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Fuel, Food or Forest? Dilemmas in a Nepali Village

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Summary. – Field data from a village *Panchayat* in the East Nepal Hill Region demonstrate that deforestation is caused not so much by fuelwood demand as by the need to clear forest areas for food supply. The method of analysis uses questionnaire survey, participant observation and direct measurements in a micro set-up to assess the demand, as well as the supply systems of food and fuel, and to analyse the impact on deforestation. Policy implications suggest that to control deforestation, food production and distribution practices need to be improved, existing forests need to be managed better to increase sustainable fuelwood supply, and the direct participation of local people is indispensable to implement desired improvements.

1. INTRODUCTION

Since the first shock of the 'oil crisis' in 1973, which heightened world sensitivity to various energy concerns, including that of rural energy, much progress has been made toward understanding the critical issues facing the rural areas of the developing countries. It first started with the realization that contrary to the patterns in the industrialized countries, energy consumption in the developing countries is derived overwhelmingly from 'non-commercial' sources, such as fuelwood, dung cakes and crop residues. This led to the acute awareness of what has come to be known as 'the other energy crisis' which refers particularly to problems such as deforestation due to fuelwood demand and decline in agricultural productivity due to the use of dung cakes as fuel rather than as organic manures for field conditioning.[1]

Compounded with these problems has also been the awareness of the low levels of energy use that will have to be substantially increased both by quantity and quality if the state of rural poverty is ever to be countered.[2] These concerns have led to the advocacy of many forms of alternative renewable energy technologies aimed at increased efficiency of fuel use and fuel substitution.[3] Particularly noticeable is the emphasis on forestry for fuelwood supply,[4] improved stoves,[5] biogas[6] and solar technologies.[7] More recently, the focus has been on the necessity of assessing rural needs and priorities as a prelude to determining proper approaches for alleviating present day problems and for improving future prospects. Technical solutions are now being scrutinized in terms of their compatibility with rural socio-economic structures.[8]

These are all healthy developments in rural energy concerns and studies. In one area, however, the dearth of information is still very serious. While there is the general recognition that rural realities differ from one country to another and also within countries, and therefore technical solutions need to be weighed accordingly, the information is still very scanty on the dynamics of interaction between energy issues, on the one hand, and rural people and organization, on the other. The few studies that do exist point to vulnerabilities, strengths,

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* This article is a condensed version of my thesis for the Doctor of Philosophy in science policy. For those who are interested in a more detailed treatment of the topic, please refer to D. Bajracharya, 'Implications of Fuel and Food Needs for Deforestation: An Energy Study in a Hill Village *Panchayat* of Eastern Nepal', Ph.D dissertation, University of Sussex (1981). I acknowledge with gratitude the financial assistance provided by the International Development Research Centre, Canada, and the Tribhuvan University Research Division through the Energy Research and Development Group, Nepal, that enabled me to pursue my research interest, including the field work in 1978. I am very thankful for comments and criticisms on earlier drafts by C. H. G. Oldham, J. A. Barnett, K. R. Smith, R. Morse, C. Schlegel, L. Pyle and M. Howes and for editorial assistance by B. Yount. Needless to say, I accept full responsibility for the text as it stands.

capabilities and interconnectedness in the resource base and organization of people in rural areas.[9] These must be understood if rural energy problems are to be tackled realistically. Therefore, the need exists for more micro-studies in rural areas which identify complex relationships in resource utilization (of which energy is a part) and in socio-economic structure. In addition, such studies must provide the necessary background in formulating appropriate mechanisms for solving problems.

This article analyses the fuel system and the food system as they interact with the forest resource and thereby influence the process of deforestation. The analysis is done in conjunction with a concurrent examination of the local socio-economic conditions in Pangma Village *Panchayat*[10] in the hill region[11] of eastern Nepal. Despite the widely-held belief that fuelwood contributes rampantly to deforestation in the Nepal hills,[12] I will argue on the basis of my data that the position needs re-examination. Historically, food deficit has been a serious problem in the Nepal hills and it has been the primary incentive in forest clearance for production of foodgrains.[13] For instance, within a 10-year period from 1964 to 1974, the area of forest cleared for agriculture is estimated by the National Planning Commission of Nepal[14] to be 672,000 hectares (ha) in the hills and 315,000 ha in the Terai.[15] The forest area in 1975 is estimated to have been 4,823,000 ha, and thus the deforestation by this process amounts to the very high rate of 17% in 10 years. If control of deforestation is the objective, emphasis on the fuelwood problem alone is, therefore, misplaced. Furthermore, developmental problems need closer examination if deforestation is to be counteracted effectively. Based on some past experiences of the people in the study area, I will draw some lessons for possible future programmes.

The local conditions of the study area are described briefly in Section 2 as a background for understanding subsequent sections. Section 3 is devoted to exploring the effects of fuelwood demand on deforestation. Section 4 looks at the pressure on forest clearance because of food deficits. Finally, the implications of deforestation for future programmes and policies for the area are examined in Section 5.

2. DESCRIPTION OF THE STUDY AREA

Traditionally, the forest has played the role of a buffer in Pangma Panchayat as it cushions the pressures due to increasing demands of fuel and food. This process is generally true of other villages in the hill region. As shown in Figure 1, fuelwood, poles/timber, *imperata* grass (for roofing) and fodder are directly extracted from the forest as needed. In addition, the forest provides the opportunity for land clearance to accommodate agricultural land expansion for food supply increment or pastures for grazing livestock. The subsistence mode of living has accordingly been maintained within limits. The landscape has, however, undergone visible changes since the wandering group of Kirantis first settled in the virgin forest area several hundred years ago.[16] The present land use pattern indicates that out of a total area of 13.4 sq km, a major portion (57%) has already been converted to arable land, only about a fifth (22%) remains in the state of being a public forest, and a small portion (11%) is scrub and scattered wooded areas. Furthermore, a high population density is also apparent: about 220 persons per sq km of total area, or 760 per sq km of arable area.

The physical environment of Pangma creates a small ecological unit within the political constituency, bounded in the north and west by hill ridges, and separated from another *panchayat* in the east by a stream. The southern boundary is the only one that is not distinctly marked. Elevation ranges from 600 m in the south to more than 2000 m in the north. Pangma may thus be regarded as a unit of interdependent settlement clusters that are self-contained with respect to other surrounding *panchayats*.

The people living in Pangma are not, however, a homogeneous group. Out of a total population of 3002, the indigenous group (the Rai) constitutes about a third of the population (30%), and the three other dominant groups are the Gurung (27%), the Brahmin and Chhetri (23%) and the Sherpa (7%).[17] These four groups, together with other minority and occupational caste groups (13%), are interspersed within the *panchayat*. The settlement areas of the dominant groups may be categorized roughly according to altitude: the Brahmin and the Chhetri are concentrated below 1200 m, the Rai between 1200 and 1500 m, the Gurung between 1500 and 1800 m, and the Sherpa above 1800 m.[18]

Regardless of ethnic and other differences, subsistence agriculture is the mainstay of livelihood, even among the occupational caste groups. Commercialization of the economy is minimal. The primary concern in any household is to own sufficient land to provide for the food requirements of the family. Forest and other wooded areas provide fuel, as well as poles for

