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The determinants of fuel wood exploitation for household energy security in Kashmir Himalaya, India

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Abstract
The study investigated the household exploitation patterns of fuel wood and the role of determinant factors in fuel wood exploitation in Ganderbal district of Kashmir Himalaya. Multi-stage random sampling technique was employed to select sample villages (9) and households (380) for field survey. Data collection was done through structured interviews and non-participant observations. Descriptive and analytical statistics were employed to analyse the data. Results revealed that total extraction of fuel wood was 768.41 tons annum^{-1} @ 0.79 kg per capita day^{-1} while the consumption was 1152.60 tons annum^{-1} @ 1.18 kg per capita day^{-1}. Thus, there is a shortage of 384.19 tons of fuel wood annum^{-1} @ 0.39 kg per capita day^{-1}. The people are resource-poor characterized by low socioeconomic conditions and inadequate biophysical assets. Correlation analysis ($r = -0.601$ to 0.670; $p = 0.000$) indicated that the determinant factors exerted a strong influence on appropriating household fuel wood exploitation. Regression analysis ('t' value = 2.215 to 8.525) revealed that household size, livestock holding, primary occupation, gross annual income, proximity to the forest, forest resource possession and access to alternative energy sources are the key determinants influencing significantly the fuel wood exploitation and the R^2 (0.778) indicated that 77.80% of the variation in the fuel wood exploitation was explained by the determinant factors. To tackle the overwhelming household fuel wood dependency on forests, policy must be directed towards the diversification of alternative energy sources, promotion of low-cost technologies, afforestation programmes and substitution fuel wood.

Keywords: Determinants, fuel wood, exploitation, energy, Kashmir, Himalaya

1. Introduction
Globally, over three billion people are dwelling in rural areas with inadequacies of energy supply for cooking, heating, lighting, cottage industries and other household functions (World Bank, 2015) [1]. Worldwide, 1.4 billion people have limited access to electricity and 2.7 billion people rely on biomass fuel for energy security (IEA, 2010) [2]. Biomass accounts for 14% of the total global energy use and is the largest energy source for the three-quarters of the world's population living in the developing countries like India (FAO, 2007) [3]. The bioenergy is the commonest service material which plays a pivotal role in socioeconomic development and livelihood sustainability in rural households (Asikuallah and Masakazu, 2017) [4]. Substantial amount of bioenergy such as fuel wood, charcoal, agricultural residues, dung and leaves are used by households and industries in rural world. The main household use is cooking and heating whereas industrial use includes mineral processing (bricks, lime, tiles, ceramics), food and agro processing, metal processing, textiles dyeing, road tarring, tyre retreading, ceremonies, power generation (Sein *et al*., 2015) [5]. Hence, the bioenergy has been nested at the intersection of world's three great challenges namely, energy security, climate change and poverty reduction and has received profound attention among the world's developmental agencies in the past few years (FAO, 2007) [3]. Bioenergy deserves a special focus in the global energy consumption equation as it accounts for a significant proportion (35%) of total energy consumption in developing countries (Lusambo, 2016) [6]. According to IEA (2012) [7] bioenergy is the world's largest single renewable energy source accounting for 10% of world primary energy supply, since much of the world's population uses wood, charcoal, straw, or animal dung as cooking fuel. The most pervasive challenge of bioenergy consumption is how to access bioenergy to facilitate economic growth without environmental deterioration (Sati and Song, 2012) [8]. Among the various forms of biomass, fuel wood is the most attractive one and occupies a predominant place in the rural energy budget of the country (Islam and Quli, 2016) [9].
Fuel wood is the main source of energy for cooking and heating for almost all households in rural world. The fuel wood accounts for over 54% of all global wood harvest per annum,

