Firewood Consumption in a Nepali Village

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ABSTRACT / People's dependence on firewood as a primary source of energy is causing serious deforestation problems in many developing countries. Reliable information on firewood consumption rates is needed to develop afforestation plans and to control deforestation. This study compares three methods used to determine firewood consumption in a Nepali village. Cultural and environmental factors that affect firewood consumption in the village are also examined.

The *weight survey* proved to be the most accurate method used. The less precise *daily recall* and *annual recall surveys* overestimated actual firewood consumption by factors of 1.76 and 1.95, respectively. Overestimates are attributed to both physical and social factors. In view of the good agreement between daily and annual recall surveys, and the much greater ease of conducting the latter, annual recall surveys are recommended as the most practical method of monitoring firewood consumption rates. Validating the survey with occasional weighed measurements is suggested as a means of improving accuracy.

Firewood consumption rates in the village were influenced by family size, caste, and season, but not by farm size. Economies of scale explained the influence of family size on firewood consumption. Preparing *kũdo* and distilling alcohol caused Newars to burn more firewood than other castes. Seasonal differences in firewood use were attributed to colder weather in January, festival observances in October, the availability of crop residues in November and December, and the higher moisture content of wood during the wet months.

Knowledge of factors influencing firewood consumption in Nepal is fragmentary, because of both insufficient study of these patterns, and unexplained variations in completed studies. Donovan (1981), in a survey of firewood consumption studies conducted between 1954 and 1980, finds the most outstanding feature of these studies to be the wide variability in firewood consumption rates: "Overall and through time, as well as with regard to geographical area . . . from the lowest to the highest the estimates vary by a factor of 67."

Donovan suggests two hypotheses to explain this finding. First, a high degree of variation was inherent in the data evaluated. Differences existed in and among regions with respect to altitude, precipitation, and temperature, factors that affect type and availability of firewood and agricultural residues used as fuel. Differences also existed among caste and tribal groups in kinds of food consumed, methods used for cooking food, the distillation of alcoholic beverages, and the number of holidays celebrated. Finally, differences existed among households in access to firewood and in the amount of labor available for firewood collection. These elements all interacted to influence the amount of firewood consumed annually per household.

The second factor Donovan hypothesizes as introducing variability into studies of firewood consumption rates is the method used for collecting and analyzing data. Of the 49 studies she lists, few state the methods used to sample the population or determine firewood consumption rates. Even when methodology is stated, the population is not systematically sampled and results are based on recalls or on the researcher's subjective assessment. Donovan suggests that the lack of uniformity among research methods "may be the most significant source of variation."

The objectives of the present paper are twofold. The first is to compare estimates of firewood consumption obtained by two qualitative survey procedures to amounts obtained with a quantitative weighing procedure. The second objective is to assess the relative influence of farm size, family size, caste, and season of the year on firewood consumption estimates.

The Setting

The study village, Bhogteni, is located near Gorkha Bazaar in central Nepal (Figure 1). There are 107 households in the village, with an average of 6.1 individuals per household. All households are engaged in subsistence farming. An average household owns 1.10 ha of land, including both irrigated rice and unirrigated corn and millet land. The caste groups found in Bhogteni are: Brahmin (31 households), Chhetri (35 households), Newar (19 households), untouchables (Kami, 9 households; Damai, 4 households; Sarki, 4 households), and others (5 households). Bhogteni is located on a ridgetop about 1200 M mean sea level (MSL). The dominant tree species in the village

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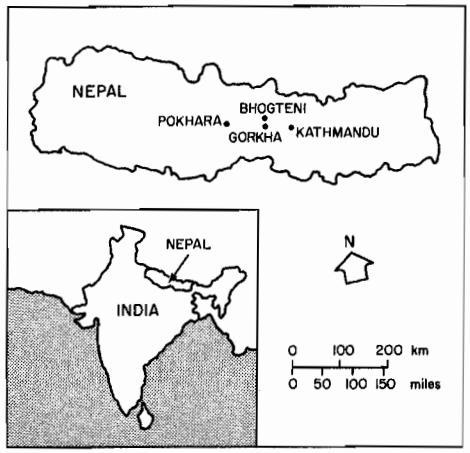

Figure 1. Location of the study village.

are *Schima wallichii* (Chiluane), and *Castanopsis indica* (Katus).

