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Fuel wood and Fodder Consumption Pattern in Gostu Gad Watershed, Pauri Garhwal, Uttarakhand

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Abstract

This paper aims to show acute changes in seasonal fuel and fodder consumption in Gostu Gad watershed, Pauri Garhwal Uttarakhand. The lack of alternate energy sources in this region is the major setback. By taking the data at three altitudinal ranges with three seasons was done by random selection of 120 households of different villages. The Freidman test was used for analyzing the data and it was observed that changes in fuelwood consumption were showing at different heights in the Gostu Gad watershed. Majority the use of fuel wood was for domestic cooking in the whole watershed and it was highest 1076.75 kg capita^{-1} year^{-1} at higher altitudes and lowest 616.85kg capita^{-1} year^{-1} in the middle altitudes. Gross annual consumption of fodder was highest 7927.80 kg in high altitudes and lowest 5642.90 kg in lower altitude villages. A proper study was done to identify the fuel consumption pattern on pilot basis in whole watershed and it revealed that at present the fuelwood use by households is 94.6% despite the other fuels like kerosene, LPG are also in the usage.

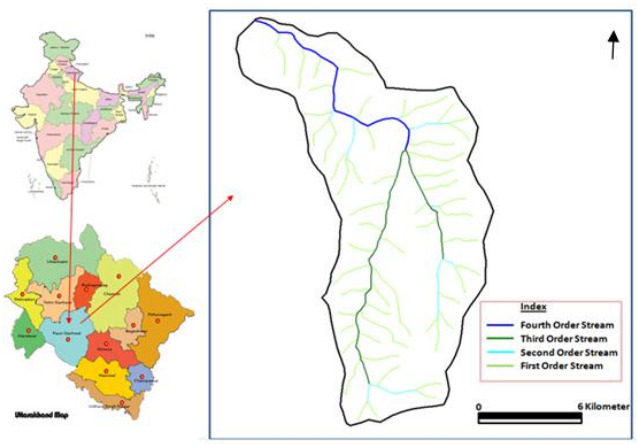
Key Words: Fuel wood, Fodder

INTRODUCTION

In India the mountainous village areas completely depends on the fuel wood which is considered to be the main source of energy even successfully meeting the all cooking energy requirements. Perhaps the majority of population in India lives in the rural regions and they wholly thrive on fuel wood, crop residues and waste of the animals. Forests and many more sites near these forests fulfill about 70 % of energy requirement by generating fuelwood that leads to removal of about 50 million tons of wood every year. This kind of natural resource management is even followed by other developing countries too. On other hand the increasing demand for fuelwood leads to degradation of resources causing Deforestation. Now shifting to bio energy can bring boons like recovery of degraded Land, prevent soil erosions and watershed protection. By entirely shifting from fuelwood to other alternate energy sources like biogas, kerosene, solar, and wind energy which do not cause environment degradation and thus it can eventually reduce the pressure on forests sites. The watershed provides variety of forest vegetations like in the upper zones of watershed has abundance of Quercus Leucotrichophora (Banj) and Rhododandron arboretum (Burans) while in the middle and lower zones has Pinus roxburghii (Chir), Terminolia belliricia (Bahera) & Terminolia chebula (Harda) in abundance. Most of the parts of watershed has spread of Pine forests. Several anthropogenic pressures such as grazing, cutting of ground herbage, trampling, lopping of tree and bushes for fuelwood and fodder has drastically affected the growth of Oak forests in these study sites and in this paper we are attempting to show the changes in seasonal bio-energy consumption at different altitudes.

LOCATION OF STUDY AREA

The catchment of Gostu Gad is lies between 30^0 12" to 30^0 15" N Latitude and 78^0 55" to 78^0 57" E Longitudes which occupies an area of 21.609 Km^2 with an elevation ranging between 622 m to 2165 m above mean sea level. Gostu gad area lies in inner Garhwal lesser Himalayas and are identified by the gentle and mature topography and it also originates from northern slope of Khirsu ridge (2165m) and joins the river Alaknanada at Dungripanth (622m). The data was collected from the villages of Gostu Gad watershed in Pauri Garhwal District Uttarakhand and then used in this paper. According to the data the main source of fuelwood and fodder is forest and agricultural area while the major energy source is wood which is used for cooking and for heating purpose. Even electricity, kerosene and oil lamps were used for lighting purposes. It was observed that majority of middle class families had their own LPG (Liquefied Petroleum Gas) however the use of traditional (Chulha) was more common for cooking while LPG was used for only making Tea. Abundant Forest resources in villages have made the villagers not pay for domestic energy. It was found that greater amount of fuelwood is collected in the winter season like from the month of October to March since the demand for domestic energy at highest point and demand for labour is relatively low.



