

Research Article

Consumption Pattern Of Fuelwood And Fodder In Western Nayar Watershed At Puari District Of Garhwal Himalaya, Uttarakhand, India

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Fuelwood and fodder consumption pattern was studied in natural resource-based three villages of Western Nayar Watershed at Pauri district of Uttarakhand, India. It was observed that Fuelwood collection in the villages started during October and finished by April end. Extensive Fuelwood collection and storage were in February, March, and April. The occasional collection was also found around the year except during rains. It was assumed that the inhabitants on average collect Fuelwood for about 180 days/year. The total green fodder consumption in Khaira village during summer was found 27.076 ± 5.873 kg/day/household from the forest, 6.892 ± 2.069 kg/day/household from the agriculture field. Total dry fodder consumption was found maximum for Khaira village during summer was 9.620 ± 2.634 kg/day/household from the forest and 7.046 ± 2.642 kg/day/household from the agriculture field.

KEYWORDS: Fuelwood; Fodder; Season; LPG.**1. INTRODUCTION**

The Himalayan landscape comprises forests and pastures where agriculture and other land uses are distributed as patches. The economy is agrarian. Which is still at the subsistence level. A typical hill village is characterized by agriculture as the main occupation and dependence on forest for daily fuel and fodder requirements [1]. The majority of inhabitants are, thus, engaged in agriculture. The agriculture pattern in this region is very complex. Terraced slopes cover about 80% of the hill agricultural land and are completely dependent on the rain. The remaining 20% area lies in the valleys and plains and is irrigated. Agriculture of the region is interlinked with farming, animal husbandry, and natural resources [2,3].

Fuelwood is the primary resource collected from the nearby forest by the rural population in Garhwal Himalaya. In valley zone 55 to 65 percent, in lower Himalaya belt 78 to 84 percent and higher Himalaya belt 84 to 98 percent of the rural population depends upon Fuelwood for their energy requirements [4]. One common feature is that the collection of Fuelwood and fodder from the forest is the responsibility of women and they have to walk a long distance for collection. This has an undesirable impact on home life and particularly the care of the children in addition to the continued destruction of forests in the neighborhood [5].

In the Garhwal part of Himalaya, most of the total human population is rural and because of geographical inaccessibility, it has very low connectivity with other areas of the country [6]. This inaccessibility of the area and deprived socio-economic status of locals are responsible for the total dependence of local inhabitants on nearby forest areas for their Fuelwood and fodder demands [7,8]. The rising anthropogenic pressure of humans and cattle in these forests has become a serious problem for their sustainability as they are the main source of timber, fuel-wood, fodder, and other non-timber forest products.

Among the natural resources of Uttarakhand, forests are the most important, both economically and environmentally [9]. Due to the

collection of a huge amount of firewood, forests near the villages are subjected to rapid degradation and overexploitation. A very small fraction of firewood comes from the agriculture fields [10].

1.1. STUDY AREA

This district falls partly in the Gangetic plains and a major part in the Himalayan. The Pauri Garhwal district situated between $29^{\circ} 45'$ to $30^{\circ} 15'$ Latitude and $78^{\circ} 24'$ to $79^{\circ} 23'$ E Longitude. The three villages viz. Ghandalu, Kyar, and Khaira of the Western Nayar Watershed in district Pauri Garhwal were selected for the study. The village Ghandalu (Altitude: 1700m) lies in the micro watershed Kandul in Dwarikhil Block. The village Khaira (Location: Altitude: 900m) lies in the micro watershed Bisgaddikhil in Jaiharikhil Block (Figure 1).