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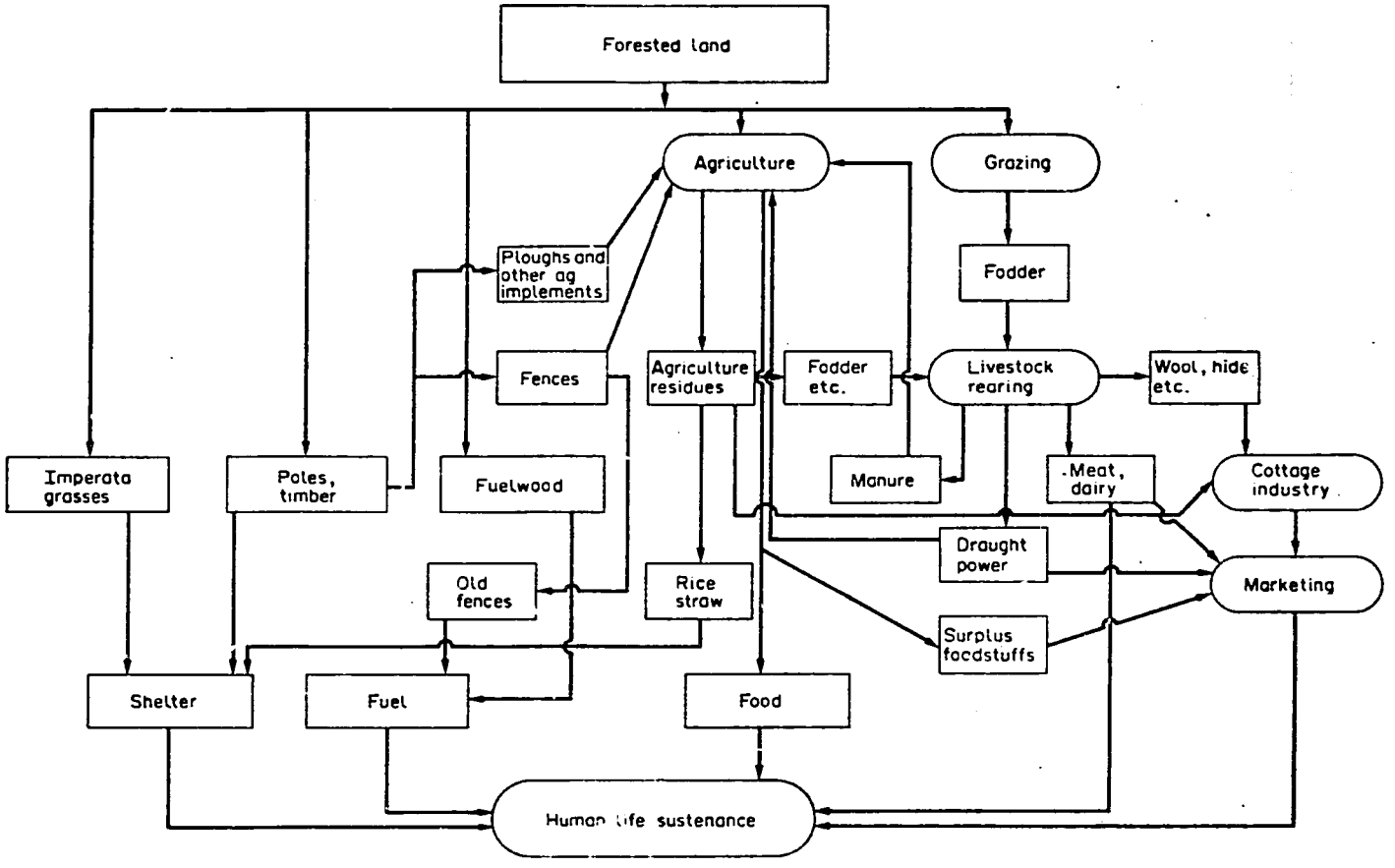

Figure 1. *Forest linkage to human life sustenance.*

construction and fencing and timber for ploughing implements.

One primary reason why the economy remains at the subsistence level is the lack of a sizeable market in the immediate vicinity. As a result, surplus foodgrains, cash crops or other marketable products have only a very limited potential for further development at this time. At present, a small market is held once a week in Khandbari, the site of district headquarters, which lies about one or two hours' walking distance from Pangma. Dharan, the nearest market centre of significance, is about three days' walking distance. Essentials such as kerosene, cloth, salt and spices have to be brought by human carriers from Dharan.

Isolation compels the people of Pangma to be self-reliant and to use resources available within the area to the maximum level. They are vulnerable, however, to the extent that innovations in resource utilization are limited. Physical difficulties severely restrict the flow of information and materials to the area. As will be seen below, the internal resources are already beginning to show signs of deterioration.

3. FUELWOOD CONSUMPTION AND SUPPLY

(a) *Patterns of consumption and supply*

The pattern that describes the consumption and supply of fuelwood is depicted in Figure 2. Three sources of fuelwood supply can be identified in Pangma: homestead surroundings, privately-owned wooded areas and public forests. In turn, the patterns of supply are dependent upon the type or quality of fuelwood collected, the season when collected, and the time lag before intended use.

Homestead surroundings provide what is collectively known as *jhikrā* which includes usable portions of old wooden fences, dried bamboo pieces, and, during difficult times, even agricultural residues such as maize and millet stalks and maize cobs. The use of *jhikrā* is particularly important in Pangma before and during autumn (September–November), when fuelwood collection from forests has not yet begun but previously collected stocks have run out. Although the amount of *jhikrā* used is significant, its acquisition is not from the forest but from the homestead surrounding areas and does not render it directly relevant to deforestation.

Fuelwood consumption in Pangma is met entirely by collection and *not* by purchase. The access to public forests has not, until now, been restricted. One of the most important factors that determines whether the need can be met is dependent upon whether a household can send the person, either from its own members or from other households, as hired labour or as a favour, to collect the fuelwood. Because labour is a determining factor the collection schedule is dependent largely upon its availability. For example, the period from May until October is a heavy agricultural season characterized by intensive labour utilization in activities related to paddy and millet, that is, field preparation, transplanting, weeding and harvesting. These activities coincide with a period when the forest floor is slippery and infested with leeches and wood is wet and heavy. The season is consequently unfavourable for fuelwood collection, which does not occur. The normal practice is to stock fuelwood in March/April sufficient to last until November. From November onward, the collection schedule resumes again. Since winter cropping has until now been practised at a very low level, the demand for agricultural labour at this time is not in conflict with the labour required for fuelwood collection.

Normally, the time required to collect one bundle of fuelwood from the forest is four or five hours or longer. Because there is no pressing demand for labour in winter, time that appears quite long to an outsider is not perceived in the same way by the villager. In fact, 'going to the jungle' signifies a socialization opportunity to many residents. It is quite common for fuelwood collectors to go to the forest in groups. Singing, dancing, gossiping, joking and other peer-group pastimes are natural occurrences during such trips. In this sense, fuelwood collection itself is either incidental or is rationalized as an excuse to get out of the domestic drudgery. The physical hardship of carrying 40 kg back is considered quite normal and complaints never occur.

Both privately-owned wooded areas and public forests provide what is collectively known as *dāurā*. *Dāurā* consists of two categories. In the first case, dead branches or other dead wood are collected. This is done when wood is required for immediate use, that is, between November and May. The logic is that the drying of fresh green wood takes a long time and, therefore, is not favoured. On the other hand, the wood that is to be stocked for the May through November period can be green because the time lapse before use is greater. For this purpose, fresh branches are cut. Since stocking for six months requires that a large volume of wood be involved, the preferable operation is to cut whole trees.

