

IMPROVING FOREST RESOURCES IN NEPAL

by

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IMPROVING FOREST RESOURCES IN NEPAL

ABSTRACT: Deforestation and accompanying environmental deterioration is a threat to the economic growth and to the survival of the Himalayan kingdom of Nepal. There is need for a comprehensive forest rehabilitation program tailored to the different conditions of the Terai plain, Middle Hills and the Highland Himalaya regions of the country. The forest resources improvement program must evolve with community participation and must provide for the long- and short-term forest needs of the people. A program of this nature may incorporate the development of alternative sources of fuel to relieve the immediate pressure on Nepal's forest resources and to ameliorate, to some degree, the present energy crisis faced by the nation. Reforestation may be usefully integrated with controlled grazing to help meet fuelwood, fodder and forage demand. Changes in institutional organization and attitudes may be required to plan and implement an effective program to improve forest resources in Nepal.

INTRODUCTION

Deforestation and accompanying environmental deterioration are a threat to the economic growth and to the survival of the Himalayan kingdom of Nepal. Nepal's predominantly agrarian population places heavy demands on their forests, particularly for fuel and fodder. Two-thirds of the 12.5 million people live in the mountainous regions where the forests are seriously depleted.¹ The nation's population is steadily increasing. The challenge of checking continued deforestation and of replenishing Nepal's forest resources must be met.

The purpose of this paper is to explore strategies for improving Nepal's forest resources through reforestation and conservation activities. Within these strategies, reforesting cut-over areas, production of fodder and forage, and the provision of fuel supplies, including alternatives to wood-based fuels, are considered. To begin, an overview of Nepal's environment and the factors causing the depletion of its resource base is needed.

BACKGROUND ON NEPAL AND ITS FOREST RESOURCES

Within the small country of Nepal there is great physical, climatic, and vegetational diversity.

The Physical Environment

Nepal is a long, narrow, rectangularly shaped country on the southern slopes of the Himalayan mountain range. It has a wide range of climates due to its monsoonal rainfall pattern and the rapid change of elevation, from 180 meters to over 8,000 meters, within 145 kilometers of latitude. Almost every climatic zone of the earth is represented, from humid subtropics in the south to arid steppe in the north.² Precipitation varies from 150 millimeters to 6,000 millimeters and 80 percent of this precipitation occurs between June and September.³ In general, more precipitation falls in the southern part of the country and less in the north. These variations within Nepal's physical environment lend themselves to division into generalized geographic regions.

Regional Divisions

In this paper three major geographic regions in Nepal will be referred to: the Terai, the Middle Hills and the Highland Himalaya regions (Fig. 1). The Terai lies between the outer