Methods

All households in Bhogteni participated in the study. Households were classified by economic status as well as by caste. The economic classification was accomplished by asking five villagers to rank the 107 village households on a scale from 1 to 3, with 1 representing the highest economic level and 3 the lowest. Responses of the five informants were similar and were averaged to determine a ranking for each household. Table 1 shows the number of households, the percent of population and the percent of land owned by economic group.

Seventy-six households participated in the annual recall survey. These persons were interviewed once, in the fall of 1981, regarding their use of public and private lands to meet firewood demands. The remaining 31 households participated in the daily recall survey and were interviewed weekly for 50 weeks between December 1980 and December 1981 regarding firewood use. Thirty of the latter households also participated in the weight survey that was conducted from August through December 1981.

Participants in the annual recall survey were asked two questions: (a) How much wood do you burn daily in the cold season? (b) How much wood do you burn daily in the warm season?

Participants in the daily recall survey represented a random sample of each of the three economic groups. Questions addressed to these persons ascertained the following: (a) amount of firewood collected since the last interview, (b) where the firewood was collected, (c) length of time required to collect it, and (d) amount of wood burned yesterday.

Table 1. Income groups by average land holdings (ha).

Groups	No. of households	Average land holdings (ha)	% of population	% of village agricultural land
Rich	13	2.50	12	27
Middle	43	1.30	40	47
Poor	51	0.60	48	26
Total	107	1.10	100	100

For the weight study, firewood was weighed at each of the participating households on four separate occasions. On the day measurements were made, the research team visited each farmer at dawn and requested that he or she set aside the amount of firewood that would be burned that day. The wood was weighed and left by the door of the house with instructions given to burn only the wood in that pile, or if any extra wood was needed, to remember how much extra wood was burned. On the following day the research team returned to each household and weighed any remaining wood or the amount of wood estimated to have been added to the original pile.

Firewood was classified by three categories according to the designation of Bajracharya (1980): freshly cut wood (*kãcho daura*), dead branches and twigs (*dar-sukaydura*) and crop residues, old fencing, etc. (*jhikra*). These woods differ in weight per unit volume because of differences in density, form, amount of air space, and moisture content.

In addition to the previously indicated questions, all householders were asked how much firewood was used for specific purposes. While undoubtedly more fuel is used for cooking food than for any other purpose, major differences in amounts used by different groups were not anticipated and, hence, amounts used for cooking were not determined. Respondents were asked to estimate amounts of firewood used for preparing *kũdo* (a mash used in animal feeding), for distilling alcohol, for space heating, and for heating water for laundry.

Results

Firewood Consumption

Three methods were used to measure firewood consumption in Bhogteni. The weight survey was considered the most accurate estimate and results obtained by this method were used as the reference point for evaluating daily and annual recall surveys.

The mean firewood consumption rate per individual per year was 0.95 m^3, as determined by the weight survey, 1.67 m^3 by the daily recall survey, and 1.86 m^3 by the annual recall survey. Volume figures are based on the assumption that 1 m^3

Table 2. Ratio of daily and annual recall results to weight results.

	Daily:weight	Annual:weight
Farm size		
Large farms	2.25	1.69
Medium-size farms	1.56	2.15
Small farms	1.73	1.84
Caste		
Brahmin-Chhetri	1.85	2.25
Newar	1.37	1.31
Untouchables	1.92	2.03
Family size		
Large families	1.73	2.13
Medium-size families	1.53	2.06
Small families	1.81	1.49
Total	1.76	1.96

Table 3. Firewood consumption by farm size and survey methodology (kg/capita/day).

Method	Large (>1.25 ha)	Medium (0.75–1.25 ha)	Small (<0.75 ha)
Weight survey	1.56	1.46	1.66
Daily recall	3.52	2.28	2.88
Annual recall	2.64	3.14	3.07
Weight survey	(0.36)[1]	(0.55)[2]	(0.68)[3]
Daily recall	(0.00)	(0.00)	(0.00)
Annual recall	(0.51)	(0.36)	(0.38)

[1] t-test significance: large vs medium-size farms.

[2] t-test significance: large vs small farms.

[3] t-test significance: medium-size vs small farms.

of wood weighs 600 kg. The amount determined by weight was significantly less than that obtained by surveys ($P < 0.05$). The amount determined by daily recall was also significantly less than that determined by annual recall ($P < 0.1$).

