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Household Energy Use Bahaviour in Rurals of Nepal

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COUNTRY BACKGROUND

Nepal, with an area of 147,181 sq.km. lies between 80°00' to 88°10' east longitudes and 26°10' to 30°30' north latitudes. It has a population of 17 million with an average annual growth rate of 2.66 percent, with 94 percent of the population residing in rural areas. The literacy rate is around 30 percent of the total population while for women it is barely 11 percent of the total population (CBS, 1988).

The country can be broadly classified into three physiographic zones: Terai (27 percent), Hill (50 percent), and Mountain (23 percent). According to land use pattern, the country can be classified as follows: Cultivated land (21 percent), Forest (37 percent), Grass land (12 percent), Shrubs (5 percent), and others (25 percent). The soil condition is more fertile in the lowlands than in the Hills. Nepal, basically, falls within the sub-tropical monsoon climate. But because of its varied topographic configuration, it experiences a wide range of climates (MFSC, 1988).

Administratively, Nepal is divided into five north-to-south development regions: Eastern, Central, Western, Mid-Western, and Far-Western. Each development region consists of 2 or 3 zones, which is divided into 4 to 7 districts. Each district is divided into 35 to 100 village panchayats which further consists of 9 wards each. The village panchayat is the lowest unit for administration.

On the economic front, Nepal relies heavily on agriculture and pasture. Agriculture employs over 90 percent of the total population and contributes about 55 percent of GDP and more than 60 percent of the export earnings. Industrial sector contributes only about 14 percent of GDP, of which 30 percent is from cottage industries. Agro-based and forest-based industries account for more than 80 percent of industrial establishment (MOF, 1989). The current per capita income is estimated at 140 USD per annum. The income distribution is skewed. About 40 percent of the population is considered to live below the poverty line (NPC, 1987).

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The major resources of energy in Nepal are traditional fuels mainly fuelwood, agriculture residue, and dung. These fuels accounts for almost 96 percent of the total energy supply and demand (Fuelwood - 76 percent, Agriculture Residue - 11 percent, and Dung - 9 percent). The entire demand for coal and petroleum products are met by imports. The consumption of commercial energy is concentrated in the urban centres as topography precludes a wide-spread distribution network. The imported fuels account for about 3.5 percent of the total energy and 88 percent of total commercial energy consumed, while almost 35 percent of export earning is diverted to import fossil fuels. The modern sector of Nepalese economy accounts for less than 5 percent of the energy consumption, while 95 percent of the total energy (excluding human and animal) is consumed in the domestic sector. The total per capita consumption of energy was 14.4 GJ (862 kg. of Fuelwood equivalent) of which 0.6 GJ (36 kg. of fuelwood equivalent) was commercial energy (WECS, 1987).

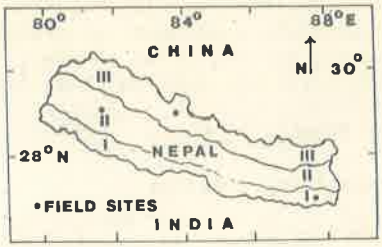
Energy demand pattern in Nepal mirrors the rural agricultural nature of its economy and the small size of its modern industrial and commercial sectors. The energy problem to be addressed is thus, two-fold. First, rural areas depend on traditional fuels for virtually all of their energy requirements which has non-monetized economy. Secondly, the country has to fulfill the energy demand of the slowly developing modern sector, which depends on imported fossil fuels. No use is made of its most abundant energy resources - hydropower and solar. The immense hydropower potential has remained almost untapped, yet forests are being eroded to create new agriculture land and to provide timber, fodder, and energy. The exploitation of forests for fuelwood has created a spectre of ecological disaster. Large scale afforestation programmes and hydropower development are thus essential, along with ingenuity in satisfying the rural domestic sector energy needs.

RESEARCH METHODOLOGY

Survey Approach

Three districts from different physiographic zones of different development regions of Nepal were chosen for research. District panchayat secretariat office and other related organizations like forestry, agriculture, etc. were contacted in order to get better acquainted with the area. The district panchayat office especially was instrumental in the selection of a village panchayat most suitable for the objective of the study. Finally, one village panchayat from each physiographic region was chosen to carry out extensive field survey to understand rural energy use behaviour and its linkage with socio-economic variables. These were: Baijnathpur village panchayat, Eastern Terai; Lekhgaun village panchayat, Mid-Western Hill; and Marpha village panchayat, Western Mountain as shown in Fig. 1.

FIG.1: LOCATION OF VILLAGES IN NEPAL



I- TERAI ; II- HILL ; III- MOUNTAIN

Detail household survey is carried out. The sampling unit for household level survey was a household. Three to four communities from each village were chosen with the help of village chairman, the selections being weighed with regard to ethnicity and income status (FAO, 1987). The household survey questionnaire included the following variables in seven parts.