2. MATERIALS AND METHODS

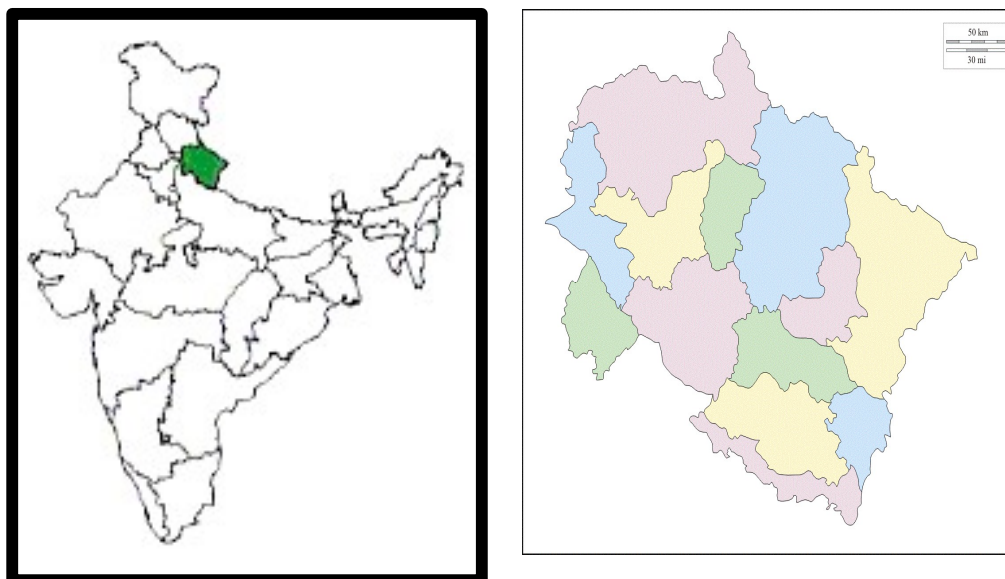
The socio-economic study is based on the survey methods using interviews of people of different age groups and gender and filling questionnaires. It also involved the approach of Participatory Rural Appraisal (PRA) by interaction with villagers, understanding them, and learning from them. The quantity of Fuelwood and fodder consumption was estimated by the weight survey method. The Fuelwood was weighed and left in the kitchen to be burnt and was weighed again after 24 hours to determine the actual Fuelwood consumption. The average consumption per day was calculated according to family size viz. 1-5, 6-7, and more than 8 persons in a family. Similarly, the fodder was weighed and left in an animal shelter and was weighed again after 24 hours to find the actual fodder consumption.

3. RESULTS**3.1. FUELWOOD/ FUEL CONSUMPTION**

The consumption of Fuelwood and other fuels is shown in Table 1, during the summer and winter seasons of Ghandalu village. It was observed that the size of the household and season directly influenced Fuelwood consumption. The average firewood consumption from the forest in

winter for Ghandalu was ranged from 12.617 ± 2.328 to 15.75 ± 1.323 kg/day per household and in summer season, it was 7.745 ± 1.032 to 12.325 ± 0.960 kg/day/household.

Figure 1. The study area of the studied watershed.



The Season also plays an important role in the per capita consumption of Fuelwood and it was found that the Fuelwood requirement highest in December, January, and February in all three villages and minimum in May and June. Consumption of Kerosene was ranged 3.571 ± 0.894 to 5.250 ± 0.645 litre/month/household during winter and while in summer consumption was 5.005 ± 0.740 to $6.500 \pm$

0.707 litre/ month/ household. The average LPG consumption in winter was found 5.057 ± 0.686 to 6.392 ± 1.198 kg/month/household, which was less than that in summer because maximum houses use Fuelwood for cooking and heating during winter. The average consumption of LPG increases during the summer period and was 6.77 ± 1.296 to 8.125 ± 1.031 kg/month/household.

Table 1. Fuelwood/fuel consumption of the Ghandalu village of Western Nayar watershed in different seasons.

Family Size	Village Ghandalu							
	Summer				Winter			
	FW Forest kg/day	FW Agriculture kg/day	L.P.G Kg /M	Kerosene lit t/M	FW Forest kg/day	FW Agriculture kg/day	L.P.G Kg /M	Kerosene lit t/M
1 to 5	7.745 ± 1.032	0.524 ± 0.088	6.770 ± 1.296	5.005 ± 0.740	12.617 ± 2.328	0.917 ± 0.325	5.057 ± 0.686	3.571 ± 0.894
6 to 7	10.408 ± 1.084	0.801 ± 0.069	8.400 ± 0.906	5.738 ± 0.833	14.591 ± 1.221	1.004 ± 0.252	6.392 ± 1.198	4.808 ± 0.670
>8	12.325 ± 0.960	1.225 ± 0.263	8.125 ± 1.031	6.500 ± 0.707	15.75 ± 1.323	1.400 ± 0.392	5.125 ± 0.629	5.250 ± 0.645

The values in the Table show the average \pm SD; FW = Fuelwood; M = Month; L = Liter

In Kyar village, the consumption pattern of Fuelwood is represented in Table 2. The average estimated fuel consumption from forest per family in winter was recorded 12.122 ± 1.822 to 16.843 ± 1.102 kg/day/household and during summer range between 7.449 ± 1.152 to 11.788 ± 2.679 kg/day/household. The consumption of firewood from agriculture field was estimated between the range of 0.432 ± 0.099 to

1.021 ± 0.223 kg/day/household in summer and 1.007 ± 0.234 to 1.223 ± 0.102 kg/day/household in winter season.

