ASSESSMENT OF RURAL ENERGY NEEDS IN HILKOT WATERSHED PAKISTAN

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Abstract

Rural energy survey was conducted in the Hilkot watershed communities in order to assess the energy needs for consumptive (household and commercial) and productive purposes (rural cottage industry, agriculture). Questionnaire, interview and Participatory Rural Appraisal (PRA) tools were used to carry out this survey. According to the survey results, firewood emerged as the largest source of energy used for cooking and heating. The consumption of firewood was 2.35 maunds/household/week. Annually each person consumes 1.13 tons of firewood for cooking and heating. Among the other sources of energy, kerosene oil and natural gas were being consumed at the rate of 1.83 liters and 3.29 kilograms/household/week. A major portion of a household annual income ranging between 29% and 47% is spent on fuel for cooking, heating and lighting only. On the average, household in the watershed spends Rs.721 monthly on fire wood procurement. Women play a key role in energy resources control and utilization. With the exception of blacksmiths and food caterers, the cottage industries have no additional impact on energy consumption other than the normal household fuel consumption.

Introduction

The study was conducted in Hilkot watershed under the project entitled "the study of people and resource dynamics in the mountainous watersheds of Pakistan Hindu Kush-Himalayas" abbreviated as PARDYP with the co-operation from International Center for Integrated Mountain Development (ICIMOD). The project is funded by IDRC and SDC. The Hilkot watershed is located in upper middle reaches of district Mansehra, Hazara Civil Division of NWFP. Located in the moist temperate region, natural coniferous forests of Kail, Deodar, Fir and Spruce are the only source of energy for the inhabitants with very little access to any other modern energy sources. Most of these forests are privately owned and the state forest department has some administrative control to protect and manage these forests. Due to increasing population, vast areas, once densely forested, have changed to bare hill slopes with few scattered trees growing away from population centers.

There are several factors which contribute to the degeneration of valuable forest resources. Among these are the lack of awareness to preserve

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forests and no access to renewable alternative sources of energy. This combined with the climatic factor (where temperature falls several degrees below freezing point for more than three months in winter season) has become the most destructive agent for the natural stands. Cooking and heating are the major requisites met from these trees. Poverty and illiteracy are also the main factors in the exhaustive destruction of natural wood lands. Small land holdings with under-productivity level is also a hurdle to develop alternative wood energy sources on farm lands as the people are ignorant of the benefits from raising energy plantations of other fast growing and multipurpose trees in agro-forestry system.

Keeping in view the current situation it was considered desirable to know about the energy use patterns of the communities. A preliminary energy survey was conducted in early months of the year 2000 which revealed that the demand for fuelwood was higher compared to the availability of wood in the area. The results were also indicative of a need to investigate in detail the energy situation in both household and productive sectors. If the natural forest resources of the watershed were to be protected from over exploitation and degradation, there must be some alternatives for wood as a source of fuel. One such option was the Renewable Energy Technologies (RETs). Furthermore, there was a need to investigate the traditional ways of heating and cooking related to health problems including role of gender in the energy sector. However, preliminary energy survey provided a basis for further studies and a persuasive power for the communities to participate in future energy programs.

Material and Methods

The methods used to carry out this survey included direct observation, interviews, questionnaire and Participatory Rural Appraisal (PRA) tools. Seven villages were selected from the map of the Hilkot watershed in such a way that the selected villages would represent the conditions and circumstances of the whole profile of the study area.

The villages selected were Sathan Gali, Sumbul, Bojri, Kund Bala, Dheri Numbardaran, Hilkot and Sayyedabad. Some of the villages were accessible to road, some were off the road, some required two hours one way mountain walk including hamlets. All the households in these villages were taken as sampling units for which sampling frames (voters' lists) were obtained from the concerned union councils. All the households in each village were allotted serial numbers from which 30 samples were selected randomly from 7 villages.