Part 1: General:

- Family composition;
- Type of house and rooms, owned or leased, etc.;
- Time spent by family members for different activities;

Part 2: Agriculture:

- Cultivated area: land owned, rented in, rented out;
- Average size of the field, average distance to the field, irrigation, source of irrigation;
- Crop details: crop types, planting period, land occupied;
- Soil preparation for different crops (ploughing, planting, irrigation);
- Harvest and post-harvest operations: crop types, harvesting, threshing, transport, agro-processing;
- Other farm inputs and production (fertilizer, farm-yard manure, seeds), agriculture production;
- Marketing of agriculture produce (quantity sold, price of commodity, distance transported, means of transport);

Part 3: Livestock:

- Type and number of livestock;
- Fodder requirement;
- Source of water supply for livestock;

Part 4: Domestic Sector:

- Food requirement, type of cooking stoves, duration of use, type of lamps, other energy devices;

- Type of fuel: source (collection/purchase), place of collection, month of collection, distance travelled to place of collection/purchase, time spent in travelling and collection, frequency of collection, price of fuel, end use such as cooking, heating, lighting, seasonal variation, energy expenditures.

Part 5: Drinking Water Supply:

- Source, consumption, quality;

Part 6: Non-Agriculture Sector:

- Non-agriculture income generating activities, energy spent for these activities, if any;

Part 7: Expenditure and Income Detail:

- Sector-wise expenditure (domestic - food, clothing, school, health care, etc.; agriculture - hired labours, fertilizer, seed, etc.; others);
- Income details (source of income, amount).

Ten to twenty percent of the total households of the village panchayat were randomly selected from each community within a village. The total number of households selected for sampling were 87 households from Baijnathpur, Terai (sampling rate - 13 percent, total hh - 664); 92 households from Lekhgaun, Hill (sampling rate - 17 percent, total hh - 548); 51 households from Marpha, Mountain (sampling rate - 20 percent, total hh - 253).

Data Base Management

Three different files were opened on Lotus 123 spread-sheet for each village. The households were inserted on rows and respective information for each household on corresponding column in the spread-sheet. Mathematically, it can be written as:

$A_{i\,j}$, where i represents each household and varies from 1 to N.

Where J represents each information for that specific household and varies from 1 to T.

The mean, standard deviation and 95 percent confidence interval for each information is calculated with the following formulae (Dixon and Massey, 1969, Wonnacott and Wonnacott, 1979);

$$\text{Mean } (X_j) = (\Sigma A_{i\,j})/N, \qquad \ldots\ldots (1)$$

where i varies from 1 to N

$$\text{Standard Deviation } (S_{x\,j}) = \sqrt{\frac{(\Sigma A_{i\,j} - \bar{x})^2}{N-1}} \qquad \ldots\ldots (2)$$

where i varies from 1 to N

95 percent confidence interval value:

$$\text{Minimum} = X_j - 1.96 * S_x/\sqrt{N} \quad \ldots\ldots(3)$$

$$\text{Maximum} = X_j + 1.96 * S_x/\sqrt{N} \quad \ldots\ldots(4)$$

These files are considered as primary data files. Secondary data files are created where all related conversion units and coefficients are kept in this file. Working files for all three village panchayats are created in order to carry out detail data analysis and plotting graphs and output tables.

Data Analysis Approach

Standardization of Variables

Local units of energy, land area, etc. were converted into standard units in order to obtain comparable results. "Joule" is the chosen energy unit. Human population is converted into standard population assigning appropriate coefficients for different age groups. Similarly, livestock population is converted into livestock unit with appropriate coefficients for each type of livestock.

Estimation of Secondary Information

Calculation of agriculture residue generated, dung produced, animal and human labour inputs for various activities are done by using standard coefficients.

Range Analysis

In order to see the effect of variables on total energy consumption per household and per capita in terms of end use and energy forms, each variable is ranged appropriately. Average and standard deviation is calculated for each range. This exercise makes insight on energy use variability easier. The variables considered for range analysis are population, livestock holding, agriculture production, agriculture commodity, cultivated land, agriculture residue generated, animal dung production, total household expenditure, different community, ethnic group, floor area of the house, no. of cookstove. It is also found that total household energy consumption per household shows linear relationship with the chosen variables, while total household energy consumption per capita shows non-linear behaviour. Hence, in this study consideration is given to analyze the effect of variables on total household energy consumption in terms of end use and various energy forms.

SOCIO-ECONOMIC CHARACTERISTICS OF RESEARCH VILLAGES

Demographic and socio-economic charateristics of research villages is compared in Table 1, where as location, resource availability, infrastructure, and felt needs of research villages are enumerated as follows:

Table 1

Demographic and Socio-Economic Characteristics of Research Villages

	Unit	Research Villages		
		Baijnath	Lekhgaun	Marpha
1. DEMOGRAPHIC COMPOSITION				
- Total Population	Nos.	3434	3855	1212
- Age wise Distribution				
- <15 yrs.		27%	36%	33%
- 15-65 yrs.		62%	60%	60%
- >65 yrs.		11%	4%	8%
- No. of Household	Nos.	664	548	253
- Household Size	Nos.	5.2	7.0	4.8
2. OCCUPATIONAL PROFILE	No. of hh			
- Agricultural Farming		117	481	213
- Unskilled Labour		513	8	0
- Skilled Labour		25	51	12
- Commerce		7	5	19
- Service		2	3	9
		664	548	253
3. LITERACY RATE		11%	23%	47%
4. TYPE OF LAND OWNERSHIP	No.of hh			
- Landless		492	21	10
- <0.25 ha.		33	20	24
- 0.25 - 0.5 ha.		25	163	57
- 0.50 - 1.0 ha.		41	165	76
- >1.0		73	179	86
5. LAND USE PATTERN	Ha.			
- Agriculture Land		627	742	181
- Forest Cover		3	1600	1480
- Pasture Land		26	250	1120
- Housing Area		30	19	14
- Snow Cover		0	0	1526
- Others		33	479	0
Total		720	3090	4321
6. IRRIGATED AREA		29%	21%	69%
7. CROPPING INTENSITY		115.4%	120.7%	164.7%
8. CROP AREA				
- Paddy		86%	22%	-
- Wheat		-	36%	22%
- Maize		-	40%	1%
- Barley		-	-	34%
- Millet		-	-	30%
- Oilseed		2%	1%	-
- Jute		8%	-	-
Total	ha.	724	895	298
9. AGRICULTURE PRODUCTION	Tons/hh	1.9	1.6	2.4
10. LIVESTOCK PER HOUSEHOLD	Lsu/hh	2.2	5.4	7.7
11. HOUSEHOLD EXPENDITURE				
- Clothing		51%	72%	63%
- Education		15%	8%	12%
- Energy		11%	0.4%	6%
Total	US$/Yr.	165	90	277
12. DISTANCE TO MARKET	Kms.	8	12	118