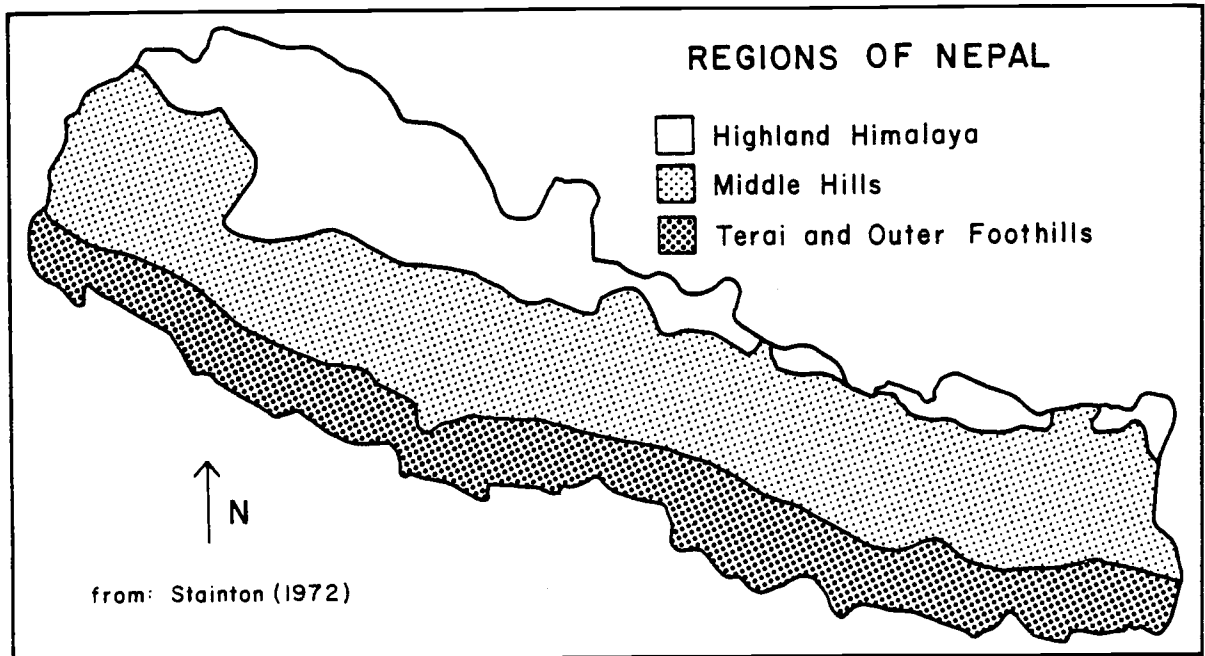


Figure 1. Regions of Nepal

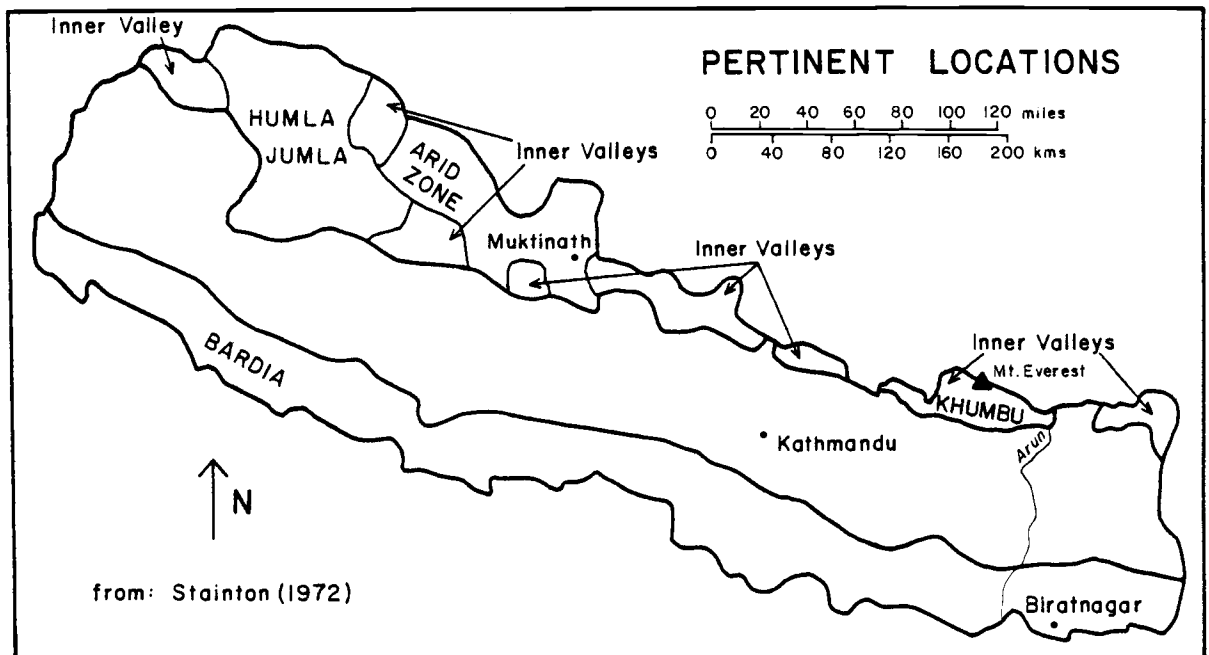


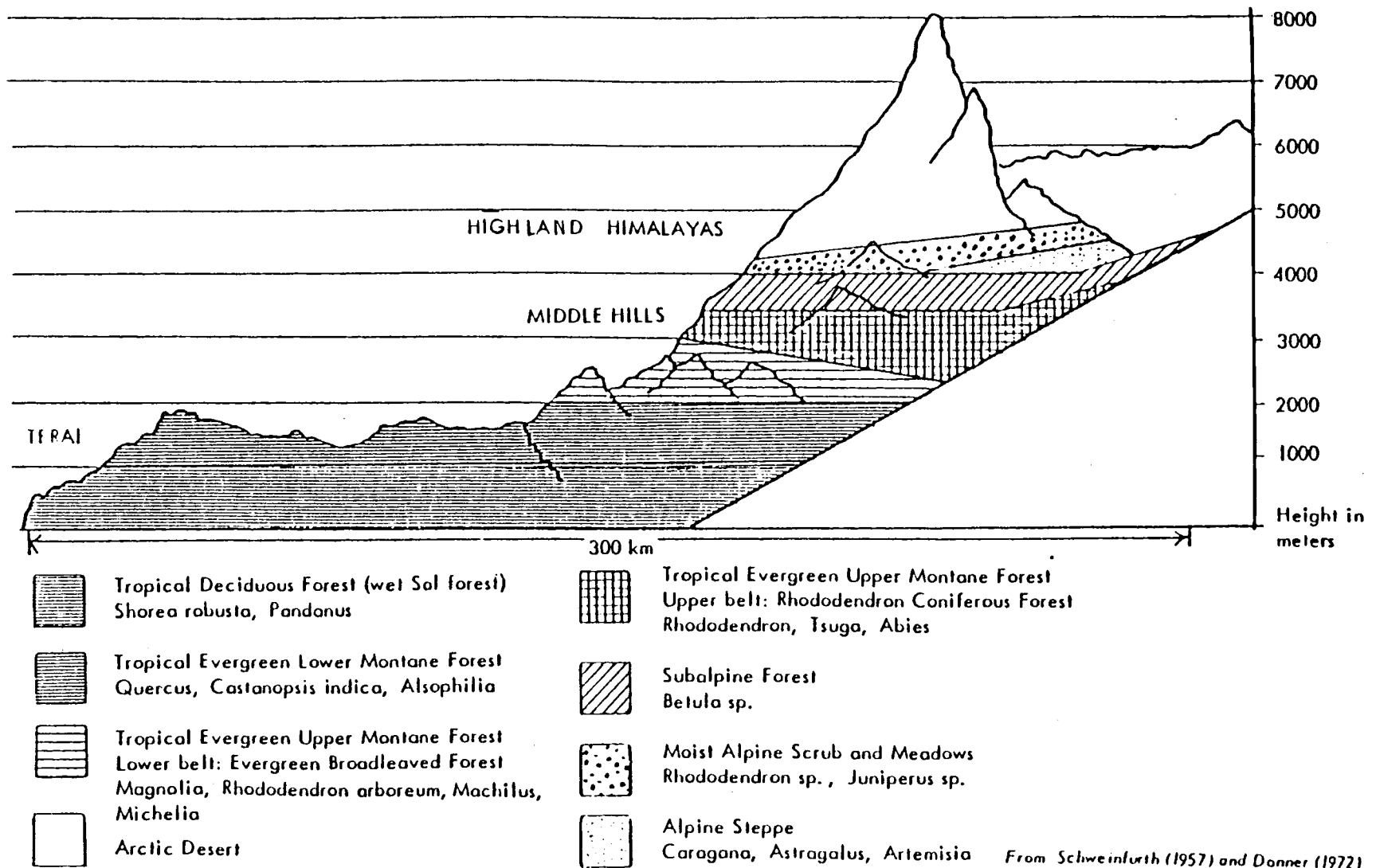
Figure 2. Pertinent Locations

foothills and the Indian border. It is as wide as 40 kilometers in some places and is part of the Gangetic outwash plain, although still politically part of Nepal. The Middle Hills region is located between the outer foothills and the main snow-covered Himalaya range. This region is the most densely populated region. The Highland Himalaya region consists of the Humla-Jumla area, the high altitude inner valleys, including Khumbu, and the arid zone, which includes the Muktinath Valley (Fig. 2). It is sparsely populated and portions are totally uninhabitable.⁴ The distribution of forest and range resources varies within these different regions.

A Sketch of the Resource Base

A spectrum of forest and range resources occurs in Nepal. It is estimated that 31 percent of Nepal is forested and seven percent is grassland. There are approximately 800,000 hectares of forest area in the Terai, 200,000 hectares of which are considered available and suitable for intensive forest and plantation management. There are approximately 3,561,360 hectares in the Middle Hills and Highland Himalaya regions, 34 percent of which is considered commercial. Nepal exports forest products, primarily to India, and this may account for 20 percent of the Gross National Product (GNP) of the country.⁵