leading to a considerable depletion of the forests (Wahab *et al.*, 2008) [10]. The fuel wood is often sourced from agricultural lands, public and private plantations and natural forests as either live or deadwood (Singh and Sundriyal, 2009) [11]. Rural families' high preference of fuel wood for both space heating and cooking and the high cost and irregular supply of alternative fuel sources such as charcoal, electricity, liquid petroleum gas (LPG) and kerosene often makes fuel wood the only viable source of energy (Ullah, and Tani, 2017) [12]. Fuel wood will continue to be the preferred domestic energy source in the future, as households do not climb up the energy ladder with increasing income (Bouget *et al*., 2012) [13]. Apart from household consumption, the bulk of fuel wood is consumed in industries, institutions, prisons, enterprises, food processers, camping sites and power production. Several challenges hinder sustainable access and utilization of fuel wood, specifically, the imbalance between supply and demand, gender inequality and knowledge gaps (Apu *et al*., 2016) [14]. The fuel wood scarcity enhances the burden of fuel wood exploitation as people have to stride long distances to fetch fuel wood. Fuel wood shortage is chiefly determined by the household's capacity to access resources such as land, labour, money and substitute fuels (Ikurekong *et al*., 2009) [15]. The indiscriminate exploitation of fuel wood has been recognized as most significant cause of forest depletion in many developing countries (Ndayambaje and Mohren, 2011) [16]. Excessive fuel wood exploitation by too many people on too few forested areas can cause significant environmental degradations including loss of biodiversity, deterioration of watershed management, release of carbon into the atmosphere, soil erosion, *etc*. (Matsika *et al*., 2012) [17]. Many forests in the country (Chandra *et al*., 2008 [18]; Mushtaq *et al*., 2014 [19]; Sharma *et al*., 2014 [20]; Baba *et al*., 2015 [21]; Islam *et al*., 2015a [22]) represent such a scenario, with huge human populations relying on vanishing, reducing and fragmenting forests to meet their household fuel wood demand. Hence, any depletion of forest resources can erode living standards as well as ecosystem stability (FAO, 2010) [23]. To tackle indiscriminate fuel wood exploitation from the forests to retard forest depletion profound policy implication is imperative. This would require a comprehensive study to determine the key factors influencing fuel wood exploitation for household energy security and devise strategies to reduce fuel wood exploitation from forests. There are several studies (Saud *et al*., 2011[4]; Mushtaq *et al*., 2014 [12]; Apu *et al*., 2016 [14]; Ullah and Tani, 2017 [19]; Asikuallah and Masakazu, 2017 [24]) on determinant factors of fuel wood exploitation across the world, but the comprehensive work to study determinant factors (social, economic and biophysical) affecting household fuel wood exploitation in Kashmir Himalaya is still lacking. With this background, the present study was designed to study household fuel wood exploitation and to identify the determinant factors which influence the fuel wood exploitation.

Materials and Methods

Study area

The study was conducted in Ganderbal district (Fig. 1) located between 34.23°N latitude and 74.78°E longitude at altitudes of 1650 to 3000 meters above MSL in Kashmir Himalaya. Total geographical area of the district is 39304 ha and the land use is categorized as cultivated land (42.42%), forest (27.86%), non-agricultural use (14.65%), barren and un-cultivable land (8.04%), permanent pastures and other grazing land (4.55%) and cultivable waste land (2.48%) (Anonymous, 2011) [25]. The district is characterized by both temperate and sub-alpine conditions and the mean minimum and maximum temperatures are 5^0 C to 20^0 C respectively, with average annual precipitation of 700 mm. Agriculture and associated activities form the main occupation of the people in the district. Total human population in the district is 297446 (158,720 male and 138,726 female) living in 136 villages and 44831 households. The district has literacy rate of 59.98%, sex ratio of 874 female per 1000 males, family size of 6.62 and population density of 1148 per km^2. Of the total population in the district, 84.19% is rural and 15.81% is urban (Census of India, 2011) [26].