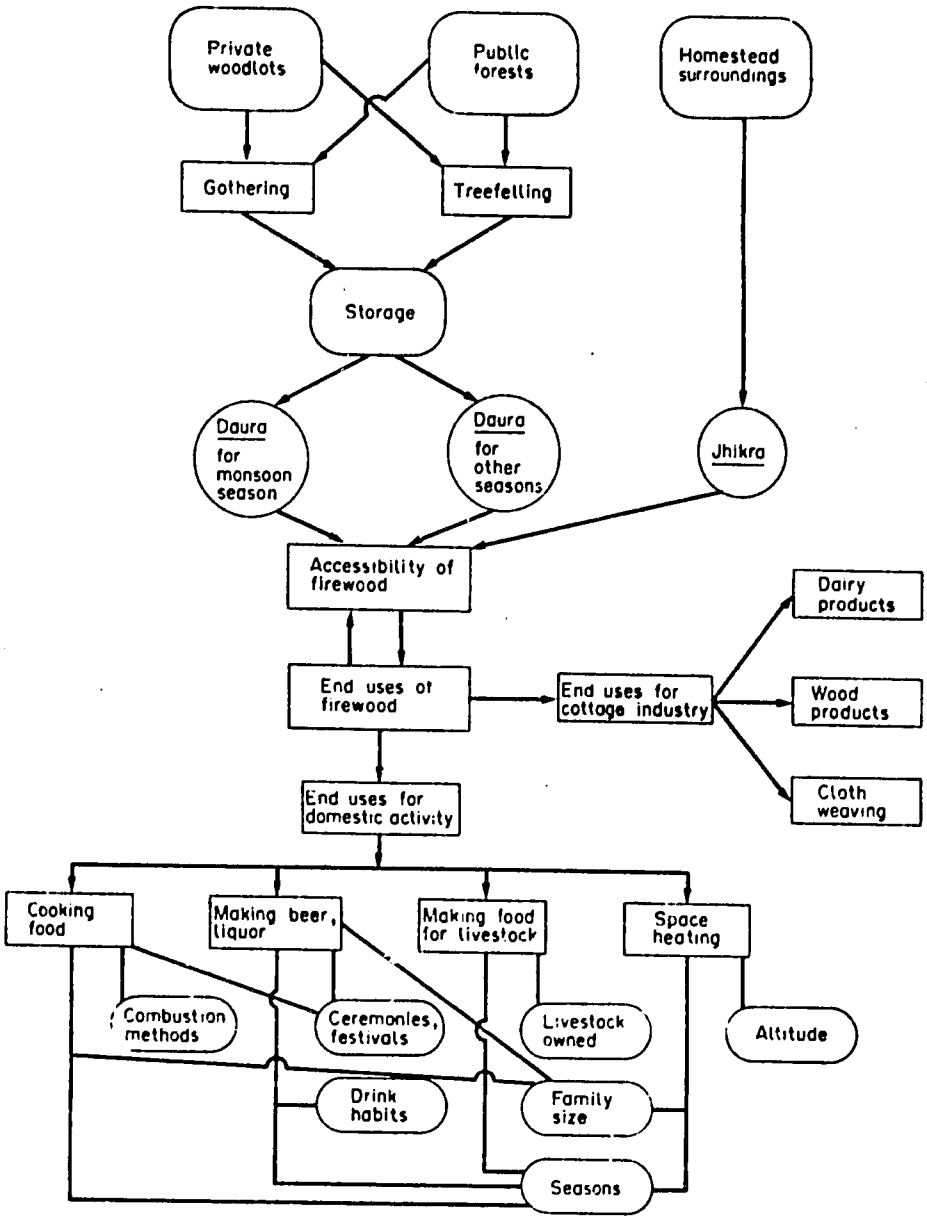

Figure 2. *Accessibility and end uses of fuelwood.*

Fuelwood for cooking is required for preparation of beer, wine and liquor; and for preparation of a fodder supplement for livestock. Fuelwood is also needed for space heating, especially during winter at the higher altitudes. Seasonal variations in use are important. For certain groups, it is not uncommon to go without cooked food, not because firewood is scarce but because grains are not available, particularly during the months of March to May. Preparation of beer, liquor and wine is similarly affected. In addition, some groups are by custom not allowed to drink or to make any forms of alcoholic beverages; these include the Brahmins and Chhetris. Cooking is done either in a stove with a semi-enclosed hearth or in an open hearth. The stove has two holes at the top for cooking pots. In the case of the hearth, the pots are placed on top of iron tripods or stones over the hearth. Hearth-users can be clearly

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demarcated by ethnic groups. The only stove-users are the Brahmins and Chhetris. All the rest use hearths. The Brahmins and Chhetris also constitute the non-drinking group. What is interesting is that the stove-users, as I will show below, consume less fuelwood per capita than the hearth-users. It can be argued that the stove-users make more judicious use of wood for cooking. If this is the case, the interesting question is why hearth-users are apparently less judicious. The stoves are made locally at no real cost and with no intricate skill. The hearth-users say that the Brahmins and Chhetris use less wood because of the stove and yet there does not appear to be any sign of their wanting to switch to the stove. Why?

It can be hypothesized that there is no pressure yet for them to change their habits. For example, fuelwood scarcity is not yet perceived as a problem, as long as they can afford the time to collect it, and thus there appears to be no need to change the technique with which they are familiar. Second, the hearth-users contend that their family deity resides in the hearth and the fire has to continue in the fireplace to keep on the good side of the deity. An interesting anecdote was related to me by a Rai on how he had tried to convert to the usage of the stove. Whether by chance or otherwise, he had encountered several misfortunes that year, such as his wife's sickness and the loss of a large portion of his land due to landslides. Under social pressure from his own family members, as well as other relatives in the area, he had to abandon the stove and turn back to the hearth. The fear of angering the family deity is deeply ingrained since childhood

Also, the hearth-users as makers of alcoholic beverages frequently prepare beer, liquor and wine for their own consumption, and it is best made on the hearth. The preparation is done with large pots, and if done on a stove, the heat coming out of the opening at the top is not distributed uniformly throughout the pot and the flame at the other opening is also wasted.

(b) *Consumption of fuelwood*

The quantity of fuelwood consumed in Pangma by type and sources of fuelwood is shown in Figure 3. The estimates were made by evaluating consumption in a sample of 182 households out of the total of 582. Simple summation of fuelwood consumption shows that the 182 households consume an annual total of 0.78 m kg of wood consisting of 0.67 m kg of *dāurā* and 0.11 m kg of *jhikrā*. The mean annual fuelwood consumption is 4290 kg per household (standard deviation 1490 kg) or 940 kg per capita (standard deviation, 420 kg). As expected, the large standard deviations in both are indications of the heterogeneity of the population, household sizes, types of stoves used, and elevation differences.

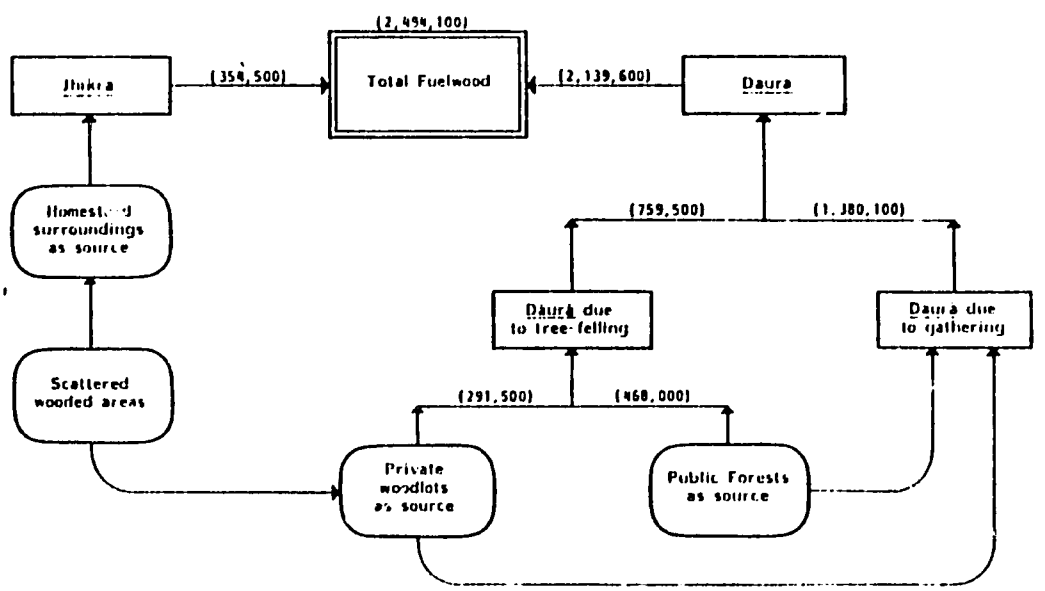

Figure 3. *Annual fuelwood consumption (kg) by sources and type.*

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Of the two categories of *dāurā*, that which is derived from cutting down trees (described henceforth as tree-fell *dāurā*) constitutes 0.24 m kg (35% of the *dāurā*). That from lopping and/or gathering of branches and deadwood (described henceforth as gathered *dāurā*) constitutes 0.43 m kg (65% of the *dāurā*). When these figures are extrapolated to include all the 582 households in the *panchayat*, the pattern of fuelwood consumption by source and form appears as shown schematically in Figure 3. To summarize what is shown, the annual total of fuelwood consumed in Pangma is equivalent to 2.49 m kg. Of that amount, 14% is derived from *jhikrā* (0.35 m kg) and the remaining 86% from *dāurā* (2.14 m kg). It is important to note also that 31% of the total fuelwood consumed is tree-fell *dāurā* and 55% gathered *dāurā*.

Not all of the total fuelwood consumed comes from the forest, and therefore, the non-forest portion is not considered directly responsible for deforestation. Thus, *jhikrā*, which constitutes 14% of total fuelwood use, is collected from homestead surroundings and scattered wooded areas, which are not considered legitimate forest areas. Also, the *dāurā*, which is derived from the forest is only partially acquired by cutting down trees. A large portion of it (i.e. 55 out of the 86%) is obtained from lopping branches and collecting deadwood and not by cutting whole trees. This is important to note because the effects on regeneration due to these two processes are different; lopping branches may stunt growth but felling trees kills the trees altogether.

In addition, tree-fell *dāurā* is derived from private woodlots, as well as public forests. Thus 19% out of the 31% of the fuelwood attributable to tree-felling comes from public forests and the remaining 12% from private woodlots.