Baijnathpur Village Panchayat

Baijnathpur is one of the 65 village panchayats in Morang district, Koshi Zone of Eastern Development Region. The elevation of the area is 72 m. above mean sea level. It is about 8 km. from Biratnagar one of the main industrial cities of Nepal. The panchayat lies on 26°29' north latitude and 87°16' east longitude.

The total population of 3434 persons (out of which 52 percent are male and 48 percent are female) is distributed among 664 households (here in after referred as hh). Age-wise distribution of the population shows that 62 percent of the total population is within the age group of 15 to 65 years. The literacy rate of the panchayat is 11 percent.

Among people of different ethnic groups such as Rajbanshi, Tharu, Mushar, and Bantar, the panchayat is dominated by the latter two groups - Bantar and Mushar (60 percent). One hundred and seventeen households are engaged in agriculture farming, while 56 hh. are Rickshaw-Pullers and 25 hh. are skilled labourers, and the rest work as farm labourers. According to land ownership 74 percent of the total households are landless, and 11 percent possess more than 1 ha. of agricultural land.

Resources Available

The land use pattern of the panchayat's 7.2 sq.km is as follows: agricultural land (91.7 percent), forest cover (0.5 percent), pasture land (3.7 percent), and land covered by housing and infrastructure amounts to 4.1 percent. There is virtually no forest in the panchayat, and the villagers have to walk more than 12 hrs. to collect wood from other panchayats.

While most of the cultivated area is rain-fed, about 29 percent is irrigated by the government managed irrigation canal. The people, however, seem troubled that during the dry winter months there is no water in the canal, while during monsoons the surplus water damages the canal and floods the cultivated land. However, cropping intensity is 115 percent.

Agriculture production of this panchayat includes paddy which covers 86 percent of cultivated area, and jute covers 8 percent. On the whole, only about 73 hh. produce sufficient food for the year. The people who do not produce enough food from their own land meet their expenses by raising livestock or working as farm labourers. The landless people work as rickshaw-pullers or farm labours. Livestock not only provides animal protein to urban dwellers but also produces the dung which is extensively used as fertilizer (11 percent) and cooking fuel (89 percent). There are about 1134 cattles, 255 buffaloes, 595 goats, and 117 pigs. Almost 62 percent of the surveyed households possess livestock. Almost 16 percent of the agriculture residue collected by the farmers is utilised for energy purpose and the rest is used as animal fodder. There are 13 diesel and 1 electric pumps, and 27 rower hand pumps for shallow water irrigation installed in recent years.

There are about 49 tube-wells in the panchayat for drinking water purpose. Electricity available from main National Grid reaches only 46 hh. This is due to the fact that the people do not have sufficient income to pay for initial investment or electricity bills even for lighting.

Infrastructures

There are about 10 tea-stalls within the village panchayat. There is a Panchayat Bhawan, 3 Primary School, 1 Middle School, and Small Farmer's Development Programme (SFDP) of Agriculture Development Bank. About 22 groups formed by SFDP were extended loan facilities on group collateral basis. There are three places within the panchayat for weekly "Haat" bazaar on different days of a week for buying and selling of their agricultural produce as well as other commodities. Almost 77 percent of houses surveyed were thatch-roofed. Only 20 man-days are spent by the farmers for weaving clothes and making jute ropes.

Felt Needs

About 42 percent of the surveyed households felt the need for establishing the system of fuelwood sales by vendors, while 30 percent of the hh wanted electricity connection to meet their lighting requirements, 20 percent wanted loans for income generating activities, 16 percent were in need of drinking water facilities, 12 percent were keen on industrial establishment and 9 percent mentioned non-availability of kerosene at market price. Almost 16 percent of the households reported difficulty in feeding their family.

Lekhgaun Village Panchayat

Lekhgaun is one of the 61 village panchayats in Surkhet District, Bheri Zone of Mid-Western Development Region. The elevation of the area is about 1176 m. above mean sea level. It is about 12 km. from Surkhet Town Panchayat, head-quarter of Mid-Western Development Region. The panchayat lies on 28°20' north latitude and 81°35' east longitude.