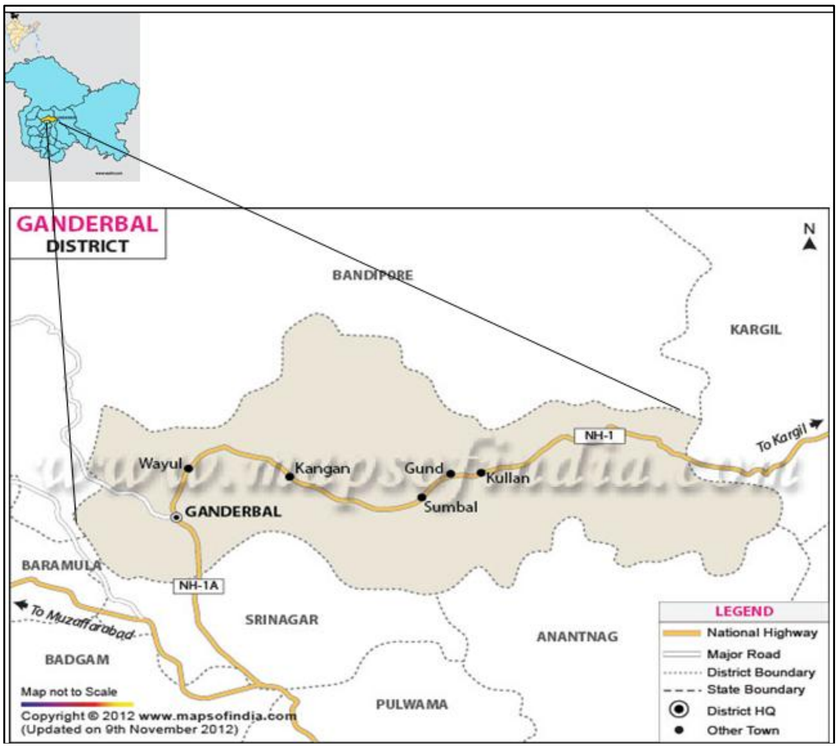

Fig 1: Location of the study area

Sampling procedure

A multi-stage random sampling technique (Ray and Mondol, 2004) [27] was employed to select the villages and households. In the first stage, three blocks namely, Ganderbal, Lar and Kanagan of the Ganderbal district were randomly selected. In the second stage, ten villages *viz*., Arhama, Yarmuqam, Manigam, Haripora, Manigam from Lar block, Wayil, Gotli bagh, Nunner, Urpash from Ganderbal block and Wussan from Kangan block were selected using simple proportionate random sampling. The households were selected using proportionate allocation and simple random sampling in the selected villages. The final sample size comprised of 380 households for the field study at 5% sampling intensity and the respondents interviewed were either household heads or eldest members.

Data collection

The data were collected through personal interviews of the respondents using a well structured pre-tested interview schedule and non-participant observation (Kumar, 2012) [28]. The interview schedule was constructed on the basis of reconnaissance survey of the region, discussion with the local people, consultation with the experts and earlier related works. The interview schedule possessed household level information on domestic fuel wood collection and consumption and socioeconomic and biophysical factors of the sample households. The socioeconomic and biophysical factors comprised were age of household head, education, household size, family labour, landholding size, livestock holding, primary occupation, gross annual income, proximity to the forest, forest visit, forest resource possession and access to alternative energy source. Interview in most cases were conducted in a group of family members in order to get in-depth information. Under non-participant observations the data were recorded by watching and noting the phenomena personally.

Data analysis

The descriptive and analytical statistics *viz*., frequency (f), percentage (%), average (x), standard deviation, range, confidence interval, F-value, co-efficient of correlation and multiple regression (Snedecor and Cochran, 1967) [29] were applied for the data analysis. The data were analyzed using MS Excel and Statistical Package for Social Sciences (SPSS) software and the results were displayed through tables.

Model specification

The multiple regression model is a multivariate statistical technique used in predicting and establishing the relationship between a dependent variable (Y) and selected independent variables (X_{1-12}). Here, a linear logistic regression model was tested to understand the relationship between household's fuel wood exploitation and their socioeconomic and biophysical characteristics. It was hypothesized that domestic fuel wood exploitation is inextricably associated with household's socioeconomic and biophysical attributes. So, variation in fuel wood exploitation among households can be explained by the socioeconomic and biophysical attributes of user households. The model is statistically expressed as follows:

$Y = a + b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots.. + b_{10}x_{12}$

Where, Y = Consumption of fuel wood (tons annum^{-1})

X_1 = Age (year)

X_2 = Education (No. of years undergone in education)

X_3 = Household size (No. of family members in a household)

X_4 = Family labour (No. of workers in the family)

X_5 = Landholding size (Land area under household management)

X_6 = Livestock holding (No. of livestock owned)

X_7 = Primary occupation (Occupation in which an individual is engaged for six months or more in a year)

X_8 = Gross annual income (₹/annum)

X_9 = Proximity to the forests (Distance between forests and house)

X_{10}= Forest visit (Frequency of forest visits)

X_{11}= Forest resource possession (No. of trees owned by the households)

X_{12} = Access to alternative energy source (Accessibility and consumption of alternative energy source)

a = Constant or intercept and

b_1-b_{12} = Regression coefficients

In the analysis, consumption of fuel wood was the regress and socioeconomic and biophysical characteristics were the repressors.