There is a prevalent pattern of forest type and dominant tree species distribution in Nepal (Fig. 3). In the low altitude, subtropical Terai (up to 1,200 meters), various types of deciduous and evergreen broadleaf forests occur, as well as areas of natural grassland. Sal (*Shorea robusta*) and asha (*Terminalia roxburghii*) are two of the dominant tree species in this region. Conifers, with some broadleaf species, are typical of the mid-mountain ranges up to 4,100 meters. Chir pine (*Pinus roxburghii*), blue pine (*Pinus excelsa*), and mixed hardwoods (*Castanea*, *Michelia*, *Schima*) are representative species. Around 3,800 meters subalpine and alpine vegetation begin,



*From Schweinfurth (1957) and Donner (1972)
Source: Byers (unpublished)*

Figure 3. NEPAL: Cross-Sectional View of Vegetative Distribution

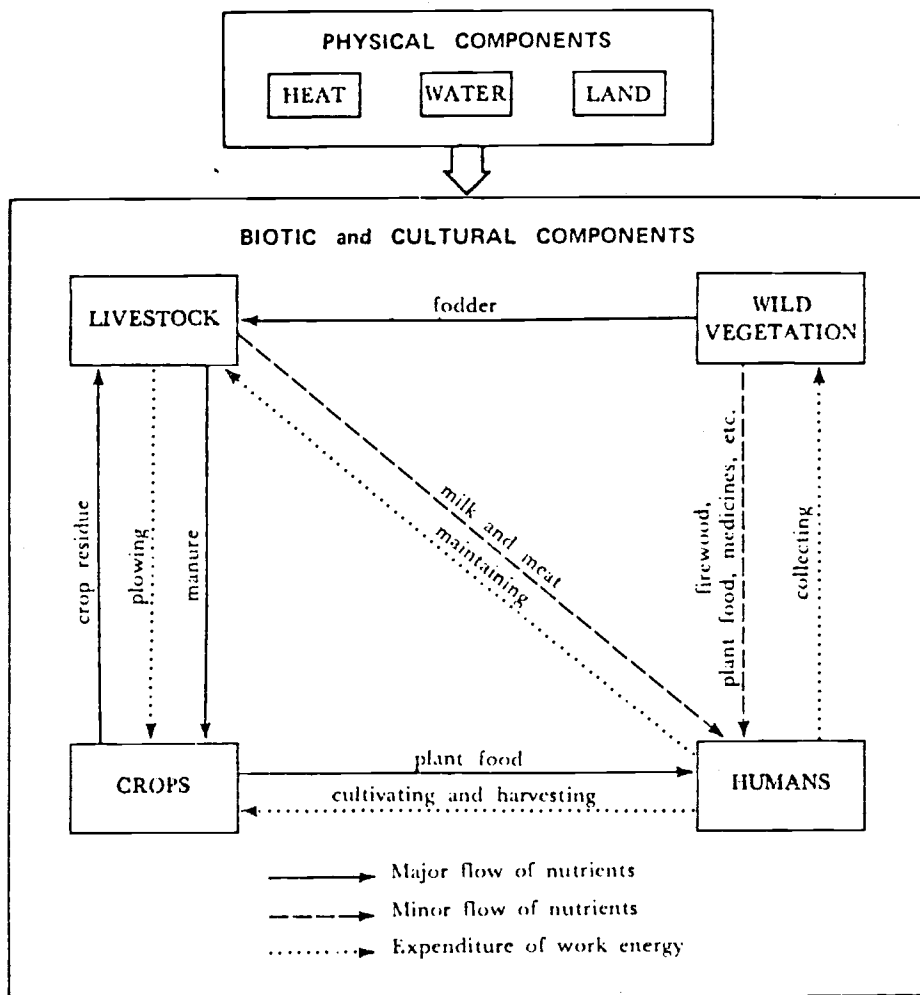
and may extend up to the permanent snowline (5,400 meters) in protected drainages. These areas are used predominantly for range.⁶ There are a number of interrelated factors which are contributing to the rapid deterioration of this valuable resource base.