In Pangma there is more than one public forest to which all residents of the *panchayat* go for fuelwood collection. Logically, the residents generally tend to go from their settlement cluster to the nearest forests. Fuelwood consumption by area is shown in Table 1. It will be noted that only the *dāurā* component of fuelwood is given. The reason is because this is, as already mentioned, the component that is expected to be supplied by the public forests. The aggregated amounts of *dāurā* consumption are extrapolated from sample households to give the total *dāurā* consumption in each area. In light of these group divisions, the question with regard to deforestation is whether grouped forest areas will sustain the *dāurā* demand of grouped settlement clusters.

(c) *Sustainable supply of fuelwood*

A sustainable supply of fuelwood is assumed to be that amount which can be safely provided by the growing stock of trees in the forest without undue damage to the forest ecology. More specifically, it is assumed here to be the sum of the annual increment of wood from the growth of stem and branches and also the production of deadwood. These are dependent upon the growing stock of trees in the forest areas.[19] The growing stock in the present estimate includes not only the timber volume of trees larger than 10 cm diameter at breast height (dbh) (as is done in the usual forestry inventory), but also small trees (less than 10 cm dbh), branches, and treetops. This latter addition, which is important from the fuelwood aspect, is very significant since it constitutes about a quarter of the total growing stock (Table 2).[20]

The annual growth of wood is estimated by assuming 7% growth rate for trees less than 13 cm dbh, 5% for trees between 13 and 30 cm dbh, and 2% for those greater than 30 cm dbh.[21] Deadwood is assumed at 3% of the growing

Table 1. *Consumption of* dāurā *in selected groups (in* 000 *kg)*

	Sample households			All households			
Group name	No. of hhlds	Gathered *dāurā*	Tree-fell *dāurā*	No. of hhlds	Gathered *dāurā* (extrapolated)	Tree-fell *dāurā* (extrapolated)	Total (extrapolated)
North	47	139.0	33.4	143	444.6	106.9	551.5
West	17	48.5	6.4	58	155.1	20.4	175.5
Middle	61	145.3	70.7	199	464.6	226.0	690.6
South	57	98.8	35.9	182	315.8	114.7	430.5
Total	182	431.6	146.5	582	1380.1	468.0	1848.1

stock.[22] The amount of sustainable fuelwood supply from public forests and scattered wooded areas is calculated accordingly. Disaggregation by forest groups, not including the scattered wooded areas, is as shown in Table 2.

Table 2. *Growing stock, annual increment and deadwood by forest groups (in 000 kg)*

Forest group	Forest area (ha)	Growing stock: Timber	Growing stock: Branches treetops etc.	Growing stock: Total	Annual growth: Timber (+)	Annual growth: Branches treetops etc. (+)	Annual growth: Sub-Total (+)	Deadwood (+)	Total sustainable fuelwood supply
North	81	4967	2581	7548	138.3	144.5	282.8	226.5	509.3
West	33	1652	816	2668	52.6	43.5	96.3	80.0	176.3
Middle	117	10,262	2710	12,972	280.8	158.7	439.5	389.1	828.6
South	97	7637	2722	10,359	206.4	138.3	346.7	310.7	657.4
Total	328	24,718	8829	33,547	680.3	485.0	1165.4	1006.3	2171.6

(d) *Consumption vs sustainable supply*

A conventional approach would take the levels of fuelwood consumption to be the sum of *dāurā* and *jhikrā* together, without distinctions. Furthermore, the supply would consist of what I have categorized as timber wood without accounting for the branches, small tress, tree tops and deadwood, and also not accounting for scattered wooded areas. On this basis, an analysis of consumption versus supply would indicate that a severe case of deforestation is under way.

Consumption is at a level of about 2.5 m kg (Figure 3), whereas the sustainable supply due to growth of timber is only about 0.7 m kg (Table 2). Even if the growth of branches and tree tops is included, the supply would still be only about 1.2 m kg, or less than half of the consumption. This would indicate that deforestation is taking place at a very rapid rate.

If it is assumed that the rate of tree growth (i.e. about 3.5%) and the consumption level (2.5 m kg) are constant, Pangma would be completely deprived of its forest resources within 15–20 years. This prognosis is in accord with the ongoing assessment regarding the impact of fuelwood consumption on deforestation in Nepal.[23] I have chosen instead to use a different basis for analysis, as will be discussed below.

Two ways of assessing the possibility of deforestation due to fuelwood needs can be utilized for the whole *panchayat* as one aggregated unit. If the *dāurā* and *jhikrā* are combined as the total fuelwood consumed, the consumption of 2.49 m kg (Figure 3) is barely met by the supply of 2.79 m kg (Table 2). Although the supply is greater by a small margin of 12%, it shows that deforestation perhaps is not yet strongly influenced by fuelwood consumption. The small margin does warrant, however, the need to take immediate measures to assure a good supply in the future.

The second way utilizes disaggregation by source and type. For example, 0.62 m kg of fuelwood supply from scattered wooded areas corresponds to the consumption of 0.64 m kg of *jhikrā* (0.35 m kg) and *dāurā* from private woodlots (0.29 m kg). A shortage of about 4% is apparent. Furthermore, given timber growth of 0.20 m kg as the main source for tree-fell *dāurā* this is what appears to be in short supply (by 48%) compared to the demand of 0.29 m kg. *Jhikra* demand of 0.35 m kg is reasonably met by the supply of 0.42 m kg. Tree felling, therefore, appears to be the underlying reason for deforestation in scattered wooded areas.

Regarding public forests, 0.47 m kg of tree-fell *dāurā* and 1.38 m kg of gathered *dāurā* have to be compared against 2.17 m kg of sustainable supply. The supply of tree-fell *dāurā*, 0.68 m kg, and that of gathered *dāurā*, 1.49 m kg, indicate that the supply of tree-fell *dāurā* exceeds its consumption by about 45% and that of gathered *dāurā* by about 6%.

Two conclusions are apparent from the above discussion:

(1) Scattered wooded areas, including private woodlots, are under stress and deforestation is caused by the demand for tree-fell *dāurā*.

(2) Public forests are not immediately under threat of deforestation. Tree-felling in particular, is more secure because of the large margin by which supply exceeds demand. Gathered *dāurā* on the other hand, is vulnerable because of the low margin of security.

Further disaggregation is possible by dividing

the *panchayat* into four units in accordance with groups of settlement clusters and forest areas. The consumption and supply of fuelwood in the North, West, Middle, and South groups are shown in Tables 1 and 2. The total *dāurā* supplied from public forest is first examined: the North is experiencing a deficit of about 8% and the West is almost at the point of equilibrium, with an excess of below 1%. The Middle and South, on the other hand, are safe. The Middle has an excess supply of about 20% and the South of about 53%. It is worth noting that the level of stress increases steadily from South to North.

A further analysis can be performed in terms of the state of gathered and tree-fell *dāurā*. It is interesting to note that gathered *dāurā* is the main cause of the deficit. Tree-fell *dāurā* demand is adequately met in all the four groups by significant margins, for example, 29% in the North, 59% in the West, 24% in the Middle, and 82% in the South. The North and West groups, which are indicated as problem areas, are under stress due mainly to the gathering of fuelwood. Consumption exceeds supply by 17% in the North and by 20% in the West. The reverse is the case as supply exceeds consumption in the Middle by 18% and in the South by 42%.

The conclusion therefore emerges that public forests *are* under stress in the North and the West, and that *dāurā* consumption due to gathering can be identified as the main reason for deforestation. Those in the Middle and the South appear, however, to be safe from deforestation due to *dāurā* consumption, regardless of whether the *dāurā* is gathered or tree-fell.

(e) *Discussion*

The above observations would clearly caution against the dangers of generalization, even in a unit as small as the *panchayat*. Although the vulnerability of the fuelwood supply system is clear in all cases, the degree of the problem is different, and consequently, the policy implications are different. For example, the adoption of the conventional approach, as I showed above, justifies unrealistically that the 'fuelwood crisis' is already predominant and warrants immediate measures both to increase fuelwood supply by means such as afforestation and to decrease fuelwood consumption through the introduction of more efficient techniques of combustion. On the other hand, the approach that I have taken indicates that the supply of fuelwood is vulnerable in so far as there are *some* areas within the *panchayat* where consumption exceeds supply, but there are others where this is not the case.

Second, in the problem areas, the problem is caused by lopping of branches rather than by clear felling of trees. Two policy implications are discernible here: (1) better distribution of resources in the *panchayat* and (2) better management that would include better facilities to cut big trees (since the present use of axes does not allow this) and would promote the growth of small trees (to increase the annual increment).