Results and Discussion

Fuel wood exploitation

The total extraction of fuel wood was found to be 768.41 tons annum^{-1} @ 0.79 kg per capita day^{-1} and 5.53 kg per household day^{-1} in the surveyed population. Of the total extraction, 25.45% was secured from forests, 38.81% from agroforestry, 14.08% from social/ community forestry and rest 21.66% from homestead forestry (Table 1). The total fuel wood consumption was recorded to be 1152.60 tons annum^{-1} @ 1.18 kg per capita day^{-1}and 8.30 kg per household day^{-1}. Thus, there is a shortage of 384.19 tons of fuel wood annum^{-1} @ 0.39 kg per capita day^{-1} which is procured by purchase from the forest depots or imported from nearby areas. Of the total consumption, cooking and heating are the major areas where 45.61 and 37.91% of the fuel wood are consumed respectively. The other categories where rest of the fuel wood is consumed are cottage industries (7.58%), household function (6.14%) and protection from wild animals, cremation, *etc*. (2.76%).

Table 1: Exploitation of fuel wood for household energy security in Kashmir Himalaya (N=380)

Extraction		Consumption	
Source	**Quantity (tons annum^{-1})**	**Category**	**Quantity (tons annum^{-1})**
Forests	195.57 (25.45)	Cooking	525.67 (45.61)
Agroforestry	298.21 (38.81)	Cottage industries	87.38 (7.58)
Social/ Community forestry	108.19 (14.08)	Heating	436.91 (37.91)
Homegarden	166.44 (21.66)	Household functions	70.74 (6.14)
-	-	Others (Protection from wild animals, cremation, *etc.*)	31.90 (2.76)
Total	768.41	Total	1152.60
X $\pm$ S.E.	2.02 $\pm$ 0.03	X $\pm$ S.E.	3.03 $\pm$ 0.05

Note: Figures in the parentheses show percentage; S.E.= Standard Error

Agrisilviculture, hortisilviculture, hortisilvipasture and agrisilvihorticulture are the major agroforestry systems being practiced traditionally to meet major quantity of the fuel wood needs in Kashmir Himalaya (Islam *et al*., 2017) [30]. *Salix alba*, *Populus deltoides*, *Robinia pseudoacacia*, *Populus nigra*, *Morus alba*, *Juglans regia*, *Ulmus wallichiana*, *Ailanthus excelsa*, *Malus domestica*, *Pyrus communis*, *Prunus persica*, *Prunus armeniaca etc*. are the tree species generally grown in agroforestry practices (Islam *et al*., 2015b) [31]. The forests were the 2nd largest source of fuel wood for the rural households in the forest-rich district (Mushtaq *et al*., 2014) [19]. People regularly visit to the proximate forest areas, collect fuel wood and bring back as head-loads to procure their household needs (Banyal *et al*., 2013) [32]. The Kashmiri homegardens supply a sizeable quantity of fuel wood for household consumption. The homegardens exhibit a complex structure, both vertically and horizontally and the size ranges from 0.0025 to 0.50 ha with an average of 0.063 possessing a rich diversity of fuel wood species (Anjum, 2017) [33]. The social/ community forestry plantations were the important land based common property resources for the rural people where they rely to a great extent for their household fuel wood supply (Islam, 2008) [34].

The local inhabitants cook several meals and feeds per day requiring sizeable quantity of fuel wood; hence, the cooking is the main area were maximum quantity of fuel wood is consumed (Islam *et al*., 2011) [35]. Heating of rooms and water is the next important sector where huge quantity of fuel wood is consumed to counter severe cold conditions during winter (Mushtaq *et al*., 2012) [36]. Cottage industries like wicker works, carpet making, silk works, reed matting, pottery *etc*. are the important subsidiary occupation for livelihood subsistence and hence, a large quantity of fuel wood is required to run these enterprises (Banyal *et al*., 2013) [32]. The local people fully depend on fuel wood to perform household functions like birth rituals of *sundr*, *zerkashi* and *khatnahal*, marriage rituals of *Gandum*, *doonlaiz*, *dapandbata*, *menzirat*, *nikaah*, *withal*, *etc*. and the death rituals of *cheharum* and *chehallum* which are integral part of their socio-culture (Baba *et al*., 2015) [21]. Similarly, the people consume a considerable quantity of fuel wood in some other activities like protection from wild animals, cremation, *etc*.