On the average, respondents in the daily recall survey overestimated firewood consumption by a factor of 1.76, while respondents in the annual recall survey overestimated by a factor of 1.95. Analyzing the data by farm size, caste, and family size resulted in overestimates of 1.31–2.25 times actual use (Table 2).

Mean monthly firewood consumption rates (kg/capita/day) for the four months firewood was weighed were: 1.75 (August), 1.49 (September), 1.75 (October), and 0.96 (November). Based on these results, 1.75 kg/capita/day or 1.07 m^3/capita/yr was considered the maximum figure for firewood consumption in the village.

Factors Affecting Firewood Consumption Rates

Firewood consumption rates were studied in relation to farm size, caste, and family size. Since these factors appeared to be interrelated, correlation coefficients were calculated to determine the degree of the relationship. Caste and farm size were correlated (0.60), and farm size and family size, to a lesser extent (0.45). This suggests that Brahmin-Chhetri households have larger farms than do untouchable households, and households of large farms have more family members than do households of small farms. Nevertheless, the correlations were low enough to warrant investigation of the independent effects of these factors.

Farm size. As indicated previously, village households were stratified according to wealth on a scale of 1–3. Since the amount of land owned was judged to be the primary determinant of economic status, the high-income group was designated as the large-farm group, the middle-income group as the medium-size farm group, and the low-income group as the small-farm group.

Trees are permitted to grow on the edges of unirrigated lands. Owners of large farms consequently have greater access to private firewood supplies than do owners of medium-size or small farms. Accordingly, it was hypothesized that size of farm would affect firewood consumption. Table 3 presents average per capita firewood consumption rates by farm size and method of measurement. Contrary to expectations, farm size did not affect wood consumption as measured by weight or annual recall. On the other hand, data from the daily recall survey indicated more wood was burned on large than on medium or small farms, and also more wood was burned on small farms than on medium-size farms.

Caste. Firewood consumption was studied in relation to caste, since caste affects type of food eaten, method of food preparation, type of stove used, whether or not alcohol is distilled, number of animals for whom food is prepared, and number of holidays celebrated—all factors that affect energy needs.

Table 4 presents farmers' estimates of firewood consumption demand by caste and according to the purpose for which the firewood is used. *Kũdo* preparation accounts for the major portion of fuelwood demand in all three caste groups. Newar households require 2.89 kg/capita/day of firewood for making *kũdo,* compared with 2.30 for Brahmin-Chhetris and 1.41 for untouchables. These findings are consistent with the livestock holdings of the caste groups, 3.5–4.5 livestock units for Brahmin-Chhetri and Newar households, and only 1.5–2.0 livestock units for untouchable households. Charcoal production necessitates fuel use only in the untouchable group, since it is made only by blacksmiths. Newars and untouchables each use approximately 0.35 kg/capita/day of fuel for alcohol production, while Brahmin-Chhetris use no fuel for this purpose. Total fuel use is estimated to be approximately 1 kg/capita/

Table 4. Estimated firewood demand by caste and task (kg/capita/day).

Task	Brahmin–Chhetri	Newar	Untouchables
Alcohol	0.00	0.38	0.35
Kudo	2.30	2.89	1.41
Laundry	0.05	0.05	0.03
Charcoal	0.00	0.00	0.69
Total	2.35	3.32	2.48

Table 5. Average firewood consumption by caste and survey method (kg/capita/day).

Method	Brahmin–Chhetri	Newar	Untouchables
Weight survey	1.4	2.4	1.4
Daily recall	2.6	3.3	2.7
Annual recall	3.2	3.1	2.9
Weight survey	(0.01)[1]	(0.94)[2]	(0.01)[3]
Daily recall	(0.00)	(0.27)	(0.00)
Annual recall	(0.97)	(0.64)	(0.70)

[1] t-test significance: Brahmin–Chhetri vs Newar.

[2] t-test significance: Brahmin–Chhetri vs Untouchables.

[3] t-test significance: Newars vs Untouchables.

day higher for Newars than for either of the other caste groups, because of the greater use of fuel for *kũdo* by this group and their use of fuel for alcohol production.

This hypothesis was tested by analysis of the results of the weight and recall surveys according to caste (Table 5). Weighed firewood measurements for the three caste groups indicated a significantly higher consumption ($P < 0.05$) by Newars than by either Brahmin–Chhetris or untouchables. No differences in firewood consumption was found between the Brahmin–Chhetri group and the untouchables. Results of the daily recall survey agreed with those of the weight survey, while no differences in firewood consumption among castes were found with the annual recall survey.