The total population of 3855 persons (out of which 51 percent are male and 49 percent female) is distributed among 548 households (hh). Age-wise distribution of the population shows that 60 percent of the total population is within the age group of 15 to 65 years. Almost 91 percent of the households are engaged in agriculture activities and out of that 2 percent are agriculture labourers. About 9 percent of the households possess technical skills for various rural craftmanships. The literacy rate of the panchayat is 23 percent, out of which 14 percent is women.

There are people of different ethnic groups such as Magar, Brahmin, Chhetri, Kami, Damai, etc. The panchayat is dominated by Magar (45 percent) and Brahmin (35 percent) communities.

According to land ownership, 62 percent of the total households possess land between 0.25 to 1 ha., and 34 percent of the hh possess land more than 1 ha. Almost 368 hh (67 percent) fall under poverty line.

Resources Available

Land use pattern of the panchayat is as follows: agriculture land (39.8 percent), forest cover (51.6 percent), pasture land (8.1 percent), and land covered by housing and infrastructure 0.6 percent. The total area of the panchayat is 30.9 sq.km. Almost 52 percent of the area is covered by forest which is being denuded rapidly due to over-exploitation. People claim that the crown density has been most rapidly decreasing during the last decade. The average time required to fetch a head-load of fuelwood is 5 hours including the journey to and from forest.

About 60 percent of potential agriculture land is being cultivated to meet their daily food requirements. Only 21 percent of the cultivated land is irrigated and the rest is rain-fed. All irrigation facilities are managed by the farmers and have been in existence for a long time. The cropping intensity of the area is 121 percent. The main agriculture production of this panchayat includes maize which covers 40 percent of cultivated area, wheat covers 36 percent, and paddy covers 22 percent. There are no modern farm machineries and equipments.

There are about 2925 cattles, 274 buffaloes, 1847 goats, and 120 pigs, altogether 5166 animals in the panchayat. Almost every household possesses livestock. More than 90 percent of agriculture residue collected is used as animal fodder and the rest for energy purpose.

There is one main river flowing across this panchayat named "Shot Khola", with minimum discharge rate of 200 lit/sec. There are about 16 traditional water wheels "Ghatta" along the river within the panchayat primarily for agro-processing activities. There are three natural springs which can be used year round for drinking water. Villagers spend an average maximum of 45 mins. to fetch a bucket "Gagri" of drinking water.

Infrastructures

There are five primary schools and one high school within the panchayat. There is a panchayat office, a Health Post, and a Primary Education Project. Besides this, there is a library run by Mahendra Youth Club. There are 5 tea-stalls and one cloth shop. Almost all of the households surveyed were thatch-roofed. Only 20 man-days is spent by the farmers for making mats, ropes, etc.

Felt Needs

About 44 percent of the surveyed households complained of fuelwood availability and collection, 40 percent wanted drinking water facilities, 30 percent of the hh mentioned the fodder problem, and 12 percent about the non-availability of kerosene at market price. Almost 26 percent of the households had difficulty in feeding their family.

Marpha Village Panchayat

Marpha is one of the 16 village panchayats in Mustang District, Dhaulagiri Zone of the Western Development Region. The elevation of the area is about 2660 m. It is about 118 km. from Pokhara, headquarter of Western Development Region as well as a main market centre. The panchayat lies on 28°50' north latitude and 83°47' east longitude.

The total population of 1212 persons (out which 49 percent are male and 51 percent female) is distributed among 253 hh. Age-wise distribution of the population shows that 60 percent of the total population is within the age group of 15 to 65 yrs. Almost 84 percent of the total hh are engaged in agriculture, 8 percent in hotel business and 5 percent hh possess technical skill. About 4 percent of the households are landless.

Almost all of the population are of the same ethnic group known as "Thakali" reputed for their hotel management practice in the rural areas.

Resources Available

Out of 43.2 sq.km. area of this panchayat, 4 percent is agriculture land, 34 percent is forest land, 26 percent is pasture land, and 36 percent of the land is covered by snow throughout the year. Only 181 hectares of land is being exploited for agricultural activities. Almost 69 percent of the total cultivated land is irrigated. This is mainly due to the fact that most of the settlement are along Kaligandaki river and this river is extensively exploited for irrigation purpose. Most of the canals are built and managed by the community itself. The cropping intensity of the area is about 165 percent.

Agriculture production of this panchayat includes barley which covers 34 percent of cultivated area, millet like cereal "Phapar" covers 30 percent, and wheat like cereal "Uoa" covers 22 percent.

There are 881 mules for transportation as it takes 6 days to reach the market centre, 39 horses, 294 he-yak, 332 she-yak, 169 cattle and 1865 goats.

There are two rivers in the panchayat, Syang Khola with minimum discharge of 250 lit/sec. and Kaligandaki, a major river of the region capable of empowering mega-projects. Almost all houses have access to electricity which is, however, used only for lighting, except in houses running restaurants and/or hotels.

Instrastructures

There are about 15 restaurants and hotels in the panchayat to cater to tourists, 6 provisional stores, 2 primary and 1 high school. There is a health post, forest office unit, agriculture office unit, Regional Agriculture Farm, Agriculture Input Corporation, and a Post office. People in this area are better off than in the surrounding villages due to high influx of tourists. Almost everything is transported from Pokhara (6 day's walk) on mules. About 45 percent of the

total agriculture production is diverted as animal feed. Therefore rice has to be brought in from neighbouring districts even for self consumption. They grow a substantial amount of apple which, in season, get spoilt due to transportation bottle-neck. There are nine solar collectors in the area mostly in hotels for the benefit of tourists. None of the households surveyed had thatch-roofs. Only 15 man-days are spent by the people for weaving carpets. Most of them augment their income selling these items.