Determinant factors

Descriptive statistics (Table 2.) of household socioeconomic and biophysical factors indicated that the families were headed by middle aged (41.46) people having low literacy (1.52), large sized families (6.18) and labour force above 3 (3.94). These families owned marginal size of land holding (1.09) and medium herd size (4.35), engaged mainly in agriculture (3.18) and earned average gross annual income of ` 86943.42. The proximity to the forests of the households was 6.04 km where the members visited frequently (2.37) to collect fuel wood to meet household needs. Average number of trees owned by the households in their agroforestry fields or homesteads was 33.67 and the families accessed limited number (3.01) of alternative energy source to substitute the fuel wood needs.

Table 2: Descriptive statistics of variables influencing household fuel wood exploitation (N=380)

Determinants (Code)	Mean	Std. Dev.	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
Age (X_1)	41.46	10.94	40.36	42.57	18.00	70.00
Education (X_2)	1.52	1.82	1.33	1.70	0.00	6.00
Household size (X_3)	6.18	2.02	5.97	6.38	3.00	10.00
Family labour (X_4)	3.94	2.31	3.71	4.17	1.00	9.00
Landholding size (X_5)	1.09	0.29	1.06	1.12	1.00	2.00
Livestock holding (X_6)	4.35	3.54	3.99	4.70	0.00	16.00
Primary occupation (X_7)	3.18	1.28	3.06	3.31	1.00	6.00
Gross annual income (X_8)	86943.42	82206.31	78651.58	95235.25	29000.00	485000.00
Proximity to the forests (X_9)	6.04	4.81	5.56	6.53	0.50	18.00
Forest visit (X_{10})	2.37	0.88	2.28	2.46	0.00	3.00
Forest resource possession (X_{11})	33.67	43.96	29.24	38.11	5.00	356.00
Access to alternative energy source (X_{12})	3.01	1.08	2.90	3.12	1.00	5.00

The prevalence of middle aged household heads could be due to the facts that the middle aged people are generally enthusiastic, innovative, experienced and hard working. The low literacy might be due to low socio-economic conditions, lack of educational facilities, higher involvement in livelihood earnings and ignorance towards education. Consideration of child as asset to the family who can contribute to livelihood earning and lack of knowledge of the family planning might be the reasons for large sized families. The large-sized family is undoubtedly responsible for high family labour. The predominance of marginal farmers is due to the nuclear and neo-local structure of families which urged early fragmentation of land from generation to generation and among married off-springs. Holding good number of livestock could be attributed to the fact that livestock rearing is the most preferred secondary occupation. Agriculture, livestock rearing, petty business and cottage industries are the main occupations fetching inadequate gross annual income. The district has rich forest resources; hence, the people have easy proximity to the forests and they visit frequently to extract fuel wood. Forest resource possession under agroforests and homesteads is age-old practice to meet household fuel, fodder, timber and other NTFPs needs. The resource-poor people with low income and inadequacies of infrastructure limit them to access alternative unconventional energy sources. Similar findings were reported by the earlier workers (Chandra *et al*., 2008 [18]; Gupta *et al*., 2009 [19]; Islam *et al*., 2011 [21]; Banyal *et al*., 2013 [32]; Mushtaq *et al*., 2014 [35]; Baba *et al*., 2015 [37]) of the state.

Correlation analysis

The correlation analysis (Table 3) indicated that among the twelve household socioeconomic and biophysical variables considered, nine variables *viz*., education (0.488), household size (0.670), family labour (0.572), landholding size (0.421), livestock holding (0.580), primary occupation (0.413), gross annual income (0.426), proximity to the forest (0.655) and forest visit (0.559) had positive significant correlation with fuel wood consumption. Forest resource possession (-0.588) and access to alternative energy source (-0.601) have shown negatively significant association with the fuel wood consumption whereas age (0.097) has non-significant relationship.