The Issues of Resource Depletion in Nepal

The issue of resource depletion is crucial at this point in Nepal's development. Pressures from domestic livestock, increasing fuelwood demands, agricultural expansion, and changes in the traditional structure of resource management systems are contributing to accelerated depletion of valuable natural resources. A dynamic interaction exists between the Nepalese and the natural resources on which they depend for their livelihood. In a study of a microgeographical ecosystem, a Middle Hills village, Hoffpauir outlined the functional linkages of the various components of the ecosystem (Fig. 4).⁷ This structure and the functional linkages can be generally applied to all of Nepal. Wild vegetation plays an integral part in the system and is directly linked to humans.

Pressures From Domestic Stock

Despite the fact that Nepal's grasslands have been nationalized, there is no management or use restriction for them. Almost 10 million cattle and buffalo as well as four million sheep and goats feed on these grasslands.⁸ One of the primary functions of wild vegetation is the supplying of fodder to cattle, buffalo, and goats. Often, particularly in Terai and Middle Hill villages, cultivatable land belonging to a village is committed to food crop production or other purposes and there is no land available for growing fodder crops. A large portion of the fodder required by the livestock during the dry winter and spring months is taken from the broadleaf trees and shrubs growing in the vicinity of the village. Thus, by



From: Hoffpavir (1978)

Figure 4. The Structure and Functional Linkages of a Village Ecosystem

the end of the dry season, the leaves of all the fodder trees are almost completely gone.⁹ In the Arun Valley of eastern Nepal, the most damaging impacts on the forests, ranging from 2,000 meters to 3,500 meters, came from shepherds who grazed their sheep in the forest while moving them up to their high alpine summer pastures.¹⁰

In the Highland Himalaya villages, forage is found near the village for only part of the year. Traditionally, the people of this region have a transhumance economy. Main villages are located near the floor of highland valleys. Meadows near these villages are used for early spring and late-fall grazing and for hay production in the summer. Above the main villages are communally owned forests which supply wood for fuel and construction. Above these forests are high pastures which are used for grazing in the summer. As the warm season progresses, livestock are moved gradually up to the high pastures. As the cold season approaches, they are gradually moved down again and allowed to graze the fields near the village after crops and hay have been harvested.¹¹

There is concern for the fragile high-altitude eco-system, in terms of its vulnerability to human disturbance:¹²

The increasing use of the meadows is affecting the species composition of the grass, and in many places is causing severe soil damage and excessive erosion. In the forests, the sheep disturb the natural undergrowth and terrestrial flora; in essence, they vie with wild herbivores for the forest vegetation and their sheer numbers along with human assistance make them overpowering competitors.

The need for fuelwood, like the need for fodder, is causing a continuous extractive drain on the wild vegetation of Nepal.

Pressures from Fuelwood Demand

Firewood used as domestic fuel represents another demand put

on Nepal's forest resources. It is estimated that fuelwood accounts for almost 75 percent of Nepal's total wood consumption and for as much as 90 percent of wood consumption in the Middle Hills.¹³ As population increases and concomitant fuel demands grow, Nepal's forest resource base continues to diminish and fuelwood shortages are becoming more common around the country. In Kathmandu, the capital city, fuelwood scarcity has become acute, the price at one point rising 300 percent in a two-year period.¹⁴

In villages some woody branches from scrubby species in village woodlots are cut for fuel, but the general lack of locally available trees is forcing villagers to travel increasingly far distances for their fuelwood supply. In a Middle Hills village, not far from Kathmandu, one entire day is needed to cut and transport a load of wood, and normally four to eight such loads are required by each household every month.¹⁵ Similar fuelwood situations have been reported in other parts of the Middle Hills and in Highland Himalaya areas such as Humla-Jumla and Muktinath.¹⁶ Attempts at planting new trees in areas of such scarcities are difficult:¹⁷

Typical of the difficulties is the failure of a reforestation scheme in west Nepal. A government agency planted young saplings across a denuded slope and, after a perfunctory explanation, asked the villagers to care for the trees as they matured. The trees were safe as long as they were only a few inches tall, but as soon as they offered any value as fodder or firewood, the villagers immediately cut them. No trees grew to be more than five feet tall before they were cut and the agency naturally abandoned its program. The villagers probably understood and appreciated need for reforestation, but the immediate demand for the trees was too great to wait. In addition, the theory of the commons was doubtlessly at work, and each villager cut as much as he could as fast as he could, fearful that his neighbor would beat him to his share.

As the vegetation is stripped from the land, fewer animals can be kept resulting in less manure with which to fertilize the fields; this results in less crop yield and less food.¹⁸ Faced with the diminishing fuel supply, some farmers resort to burning dung for cooking and warmth, thus depriving their fields of even more of the needed fertilizer.¹⁹

The loss of soil fertility in combination with increasing deforestation and overgrazing, contribute to accelerating soil erosion and the deterioration of Nepal's valuable watersheds. This is resulting in the very serious problem of flooding downstream. The consequences of soil erosion and landslides in Nepal, brought by degradation of its watersheds, extends beyond Nepal's southern border and threatens India with increased flooding as well.²⁰

This vicious cycle of economic and environmental deterioration threatens to continue in the mountainous regions of Nepal. With population continuing to grow and the amount of productive cropland steadily decreasing, the average hectare of arable land in the hills, for example, must support at least nine people.²¹