MATERIALS & METHODS

The watershed was categorized into three altitudinal zones viz. 500-1000 (m), 1000-1500 (m), and 1500-2000 (m) above mean sea level (a.m.s.l) to determine the altitudinal difference in the agro-ecosystem affecting the watershed. In this case five of the villages were opted for detailed study on fuelwood and fodder consumption activity at each respective altitudinal zone. Even to study the detail ecosystem functioning two villages were selected from the watershed. The household data like total number of people in the respective family, livestock holding, source and requirements of fodder for livestock, source and requirement for fuelwood, road and other infrastructures, total distance from the forest, socio-economic status and level of education were collected by interviewing the people during the year 2017-18 in the study areas. As after proper surveying eight households from each of the village were identified for complete data collection of fuelwood and fodder resources and agro ecosystem functioning. It covered around 120 households where in quantity of fuelwood consumption was estimated using weight survey technique over a period of 24 hours. The quantification of fuelwood use was taken separately during summer, winter, and rainy seasons. The process included a wood lot being weighed and left in the kitchen of the household while household was requested to burn the wood from this particular lot only and then nearly after 24 hours household was rechecked by measuring the actual fuelwood consumption. This technique was also applied for the estimation of fodder consumption.

Data Analysis for fuel and fodder

Parameters for fuelwood that were analyzed using Freidman test are listed below.

Decision Rule:

Reject H0 if M (T.S) critical value at X^2=5%, k-1 d.f

Calculation method:

The differences between the sum of the ranks is evaluated by calculating the Friedman test statistic T.S. from the formula

The treatment sum of square (T.S) was calculated as

$$T.S.= \frac{12}{nk(k+1)} \sum T_i^2 - 3n(k+1)$$

Where:

k= number of columns (often called “treatments”)

n=number of rows (often called “block”)

T_i=sum of the ranks in column i.

RESULTS AND DISCUSSION

General Characteristics of respondent Households

The study of socio-economic condition of local people was of high importance as it played a vital role in understanding the contribution of fuelwood. The average household member size was found to be 5.10 members. Hence size of the family and education level also plays an important role in planning and proper utilization of the fuelwood. From understanding of family size classes, nearly 25.83% belonged to the smaller household class while 8.33% were in the larger household class. The gross illiteracy rate was recorded as 68.67% and lowest average annual income (65785.56+-26903.64 INR) was determined in small households compared to that of other household classes whereas the highest annual income was determined to be 286306.66+-179481.7 INR for only very large households. The overall annual income was estimated as 197214.72+-169643.6 INR. The main source of livelihood is the practice of herding for each of the settlement and single families are dependent on various occupations too.

The survey showed that each household cooked their food on traditional mud stove known as Chulha and reason behind this was the easy availability of fuelwood with no cost in it. The gross adult cattle unit holding is about 486, with average adult cattle unit of 23.16+-9.41 per household.