The interviews were structured as well as unstructured based on pre-planned questionnaires and an informal talk with the communities through PRA techniques. The interviews were conducted by the male and female members of the project team with the male and female members of the households, entrepreneurs of the rural cottage industries and commercial micro-enterprises operated at the household level.

Results and Discussion

Methods of acquiring fuel wood

The methods of acquiring fuel wood are thinning, lopping and culling executed by men and women both in the state forests and community owned (Guzara) forests (Table-1). Men and women walk two to four kilometers per trip to the forests for thinning, lopping and culling of fuel wood. The average time taken per trip is about two to four hours. During summer, three to five trips are made to the forests for collection of fuel wood and for winter fuel wood is collected, purchased and stored well in advance before the fall of winter. The methods of acquiring fuelwood in different communities are shown in Table-1.

Table 1. Methods of acquiring firewood

Village	Methods	Place	Who (Male, female)	Time taken (Hours)	Distance (in ilometers)	No. of collection per week
Sathan Gali	Thinning Lopping Culling	Forest	Male and Female	4	3	3
Bojri	Thinning Lopping Culling	Forest	Male and Female	1.75	1.8	3
Sumbal	Thinning Lopping Culling	Forest	Male and Female	2.35	2.14	3
Syedabad	Thinning Lopping Culling Purchased	Forest Market	Male and Female	2.00	2	2
Kund Bala	Thinning Lopping Culling Purchased	Forest Market	Male and Female	2.50	2.71	2
Dheri Numberdara n	Thinning Lopping Culling	Forest	Male and Female	2.85	5.64	3
Hilkot	Purchased	Market	Male	3	7	2 van/year

Those families which are unable to go to forests for collection of fuel wood, can purchase from the donkey owners who perform the activities of thinning, lopping and culling at the forests. A donkey owner takes at least two hours to reach the nearby forest, spends couple of hours in collection of wood and then comes down to the village in a couple of hours. A donkey load of about 60Kgs is sold for Rs.100 but it is never weighed at the time of sale or purchase. Another source of fuel wood procurement is Datsun pick up which carries a load of about 30 Maunds or about 1200 Kgs which is being sold at a price of Rs.1600 per load. Datsun owners charge extra Rs.100 for dullay (branches of tree) wood which are good burner and produce good amount of coal.

Cooking and heating habits

Generally there are three main sessions of cooking each day and each session lasting for an hour and a half for breakfast, lunch and dinner in addition to morning and afternoon sessions of tea making (Table-2). Women start fire soon after morning prayers or a little bit later around 5:30 to 6:00 a.m. for preparation of breakfast. The second session of cooking meal for lunch starts around 12:00 noon and the third session starts at 7:00 p.m. for dinner. All of the three sessions and tea making take a total of seven to eight hours per day.

Table 2. Cooking and heating habits

Village	Heating-hours/day	Heating-months/year	Cooking food hours/day	Lighting-hours/day
Sathan Gali	19.25	4.50	7.38	3.25
Bojri	17.63	5.13	8.00	3.00
Sumbal	19.28	4.86	7.43	3.00
Syedabad	18.00	4.67	8.00	4.00
Kund Bala	18.86	4.72	8.00	3.50
Dheri Numberdaran	17.43	5.29	7.00	3.00
Hilkot	17.8	5.40	7.00	3.00

Because of severe cold during winter, each and every household practices heating rooms for a duration of 18 to 20 hours per day and this continues during the whole winter period of five months from November through March. During winter the fuel consumption increases by more than 100% of the level of fuel consumption in summer. During winter, 18-20 hours of heating is simultaneously used for meal cooking and boiling water etc.