Pressures from Agricultural Expansion

Facing an increasing population and the continued loss of arable land in the Middle Hills, His Majesty's Government (H.M.G.) of Nepal has sponsored a resettlement scheme. The rationale for resettling people from the hills into the more productive and, up until now, less exploited lowlands of the Terai region, is that it will relieve some of the present pressures on the hill environment.²²

Unfortunately, more land has been cleared by illegal settlement than through H.M.G.'s program. It is estimated that if the present de facto 3.6 percent growth rate in the Terai continues, all the good farmland will be occupied in little more than ten years.²³ It is also estimated that conversion to agriculture in the last 30 years has wiped out approximately 145,000 hectares of

Terai forest.²⁴

Thus, it is evident that although resettlement does, at present, relieve the critical demand upon the land resources of the hills, resettlement by itself is not a permanent solution to Nepal's agricultural needs. As Nepalese development experts have plainly stated, "Pessimistically, impending disaster in the hills shortly precedes that in the terai."²⁵ This is all the more relevant in light of the fact that no provision was made to preserve forests for the basic needs of settlers until 1974.²⁶

The Terai is an area of high forest production potential as well as a prime area for resettlement. The competition for the relatively small land base has caused some conflict. The primary target of forest development and management in the Terai is impeded by the resettlement program. The Department of Resettlement was transferred from the Ministry of Agriculture to the Ministry of Forestry recently in an attempt to reduce this conflict.²⁷ The displacement of traditional control systems has threatened forest resources as well.

Displacement of Traditional Control Systems

In an effort to bring Nepal's forest resources under national control, H.M.G. displaced traditional systems of resource management and replaced them with a new bureaucratic structure. This displacement has caused some sociological and regulatory problems; the situation in Khumbu is a good example.

The inner valley of Khumbu, in eastern Nepal, has become well known around the world because of the people who occupy the valley, the Sherpas. As late as 1957 village forests in Khumbu were controlled by the local community. The system worked well at a time when the village communities were largely self-contained and had few contacts with outsiders. Since that time all forests not privately owned have been nationalized.²⁸

In this high altitude area there are limited timber resources and the Sherpa system of forest guards met a real need, whereas the new administrative system leaves no role for such local control of natural resources. In order to acquire a permit to fall timber, a villager must now walk at least four days.²⁹ There are no Forest Department officials in the Khumbu area and illegal cutting cannot be controlled:³⁰

The forests in the vicinity of villages have already been seriously depleted, and particularly near Namche Bazar whole hill slopes which were densely forested in 1957 are now bare of tree growth and villagers have to go further and further even to collect dry firewood. In this case the replacement of an efficient and well-tryed system of local control by a bureaucratic machinery has not been successful, and the Sherpas are conscious of the diminishment of local timber resources without being able to stop the inroads into forests which, being claimed by the government as state property, are no longer under their control.

Wild vegetation, particularly the forest resource base, is an important functional link in Nepal's ecological system. A halt to the depletion of this resource base is critically needed.

STRATEGIES FOR IMPROVING FOREST RESOURCES

There is no question that Nepal's forest resources are rapidly diminishing. It remains to be seen whether this trend will be reversed. Efforts by H.M.G., thus far, have not been adequate in stopping this environmental deterioration. The following discussion is an outline of strategies which may be useful in effectively countering the destruction of Nepal's forest resource base.

Any approach to forest development in Nepal must integrate a number of essential elements in order to be effective. A forest management plan must deal with reforestation and afforestation of cut-over and denuded areas, production for agricultural needs, and provision of fuel supplies from both wood-based and alternative energy sources.

Reforestation and Afforestation of Cut-Overs and Denuded Areas

A top priority for a forest management plan in Nepal is the re-establishment of trees in impoverished forests and the extension of forest cover. The principal objectives of a tree-planting program should include the restocking of natural forests and the establishment of man-made forests.³¹ An important prerequisite for any type of planting is the availability of adequate seeds and nursery stock.

Small, temporary nurseries are needed country-wide to meet immediate localized needs for plants in a massive tree-planting effort. A network of permanent nurseries must be established as well to sustain seed and seedling production for long-term forestry needs in Nepal.

One successful labor-intensive seedling production method used in Morocco utilizes mud pots formed in the nursery beds by a hand-operated device. To allow for the poor quality of seeds, extra seeds are planted in each mud pot and any surplus seedlings are removed early. At high elevations, where mud pots would crumble due to alternate freezing and thawing, perforated polyethylene bags are used instead. The mud pots and plastic bags are then easily transportable to planting sites when the seedlings mature.³² A similar method of seedling production can be adopted in Nepal on a large scale.

The restocking of impoverished natural forests involves

supplementing the slow process of natural regeneration and, in some forests, increasing the proportion of valuable species. Supplementing natural regeneration augments and accelerates the natural restocking process. A common practice in western Himalayan pine forests in India is to plant seeds in burned or clear-felled patches of forests and then to use surplus seedlings from these temporary nurseries to fill in vacant spots elsewhere in the stands.³³ In some temperate mixed forests, seeds or seedlings of the more valued species are planted in cut-over areas to make up for selective cutting of these species and to ensure their continued production.³⁴

Man-made forests should be established in Nepal for both conservation and production purposes. Extending vegetative cover over denuded and eroding areas using forest plantations will greatly aid in erosion and torrent control, slope stabilization, and the general protection of Nepal's watersheds. *Utis (Alnus nepalensis)* is a fast-growing species which is known in Nepal for its ability to revegetate eroded hillsides.³⁵ Chir and blue pine are two of a number of species successfully used in India to cover denuded and eroded land.³⁶

Well-managed forest plantations can help to boost Nepal's timber production. Sal is a native species well suited for this purpose.³⁷ Sal plantations should be sown with well-ripened seeds as the seedlings do not transplant well.³⁸ Preliminary nursery and field trials have shown that the best exotic species for plantation plantings are teak in the Terai and poplar in the mountains. Unfortunately, plantation trials indicate that deep soil cultivation is necessary in the Terai to break up a relatively impervious layer caused by periodic fires and compaction from cattle grazing.³⁹ Forest plantations are also needed for production of Nepal's agricultural and fuel needs.