Table 3: Correlation of determinant variables with fuel wood exploitation (N=380)

Determinants (Code)	r	p
Age (X_1)	0.097	0.060*
Education (X_2)	0.488	0.000**
Household size (X_3)	0.670	0.000**
Family labour (X_4)	0.572	0.000**
Landholding size (X_5)	0.421	0.000**
Livestock holding (X_6)	0.580	0.000**
Primary occupation (X_7)	0.413	0.000**
Gross annual income (X_8)	0.426	0.000**
Proximity to the forest (X_9)	0.655	0.000**
Forest visit (X_{10})	0.559	0.000**
Forestry resource possession (X_{11})	-0.588	0.000**
Access to alternative energy source (X_{12})	-0.601	0.000**

*= non-significant; **= significant ($p<0.01$)

The probable reasons for positively significant correlation between education and fuel wood consumption might be that the education develops knowledge which makes the persons aware of utilizing the most cost-effective, easy accessible and eco-friendly sources of household energy (Apu *et al*., 2016) [14]. The larger sized families consume more quantity of fuel wood in cooking, heating, household functions *etc*. as compared to small sized families (Onyeneke *et al*., 2015) [38]. High labour investment in fuel wood extraction helps the people to meet their household requirement very easily and timely; hence the higher the labour force the higher the quantity of fuel wood exploitation (Islam *et al*., 2015a) [22]. The persons who have larger size of land holding will also have more livelihood diversification by encompassing appropriate combinations of farm enterprises requiring larger quantity of fuel wood (Sharma *et al*., 2014) [20]. Hence, the proportion of fuel wood exploitation increased with the increase in landholding size. Fuel wood is a vital energy source for preparation of feed for livestock as well as livestock products and bye-products in Kashmir Himalaya (Banyal *et al*., 2013) [32], thus, the size of livestock holding is directly related to the quantity of fuel wood exploitation. Farming conform the backbone of the economy sustaining it as the primary occupation of most of the households. The families engaged in non-farming occupations were also doing farming as their subsidiary occupation. The households who are fully involved in farming exploit more fuel wood than the households who are not fully involved in farming (Dhanai *et al*., 2015) [39]. This implies that the exploitation of fuel wood was higher in the households with diversified occupational pattern. The gross annual income is the prominent indicator of financial capital possessed by the people which govern the purchasing power for livelihood sustenance (Bhattarai, 2013) [40]. The persons thus, who have higher gross annual income also have higher quantity of fuel wood purchased from the forest depots or imported from the nearby areas. The heterogeneity of households in proximity to the forests has clear-cut impact on the quantity of fuel wood exploitation (Sein *et al*., 2015) [5]. That's why the amount of fuel wood exploited varied greatly between proximate and distant households. The frequency of forest visits exerted a strong influence on appropriating fuel wood exploitation from forests (Ali and Benjaminsen, 2004) [41]. Thus, higher the frequency of forest visits in the households the higher was the fuel wood exploitation. The inequalities among households in forestry resource possession differentiate apparently the scale of fuel wood extraction from forests (Bearer *et al*., 2008) [42]. Hence, the higher the forestry resource possession the lower was the extraction of fuel wood from forests and vice-versa. The availability and access of diverse energy sources in the villages is a key factor influencing exploitation of fuel wood (Chandramolly and Islam, 2015) [43]. Thus, it is obvious that the households who have higher access to alternative energy sources also have limited requirement of fuel wood and vice-versa. Since, fuel wood exploitation is a mandatory activity to meet household energy security among the people of all age groups whether young, middle-aged or old in the Kashmir Himalaya (Mushtaq *et al*., 2014) [19], hence, the age had non-significant correlation with fuel wood exploitation.

Multiple regression analysis

Linear multiple regression was done to analyse the determinants of fuel wood exploitation and the relationship is described in the following formula:

$Y = 0.999 - 0.020X_1 - 0.019X_2 + 0.447X_3 + 0.000X_4 + 0.147X_5 + 0.040X_6 - 0.492X_7 + 3.266X_8 + 0.100_9 + 0.032X_{10} - 0.005X_{11} + 0.177X_{12}$

Where, Y = Consumption of fuel wood (tons $annum^{-1}$)

$X_1 – X_{10}$ = Determinants factors

The linear form indicated that among the determinants factors seven variables *viz.*, household size, livestock holding, primary occupation, gross annual income, proximity to the forest, forest resource possession and access to alternative energy source were statistically significant in influencing the fuel wood exploitation (Table 4.). The linear form is a lead function because it has the R^2 value of 0.778, the F-value of 107.25 and seven significant variables. The value of the coefficient of determination (R^2) indicated that 77.80% of the variations in the volume of fuel wood exploited by the households is explained by the determinant variables in the regression model. The implication of this outcome is that 77.80% of fuel wood consumption is induced by the determinants variables. The magnitude of F value indicated that the R^2 is statistically significant ($p < 0.05$) which clearly showed that the model is very strong, reliable and has high predictive ability.