Fuel consumption during summer

During the summer months an average consumption of fuel wood per week ranges between two to slightly over three maunds. Fuel wood during summer is only used for cooking of three meals plus snacks for a duration of eight hours per day. Kerosene oil and gas is used for lighting purposes. Agricultural residue consisting of threshed corn ears is used as a supplementary fuel. Weekly consumption of fuel during the summer period is given in the Table-3 below:

Table 3. Weekly consumption of energy

Village	Fuelwood (Maunds)	Kerosene oil (Liters)	Gas (Kgs.)	Agri. residue (Maunds)	Others - battery cells
Sathan Gali	2.91	2	4	--	--
Bojri	1.55	1.2	1.42	--	--
Sumbal	3.21	1.2	--	--	--
Syedabad	2.55	1.25	5	--	--
Kund Bala	2.2	3	-	--	--
Dheri Numberdaran	2.03	2.08	5.5	--	--
Hilkot	2	2.1	7.12	--	--

As will be seen from the above table, that the major source of household energy consumption is the fuel wood, which is used for cooking, heating and lighting. Kerosene oil and Gas are used for lighting purposes only where there is no electricity available in the village. Agricultural residue, which consists of threshed corn ears only is used as a minor casual burning material along with firewood.

Monthly expenditure on fuel

An average household monthly expenditure on fuel during summer in the selected seven villages of Hilkot watershed area is given in the Table-4 below:

As will be seen from the table above, that the kerosene oil, gas and batteries are commercial items, which were procured by the household from the market and the electricity was supplied to the household by the government agency. The average monthly electricity bill is around Rs.135. The average electricity bill is low because the people use electricity only for light purpose for very short time. However, the expenditure on fuel wood reflects an imputed

value of the fuel wood consumed in one month based on prevalent market wood prices. The wood actually might have not been procured from the market but instead might have been cut from the forest free of cost. In that case, the monthly fuel wood expenditure might represent a transfer of resources from national economy or society to the rural community and the resultant cost to the society will be decay in environment as a result of disruption of natural resource balance.

Table 4. Household monthly expenditure on fuel

Village	Fuelwood Rs.	Kerosene oil (Rs.)	Electricity (Rs.)	Gas cylinder (Rs.)	Others-battery (Rs.)
Sathan Gali	940	86	-	255	-
Bojri	615	98	-	123	50
Sumbal	857	54	119	100	-
Syedabad	510	42	100	197	-
Kund Bala	872	-	104	-	-
Dheri As umberdaran	686	66	137	445	40
Hilkot	566	25	202	648	-

Percent of income spent on fuel

An average household in the watershed spends a large portion of his income on procuring fuel (Table-5). This implies an extra burden on already dwindling mountain household economy. The mountain communities usually have enough time as compared to money which is always scarce, therefore everyone tries to exchange time (spent in collecting firewood in jungle) for money (spent on purchase of firewood in the market). This fact blocks the leakage of pressure to other areas and concentrate it within the watershed. Thus the natural forests are always under pressure.

Table 5. Percent of household income spent on fuel

Village	Average annual household income (Rs.)	Average annual household expenditure on fuel (Rs.)	Expenditure on fuel as % of household income (Rs.)
Sathan Gali	43572	20072	46%
Bojri	38315	13707	36%
Sumbal	52144	17845	34%
Syedabad	43957	12738	29%
Kundbala	55640	15656	37%
Dheri Numberdaran	41770	19438	47%
Hilkot	51740	20122	39%

The table above shows that a major portion of an household income ranging between 29% to 47% is spent on fuel for cooking, heating and lighting only. This means that the resources available to meet the needs of food, clothing, health and education are not sufficient and this reflects the height of poverty prevailing in the project area. Efforts are needed to generate resource-saving renewable energy technologies, which are unknown to the communities of the area.