Fuelwood Consumption

The usage of fuelwood as a primary one for both domestic and commercial use has severely led to deforestation and soil erosion in whole of Himalaya thus threatening its biodiversity. The study area Gostu Gad has the major source of fuelwood and fodder in its forest and agricultural land while domestic cooking is the major source of fuelwood in whole of the watershed. Also firewood is used for cooking purpose and warming the houses in the winter season. There are other alternate sources of energy like LPG, Kerosene, solar lamps and electricity in the watershed. For lighting purposes electricity and kerosene is used in all the villages and some of the households are using kerosene for cooking food too. It was noticed that LPG is only used during the guest visit and Chulha is used regularly. The fuelwood consumption by villagers from different altitudinal categories of Gosu Gad watershed changes significantly among different altitudes but the seasonal fuelwood consumption is not that same for all the season. It is shown in Table 2. Fuelwood requirement was estimated 4.08 kg in winter, 2.77 kg in summer, and 2.01 kg in rainy (per capita per day) in the villages of high altitudinal regions followed by 2.81 kg in winter, 1.69 kg in summer and 1.30 kg in rainy (per capita per day) in lower altitudinal regions and 2.42 kg in winter, 1.56 kg in summer, 1.11 kg in rainy (per capita per day) in the middle altitudinal regions. It clearly showed that fuelwood consumption is greater in higher altitudes as forests are easily accessible, low temperature areas and poor road network. Poverty and migration are considered to be the reasons for higher fuelwood consumption in higher altitudes too.

Table- 1: List of food crops cultivated in Gostu Gad Watershed

Crop Name	Botanical Name	Sowing Time	Harvesting Time
Cereals and Millets			
Paddy	*Oryza sativa*	March –April	October-November
Wheat	*Triticum aestivum*	November-December	April-May
Barley	*Hordeum vulgare*	----------do----------	----------do----------
Finger millet	*Eleusine coracana*	April-May	October-November
Barnyard millet	*Echinochloa frumentosa*	----------do----------	----------do----------
Foxtail millet	*Sateria italic*	----------do----------	----------do----------
Maize	*Zea mays*	----------do----------	----------do----------
Pulses			
Bhat	*Glycine soja*	April-May	October-November
Soyabean	*Glycine max*	----------do----------	----------do----------
Horse gram	*Macrotyloma uniflorum*	----------do----------	----------do----------
Pea	*Pisum sativum*	----------do----------	----------do----------
Cow pea	*Vigna ungiculata*	----------do----------	----------do----------
Pigeon pea	*Cajanus cajan*	----------do----------	----------do----------
Gram	*Cicer arientinum*	----------do----------	----------do----------
Lentil	*Lins esculenta*	----------do----------	----------do----------
Black gram	*Vigna mungo*	----------do----------	----------do----------
Oil seed			
Mustard	*Brassica compestris*	October-November	March-April
Mustard black	*Brassica nigra*	----------do----------	----------do----------
Seame	*Sesamum indicum*	March-April	October-November
Spices			
Chili	*Capisum annum*	May-June	September-October
Turmeric	*Curcuma longa*	October-November	February-March
Garlic	*Allium satium*	February-March	June
Coriander	*Coriandrum sativum*	----------do----------	----------do----------
Vegetable			
Potato	*Solanum tuberosum*	February-March	September-October
Onion	*Allium cepa*	----------do----------	----------do----------
Radish	*Raphanus sativus*	----------do----------	----------do----------
Ladies finger	*A.esculentus*	----------do----------	----------do----------
Bringil	*Solanum melongena*	----------do----------	----------do----------
Pumpkin	*Cucurbita mixima*	----------do----------	----------do----------
Bitter gourd	*M.charantia*	----------do----------	----------do----------
Bottle gourd	*L.siceraria*	----------do----------	----------do----------
Cucumber	*Cucmis melo*	----------do----------	----------do----------

Table- 2: Energy consumption in different altitudinal zones in Gostu Gad Watershed.

Altitudinal Zone (Meter) (a.m.s.l.)	Fuel Wood (Kg) Person^{-1} Day^{-1}			Annual Consumption of Fuel Wood (Kg)	Fuel Wood (Kg) Household^{-1} Day^{-1}			Annual Consumption of Fuel Wood (Kg)
	Summer	Winter	Rainy		Summer	Winter	Rainy	
500-1000	1.69	2.81	1.30	704.45	6.72	10.05	5.11	2660.85
1000-1500	1.56	2.42	1.11	616.85	5.72	8.86	4.05	2266.65
1500-2000	2.77	4.08	2.01	1076.75	7.48	10.45	5.41	2839.70
(Mean)	**2.00**	**3.10**	**1.47**	**799.35**	**6.64**	**9.78**	**4.85**	**2589.06**