Felt Needs

About 65 percent of the surveyed household expressed the need for transportation facilities, while 16 percent of the hh wanted a bridge across Kaligandaki river and irrigation, and 9 percent mentioned the problem of marketing apples and vegetables. Almost 10 percent of the households expressed the difficulty of feeding their family.

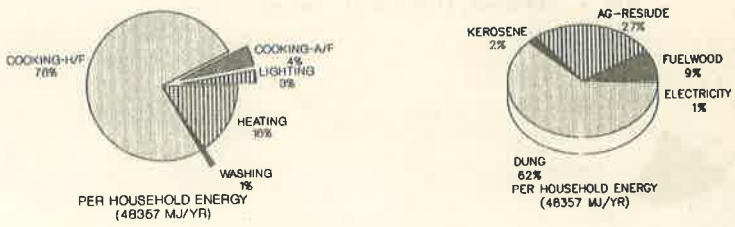
RURAL HOUSEHOLD ENERGY USE BEHAVIOUR

Rural Household Energy Use Pattern

Seven different household activities requiring energy have been identified on the basis of information collected during the survey. They are: cooking human food, cooking animal feed, preparing alcohol, washing clothes, heating, cooling and lighting. It is observed that the main source of household energy requirement is traditional energy.

Per household energy requirement in household sector of Baijnathpur village panchayat (Terai) amounted to 48357 MJ per year (equivalent to 2.9 tons of fuelwood), out of which 76 percent is required for cooking human food, 16 percent for heating and 3 percent for lighting as shown in Fig. 2. The main forms of energy in Baijnathpur are animal dung

FIG. 2 BAIJNATHPUR, TERAI-NEPAL

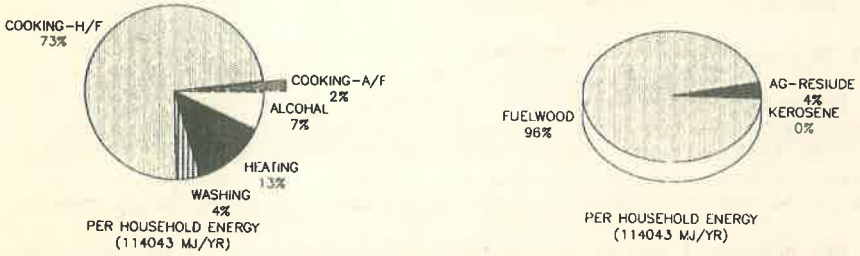


(62 percent), agriculture residue (27 percent) and fuelwood (9 percent) as there are no forest in nearby areas. The main supplier of energy for cooking is animal dung, while a few households use fuelwood. Agriculture residue provides the main energy for heating. Only 3 percent

of total energy required is in the form of commercial energy -- that too, for lighting purpose, out of which 23 percent is electricity and the rest is kerosene because of the fact that only few households have electricity connections.

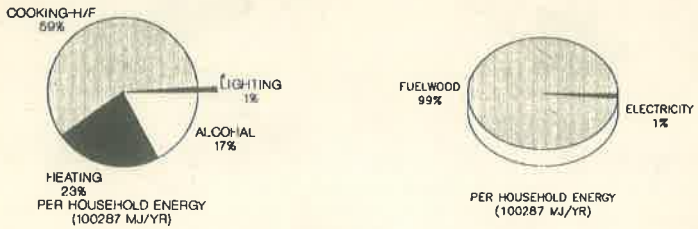
Per household energy requirement of household sector of Lekhgaun (Hill) amounted to 114043 MJ per year (equivalent to 6.8 tons of fuelwood), out of which 73 percent is required for cooking human food, 13 percent for heating, and 7 percent for alcohol brewing as shown in Fig. 3. The main supplier of energy are fuelwood (96 percent) and agriculture residue (4 percent). Kerosene is the only source of commercial energy being used in Lekhgaun and that too only for lighting and its share in total household energy requirement is nominal.

FIG. 3 LEKHGAUN, HILL - NEPAL



Per household energy requirement of household sector of Marpha village panchayat (Mountain) amounted to 100287 MJ per year (equivalent to 6 tons of fuelwood), out of which 59 percent is required for cooking human food, 23 percent for heating, 17 percent for alcohol brewing, and 4 percent for lighting as shown in Fig. 4. The main form of energy is

FIG. 4 MARPHA, MOUNTAIN - NEPAL



fuelwood (99 percent), while electricity is used for lighting. No use of kerosene is made because almost all households have electricity connection which they preferred for lighting.

Fuelwood constitutes predominant source of energy in the villages of Hills and Mountains, while dung is the major fuel in the Terai. Use of animal dung and agriculture residue seem to be directly related to the availability of fuelwood in the area. Where fuelwood is in short supply people are shifting towards using animal dung and agriculture residue.