Third, and more important, the present study demonstrates that the existing forest area in Pangma has the capability to supply the requisite amounts of fuelwood, and the vulnerability is understood only in so far as future problems are anticipated. If no changes are assumed in present consumption patterns, there will still be an increase in fuelwood demand due to population increase. This will increase the stress on the forest. Also the supply of fuelwood will be further curtailed due to possible deterioration of the forest ecosystem caused by factors other than fuelwood demand.

The very reason that a situation of vulnerability is created at the present time is the result of the forest area having been previously cleared for purposes other than fuelwood supply. The easing of the problem depends upon whether these other factors can be controlled. The following section examines the food aspect in the context of its possible effects on deforestation.

4. FOOD CONSUMPTION AND SUPPLY

(a) *Levels of food consumption*

Consideration of food in this analysis is restricted to rice, millet and maize since most of the agricultural land in Pangma is devoted to these three crops. The consumption per capita ranges from 145 kg in the West to 179 kg in the North to 200 kg in the South to 201 kg in the Middle (Table 3). In nutritional terms, even the high averages of 200 kg per capita per annum in Pangma are in the neighbourhood of minimum requirements. The National Planning Commission (1978) estimates the daily requirement of grains to be 605 grams per capita (220 kg per annum) in order to derive an average of 2250 calories of energy per day. Clark (1977) believes that 'the minimum and maximum requirements of 1625 and 2012 calories/day can be met by

the [cereal] consumption of 185–230 kg/person/year'.[24] In both of these standards, the average levels of consumption in the North and West are below the 'minimum' requirements. Furthermore, the *panchayat* average of 190 kg per capita/year is at the bare minimum level.

The severity of food problems in Pangma can be seen by another measure. If the Pangma resident's standard is used, i.e. a satisfactory amount of grains per meal of one *mana* (equivalent to 0.45 kg), or if the National Planning Commission's lower standard of 0.61 kg per day is used, or even if Clark's maximum figure for grain consumption (250 kg/year/person) is used, a consumption level over 250 kg per person per year would be considered adequate. On the other hand, an amount less than half that quantity (i.e. 125 kg/person/year) could be safely said to constitute a destitute level. If these two figures are used to define the range, it is possible to assess the severity of the food problem by estimating the distribution of households in three strata, namely: (1) destitute level (less than 125 kg per person per year), (2) tolerable level (125–250 kg per person per year), and (3) satisfactory level (over 250 kg per person per year).

A majority of households (53–59%), regardless of settlement group, fall into the tolerable category. However, the destitute group is also large (23–35%). Thus, 76–94% of the households can be considered vulnerable with respect to consumption of foodgrains. Higher percentages are found in the West (94%) and the North (87%), as opposed to the South (76%) and the Middle (78%).

(b) *Food supply*

Food supply is determined in Pangma mainly by three factors: (1) area of arable land tilled, (2) yield and (3) form of land tenure. Whereas the first two determine production, the last factor determines the share to which the household is entitled. Because of the subsistence economy that prevails in the *panchayat*, this share is the major factor that determines the level of consumption within the household. Supply is therefore considered to be equivalent to the share of the produce to which the household is entitled.

Food production in each household is estimated by using locally reported yield estimates for rice, millet and maize in different settlement groups. Net food income represents the cultivator's share of total grain production, after subtracting any costs incurred by share-cropping or mortgage arrangements. As expected, the shares of all grains in the North and the West are considerably lower than in the Middle and the South. This is due mainly to the very low quantities of rice consumed (55 and 69 vs 138 and 136 kg). The figures for millet and maize are more or less similar, except in the West where they are substantially lower than in the other groups (Table 3).

(c) *Food consumption vs supply*

As shown in Table 3, there is a deficit in rice in the North and West but not in the Middle and South. The surplus of millet and maize compensates for that deficit in the West but not the North. Thus only the North turns out to be the grain deficit (−3 kg/cap) region, although by a small margin. In addition, the grain surplus in the West (+15 kg/cap) has a much smaller margin than that in the Middle (+57 kg/cap) and the South (+48 kg/cap). If the foodgrain requirement on the average is taken as 200 kg/cap, the surplus in the West amounts to 9% as opposed to 24–29% in the Middle and the South. From this perspective, the food supply situation appears to be the worst in the North and the West, even though the *panchayat* as a whole exhibits a net surplus.[25]

A better assessment is possible by studying the distribution of households according to levels of deficit and surplus. More than half of the households in the North (55%) and in the West (59%) are in deficit, whereas the representation is considerably less in the Middle (42%) and in the South (33%). A more revealing comparison is the representation at the higher levels of deficit and surplus. For example, 24% of the households in the North are at a level of deficit higher than 63 kg/cap, as opposed to 16% in the Middle and 12% in the South. Conversely, the representation at the higher levels of surplus above 63 kg/cap is smaller in the North (19%) and in the West (16%) than in the Middle (36%) and in the South (44%). The vulnerability in the North and the West, with respect to the food supply situation, is clearly much greater. The higher representation of deficit households in the North and the West indicates therefore a greater probability that they will have to seek other opportunities for food production.

(d) *Implications for deforestation*

The important question now is: what are

Table 3. *Per capita consumption, availability and balance of grains (kg) in settlement areas*

	Rice	Millet	Maize	Combined
North				
Consumption	80	57	42	179
Availability	55	68	53	176
Balance	−25	+11	+11	−3
West				
Consumption	88	21	36	145
Availability	69	56	38	163
Balance	−19	+35	+2	+18
Middle				
Consumption	132	44	25	201
Availability	138	65	55	258
Balance	+6	+21	+30	+57
South				
Consumption	129	36	35	200
Availability	136	69	43	248
Balance	+7	+33	+8	+48
Whole *panchayat*				
Consumption	113	43	34	190
Availability	109	66	49	224
Balance	−4	+23	+15	+34

the implications of the food supply and demand situations in Pangma for deforestation? The basic reasoning is as follows: if a surplus of foodgrains is apparent, while the level of consumption is also not too low, pressure to extend cultivation into existing forest areas is minimal. This would imply that, at the present time, deforestation due to food needs is negligible. On the other hand, if there is a deficit of foodgrains and the level of food consumption is at the same time low, the pressure to seek additional opportunities for foodgrain production can be assumed to be great. I will analyse below the extent to which land purchasing as well as cropsharing and/or mortgaging supplement food supply requirements. Subsequently I will look into the chances of forest clearance as a mechanism for the same purpose.

Land purchase is an effective means for increasing the availability of food. This, however, is an opportunity available only to a privileged group of households in the community. The reason is obvious: cash for land purchases is not easily attained, particularly if the household does not have any member who is gainfully employed outside of the community. The history of land purchases in Pangma reveals that they are directed mainly toward the acquisition of riceland. Thirty-one out of the 181 sample households (17%) reported such purchases in the last 30 years (Table 4).

Two observations can be made. The first is that in terms of purchasing capability, the North and the West lag behind the Middle and the South. Second, the purchases in the past have involved fairly large pieces of land, according to Pangma standards, by a select and privileged group of households. The opportunity cannot therefore be considered a viable one, especially for those who are poor and are already experiencing food deficits.

Households that have entered into other land transactions such as cropsharing or mortgaging are in a better position in terms of food supply, compared to those that have not. The question that pertains to the discussion here is which forms of transaction could be considered as being more helpful toward alleviating the problem of deforestation and to whom should these opportunities be made available, if anyone. Generally speaking, the largest number of these transactions take place with regard to riceland. Also, the transactions occur mainly among those households that already own some land and till it as well. Since riceland is the dominant form involved in cropsharing or mortgaging, the frequency of their occurrence in the North and West is of less significance, primarily because of the unsuitability of most land for rice cultivation in those regions. These are the regions where

Table 4. *Purchases of riceland in different settlement groups (in the last 30 years)*

	Sample hhlds purchasing (No.)	Hhlds represented (%)	Amount of land purchased (ha)	Average amount purchased per household (ha)	Cultivated land represented (%)
North	9	19	3.29	0.36	16
West	3	18	1.23	0.41	16
Middle	11	18	5.18	0.47	15
South	8	14	5.54	0.69	16
Total	31	17	15.24	0.49	16

the problem of food shortage is more acute. Furthermore, since the ability to enter into these transactions presupposes that the household should already possess a sufficiently large piece of land of its own, transaction is not ordinarily a means by which the poorest households could hope to upgrade their food supply by a substantial amount. On the average, cropshared land contributes an additional share of about 0.05 ha/cap only. In the absence of some land owned by the household itself, this increment alone is rarely sufficient to support the food requirement.