Preferred Firewood species and their availability

The fuelwood is preferred by lot of villagers is because of its easy availability from nearest forest, no cost related, low socio- economic status and lack of alternate source of energy. A total of 32 species were identified as the preferred firewood and 28 species were recommended as preferred fodder species. Villagers never selected tree species for fuelwood but they collected all the species of tree available in their areas. The principle aspect employed by the villagers for the selection of species were good fuel characteristics like high calorific value, producing less smoke, burns well with gradual flame and durable ember. From low and middle altitude interviewees it was found that each year they have to travel far distances to collect the firewood which signifies the increasing scarcity but in near future use of these resources would become difficult task and they will be left with no option rather than making use of whatever is available to them. Villagers travel formidable distances (1-4 km) and spent more time ranging between few hours to more than half a day to collect the preferred firewood. We analyzed that those who traveled with their cattle were also involved for collection of fuelwood and these kind of walks were done by mostly adults and sometimes both genders. They even stored large collection of gathered fuelwood for the winter and rainy season as that time demand is quite high.

Fodder Consumption

The greatest amount of fodder is available in the form of grasses, hay leaves and young stems etc. All these were collected in the watershed and the fodder statistics varies in different villages of the watershed. It was found that minimum amount of fodder was around 40.20 kg household^{-1} day^{-1} which was collected during winter season in the middle altitude and highest was 92.70 kg which was collected during summer season in middle altitude villages (Table 3). People of middle and lower altitude collected maximum fodder from their farmland and their farm trees. In rainy season fodder consumption was high and low during winter season. Fodder consumption (per animal per day) is highest 21.72 kg in the higher altitude region followed by 17.06 kg in the middle and 15.46 kg in the lower(Table 4). The gross annual consumption was found highest (7927.80 kg) at the high altitude and minimum (5642.90.25 kg) at the lower altitude (Table 4). From analysis on the basis of Friedman Test consumption varied significantly among different seasons in the watershed which depended upon the availability of the green grass and various fodder sources. Here people got fodder from two sources that is forest and the farmland. The fodder which was grown naturally was from the pastureland, riverside forest, roadside bunds, and agro forests. The lopped trees like Bauhinia retusa (semal), Grewia optiva (Bhimal), Quercus leucotrichophora (Banj) also contributed the fodder needs. The most important crops grown in farming whose residue is used as fodder includes paddy, wheat, Barnyard, millet, foxtail millet, pea and finger millet. However the quantity of fodder required altered with the number and size of livestock, on an average at least one collection per day is obligatory.

Table 3: Fodder Collection (Kg) household^{-1} day^{-1} from different altitudinal zones in Gostu Gad Watershed

Season	Altitudinal Zone (Meter) (a.m.s.l)								
	500-1000			1000-1500			1500- 2000		
	Dry	Green	Total	Dry	Green	Total	Dry	Green	Total
Winter	19.75	27.25	47.00	21.25	18.95	40.20	21.40	19.25	40.65
Summer	21.40	42.30	63.70	29.45	63.25	92.70	27.40	54.20	81.60
Rainy	00.00	53.90	53.90	00.00	82.45	82.45	00.00	64.50	64.50
(Mean)	**20.57**	**41.15**	**54.86**	**25.35**	**54.88**	**71.78**	**24.40**	**45.98**	**62.25**

Table- 4: Fodder Consumption (Kg) animal^{-1} day^{-1} in different seasons at different altitudinal zones in Gostu Gad Watershed

Altitudinal Zone (Meter) (a.m.s.l.)	Seasons			Average Consumption Animal^{-1} Day^{-1} (Kg)	Annual Consumption Animal^{-1} (Kg)
	Winter	Summer	Rainy		
500-1000	11.74	14.55	20.10	15.46	5642.90
1000-1500	16.15	16.85	18.20	17.06	6226.90
1500-2000	18.45	21.08	25.65	21.72	7927.80
Mean	**15.44**	**17.49**	**21.31**	**18.08**	**6599.20**

Table 5: Grazing hours and distance traveled by the animal from villages in Gostu Gad Watershed