Table 4: Multiple regression estimates of the determinant variables of fuel wood exploitation (N=380)

Determinants (Code)	B	SE (B)	Beta	't' value
Age (X_1)	-0.020	0.004	-0.193	-0.590
Education (X_2)	-0.019	0.062	-0.032	-0.311
Household size (X_3)	0.447	0.052	0.891	8.525*
Family labour (X_4)	0.000	0.042	-0.001	-0.016
Landholding size (X_5)	0.147	0.214	0.039	0.688
Livestock holding (X_6)	0.040	0.017	0.129	2.397*
Primary occupation (X_7)	-0.492	0.060	-0.569	-8.251*
Gross annual income (X_8)	3.266	0.000	0.242	3.416*
Proximity to the forest (X_9)	0.100	0.024	0.436	4.216*
Forest visit (X_{10})	0.032	0.080	0.026	0.400
Forest resource possession (X_{11})	-0.005	0.001	-0.187	-3.945*
Access to alternative energy source (X_{12})	0.177	0.080	0.174	2.215*

a = 0.999 F = 107.25* R^2 = 0.778 Multiple R = 0.882 Adjusted R^2 = 0.771

* = Significant at 5% level of probability

The multiple regression analysis indicated that the determinant factors *viz.*, household size, livestock holding, primary occupation, gross annual income, proximity to the forest, forest resource possession and access to alternative energy source had significant contribution to the fuel wood exploitation and thus, were the potential predictors in explaining the variation in the fuel wood exploitation.

The household size has direct linkage with the quantity of fuel wood exploitation. This implies that larger families exploit more fuel wood than their counterparts with smaller families. Livestock holding has direct influence on quantity of household fuel wood exploitation which implies that the larger livestock holders exploit more fuel wood than the larger livestock holders. Primary occupation and gross annual income are the prominent economic resources which have direct link with the household fuel wood exploitation. This implies that the households who are fully involved in farming and having considerable gross annual income exploit more fuel wood than the households who are not fully involved in farming and have low gross annual income. The dependency on fuel wood for household energy security is higher among proximate families than the distant families. Similarly, the higher the forest resource possession in the households lower is the dependency on forests for fuel wood. Access to alternative energy sources is the crucial variable having direct impact on fuel wood exploitation, hence, the families who have higher access to alternative energy sources have lower dependency on fuel wood. Several studies (Sapkota and Oden, 2008 [9]; Egeru *et al*., 2010 [44]; Ndaghu *et al*., 2011 [45]; Ebe, 2014 [46]; Islam and Quli, 2016 [47]) emphasize that the household socioeconomic and biophysical determinants drivers are important actors in fuel wood exploitation for household energy security.

Conclusion

The foregoing discussion led to conclude that the rural people exploit enormous quantity of fuel wood mostly from the forests and their farms and utilize same for cooking and heating their homes in Kashmir Himalaya. Households' dependency on fuel wood as a source of energy is overwhelming. The fuel wood is chief, exceptionally preferred and cheap energy source because the area is characterized by resource poor, low income and peasant farmers with inadequacies of socioeconomic and biophysical infrastructure. The analyses herein suggest that varying degree of household's fuel wood exploitation is primarily driven by several socioeconomic and biophysical conditions. The household size, livestock holding, primary occupation, gross annual income, proximity to the forest, forest resource possession and access to alternative energy source are the statistically significant determinant factors affecting household fuel wood exploitation. The study has evidently shown that there is a huge pressure on natural forests for fuel wood to meet household energy security resulting in deforestation and degradation of the natural environment. Diversification of alternative energy sources, reduction of the prices of alternative energy sources, provision of rural infrastructure, development and promotion of low-cost technologies for reducing fuel wood consumption, implementation of afforestation programmes, substitution of fuel wood and awareness development towards environmental protection and biodiversity conservation will have a significant impact on reducing pressure on natural forests in the study area.

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