Production for Agricultural Needs

Integrated forestry combines forestry with agricultural

production. Taungya plantations and forest grazing are two integrated forestry practices which may be useful in Nepal. In taungya plantations, local field crops are grown in between widely spaced rows of young trees. In West Bengal on Nepal's eastern border, sal and oaks are used successfully in taungya plantations.⁴⁰ Where taungya cultivation is possible, the costs of establishing tree plantations can be cut considerably.⁴¹ Although there has been little, if any, research in lesser developed countries dealing with forest grazing as a management strategy, it may be a useful way to approach the problem of indiscriminate forest grazing now so prevalent in Nepal.

In New Zealand researchers have found integrated farm forestry to be technically feasible and that "combined forestry and farming management is flexible because the balance between planted and unplanted pasture, and between grass and wood production on the planted portion, can be varied to suit objectives (and competence) of the organization involved."⁴²

Studies in the southern United States found that grazing has little effect on survival of regenerated pine stands.⁴³ One researcher concluded that since the supply of forage changes dramatically after a few years with a regeneration stand, long-range planning and cooperation should provide for a variety of tree stand ages to ensure high forage yields.⁴⁴ Other researchers found that once green herbage is plentiful on a plantation, browsing of tree seedlings is minimized. They suggest that withholding livestock from areas planted with seedlings until forage appears within the stand might be helpful in reducing the mortality which could occur otherwise.⁴⁵

A review of current literature on forest grazing excluded goats, saying that goats are universally considered undesirable in forests. In this survey, literature from all over the world unanimously agreed that forest grazing must be controlled to be successful.⁴⁶

Finally, in considering the economic viability of the integrated forest-grazing system, New Zealand researchers found that "even the secondary benefits may be sufficient on their own to justify joint land use as, for example, planting for soil stabilization plus wood production."⁴⁷ The researchers mention two such cases.⁴⁸

Although forest grazing could not be identically practiced in Nepal, the fundamental idea of combining forest plantations with forage production may be feasible. The system would most probably succeed at the lower altitudes where growth is faster. Fodder trees are one additional parameter which might be included in a plantation rotation since many broadleaf species are presently used for fodder in Nepal. In one Middle Hills village the following species were found to be used for fodder: *Litsea polyantha*, *L. lanuginosa*, *Artocarpus lakoocha*, *Fiscuscunia*, *Eleocarpus* spp., *Bauhinia variegata*, *B. purpurea*, and *Terminalia belerica*.⁴⁹ Other species may also be useful in augmenting fodder supply.⁵⁰

Forest plantations and integrated forest management cannot immediately supply all the forage and fodder needs of Nepal, but they may prove to be a useful means of supplementing the growing demand for these resources and for fuel as well.

Provision of Fuel Supplies

Provision of domestic fuel is an important factor in Nepal's forest resource development. The establishment of fuelwood plantations, more efficient utilization of fuelwood, and the development of alternative energy sources will relieve much of the pressure on Nepal's natural forest resources to produce domestic fuel.

Fuelwood Production and Efficient Utilization

The accurate assessment of fuelwood demand is essential in developing a fuelwood plantation scheme for Nepal. In a case study

of the Bardia district in the western Terai, Earl developed a method for assessing demand and wood production potential. He determined that if H.M.G.'s resettlement of the area stopped in 1980, the amount of natural forest area needed to supply fuel for the district in 1981 would be 13,414 hectares, and in 1982, 47,298 hectares. He also estimated that the 1982 demand of 27,298 hectares of natural forest could be cut to 5,912 hectares, if Eucalyptus plantations were established and harvested on a 7-year rotation. Earl concluded that even with the cessation of resettlement, there would still be a two percent/year increase in demand for the district due to population increase. The practical solution to meeting this demand, he suggests, is to assume that all natural forests in the district will be needed for fuelwood, but this demand on the natural forest could be decreased in proportion to the amount of land planted with intensively managed fuelwood plantations. In other words, he estimated that for every 100 hectares planted with Eucalyptus, 700 hectares of natural forest could be saved for other uses.⁵¹ This may sound easier than it is considering the previously noted problem of an impervious surface layer in the Terai.

In further analyzing the fuelwood needs of the Bardia district, Earl suggests that the Forest Department of H.M.G. regulate cutting, sales and replanting in managing the forests of the district, or have cutting and sales handled by private enterprise in conjunction with the Forest Department. The Forest Department could use royalties received, in meeting management needs. Earl concludes that "the problem is not difficult to solve if plans are made to ensure that part of the forest is reserved for future fuel needs."⁵²

Earl's method should be examined for its applicability as a model for fuelwood plantation programs in other parts of Nepal. In addition to Eucalyptus, a number of other species have proven useful for fuelwood plantations in India and may be useful in Nepal as well.⁵³

More efficient utilization of fuelwood can lessen the amount of wood wasted in domestic use and by lessening demand, efficient utilization will cut down on forest encroachment. With this in mind, work has been done in modifying present wood-burning stoves (chulos), which are widely used across the country, to make them more energy-efficient yet still culturally acceptable.⁵⁴ In some cases, the use of charcoal, as a domestic fuel, is a more efficient utilization of wood for fuel.