Altitudinal Zone (Meter) (a.m.s.l.)	Season					
	Winter		Summer		Rainy	
	Grazing Time (hrs)	Distance (Km)	Grazing Time (hrs)	Distance (Km)	Grazing Time (hrs)	Distance (Km)
500-1000	2.0	2.0	4.5	4.0	3.0	2.5
1000-1500	1.5	2.0	5.0	4.5	3.0	2.5
1500-2000	2.0	2.5	4.5	3.0	3.0	3.0
Mean	**1.83**	**2.16**	**4.66**	**3.83**	**3.0**	**2.66**

Table 6: Labor input for fuel wood and fodder collection on daily basis by men and women in different seasons in Gostu Gad Watershed

Altitudinal Zone (Meter) (a.m.s.l.)	Season								
	Winter			Summer			Rainy		
	Men (%)	Women (%)	Child (%)	Men (%)	Women (%)	Child (%)	Man (%)	Women (%)	Child (%)
500-1000	20.15	65.10	14.75	24.50	58.40	17.10	18.10	56.50	25.40
1000-1500	22.00	68.95	9.05	25.45	59.75	14.80	21.20	55.50	23.30
1500-2000	11.25	75.95	12.80	20.65	66.13	13.22	14.40	65.00	20.60
Mean	**17.80**	**70.00**	**12.20**	**23.53**	**61.42**	**15.04**	**17.90**	**59.00**	**23.10**

Table 7: Time consumed for fuel wood and fodder collection and distance traveled by the villagers during different seasons at different altitudinal zones in Gostu Gad Watershed

Altitudinal Zone (Meter) (a.m.s.l.)	Season					
	Winter		Summer		Rainy	
	Time Consumed (Hrs)	Distance Traveled (Km)	Time Consumed (Hrs)	Distance Traveled (Km)	Time Consumed (Hrs)	Distance Traveled (Km)
500-1000	3.5	5.0	4.0	6.0	2.0	1.5
1000-1500	3.0	4.5	3.5	5.0	2.0	0.5
1500-2000	2.0	3.0	3.0	4.5	2.0	0.5
Mean	**2.83**	**4.16**	**3.5**	**5.16**	**2.0**	**0.83**

CONCLUSIONS

Fuelwood consumption disparities are studied at three different altitudes across three different seasons. Based on sample survey conducted in the year 2006-07, fuelwood/fodder consumption is analyzed using Fried.s man test. While working upon the statistics of fuel, fodder consumption it has been figured out that all the villages of watershed under study have a problem of fuel and fodder extraction and as villagers rear animals for their instant income for milk selling or meat purpose the livestock grazing goes randomly and absence of knowledge and awareness erosion and loss of sensitive plant species which may have medicinal and soil binding properties [1].

Therefore it is crucial that rural energy and fodder requirements are addressed at the policy level and policy makers to find a suitable local-specific need based alternative programmes. Here, in this study, it is indicated that if the pressure of fuelwood consumption demand is high, then alternative interventions like electrification, providing subsidized LPG cooking etc. may be suggested. But to deliver such alternatives, the need arises to have a system with appropriate institutional frameworks, delivery mechanisms, business models, capabilities and outcome measurements tools [2] which is a time taking process in the remote areas like in Himalaya. Afforestation with ecologically as well as socio- economically viable Himalayan fuelwood and fodder species will not only check the degradation in the Gostu Gad watershed but also provide the much needed fuel and fodder requirement of the hill people.

Thus, in the remote hilly areas we suggest the adopting integrated approach to rural development like promotion of agro- forestry. Plantation of locally available multipurpose tree species can be promoted in the region in the wasteland. Moreover, the promotion to use biomass as one of the source of energy (through agro-forestry, for example) in the mountainous region of Himalaya not only improved the livelihood condition but will also bring better ecological health in the catchment. Energy development and utilization should be placed in a sustainable development context to ensure that no dimensions, resource or policy tools are overlooked [3] and countries like India with diverse agro-climatic zones need to have local specific energy policy. Therefore, looking into the limitations of alternative energy sources like LPG, Solar technology, biogas etc. and understanding the social system, integrated agro-forestry system and utilization of wasteland for supporting woody & fodder vegetation and can be developed to meet the fuelwood/fodder and timber needs of the watershed may be the better option to meet not only the future demand of fuelwood/fodder but also to improve the livelihood condition in the remote mountainous areas.

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