Family size. If economies of scale exist in relation to firewood consumption, family size will influence per capita firewood consumption rates. It was hypothesized that large families (9–20 members) burn less wood per capita than do medium-size families (5–8 members) or small families (1–4 members). Table 6 shows average per capita firewood consumption rates by family size groups and by method. According to all three methods, differences between family size groups were as hypothesized. Large families burned significantly less wood per capita than did medium- or small-size families. Medium-size families burned significantly less wood per capita than did small families.

Season. Firewood consumption data were evaluated

Table 6. Average firewood consumption by family size and survey method (kg/capita/day).

Method	Large (9–20)	Medium (5–8)	Small (1–4)
Weight survey	0.93	1.40	2.44
Daily recall	1.61	2.15	4.43
Annual recall	1.98	2.89	3.65
Weight survey	(0.00)[1]	(0.00)[2]	(0.00)[3]
Daily recall	(0.00)	(0.00)	(0.00)
Annual recall	(0.00)	(0.00)	(0.00)

[1] t-test significance: large vs medium-size families.

[2] t-test significance: large vs small families.

[3] t-test significance: medium-size vs small families.

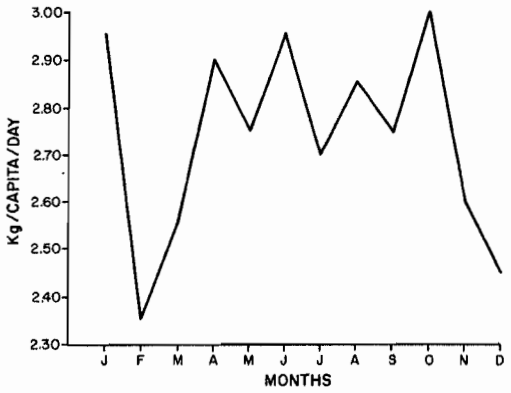

Figure 2. Firewood consumption per month (daily recall survey).

according to season of the year, since weather fluctuations and holidays occurring at various times of the year were expected to influence fuel consumption. Data used for this purpose were obtained with the daily recall survey, since this was the only method that was used throughout the year. Firewood consumption estimates (kg/capita/day) for each month are presented in Figure 2. While it is recognized that amounts of firewood estimated in this manner exceed actual use, there is no reason to suspect seasonal bias in these data, and hence they would appear to offer a valid basis for seasonal comparison.

The data indicated that firewood consumption was high in January, low during February and March, rose to a fairly high but unstable level from April through September, peaked in October, and dropped again in November and December.

The high firewood consumption in January and October finds ready explanation in lower temperatures and in holiday celebrations, respectively. In 1981, January temperatures averaged 3.4°C and 3.6°C lower than December and February temperatures. October was the month of the two major Nepali festivals, Desain and Bhai Tika. Desain requires extra fire-

wood for animal sacrifices, and both Desain and Bhai Tika are occasions when guests are entertained. Large amounts of corn cob and stalk residues were burned after the harvest in November and December. This accounts for low firewood consumption during these months.

Fluctuations in firewood consumption during the spring and summer months are more difficult to explain. Since moisture content of the wood most likely affects the amount that is burned, the relationship between amounts of weekly rainfall and amounts of firewood consumed was examined. A plot of these figures indicated that high rainfall was associated with high firewood consumption.

A chi-square test was used to compare expected and actual firewood consumption data in periods of below average and above average rainfall. A chi-square value of 3.57 was significant at the 0.062 level, suggesting that only 6.2% of the time differences of this magnitude would have occurred by chance. When data from January and October, months when wood consumption was high but not related to rainfall, were deleted, the chi-square value was 6.0 ($P < 0.015$).

Results of the daily recall survey indicated that on the average, 2.91 kg/capita/day of wood was burned during wet weeks and 2.51 kg/capita/day during dry weeks. A crude measurement of the moisture content of firewood during four weeks of high rainfall produced values ranging from 21% to 63% dry weight, with an average of 32%. During the dry season, wood was assumed to have a moisture content of approximately 20% dry weight. The National Academy of Science (1980), estimates that drying wood to a moisture content of 20%–25%, reduces the amount of wood needed for a given heating requirement by 20% or more. This suggests that the high firewood consumption rates recorded during the wet season were due to farmers burning more wood in order to achieve a constant energy level.