Rural cottage industries and commercial microenterprises

A total of seven rural cottage industries operated at the household level and one commercial enterprise were interviewed. These enterprises included two tailor masters, one male and one female, one carpenter-cum-blacksmith, one quilt maker, one food caterer, one embroidery worker and one general store owner. With the exception of carpenter-cum-blacksmith and food caterer, the businesses of all the enterprises have no additional impact on the energy consumption other than the normal household fuel consumption. The investment made, inputs used and types of output produced by these enterprises are given in Table-6 and Table-7. Both the male and female tailor masters own a sewing machine. The male tailor master bought it at a cost of Rs.105 about thirty-five years ago while the female tailor master got it free of cost from the Government charity (Zakat) fund. The annual operating and maintenance cost of sewing machine is between Rs.120 to 300 including the variable cost of parts such as needles, bobbins, thread reels and buttons. The annual output ranges between 20 to 60 suits per month which cost Rs. 50 to 80 per suit. Another embroidery worker who spent just Rs.5 on purchase of needles for embroidery works and has produced one set of bed sheet along with pillow sheets and one shawl per month which has been sold at a price of Rs.850 per set and Rs.350 per shawl. The quilt maker who invested Rs.1500 on lint processor and has produced 4 sets of quilt, pillow and mattresses per month at a cost of Rs.80/set. The General Store operator invested Rs.10,000 in 1986 with an annual operating and maintenance cost of Rs.2400. In the initial years he had earned a profit of Rs.3000 per month. But later on, due to increase in cost of living, the leakage out of investment and profit increased leading to decrease in inventory and consequently led to reduction in profit to Rs.40 per month. All of these businesses operated at the household levels and have had no direct impact on fuel consumption.

The carpenter-cum-blacksmith invested Rs.80,000 on equipment including electric drill, electric motor, saw machine. The entrepreneur

Table 6. Production of rural cottage industries and commercial micro-enterprises in hillkot watershed management area

Organization	Year estt.	Investment Rs	O&m cost/yr.(Rs)	Inputs /unit of out put			Output/month		
				Types	Quantity	Price/unit (Rs)	Type	Quantity/M	Price/unit (Rs)
Tailor master	1965	105	120	Machine	1	105	Men's Suit	30-60	80
Afsar Khan				Cloth/owners	---	---			
				Thread (reel)	1	2			
				Button	6	2			
Tailor master	1987	Sewing machine	300	Machine	1	---	Suit	15	50
Maqbool Nisa		denoted by		Needle	2	10	Boys suit	5	30
		zakat fund		Bobbin	2	2			
				Thread reel	1	2			
Carpenter cum	Inherited	80,000	4800	wood(owner)	12cft/door	200/cft	Doors/	7	60 Maunds/year
Blacksmith					8cft/window		Windows		From villagers
					4cft/bed		Agricultural	42	
							Implements		
Quilt Maker	Inherited	1500	100	Cotton thered	12kg/lint/set				
				cloth	Pillow	30kg	Pillow		
					Quilt	10/reel	Quilt	4	80/set
					Mattress	30	Mattress		
Food caterer	Inherited	4000	---	Pots	2	2000	Food	1 event	80/pot
				Dishes/spoon	Event	2000	Catering	---	
				blades/scissors	Set	3200	Haircutting	---	30Mds/year
				Shaving achine					
				Wood	1.5md/pot	100	Circumcision	event	200
Embroidery work	1992	5	5	Needle	1	1	Bed sheet	1	500
Noorunisa				Thread			Pillow sheet	1	350
				Cloth			Shawl	1	350
				Labour					
Ahsan general Store	1986	10,000	200	10,000			Grocery	---	1200/Monthprofit

Table 7. Monthly fuel utilization by rural cottage industries and commercial micro-enterprises in Hilkot watershed management area