Total household energy consumption per household is highest in the Hills, while in terms of total energy use per capita is highest in the Mountains. This may be due to hh size as well as extra heating requirements at high altitudes. It is also noted that due to increase in altitude the amount of alcohol consumption increases. Almost 17 percent of the total energy per hh is consumed for alcohol brewing in the Mountains, while it is about 7 percent in the Hills, and 1 percent in the Terai. Cooking human food consumes about 55 percent to 75 percent of the total energy in all villages, whereas heating requirements consume about 15 percent to 20 percent of the total energy. Lighting energy requirement amounts to less than 3 percent of the total energy. Almost 20 percent of the total households surveyed resorted to commercial forms of energy for lighting and the rest use pine tree chips "Diyalo" or vegetable oils. Lighting, as we have seen, is the only activity at household level which requires commercial forms of energy. Per capita cooking energy requirement is highest in the Mountains presumably due to temperature difference as well as fuelwood availability factors. The use of energy for preparing animal feed is noticed only in the Hills, probably due to traditional expectation of Brahmins and Chhetris that cooked feed will result in more production of milk. Almost 4 percent of the energy is spent for washing clothes. This practice, however, is not observed too frequently in the Mountains due ostensibly to raised conservation consciousness. The amount of commercial energy use per capita is high in areas with electricity. The Terai and Mountain panchayats surveyed have access to electricity, which however, finds minimal use except for lighting due to low purchasing power of the rurals. It is also interesting that the absolute level of energy use is significantly low in Terai panchayat compared to other villages where there is a good access to "free" fuelwood.

Table 2 depicts percentage variation in estimated figures of energy requirement per household in the rurals at 95 percent confidence interval and also corroborates the discussions given above.

Factors Influencing Rural Household Energy Use

It is very important to understand the diversity in the energy consumption pattern in the household sector of rural areas within and between communities due to influence of exogenous and indigenous variables. This section explains some of the sources of variation in

Table 2

Percentage Variation in Per Household Energy Requirement at 95 Percent Confidence Interval

	Research Villages		
	Baijnath	Lekhgaun	Marpha
END USE			
- Cooking-H/F	± 8%	± 11%	± 10%
- Heating	± 33%	± 19%	± 11%
- Lighting	± 12%	± 44%	± 20%
ENERGY FORMS			
- Fuelwood	± 41%	± 11%	± 9%
- AG-Residue	± 21%	± 15%	-
- Animal Dung	± 11%	-	-
- Electricity	± 50%	-	± 21%
- Kerosene	± 12%	± 44%	-
Total Energy	± 10%	± 11%	± 9%

energy use for different household activities by observing the effect of thirteen major variables which is likely to significantly affect the pattern of household energy use. The effect of these variables on energy consumption is analyzed at the very simple level of the difference in average per household energy consumption on the basis of a single independent variable as shown in Table 3.

Total energy consumption per household increases with the household size in all the villages. It is evident from the Table that there is substantial increase in energy requirement for cooking human food and for heating activities in all research villages with the increase in the household size. It is also important to note that the major forms of energy requirement whether fuelwood or animal dung increases with the increase in hh size.

Per household energy requirement for cooking and heating increases with the increase in land holding and agriculture production of a household. The consumption of major forms of energy also increases with the increase in land holding and agriculture production. Same is the case for commercial energy use behaviour. This is not unexpected as land holding and/or agriculture production could roughly indicate the income level in subsistence economies which depend mainly on agriculture.

Agriculture commodity required by a household compared to agriculture production shows better relationship specifically in Baijnathpur Village Panchayat because this panchayat has a higher percentage of landless people.

Table 3
Cross-Classification of Energy Requirement by End Use and Demographic and Socio-Economic Variables

Unit : MJ/HH/YR.

End-Use Energy	Baijnathpur			Research Villages Lekhgaun			Marpha		
	Size of the Household								
	1 - 4	5 - 8	> 9	1 - 4	5 - 8	> 9	1 - 4	5 - 8	> 9
	(19)	(47)	(21)	(13)	(49)	(30)	(18)	(28)	(4)
Cooking	29725	36976	53376	49703	82601	145378	56905	85010	119908
Heating	3885	6418	13633	10373	12916	20789	16344	26069	36816
Lighting	701	1060	1467	486	314	799	750	1384	1119
TOTAL	34310	44454	68477	60561	95832	166965	74000	112463	157843
	Cultivated Land Per Household (ha.)								
	Landless	0.1-4.0	> 4.0	0.1-4.0	1.1-4.0	> 4.0	Landless	0.1-1.0	1.1-4.0
	(35)	(22)	(30)	(44)	(44)	(4)	(1)	(33)	(16)
Cooking	33502	37828	54997	76528	106157	254190	60894	72433	89565
Heating	239	5238	28408	12670	14490	49088	25025	22902	24411
Lighting	1021	836	1834	329	436	2995	1104	924	1570
TOTAL	34762	43902	85239	89528	121084	306272	87023	96259	115546
	Agriculture Production Per Household (Tons.)								
	Nil	0.1-2.0	> 2.0	Nil	0.1-2.0	> 2.0	Nil	0.1-2.0	> 2.0
	(34)	(21)	(32)		(72)	(20)	(1)	(41)	(8)
Cooking	33748	37348	47118		84692	164582	60894	73706	100172
Heating	130	3339	19615		13538	23871	25025	25025	27338
Lighting	1000	1112	1119		356	1209	1104	1030	1962
TOTAL	34877	41799	67852		98586	189662	87023	99761	129471
	Agriculture Commodity Per Household (Tons.)								
	0.1-2.0	2.1-5.0	> 5.0	0.1-2.0	2.1-4.0	> 4.0	0.1-2.0	2.1-4.0	
	(46)	(25)	(16)	(68)	(20)	(4)	(33)	(17)	
Cooking	33660	42584	50662	81448	124984	254190	64110	104035	
Heating	1243	6701	27315	13295	14549	49088	19513	31027	
Lighting	915	1362	1111	364	446	2995	1058	1419	
TOTAL	35818	50647	79089	95108	139979	306272	84681	136481	
	Livestock Holding Per Household (LSU)								
	Nil	0.1-5.0	> 5.0	Nil	0.1-5.0	> 5.0	Nil	0.1-5.0	> 5.0
	(19)	(53)	(15)		(48)	(44)	(13)	(14)	(23)
Cooking	36317	36435	56519		75985	145619	67631	64980	95250
Heating	1068	5660	25522		12776	20859	20890	19456	27011
Lighting	1020	969	1574		479	786	736	1085	1285
TOTAL	38405	43064	83615		89240	167264	89257	85521	123585
	Total Household Expenditure (US$/Yr.)								
	4-40	41-200	> 200	20-80	81-120	> 120	30-200	200-400	> 400
	(25)	(37)	(25)	(43)	(34)	(15)	(11)	(25)	(14)
Cooking	33402	38104	51073	68507	106798	165199	55704	75690	110192
Heating	1109	3748	23832	12011	14436	25608	16643	22256	34725
Lighting	863	1261	1027	221	448	1394	503	1345	1460
TOTAL	35374	43113	75932	80740	121682	192201	72851	99291	146377