Discussion

The lack of consistent data on firewood consumption in Nepal led to a village study in which firewood usage was measured by weight. An attempt to assess firewood usage obtained in this manner with values reported in the literature and with estimates obtained by recall methods suggests that firewood consumption may vary among regions of Nepal and that crude measurements of firewood usage may overestimate true consumption.

With regard to agreement with published studies, the present study supports the claim of Donovan (1981), who reviewed available literature on the question and stated that firewood consumption data cluster around 1 m^3 per capita per year. This figure is remarkably close to the 0.95 m^3 average and the 1.07 m^3 maximum values obtained in the present study.

Donovan, however, suggests that the 1-m^3 figure is probably too low and indicates that 1.4 m^3 per individual more accurately reflects actual consumption. She supports this higher estimate by reports of Bajracharya (1980), Kawakita (1979), and Levenson (1979), all of whom report, after prolonged residence in a specific study area, firewood consumption rates in excess of 1 m^3 per person. The higher firewood consumption in the cited studies than in the present study might be attributable to greater availability of firewood and lower population densities in the areas studied. The region studied by Levenson had access to 880 ha of forest land with a mean annual growth increment of 12.5 m^3/ha, while Bajracharay's study panchayat had access to 328 ha of forest and 96 ha of woodland, providing an annual growth increment of 4.8 m^3/ha. These forest resources may be contrasted with the 73 ha of scrub land and 39 ha of degraded forests with a mean annual growth increment of 1.85 m^3/ha/yr in Bhogteni. Moreover, Bhogteni has a much higher population density than either of the other study sites, 318 persons/sq km compared with 223 reported by Bajracharya and 101 by Levenson. These figures suggest that firewood is a much scarcer commodity in Bhogteni than in other villages studied. Thus, it is not unreasonable to conclude that because of the greater availability of firewood from public lands and the lower population density, firewood consumption was actually greater in the Bajracharya and Levenson studies than in the present study.

With regard to method used to estimate firewood consumption, the present study found that consumption was overestimated by both daily and annual recall surveys in contrast to weighed measurements. This finding disagrees with those of Bajracharya and Levenson, who found that respondents in their studies underestimated firewood consumption on recall surveys. This discrepancy may be due in part to the greater willingness of villagers in the present study to reveal information regarding firewood collection practices. As mentioned, the villages studied earlier had greater access to public forest lands than Bhogteni. It is quite likely that forest officials have expressed more interest in protecting these valuable forests than the degraded forests of the Bhogteni area. Consequently, villagers studied by Bajracharya and Levenson may have been more relunctant to reveal dependence on forest resources for firewood than were villagers in the present study, where no threat has been implied by forest officials as a consequence of collecting firewood on public lands.

The tendency for villagers in Bhogteni to overestimate firewood consumption by the recall methods deserves further comment. It appears that both physical and social explanations may be involved. A very simple reason for the overestimates

might be that in recalling amounts of firewood used, respondents consistently reported numbers of bundles of wood in whole numbers rather than in fractions. It seems likely that numbers were rounded up rather than down, a partial reason for the overestimate.

Another physical explanation for the overestimate may be the use of an inappropriate factor for converting bundles of firewood to a weighed amount (kg). Two hundred bundles of firewood were weighed throughout the year and the average value of 6.3 kg/bundle was used to convert number of bundles burned to kilograms. Since a load of firewood equals four bundles, a load of firewood would be expected to weigh 25.2 kg. Actual weighing of 30+ loads of firewood resulted in a value of 28 kg; this falls within the range of 20–40 kg reported by Donovan (1981) for the weight of a load of wood. It is conceivable, however, that this weight is more appropriate for *kãcho daura* than for *dar-sukay daura,* a lighter wood constituting a large portion of the firewood used in some households. An error of this nature would result in an overestimate of firewood consumption.

While these physical reasons explain in part why firewood consumption was overestimated in the recall surveys, social reasons are also likely. Consistent overestimates of firewood consumption in a region of limited firewood availability suggests that firewood consumption rates are less than farmers actually consider desirable. The researcher noted in his weekly visit with farmers that firewood consumption appeared to have meaning beyond the amount of energy obtained, being interpreted by farmers as an indicator of social status. This is understandable, since higher firewood consumption implies that more food is cooked, more guests are entertained, and more animals fed—all indicators of high social status in Nepali society. It is not unreasonable, then, to suggest that a farmer's desire to upgrade his social status may offer a partial explanation for the inflated firewood use estimate.