Although cropsharing or mortgaging plays the role of dampening the problem of food needs, the real beneficiaries are limited to those who already are in some position of strength. In addition, the households in the Middle and in the South are the real beneficiaries, mainly because of the proximity at which they live with respect to some large landowners in the Middle and the South who are willing to part with their land for cropsharing and mortgaging. The households in the North and the West, in contrast, are relatively less fortunate in this respect.

The forced choice now consists of resorting to the slash-and-burn technique of agriculture in order to produce millet and maize since the production of rice is not suited to land in these areas. People told me that given a choice, they prefer not to practise slash-and-burn agriculture. Extensive land tracts that would permit sufficient rotations of fallowing and cultivating are not available but slash-and-burn is still adopted as a response against inadequate food availability. They complain that the amounts of grain produced in these marginal areas are low and that guarding such cultivated areas from animals and birds until harvest time is a difficult chore, particularly because they are located near the forests and far away from settlement areas.

Two stages can be noted in Pangma with regard to forest clearance. In the first stage, the clearance has already occurred. In the second stage, the clearance is perhaps likely to take place in the future. The ownership of *pākhobāri* (agricultural land of marginal value and relatively poor quality, but usable for the cultivation of millet and some maize) and *bānjho* land (temporarily abandoned fallow land) represents the first stage, and the ownership of private forest areas represents the possibility for the second. Table 5 summarizes the distribution of households who claim ownership to *pākhobāri*, *bānjho* and forest area. Not surprisingly, the frequencies of households reporting ownership of *pākhobāri* is much higher in the North and the West than in the Middle and in the South. Indications are that a large number of households in the North and the West are already resorting to slash-and-burn.

Table 5. *Distribution of households owning* pākhobāri, bānjho, *and private forest*

	Total no. of sample hhlds	*Pākhobāri*		*Bānjho*		Forest	
		No. of hhld	Per cent	No. of hhld	Per cent	No. of hhld	Per cent
North	47	27	57	13	28	14	30
West	17	13	76	4	24	3	18
Middle	60	20	33	14	23	16	27
South	57	14	25	4	7	9	16
Panchayat	181	74	41	35	19	42	23

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At the same time, it ought to be noted that the representation of the households from the Middle and the South is also not small.

People in Pangma told me that, ordinarily, they prefer to keep *bānjho* land fallow for 2 - 3 years to allow sufficient nutrient regeneration. From this perspective, the representation of households who report ownership of *bānjho* land should have been in the same order of magnitude as that for *pākhobāri*. As shown in Table 5, this is clearly not the case since the reported ownership falls short by two times in the North and three times in the West. This characteristic indicates short fallow periods, which is symptomatic of growing pressures to cultivate more frequently.

The likelihood of future forest clearance is great. A significant number of households claim ownership of land where forests still stand. Thirty per cent of households in the North, 18% in the West, 27% in the Middle, and 16% in the South report such ownership. The Forest Office does not recognize these ownership claims, but the fact remains that forest boundaries have not been marked, despite the Forest Nationalization Act of 1957, and the registration of cultivated land ownership in 1968.

These attempts by the government have only exacerbated forest clearance, rather than controlled it. The nationalization of forests effectively removed the mechanism of local control through village headmen and furthermore created the fear that the government was going to take the forest land away from the people. For these reasons, many people cleared forest areas and claimed them as privately-owned agricultural land. The same effort was further intensified in 1968 when the residents were forced by law to register land ownership. In the absence of a cadastral survey, verbal statements and the endorsement by the elected chairman of the *panchayat* were accepted by the government officers. They made spot checks, however, and villagers cleared forests to prove the state of cultivation – just in case. The cadastral survey had still not been carried out in 1978–79 when my research was being done. I suspect that more forest clearance will take place when the survey is administered.

If the pressure to acquire more food persists, as the circumstances in Pangma indicate, and if there are no other possibilities, the forest land which is reported to be privately-owned will be the first area to be cleared. Even if the land is not owned by the household under food pressure, the members concerned will most possibly ask for permission to cultivate in the forest land as a favour on a yearly basis. From my own personal observation I have noted, particularly in settlement clusters in the North and the West, that such permission was granted upon receipt of annual gifts which might include one or two bottles of liquor or two or three pots of beer.

Deforestation due to expansion of agricultural land into forest areas is indicated by aerial photographs taken in 1978. Patches of cultivation, temporarily abandoned fields in the middle of forest areas, and the cultivation of millet fields in the immediate vicinity of forest areas are especially noteworthy in this respect. Interviews with people in the *panchayat* revealed the continuing practice of slash-and-burn cultivation, especially in the North and in the West where the problem of food deficit is the greatest. The chronic problem of this deficit, compounded with the limited opportunities for increasing food productivity, reinforces the trend in deforestation.

(e) *Introduction of new technologies?*

The three opportunities mentioned above (land purchase, land transactions and forest clearance) are the mechanisms that have been used traditionally by the residents in Pangma to increase food production. The fundamental approach in each is to increase the area of cultivated land. There are, however, other promising approaches that can be used to increase the productivity of land and/or labour, but that are not presently being used for a variety of constraints. The people in Pangma will eventually have to think about alternatives if further deforestation is to be checked and when the exploitable marginal land from forest clearance is exhausted.

The most prominent possibility is that of cropping on the same land more than once. Presently, less than 10% of the arable land is cropped twice. Including the preparation of land for the transplanting of paddy and millet, agricultural land is occupied at the present time from May/June until harvest time in November/December. Only maize is planted as a double crop on some of the land. The significant constraints to double cropping were reported to me as follows:

- limited irrigation facility for cropping in winter;
- limited availability of organic manure (which is barely sufficient for the present extent of maize cropping);
- limited access to chemical fertilizer

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because of physical isolation, cost, and inadequate information;
- limited availability of government extension services;
- present pattern of human labour use in essential miscellaneous activities during winter, for example, fuelwood collection, marketing trips lasting several weeks, and involvement in domestic crafts and industries.

The decision to intensify cropping in Pangma is, therefore, a very complicated process from many different aspects. In many respects, a fundamental structural change in the present life style is required. Many of the constraints mentioned above are not irremovable, but require, however, sufficient incentives to change either by force due to intolerable food scarcity and land scarcity or by the attraction of the greater and more satisfying rewards of human well-being.

The above argument applies to other prospective technologies, such as the introduction of new seeds. An anecdote that I heard from several people in Pangma is of interest here. A year before I came to the village, the District Agriculture Office introduced improved high-yield varieties of maize in the region. Seeds and fertilizers were distributed at subsidized prices. Several farmers from Pangma were willing to experiment and had gone to Khandbari to buy seeds and fertilizers. They worked that winter on experimental plots, one consisting of the local variety and the other of the improved variety. The result of the improved variety was a total disappointment because the rates of survival and of growth of the new plants were very much lower than those of the local variety. During harvest time, the number of mature maize cobs was negligible in the improved variety. As one farmer said, 'the plants were merely good as fodder for the livestock'. Later I confirmed the story with the acting chief of the Agriculture Office and he admitted that: (1) the distributed seeds were found to be 'old' and (2) the farmers had applied too much fertilizer which 'burned' the seeds.

The main point is the faulty extension practice that inhibits incentives for innovation. There is a deep-seated mistrust and cynicism about government officials in general, and I heard of many stories of misconduct by officials. I have also personally observed much condescending and sometimes insulting behaviour toward village laymen by the officials when the villagers visit government offices and also when the officials go on village tours. The kind of failure that the story above depicts reinforces the mistrust and cynicism of the villagers. In order to introduce any new technology successfully, there is as much a need for a structural change in government extension practices as in the thinking of the local villagers.

Of all the opportunities, forest clearance and thus usage of the marginal land for producing millet and some maize remains the most attractive. With regard to which regions of the *panchayat* are more vulnerable, the answers are clear-cut as well. The North and the West are the areas where the levels of food consumption are the lowest, the potentials of food supply are the smallest, and the opportunities for future improvement are the bleakest. These are the regions where the problems of deforestation are also going to be the biggest. The prospect of future deforestation is, therefore, indeed grim. The residents of Pangma are no less aware of the problem. They bemoan vigorously their inability, on the one hand, to meet food needs adequately throughout the whole year and, on the other hand, to find alternatives for improvement. The situation is one of desperation and their preoccupation lies less with the fuel problem than it does with the food problem.