LPG and kerosene was a secondary source of energy for cooking and heating and the consumption also depend on the size of the family. Consumption of Kerosene in the winter season was 4.500 ± 0.980 to 6.500 ± 0.650 liters/month/house and it increases in the summertime

which was calculated 5.692 ± 0.989 to 10.213 ± 0.301 liters/month/household. The availability of LPG for villagers was found less as compare to kerosene and the average consumption of LPG increases during the summer period 6.66 ± 0.778 to 8.565 ± 0.199 kg/month/household (Table 2).

In village Khaira the Fuelwood consumption from forest per family in the winter season was 11.114 ± 1.712 to 15.333 ± 1.041

kg/day/household and in summer the consumption decreases with range of 6.349 ± 1.062 to 10.633 ± 2.325 kg/day/household. Consumption of kerosene oil was again observed greater in summer season as compare to winter season. The LPG consumption was 6.600 ± 1.340 to 9.667 ± 1.607 kg/month/household in winter and summer LPG consumption range between $8.7+0.926$ to $9.867+0.231$ kg/month/household (Table 3).

Table 2. Fuelwood/fuel consumption of the Kyar village of Western Nayar watershed in different seasons.

Family Size	Village Kyar							
	Summer				Winter			
	FW Forest kg/day	FW Agriculture kg/day	L.P.G Kg /M	Kerosene lit t/M	FW Forest kg/day	FW Agriculture kg/day	L.P.G Kg /M	Kerosene lit t/M
1 to 5	7.449 ± 1.152	0.432 ± 0.099	6.66 ± 0.778	5.692 ± 0.989	12.122 ± 1.822	1.007 ± 0.234	4.500 ± 0.998	4.500 ± 0.980
6 to 7	9.890 ± 1.689	0.876 ± 0.096	7.875 ± 0.395	7.770 ± 0.389	14.829 ± 1.392	1.022 ± 0.199	7.100 ± 0.656	5.500 ± 1.000
< 8	11.788 ± 2.679	1.021 ± 0.223	8.565 ± 0.199	10.213 ± 0.301	16.843 ± 1.102	1.223 ± 0.102	7.657 ± 1.120	6.500 ± 0.650

The values in the Table show the average \pm SD; FW = Fuelwood; M = Month; L= Liter

In all studied villages, *Quercus leucotrichophora* and *Myrica esculenta* emerged as the dominant source species for Fuelwood from the forest. The other common trees used by villagers as firewood are *Lagerstroemia parviflora*, *Boehmeria rugulosa*, *Pinus roxburghii*, and

Toona ciliata. The common Fuelwood collected from agriculture is *Grewia optiva*, *Pinus roxburghii*, and *Pyrus pashia*. These were the preferred Fuelwood plant species based on the characteristics and availability.

Table 3. Fuelwood/fuel consumption of the Khaira village of Western Nayar watershed in different seasons.

Family Size	Village Khaira							
	Summer				Winter			
	FW Forest kg/day	FW Agriculture kg/day	L.P.G Kg /M	Kerosene lit t/M	FW Forest kg/day	FW Agriculture kg/day	L.P.G Kg /M	Kerosene lit t/M
1 to 5	6.349 ± 1.062	0.329 ± 0.084	8.79 ± 0.926	5.252 ± 0.969	11.114 ± 1.712	1.067 ± 0.296	6.600 ± 1.340	5.822 ± 1.113
6 to 7	9.286 ± 1.389	0.641 ± 0.093	9.643 ± 0.439	7.000 ± 0.370	13.429 ± 1.272	1.057 ± 0.259	8.214 ± 0.859	7.000 ± 1.071
< 8	10.633 ± 2.325	0.923 ± 0.107	9.867 ± 0.231	9.167 ± 0.2887	15.333 ± 1.041	1.500 ± 0.100	9.667 ± 1.607	7.167 ± 0.764

The values in the Table show the average \pm SD; FW = Fuelwood; M = Month; L= Liter

3.2. FODDER CONSUMPTION

The consumption of fodder from forest and agricultural land is shown in Table 4, during summer and winter seasons for all three villages. The total green fodder consumption from forest was found maximum (30.081 ± 7.010 kg/day/household) in village Ghandalu during summer season and minimum (21.398 ± 5.238 kg/day/household) in village Khaira during winter season. In context of green fodder from agriculture fields, the consumption was greater (13.125 ± 3.577 kg/day/household) in winter season at village Khaira followed by village Kyar (10.500 ± 2.950

kg/day/household) and village Ghandalu (8.056 ± 2.473 kg/day/household).