Fuel used /month	Tailor master	Tailor master	Carpenter -black smith	Quilt maker	Food caterer	Embroidery	General store
	C H L	C H L	C H L	C H L	C H L	C H L	C H L
Fuelwood(Mds)	10 41 1	6 41 3.5	7 52 --	10 40 1	11 38B --	4 30 --	7 17 --
Charcoal	--	-	20B				
Kerosene (L)		20	6	4	1	1	3
Gas (Kg)		10	10				8
Electricity Rs/M	100		700B		290B	100	400
Energy devices	MS MS	MS MS KL/GS/M	MS M/EM/SM/ED G/T/BU	M MS MS/KL	MS MS T/BU	MS MS BU/T	MS -- --
Operating hrs/day	6 18 2	6 18 3	7 16 3	6 18 3	7 15 4	6 18 4	8 15 4
Price/unit							
Fuel Rs/Maund	80	70	80	80	80	70	80
Kerosene Rs/Ltr	15	15	15	17	15	15	15
Gas Rs/Kg		30	30				30
End use:							
Domestic (D)	D	D	D/B	D	D/B	D	D
Business (B)							
Legends							
MS = Mud stove		T =Tube					
EM = Electric motor		KL =Kerosene Lamp					
SM = Saw machine		BU=Bulb					
ED = Electric drill		M =Mudstove					
D = Domestic							
B = Business							
G =Gas							
C =Cooking							
H =Heating							
L =Lighting							

manufactures about 500 agricultural implements, 70-80 doors and windows and about 60 beds per annum for the villagers. The wood are provided by the villagers. The entrepreneur gets paid in kind at the time of harvest of the crop. The payment to the entrepreneur is based on the output of each villager as he gets 1 kg per 20 kg output of the farmer. His annual receipt is about 60 maunds per year which is equivalent to Rs.15,000 per annum. However, the villagers are of the opinion that the annual proceeds of the carpenter-cum-blacksmith are much more than 60 maunds. His business related energy requirements are 20 kg. Charcoal per season which cost Rs.280 and Rs.700 per month of electricity. These seasonal activities are carried out during the months of September and March and April. The entrepreneur's household energy requirements are similar to the other households in the village.

Another agent that provides services to the community is the village food caterer. Professionally, the agent is a barber who provides the services of hair cutting and cooking meal at special occasions such as birth, wedding and deaths. The food caterer has invested Rs.4000 in procurement of 2 pots (Degs) for cooking rice for big gathering. All inputs are provided by the owners, the food caterer only takes cooking charges at the rate of Rs.100 per pot. Like other village professionals, he is also paid in kind. The professional gets 1 kg of grain per 20 kg output of the villagers. His total proceeds are about30 maunds per year. In addition he gets Rs.200 per circumcision.

Roles, responsibilities and benefits

Women play key role in energy resources control and utilization as they are responsible for cooking food, collecting, storing and managing fuels and construction of mud-stove (Chulas), a fireplace. Women determine the need and make decisions about quantity and timing of collection or purchase of fuel wood. Firewood collection is primarily carried out both by men and women for household consumption as well as for commercial purposes, usually three trips in a week. Women carry the fuelwood load on their head while men carry the same on their back. No record of fuel collection by men and women is maintained. However, some families may purchase from donkey owners or van operators at an average rate of Rs.80 to Rs.100 per donkey load, or Rs.1400 to Rs. 1500 per van load which is actually not weighed although it is assumed to be around 60-75 kg per donkey load or about 30-35 maunds per van load. As mentioned in Table 5, the average annual expenditure on fuel ranges from Rs.13,000 to 20,000. If this expenditure is actually not met from the income of the households of the project area then the collection of firewood is in fact non-monetary income, which is the indirect income of the households or the key

actors involved in fuel wood collection and marketing which include men, women, donkey owners and van operators. Staff of the Forest Department can play key role in motivation and organization of communities into self-disciplined Community Based Organizations to tailor their fuel needs and save the natural vegetation simultaneously. As all villages of the project area are homogenous in character, therefore access to abundant fuel wood is about evenly distributed.