5. IMPLICATIONS FOR POLICY

The fuel and food situations in Pangma suggest that: (1) the continuance of deforestation is the result of chronic food deficit, which brings about the pressure to clear forest areas; (2) the effect of deforestation is thus to reduce the sustainable supply of fuelwood; and (3) when the reduced supply is exceeded by the level of fuelwood consumption, additional extraction of fuelwood will also begin to cause deforestation. This sequence of events can be illustrated by the comparison of the food and fuel situations in the subregions of Pangma.

The North and West regions of Pangma are characterized by a very vulnerable fuel situation as evidenced by the fact that extraction of gathered *daura* exceeds the sustainable supply. This is not so in the Middle and in the South. Also, the food supply situation is more vulnerable in the North and in the West than in the Middle and South. The implication is that the greater degree of food deficit in the North and West is not unrelated to greater deforestation in those regions. The aerial photographs and the reported ownership of *pakhobari* and *banjho* support the observation that forest clearance for agricultural production is greater in the North and in the West than in the Middle and the South. Furthermore, the sustainable supply

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of fuelwood from the remaining forest in the region can no longer meet the level of consumption. It is safe to assume that deforestation is also being caused by fuelwood extraction.

In the Middle and the South, it is possible to identify patches of encroachment due to agricultural activities. Deforestation is, therefore, occurring. Yet the pace of deforestation is perhaps not as fast, probably because the food deficit problem is not yet as critical as in the North and the West, and the present forest area provides the sustainable supply of wood which is until now greater than the level of fuelwood consumption.

The conclusion is that food deficit leads to deforestation to such an extent that fuelwood scarcity at a later stage becomes an added influence. Inasmuch as fuelwood scarcity is a problem, food deficit lies at its root. This conclusion confirms what was repeatedly hinted at by people in Pangma during the course of my research. This may, however, cause some discomfort to advocates of the 'energy crisis' in national as well as international circles because the problem with regard to energy, or more specifically fuelwood, is only a secondary problem. Energy cannot be isolated as the single most important priority in the rural areas.

Viewed from the eyes of a peasant in Pangma who does not use any petroleum or chemical fertilizer and who at most uses kerosene sparingly (on the average 0.7 litre per household per week) for lighting purposes, the effect of the world oil crisis has been minimal. He has so far been managing to get the required amount of fuelwood, although it is perhaps taking him a little more time than before to collect. On the other hand, food has been a chronic problem and he has to capitalize on any available opportunity to increase food supply, even at the cost of deforestation. From his standpoint, as far as he is concerned, this is the trade-off.

Arguments can be made that the problems discussed above are valid to a great extent for other *panchayats* in the Hill region of Nepal. Modes of economic production, distribution of physical resources, patterns of resource utilization, interactions of different ethnic groups, and many other characteristics described by researchers in other parts of the Hill region are quite similar to my own observations in Pangma.[26] Also Pangma typifies many signs of underdevelopment, such as: difficulty of physical access; subsistence economy which does not provide much purchasing capacity; limited resources; lack of effective information exchange and extension network; dependence on external assistance for improvement even though its commitment and continuity are impermanent. Although cultural differences and related organization aspects are location-specific, the essence of the argument as stated above is similar. The Pangma experience can then be treated as a microcosm of the general scenario. Under these circumstances, what are the possible means of controlling deforestation in Pangma and other villages in the Hill region?

The critical problem is how patterns of sustainable land use can be maintained. Because land is a constant, increasing the productivity of land is one important possibility. The dilemma is how this can be done under existing conditions of underdevelopment. I have already indicated the structural changes in society that will be required to raise the productivity of agricultural land. The required changes rest as much on the local people as they do on government officials or development project officials. Cooperation between local people and project officials in the formulation and implementation of projects has to be practised. Theoretically, this concept has already been incorporated in the Sixth Plan of the government.[27] The challenge is whether a workable strategy for confronting the prevailing problems can be formulated with a sensitivity to social, cultural and organizational differences.

NOTES

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2. For reference, see: A. V. Desai, 'Development and energy consumption', *Oxford Bulletin of Economics and Statistics* Vol. 40, No. 3 (1977); Food and Agriculture Organization (FAO), 'Energy and agriculture', in the *State of Food and Agriculture, 1976*, Agricultural Series No. 4 (Rome: 1977); E. Cecelski,

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4. Regarding specifics on forestry for fuelwood supply, see: National Academy of Sciences, *Firewood Crops: Shrub and Tree Species for Energy Production* (Washington, D.C.: 1980); K. Openshaw, 'Woodfuel: time for reassessment', *Natural Resources Forum*, Vol. 3, No. 1 (1970), pp. 35–51; Food and Agriculture Organization (FAO), *Forestry for Local Community Development*, FAO Forestry Paper No. 7 (Rome: 1978); J. E. M. Arnold, 'Wood energy and rural communities', *Natural Resources Forum*, Vol. 3 (1979), pp. 229–252; and E. P. Eckholm, *Planting for the Future: Forestry for Human Needs*, Worldwatch Paper 26 (Washington, D.C.: Worldwatch Institute, 1979).

5. Concerning wood stoves, see: G. deLepeleire, K. K. Prasad, P. Verhaart and P. Visser, *A Wood Stove Compendium* (Eindhoven: Eindhoven University of Technology, Wood Burning Stove Group, 1981); K. K. Prasad, 'Woodstoves: some thoughts on the technology and its development', paper presented at the NGO Forum on New and Renewable Sources of Energy, 8–17 August 1981, Nairobi, Kenya; D. V. Shaller, 'A socio-cultural assessment of the Lorena stove and its diffusion in Highland Guatemala', mimeographed; and Y. J. Shanahan, *Report on the Workshop on Stove Projects*, 6–11 April, 1981, Sri Lanka, (London: Intermediate Technology Development Group, 1982).

6. On biogas, see: C. Prasad, K. K. Prasad and A. K. N. Reddy, 'Biogas plants: prospects, problems, and tasks', *Economic and Political Weekly*, Vol. IX (32/34), (1971), pp. 1347–1364; National Academy of Sciences, *Methane Generation from Human, Animal and Agricultural Wastes* (Washington, D.C.: 1977); A. Barnett, L. Pyle and S. K. Subramanian, *Biogas Technology in the Third World: A Multidisciplinary Review*, IDRC-103e (Ottawa: International Development Research Centre, 1978); Economic and Social Commission for Asia and the Pacific (ESCAP), *Guidebook on Biogas Development*, Energy Resources Development Series, No. 21 (Bangkok: 1980); and M. T. Santerre and K. R. Smith, 'Measures of appropriateness: the resource requirements of anaerobic digestion (biogas) systems', *World Development*, Vol. 10, No. 3 (1982), pp. 239–261.

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8. See, for example: Food and Agriculture Organization (FAO), 1978, *op. cit.*; M. W. Hoskins, 'Community participation in African fuelwood production, transformation and utilization', discussion paper prepared for Workshop on Fuelwood and Other Renewable Fuels in Africa (Paris: 29 November 1979); A. K. N. Reddy, 1979, 'Alternative and traditional energy sources for the rural areas of the Third World', paper presented at the Royal Institution of International Affairs Forum of Third World Energy Strategies and the Role of Industrialized Countries (20–22 June 1979); B. Agarwal, *The Woodfuel Problem and the Diffusion of Rural Innovations* (London: Tropical Products Institute, 1980); and D. H. Wood, D. Brokensha, A. P. Castro, M. S. Gamser, B. A. Jackson, B. W. Riley and D. M. Schraft, *The Socio-Economic Context of Fuelwood Use in Small Rural Communities*, AID Evaluation Special Study No. 1 (Washington, D.C.: Bureau for Program and Policy Coordination, 1980).

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10. A village *panchayat* is the smallest political constituency and administrative unit in Nepal. There are about 4000 village *panchayats* distributed over 75 districts in the country. Normally, it consists of a population between 3000 to 6000 in an area between 10 to 30 sq km.

11. Nepal has three distinct geographical regions. The Terai is the region of plains bounded by the Indian border in the south and the Siwalik range in the north. Its elevation ranges between 30 and 1000m. The Hill region, ranging between 1000 and 3000m, starts from the Siwalik range and goes to the Mahabharat range. The Mountain region then stretches up to the Himalayan range and has an elevation of 3000–8000m. About two-thirds of the population live in the Hill and Mountain regions (mostly in the Hill) and one-third in the Terai.

