fuelwood.

It is found that the average labor productivity of households on fuelwood production is lower. It is evidence of declining forest stock and more distant forest locations from households in mid-hill Nepal. Due to their higher dependency on forests leading to deforestation, forest stock and forest locations are found shifting far ahead. Slowly and gradually, the rural poor household's fuelwood-based production function has been slow and their time allocation behavior has been changing to explore alternatives for their livelihood because of deforestation-induced shifting forest locations. In the absence of alternatives, the struggle of the poor rural households would be unexpectedly tough. In the climate perspective and resources balanced perspectives, this will be a serious issue if the policy initiation is not considered.

We conclude that rural household leisure time, poverty, and illiteracy, along with lack of alternatives (opportunity cost of labor) explain their household fuelwood collection and production, although agricultural productivity is lower. This production function indicates a higher dependency of the rural households on forest resources for livelihood objectives. When Household maximizes the utility of forest resources, it will deepen more deforestation issues and its consequent threat-climate change issue. From this outcome, poverty and illiteracy explain household time allocation behavior and decision process in forest household production of rural areas without thinking what will be effects of deforestation on their household livelihood behavior and decision. Optimization behavior of forest household production and time allocation behavior results in higher deforestation rate, generation of the distance between forest and household, declining marginal labor forest productivity, and declining forest biomass stock. IPCC (2001) and IPCC (2021) provide sufficient evidence of carbon emission from deforestation. Thus, forest household behavior and time allocation behavior of rural areas of developing countries leads to deforestation and then climate change issues, despite its lower contribution. Therefore, policy alternatives on the efficiency of fuel consumption, institutional development, and development of labor market are required for addressing such household production behavior and labor time allocation pattern for reducing deforestation and GHG emission.

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