Charcoal. Charcoal is a common fuel source in many developing nations. Its use in Nepal may be appropriate, particularly in areas of high population densities.

Fuelwood is generally cheaper than charcoal in rural areas for heating and cooking but it is difficult to produce a sustained supply of fuelwood to urban areas because nearby forests are often converted to other uses. Thus, as production centers grow farther from consumption centers, charcoal may become more in demand than wood for fuel.⁵⁵ It is interesting to note that, despite a government subsidy for fuelwood, charcoal and coal are marginally cheaper than other fuels (Table 1).

TABLE 1. RELATIVE COSTS OF FUELS AND POWER COMPARED ON THE SAME CALORIFIC VALUE BASIS IN TWO DIFFERENT AREAS (Fuelwood taken as unity)

Fuel	Kathmandu (1973)	Terai towns (1973)
Fuelwood	1.0	1.0
Charcoal	0.8	0.7
Coal	0.8	0.9
Fuel oil	-	-
Paraffin	1.6	1.6
Electricity	8.5	9.3
	(domestic)	
		from Earl (1975)

Nonetheless, people in Nepal's capital, Kathmandu, prefer wood, primarily Sal, for fuel.⁵⁶ This preference for wood may eventually change once transport costs of wood become more significant. Transport costs are twice as much per calorie for wood as for charcoal, thus a point where charcoal is preferable may soon be reached.⁵⁷

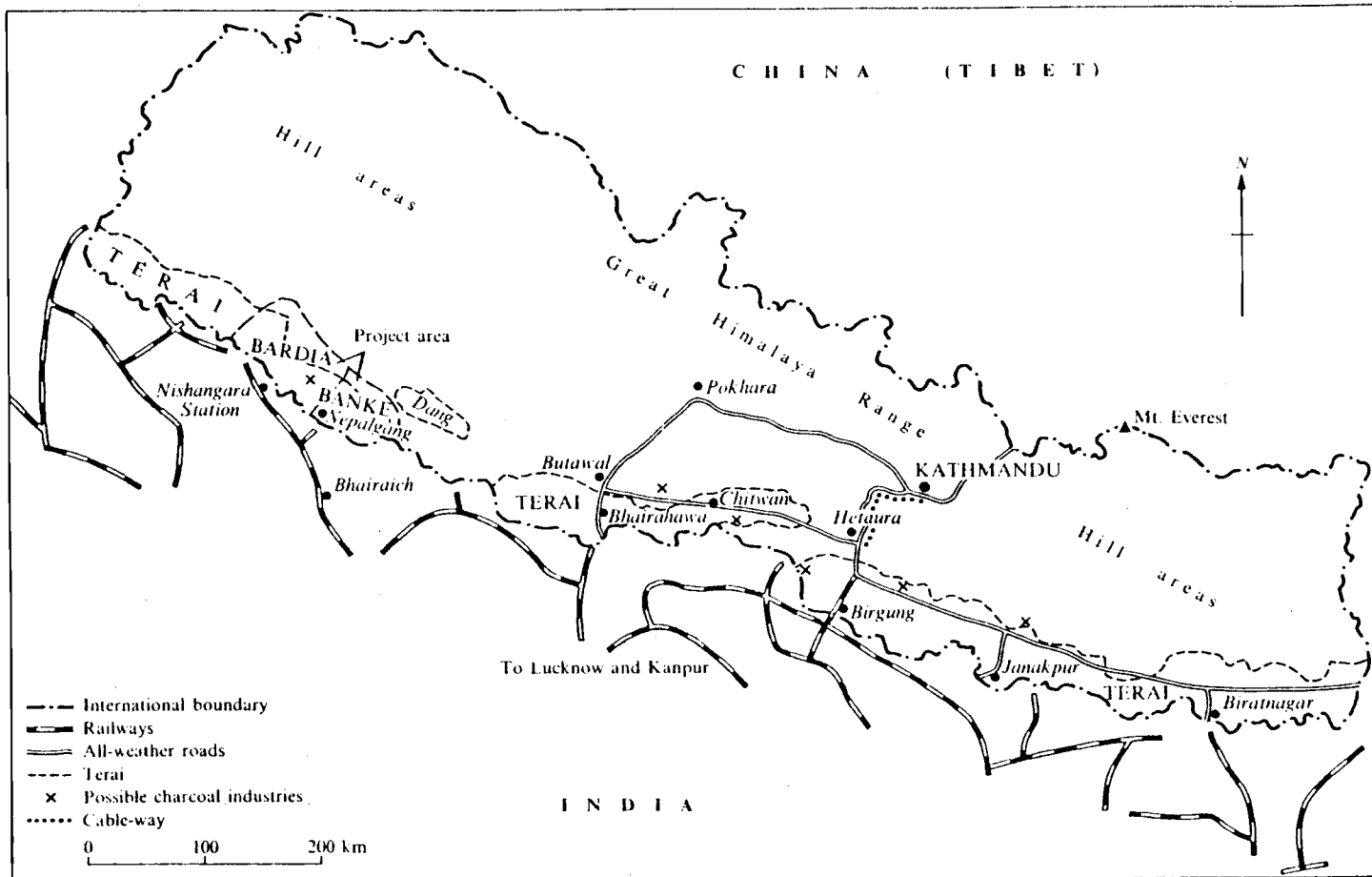
It has been estimated that 75 m³/ha of charcoal could be produced in the Terai.⁵⁸ A number of possible charcoal production sites have already been identified (Fig. 5). For further discussion of the potential of charcoal use in Nepal, refer to Earl's publication on the subject.⁵⁹

Charcoal may prove to be a more efficient use of some of the present fuel wood supply in some regions of the country, but there are alternative fuel technologies available which are not directly related to wood.