12. See, for example: E. P. Eckholm, 1975, *op. cit.*; Energy Research Development Group (ERDG), *Nepal: the Energy Sector* (Kathmandu: Tribhuvan University, Institute of Science, 1976); A. Macfarlane, *Resources and Population: A Study of the Gurungs of Nepal* (Cambridge University Press, 1976); World Bank, *Nepal: Forestry Sector Review*, Report No. 1952-NEP, South Asia Projects Department (Washington, D.C.: 1978); M. Banskota, 'The Nepalese Hill Agro-ecosystem: A Simulation Analysis of Alternate Policies for Food Production and Environmental Change', Ph.D. dissertation, Cornell University, Ithaca, New York and Michigan: University Microfilms International (1979); FAO/World Bank Cooperative Programme on Investment Centre, Draft report of the Nepal Community Forestry Development Project preparatory mission, Report No. 16/79 NEP 12 (Washington, D.C.: 1979); D. Hughart, 1979, *op. cit.*; and National Academy of Sciences, *Proceedings, Workshop on Management of Renewable Resources: Problems, Strategies, and Policies*, Kathmandu, Nepal, 6–13 February 1981 (Washington, D.C.: 1981).

13. For a detailed treatment of the historical and political perspectives on the topic, see: D. Bajracharya, 'Deforestation in the food/fuel context: historical and political perspectives from Nepal', *Mountain Research and Development* Vol. 3 (1983), pp. 227–240; and D. Bajracharya, 1981, *op. cit.*

14. See National Planning Commission, Draft proposals of the task force on land use and erosion control (Kathmandu: 1974).

15. See note 11 regarding the explanation for what the Terai is.

16. Local legend speaks of the area being donated by the local chief of the time to a group of wandering Kirantis, and the name of the study area, Pangma, accordingly signifies 'gift' in the Kiranti language. The legend also speaks of the exiles, who described themselves as hunter-gatherers, asking for a place where the mongoose (*nyauli*) squeaked and the pheasant (*piura*) sang. This indicates the Kiranti inhabited Pangma while it was in the state of a forest.

17. The first entry of Brahmins, Chhetris and Gurungs in large numbers dates back to 1773 when the army of King Prithvi Narayan Shah of Gorkha, which consisted of people from the above groups, conquered the area. This was a part of the campaign which eventually led to the annexation of many independent small principalities into what is now the Kingdom of Nepal. The second wave came during the war with Tibet toward the end of the eighteenth century. In both cases, many people from the army settled in the area when the military operations came to an end. See Janch Bujh Kendra, *Mechi Dekhi Mahakali*, Vols. I–IV (Kathmandu: 1975), in Nepali.

18. This type of population distribution by ethnic groups at different elevations is typical in the 'mid-hill' region of Nepal. The influence of climatic zones and vegetation on the development of 'vertical structures of cultures' is theorized by Kawakita (1976).

19. The growing stock is determined as follows:

(1) $A_F \times \rho_T = N_T$

(2) $N_T \times \rho_V = V_W$

(3) $V_W \times \rho_W = W_W$.

A_F, the forest area, was determined from aerial panchromatic photographs that were taken by Huntings Survey Ltd., UK, on 6–8 December 1978 as part of a survey conducted for the Kosi Hill Area Rural Development Project. The photographs, taken from 7600 m above sea level, were reproduced at a scale of 1 : 20,000. I used nine photographs to cover the entire area of Pangma *panchayat*.

For estimating ρ_T, the number of trees per unit forest, I requested V. P. Jaiswal, a forester, to do the tree inventory on 13 forest sites. Trees of various diameter at breast height (dbh) were counted. See V. P. Jaiswal, 'Forest working schemes for Pangma forests', Report submitted to Energy Research and Development Group (Kathmandu: 1978).

ρ_V, the wood volume per tree, was estimated by using the volume table derived by the forest Resources

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Survey for 'miscellaneous species in the hills'. Tree heights were assumed. See Department of Forests, *Tree Volume Table for Nepal*, Forest Resource Survey Report No. 3 (Kathmandu: 1967).

The density fuelwood, ρ_W, was estimated by Levenson for samples of various species, namely, *Daphniphullum himalayense*, *Castanopsis indica*, *Eurya cerasifolia*, *Schima wallichii*, *Alnus nepalensis* and *Symplocos ramosissima*. See B. Levenson, 'Fuelwood utilization: a study of the demand and the available fuelwood resources at six selected villages', Phewa Tal Technical Report No. 9 (Kathmandu: 1979). Many of these species are common in Pangma as well. Levenson's measurements included fresh green wood as well as air-dry wood. Assuming an average 75% moisture content, I assessed a density of 0.74 g/ml.

20. The fact that these parts are ignored is indicative of the bias until recently with regard to commercial logging interest in forestry. Understandably, harvesting of small trees, branches and treetops is of little relevance from that standpoint. This is certainly not the case with regard to fuelwood collection by people in rural areas.

21. Estimates of annual growth of trees are far from satisfactory. Levenson, 1979, *op. cit.*, assumed 12.5 m^3/ha, and Wormald and Gurung, 1976, *op. cit.*, estimated 10–15 m^3/ha in unmanaged forests and 25–30 m^3/ha in managed forests in western Nepal. I used the graded rate of growth according to dbh classes similar to the one taken by Forests Resources Survey, Department of Forests, *Forest Statistics, Hill Region*, Forest Resources Survey Report No. 21 (Kathmandu: 1973). Accordingly, my estimate corresponds to 4.8 m^3/ha if all parts of the tree were assumed and 2.8 m^3/ha if only timber volume was accounted. Clearly, mine was a very conservative estimate which only strengthens the thesis I am putting forth with respect to a de-emphasis on deforestation due to fuelwood consumption.

22. The accounting of deadwood is of little relevance to a forester if logging is the driving force in forestry. R. T. Forbes (ed.), *Forestry Handbook* (New York: Ronald Press, 1955), assumes 'a flat 10 to 20 per cent reduction' due to 'mortality'. The literature on litter generation in forests is common in ecology studies, however. For example, the percentage of falling wood from trees is found to be 4.29% in the Amazonian forest according to H. Klinge, W. A. Rodrigues, E. Brunig and E. J. Fittkau, 'Biomass and structure in a central Amazonian rain forest', Chapter 9 in F. B. Golley and E. Medina (eds.), *Tropical Ecological Systems: Trends in Terrestrial and Aquatic Research*, Ecological Studies 11 (New York: Springer: 1975), and 8.88% in the miombo in Africa according to F. Malaisse, R. Freson, G. Goffinet and F. Malaisse-Mousset, 'Litter fall and litter breakdown in Miombo', Chapter 12 in F. B. Golley and E. Medina (eds.), *op. cit.* My use of 3% is an aribitrary but conservative estimate.

23. See the references cited in note 12.

24. See: National Planning Commission, *A Survey Report on Employment, Income Distribution, and Consumption Patterns in Nepal*, Summary Report, Vol. IV (Kathmandu: 1978); and C. Clark, *Population Growth and Land Use*, 2nd edn (London: Macmillan, 1977).

25. As a point of information, it may be noted that although a surplus of grains exists in the *panchayat*, it is unlikely that the surplus is stored away for times of misfortune. Instead, the surplus - especially of millet and maize – is more likely to be used in making alcoholic beverages. A surplus is apparent to the extent that, in this analysis, only the proportion of grains consumed as dietary staples has been considered.

26. See, for example: J. T. Hitchcock, *The Magars of Banyan Hill* (New York: Holt, Rinehart and Winston, 1966); L. Caplan, *Land and Social Change in East Nepal: A Study of Hindu Tribal Relations* (Berkeley: University of California Press, 1970); L. Caplan, *Administration and Politics in a Nepalese Town: The Study of a District Capital and Its Environs* (London. Oxford University Press, 1975); A. P. Caplan, *Priests and Cobblers: A Study of Social Change in a Hindu Village in Western-Nepal* (San Francisco: Chandler, 1975); J. Kawakita, *The Hill Magars and Their Neighbours* (Tokyo: Tokai University Press, 1974); J. Kawakita, 'The vertical structure of cultures in central Nepal Himalaya. A synthetic perspective of three points of view: ecology, culture, history' (Tokyo: 1976); Janch Bujh Kendra, 1975, *op. cit.*; Macfarlane, 1976, *op. cit.*; Wormald and Gurung, 1976, *op. cit.*; and Levenson, 1979, *op. cit.*

27. National Planning Commission, *Draft of the Sixth Plan, Part I (Summary)* (Kathmandu: 1980), in Nepali.

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