Impact on natural resources

One of the major factors that impact on the natural resource exploitation is the socio-economic condition of the area. The people of the Hilkot Watershed Management Project are handicapped and poor as reflected by their low land and animal possession and are forced to cut fuel wood from the forests for their survival in the extreme cold mountain weather. The people of the area spend about 29% to 47% of their income on fuel, which is comparable to mountain areas of Nepal and Bangladesh. In the mountainous villages of Nepal one-fourth of the income is spent on fuel. Similarly, in Bangladesh people of mountain villages spend 90% of their income on food and fuel is collected free of cost. If the household expenditure of 30% to 47% of the Hilkot watershed management area is not outside the monetary economy then it will seriously affect the nutritional levels of villagers. If the fuel wood is an economic transaction then as prices of the commercial fuel increase, the expenditure on food will certainly decline affecting the daily minimum recommended food intake. Currently, the fuel is available in abundance and with the increase in population in future, the land and forest resources will dwindle creating a problem of mountain ecosystem. Pastoral uses are other factors, which exploit the natural resources through uprooting plants and preventing regeneration. This is a key issue of concern, which should be tackled through effective community development programme to preserve the natural resource base.

Pressure on natural resources can be released by switching from biomass sources of fuels to availability of other alternative fossil fuels or alternative frugal and adaptable renewable energy technologies.

Another impact of consumption of biomass fuels is on the environment of the household, which causes indoor air pollution leading to various lung and eye diseases, which will reflect in a higher cost to the society in terms of human resource availability.

Total fuel requirement

Based on the survey results, fuel wood requirements have been estimated as under:

Table 8. Fuel wood demand projections for Mansehra district

District	No. of household 1998 census	Household size 1998 census	Household size-survey	Average consumption per household (Tons)	Total annual requirement-2000 (Tons)	Total fuel requirement in 2010 (Tons)
Mansehra	177,311	6.44	7.61	8.16	1,526,648	1,923,947

According to 1998 Census, the total number of household in Mansehra District is 177,311. Out of the total households in Mansehra District, 94.36% households are located in the rural areas while urban households are just 5.34%. According to 1998 Census household size, the fuel requirement is 1.33 tons per person per annum as compared to 1.13 tons per person per annum of the surveyed household size. Based on the survey results, the fuel requirements for Mansehra District as a whole for the year 2000 have been estimated at 1,526,648 tons. Considering the average annual population growth of Mansehra District of 2.34%, the fuel requirements for the year 2010 have been projected at 1,923,947 tons showing an increase of 26% over a period of ten years. How this increase in demand for fuel will affect the forests in the Hilkot watershed management area? To look at the ecological impact of the increase in demand for fuel, various questions will have to be answered. These questions inter-alias, include, the amount of biomass availability, what types of species are available for cutting, analysis of degree of competition between human and animal for biomass resources, what species are preferred by human in terms of burning and what species are preferred by animals for browsing; is there any danger of elimination of any specie as a result of cutting and browsing. If the speed for cutting and browsing is faster than the growth in vegetation, then there is a concern for restoring a balance in natural resources. The increase in demand for fuel of 26% for Mansehra District alone over a period of ten years can not be supported by an increase in vegetation in such a short period of time, the situation therefore demands for finding alternative sources of renewable energy technologies which are cost effective and at the same time will restore the balance in natural resources.

Conclusion and Recommendation

It is concluded that firewood is the main source of energy for mountain communities. These communities have very little access to other sources of energy like natural gas and electricity. Due to its low price and easy availability, firewood is relied upon for cooking and heating through out the year, which bring the natural forest resources of the area under immense pressure. Under the circumstances of increasing population and decrease in forest cover, energy crisis may be expected after few years in addition to the degradation of environmental conditions.

Hence, it is recommended that alternate sources of energy should be sought to reduce pressure on forests. Sustainable management and exploitation of forest resources is also a need of the day. There is a need to create awareness about the current situation in the watershed. Both male and female population of the watershed should be organized into Community Based Organizations and already present organizations should be strengthened through participatory development approach for maintaining a balance in natural resources. National and international institutions which are engaged in renewable energy technologies (RET) should be approached for extending their outreach activities to the area through demonstration of RET technologies and training of the communities to adopt these technologies. Economic incentives in terms of subsidy be provided for adoption of new alternative technologies as poverty in the area is a key hindrance for adoption of such alternatives.

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