While the inflated figure for firewood consumption resulting from the recall data suggests that these estimates do not accurately reflect consumption, their much lower cost in terms of time and cooperation virtually assure that they will, nevertheless, be used to a greater extent than the more accurate weighed measurement. Even the weight survey contains some possibility of error, since only highly motivated respondents are willing to cooperate to this extent, and since even cooperative farmers can yield biased data if they are unable or unwilling to provide accurate information about substitutions or additions to the weighed wood supply designated for burning. Nevertheless, weighed measurements of wood appear to be the best indicator of actual use.

The researcher hoped to identify a simple method of estimating firewood consumption that would yield results comparable to those obtained by weighing. While the daily recall survey yielded results somewhat closer to those of the weighing procedure, both recall methods overestimated consumption. Considering that identical households participated in the daily recall survey and in the weight survey, anticipated agreement between the two measurements was greater than observed agreement. Since the annual survey overestimated actual consumption only slightly more than did the daily survey, the additional time involved in conducting a daily survey compared with the relative ease of conducting an annual survey hardly seems warranted.

Farm size, caste, family size, and season of the year were variables hypothesized to affect firewood consumption rates. Of these, caste, family size, and season were actually found to exert some effect on energy use. While it appeared that the greater availability of firewood resources to persons living on larger farms might favor consumption of larger amounts of fuel, this hypothesis was not supported by the data. This finding is in agreement with that of Cecelski and others (1979), who hypothesized that farm size (income) would not affect firewood consumption because fuel use increases more slowly than income.

With regard to caste, both the weighed data and the daily recall survey indicated that Newars burned more firewood than did either Brahmin–Chhetris or untouchables. Furthermore, Newars overestimated their fuel consumption to a lesser extent than either of the other caste groups. It seems that Brahmin–Chhetris and untouchables, both caste groups with strong ties to Indo-Aryan traditions, may perceive firewood consumption as a social status indicator, and hence tend to overestimate in an attempt to achieve a higher status. The Newars, the indigenous inhabitants of the Kathmandu Valley, may be less influenced by this factor.

Family size, unlike farm size, was related to energy use. Even though per capita consumption of firewood in large families was less than for small families, total wood consumption and thus total available energy was greater for families with more members than with fewer members. Since larger families tend to live on larger farms, this suggests that energy requirements were more adequately met for large farm owners, simply because they have larger families.

Season also had a pronounced effect on energy use with temperature, festival observance, and rainfall all influencing need. The observation that firewood consumption was appreciably higher in wet than in dry seasons suggests that measures to protect firewood from moisture during rainy seasons would reduce firewood consumption substantially.

Summary and Conclusions

Present firewood consumption patterns provide basic knowledge for designing forest management plans to meet

immediate and long-term energy needs in rural Nepal. A study of firewood consumption rates in Bhogteni revealed that mean consumption measured by weight was 0.95 m^3/person/yr, with a maximum value of 1.07 m^3.

Comparison of firewood estimates obtained by daily recall and annual recall with those yielded by the weight survey indicated that results obtained by the less precise procedures overestimated actual consumption by factors of 1.76 and 1.95, respectively. Overestimates were attributed to both physical and social factors. In view of the good agreement between daily and annual recall survey data and the much greater ease of obtaining the latter, annual recall surveys are the most practical method of monitoring firewood consumption rates. Validating the survey data with occasional weighed measurements is suggested as a means of improving accuracy.

Firewood consumption rates in Bhogteni were influenced by family size, caste, and season, but not by farm size. Economies of scale explain the smaller per capita consumption in larger families. Larger families, however, used more total fuel. The Newar caste used more fuel than did either the Brahmin–Chhetris or the untouchables because they used greater amounts of firewood for making *kũdo* and also because they distilled alcohol. In the recall surveys, Newars overestimated consumption less than did the other caste groups, probably because they are less influenced by Indo-Aryan cultural values than are the other castes.

Seasonal differences in firewood use were attributed to colder weather in January, festival observances in October, availability of crop residues in November and December, and the higher moisture content of wood during the wet months.

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