	Agricultural Residue Produced Per Household (Tons.)								
	Nil	0.1-4.0	> 4.0	0.1-2.0	2.1-4.0	> 4.0	0.1-2.0	2.1-4.0	> 4.0
	(34)	(20)	(33)	(39)	(25)	(27)	(26)	(17)	(6)
Cooking	34202	36196	46674	72619	96659	138094	69433	81758	104700
Heating	3	3539	18182	12624	14374	19669	21701	22191	34146
Lighting	1032	1112	1109	290	433	871	1021	1109	1702
TOTAL	35237	40846	65965	85534	111465	158634	92155	105058	140548
	Animal Dung Availability Per Household (Tons./Yr.)								
	Nil	0.1-4.0	> 4.0	0.1-4.0	4.1-8.0	> 8.0	Nil	0.1-4.0	> 4.0
	(19)	(37)	(31)	(27)	(41)	(23)	(13)	(11)	(26)
Cooking	36317	34636	51726	70541	91460	146007	67631	60114	90101
Heating	1068	3803	20768	13528	13277	20747	20890	18856	26451
Lighting	1020	955	1436	403	413	777	736	884	1446
TOTAL	38405	39394	73929	84473	105149	167530	89257	79854	117999
	Floor Area of a Household (Sq. Ft.)								
	100-300	301-900	> 900	100-300	301-900	> 900	100-300	301-900	> 900
	(50)	(37)		(10)	(74)	(8)	(9)	(26)	(15)
Cooking	33692	48089		71293	94867	195023	61807	75415	84701
Heating	2720	15989		11364	14868	30494	20389	21972	25667
Lighting	874	1335		312	386	1715	339	1014	1848
TOTAL	37286	65413		82969	110120	227232	82535	98400	112216
	No. of Cookstoves Possessed by a Household (Nos.)								
	One	Two	> Two	One	Two	> Two	One	Two	> Two
	(18)	(69)		(66)	(22)	(4)	(38)	(12)	
Cooking	34395	40644		91319	95078	234052	74658	87269	
Heating	1695	9254		13747	13080	49088	23218	24092	
Lighting	1101	1074		206	964	2722	905	1861	
TOTAL	37191	50972		105272	109122	285862	98781	113222	
	Different Locality Within a Village Panchayat								
	Baijnath	Ghinaha	Dhanpura	Lekhgaun	Finkada	Sirupata	Marpha	Syang	Chairo
	(27)	(22)	(21)	(23)	(47)	(22)	(26)	(16)	(8)
Cooking	38190	42150	40022	95823	94823	108833	75499	82166	75822
Heating	10639	7672	6720	14972	16217	12949	23127	25622	20016
Lighting	445	1475	1556	0	800	366	1471	918	473
TOTAL	49274	51297	48298	110795	111840	122148	100097	108707	96311
	Various Ethnic Groups								
	Bantar & Mushar	Tharu & Rajbansi	Others	Brahmin & Chetri	Magar	Kami & Damai			
	(32	(48)	(7)	(29)	(44)	(19)			
Cooking	36029	42446	32267	82713	115090	83616			
Heating	2032	10515	4370	12139	17779	13290			
Lighting	1009	1072	1061	774	232	701			
TOTAL	39070	54034	37698	95626	133100	97606			

Note: Bracketted Figures are No. of Sampled Households.

Livestock holding shows relationship with total energy consumption per hh but has less significance in terms of disaggregated end use. Livestock holding does not show a good correlation with energy required for cooking animal feed. This may be due to different feeding habits of people belonging to different ethnic groups. In subsistence agriculture livestock possessed by a household may also depict its level of affluence.

Total household expenditure shows positive correlation for all energy consuming household activities in all research villages, as it is a main indicator of rural household income. It is also noteworthy that higher the household expenditure higher is the consumption of commercial fuel or, in other words, better the purchasing power higher is the consumption of commercial fuels. Most of the rural households were reluctant to provide information regarding income but were quite willing to impart information about their expenditures. Hence household expenditure is assumed to be a good measure of income of a particular household.