As far as the dry fodder consumption pattern from forest was concerned, the highest (17.179 ± 4.212 kg/day/household) consumption recorded for village Ghandalu during winter season and lowest (9.620 ± 2.634 kg/day/household) for village Khaira during summer season. The fodder consumption through grazing was observed comparatively higher during summer season for all three villages of studied watershed (Table 4). The most preferred tree fodder species in Khaira were *Bauhinia purpurea*, *Bauhinia Variegata*, *Boehmeria rugulosa*, *Celtis australis*,

Grewia optiva, Ficus roxburghii, Lagerstroemia parviflora, Leucaena Leucocephala, Albizzia lebbek, Terminalia alata, etc.

4. DISCUSSION

Based on the Fuelwood consumption pattern at different altitudes, it seems imperative to seriously consider the problem of deforestation since the past few decades witnessed the loss of forest cover owing to population rise, construction of roads, and the market forces [11]. The

use of a diversity of Fuelwood species depends on the wood quality, accessibility, and availability around the villages [12]. In the studied villages, Fuelwood was either cut directly from the forests or dead wood of any kind collected. Fuelwood collection is mainly done by the village women, whereas it is a little contribution by men in the higher altitude. At low altitude village Khaira the villagers have to walk long distances in search of firewood (3–5 km daily), while at higher altitude village Ghandalu, it is reduced to 1–1.5 km due to plentiful resources around.

Table 4. Fodder consumption pattern in different seasons of studied villages of Western Nayar watershed.

Village	Summer					Winter				
	Forest		Agriculture		Grazing Hr./day	Forest		Agriculture		Grazing Hr./day
	Green Fodder kg/ day	Dry Fodder kg/ day	Green Fodder kg/ day	Dry Fodder kg/ day		Green Fodder kg/ day	Dry Fodder kg/ day	Green Fodder kg/ day	Dry Fodder kg/ day	
Ghandalu	30.081 ± 7.010	10.011 ± 4.185	6.952 ± 1.941	8.056 ± 2.473	7.129 ± 1.180	24.605 ± 4.975	17.179 ± 4.212	8.000 ± 2.065	6.113 ± 1.709	3.919 ± 0.963
Kyar	28.065 ± 6.910	9.200 ± 2.220	6.200 ± 1.980	6.800 ± 2.250	5.980 ± 1.650	23.698 ± 6.258	14.567 ± 3.900	10.500 ± 2.950	8.250 ± 1.750	4.100 ± 1.142
Khaira	27.076 ± 5.873	9.620 ± 2.634	6.892 ± 2.069	7.046 ± 2.642	6.947 ± 1.875	21.398 ± 5.238	11.158 ± 3.207	13.125 ± 3.577	10.240 ± 2.993	4.228 ± 1.232

The values in the Table show the average ± SD

Bhatt and Sachan [7] have found that liquid petroleum gas (LPG), kerosene, and cow dung are also used to meet energy requirements but in low quantities. On average, LPG and kerosene, and cow dung contribute to only 2% of the energy requirement. Thus Fuelwood forms the major source of energy. The present study also reveals that firewood collected from the forest is the main source of fuel for the cooking and heating needs of the people in the region.

It was found that in all the three villages Fuelwood consumption from the forest was more in winters than summers. The Fuelwood consumption during winter from forest maximum 16.843+1.102 kg/day/household for Kyar, 15.750+1.323 kg/day/household for Ghandalu, and 15.333+1041kg/day/household for Khaira. During the summer season, the Fuelwood consumption from the forest for Ghandalu, Kyark, and Khaira was 12.325+0.960, 11.788+2.679, and 10.633+2.325 kg/day/ household respectively. The values recorded are in the range of reports for other villages of the Garhwal Himalaya (14.65 kg/household/day) by Awasthi *et al.* [11] this could be due to a similar altitudinal range and resource use pattern.

5. CONCLUSION

The present investigation observed that more dependency on the forest for Fuelwood still under normal practice even the proper availability of LPG on one hand and also for the supply of fodder on the other hand. Most of the tree species for Fuelwood and fodder supply are very common in all studied villages and therefore significant effects may also influence this species diversity. Proper education, awareness, and a holistic approach would bring sustainability ensuring a better quality of life, improved economic status, and minimize the adverse effect on the life-support environment. It is suggested to establish a village woodlot by plantation of mixed multipurpose trees. Availability of fodder, Fuelwood, and timber from the degraded community lands would reduce threats of degradation to existing forests together with improvement in the livelihood of the local communities and global environmental benefits.

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AUTHOR CONTRIBUTIONS

This work was carried out with the collaboration of all authors. KSP and VS designed the experiments, developed the methodology, and prepared the manuscript. KSP collected the data and carried out the analysis. BNP and VS assisted with manuscript preparation. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

None.

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