It is evident from the analysis that availability of agriculture residue increases the percentage share of agriculture residue as energy. Agriculture residue is mainly used for heating purpose since dung is preferred for cooking in the Terai. In the Mountains people still do not use agriculture residue as fuel. But in the Hills it is finding its place as cooking fuel.

It can be seen from the table that the percentage share of dung as energy increases with its availability. In Lekhgaun (Hill) and Marpha (Mountain) village dung is not a major energy source due to availability of "free" fuelwood, while in Baijnathpur dung contributes 62 percent of total energy requirement of a household.

Energy required for lighting shows positive correlation with the floor area except in case of Lekhgaun village where there is no electricity. It means that lighting with electricity shows a good correlation with floor area, while with kerosene the relationship is not so distinct. This may be due to low kerosene consumption. In Lekhgaun there is not much variation in kerosene consumption because of the tendency of people to minimize use of kerosene by going to bed early. No. of cookstoves possessed by a hh does not exhibit much difference in the level of energy consumption.

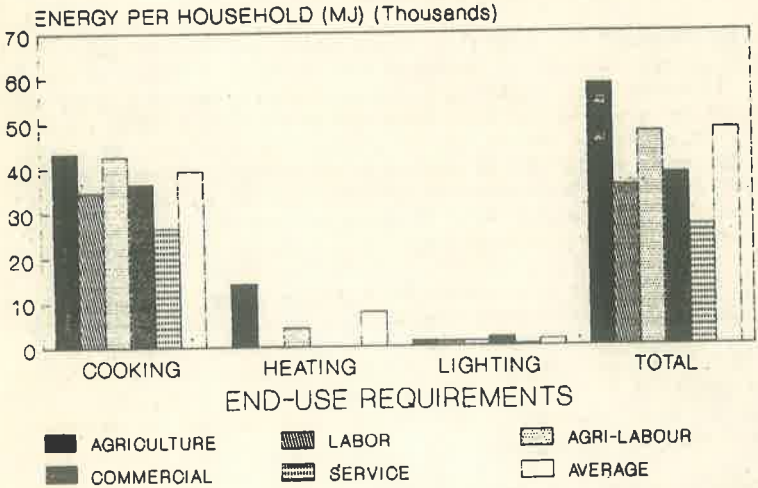
It is noticed that the amount of energy consumption does not vary significantly within different communities of the panchayat. There is however, substantial difference in energy consumption based on topography. Total energy consumption is almost double in the Hills and Mountains compared to Terai. This may be due to forest accessibility as well as altitude whereby higher quantity of energy is demanded for heating and alcohol brewing.

Household energy use among different ethnic groups could be studied only in case of Lekhgaun (Hill) and Baijnathpur (Terai). It is noticed that there is substantial difference in energy consumption between Magars and Brahmins of Lekhgaun. This could be explained by three factors: first, Magars brew alcohol for self consumption which consumes

almost 10 percent of total energy, while Brahmins do not practice alcohol brewing; second, Magars have most inefficient cookstove i.e. Tripod Stand "Odan", while Brahmins have two close-mud-stove which is more efficient; third, type of food preferred is different and so is the intensity and type of flame required. In Terai, the level of energy consumption shows some variation among different ethnic groups due to varying levels of income. Mushar and Bantar are backward landless communities and so their energy consumption is comparatively low.

Relationship between occupation and energy consumption behaviour could be studied only in Terai because more diverse occupations are observed there, while it was not so in the Hills and Mountains. It can be derived from the Fig. 5 that service holders are efficient energy users due evidently to better education and exposure. It is also noticed from the table that the labourer uses less energy and this could be due to less availability of "free" traditional energy forms. Labourers, particularly, collect dung from the field or outside as animal dung is the main source of their cooking energy but do not possess any livestock The hh engaged in business still prefer to purchase, because they assign higher opportunity cost for their labour and can afford to buy fuelwood.

FIG. 5 ENERGY FOR VARIOUS OCCUPATIONS
BAIJNATHPUR, TERAI-NEPAL



CONCLUSIONS

In general the level of energy use is high in places where "free" fuelwood is available. The attitude towards rational use of energy only occurs when there is a problem of access to "free" fuels. Change in socio-economic variables affects energy use pattern in the Terai noticeably as compared to the Hills and Mountains. This is obviously due to unrestricted accessibility to "free" fuelwood. In places where fuelwood is scarce, rural people have a natural tendency to shift towards animal dung and agriculture residue (non-monetized fuels) rather than spend money on fuels which may be available and convenient. This may be due to the fact of assigning low opportunity cost for the time they could save by avoiding journeys to and from the forest. Another obvious reason could be their low purchasing power. Thus, rurals are moving into the vicious cycle of energy and environment crises ignorantly, as they shift from fuelwood to other forms of traditional energies reducing the level of nutrients going to the field and to the animals thereby reducing productivity of land, or demanding the import of chemical fertilizer which obviously increases demand for foreign currency negating the national balance of payment situation. Thus the situation in the rurals is very complex as people do not realize the global nature of energy crises as we know it but are, and will continue being the victims of resultant hunger and "more" poverty. A timely concerted effort in management and planning of rural energy would surely divert and dampen the impending crisis.

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