Lessening Wood Demand with Alternative Energy

In order to relieve some of the pressure on existing forests and to allow for the time lag involved in generation of fuelwood in forest plantations, alternative sources of fuel are important to meet Nepal's growing energy demand. The only hope for a successful fuelwood plantation program is the immediate provision of alternative fuel, thus allowing for long-term plans to bear fruit. This is evident from the description of the failure of a reforestation scheme in West Nepal that was mentioned earlier in this paper. Hydroelectricity, biogasification, and solar energy have potential for use as sources of alternative energy in Nepal.

Hydroelectricity. Nepal has a vast potential for the production of hydroelectric power. Eventually hydroelectric power may supply an increasing share of the power needs of large towns and industry in Nepal. Because of the huge capital expenditure required, progress has been slow.⁶⁰ In 1970-71 H.M.G. spent more



From: Earl (1975)

Figure 5. NEPAL: Infrastructure and Proposed Charcoal Development Areas

than twice as much on electric power development than it spent on forestry development:⁶¹

The economy of Nepal is agrarian, and because of the infra-structural problems, electricity is likely to be only complementary to fuelwood, which must be provided in rural areas if serious social and economic consequences are to be avoided.

Problems in planning and mobilization have also plagued the development of hydroelectricity in Nepal. According to one eminent Nepalese authority, Nepal's estimated hydroelectric potential is 83,000 mw. which he says is equal to the combined installed capacity of Canada, the United States and Mexico. By 1970, this potential had only been tapped by an installed capacity of 45,000 kw.⁶² He writes:⁶³

Most of the power installations (60%) are located around the capital, which contains comparatively few large industrial establishments, while industrial areas like Biratnagar in the eastern Terai, face power shortages. The price of electricity to a domestic consumer in Kathmandu is lower than the tariff that industries in Biratnagar pay. As a result of mislocation, power investment too has failed to contribute to raising productivity.

From an environmental standpoint, Nepal has little chance of becoming an exporter of electricity to India because of continually disintegrating watersheds. Erosion is such that if any river is dammed to produce hydroelectricity, it will soon be rendered useless because of excessive sedimentation.⁶⁴

Biogasification. The development of methane digesters (bio-gas or gobar-gas plants) is still in its infancy in Nepal,

but it is already evident that biogasification has great potential in supplying some of the cooking and heating needs of the country.⁶⁵ A number of small plants are already operating.⁶⁶

Any evaluation of the utility of bio-gas should consider not only the fuel production potential but the benefits of the slurry waste produced by the process as fertilizer, also.

Biogas plants can be constructed on a small scale to serve the needs of one or two families, or at a larger scale to serve an entire community. The large plants can be integrated into entire agricultural production systems which incorporate livestock production, biogas generation, fisheries, and aqua-culture as well as crop and fodder production.⁶⁷ For efficiency these plants are large and require large capital expenditures. For this reason, they are not applicable for use in most Middle Hills or Highland Himalaya villages. Nonetheless, they might be useful near larger population concentrations, especially in the Terai.

For the most part, experts in Nepal see the constraints on developing biogasification in the country as organizational rather than technological.⁶⁸ Community bio-gas plants are probably most desirable because of their economies of scale, but they are expensive to build. Small-scale, family-sized units require approximately three head of cattle to produce enough manure to keep the units operational. Unfortunately, at present the majority of agricultural families in Nepal own one to two cattle per family.⁶⁹ A cooperative effort among families might supply a bio-gas unit of this type with sufficient manure to operate as a supplemental source of the fuel for the families.

There is an additional constraint to bio-gas development in the more temperate areas of the country. Methanogenic bacteria require a temperature above 46°F to generate gas. A good temperature range is between 68°F and 104°F.⁷⁰ Because of the low winter temperatures in the mountainous regions of the country, a different gas-generating unit design with a supplemental heat source may be required.

The Chinese have had success with biogas as a substitute for fuelwood. Biogas generation is being adopted on a large scale due, in part, to construction efforts supported by mass training of technicians. Efforts are successful even in Szechwan where the average January temperature is around 45°F.⁷¹ The Chinese found that as long as a digester is tightly sealed, a variety of non-imported materials can be used in construction.⁷² The smallest units are built for approximately \$5 US and a typical 10 cubic meter digester can provide a southern Chinese peasant family with all cooking and lighting energy for summer and autumn, if properly managed.⁷³

Low temperatures may limit biogas production at higher elevations in Nepal to the hot spring and summer months, but if seasonal energy demands in the hills could be met by biogas plants, it would greatly relieve the pressures now put on forest resources.⁷⁴

Solar energy. Solar energy potential is high in Nepal. The skies are clear over the nation for most of the year except during the torrential downpours of the monsoon. If even a fraction of this energy were tapped, it would supplement the energy needs of the country.⁷⁵ Technical research is just beginning in Nepal dealing with solar energy capture. Social barriers to acceptance relating to cooking outside and with a strange solar cooker will also need to be dealt with.⁷⁶

It should be recognized that demand for fuelwood will still remain high even with the initial development of alternative energy sources. Hydroelectricity, biogas, and solar energy can only complement wood as sources of domestic fuel in the near future. The objective of meeting Nepal's fuelwood demand in the larger context of improving the country's forest resources, requires comprehensive long-range planning. The planning process has many social and institutional constraints.

SOCIAL AND INSTITUTIONAL CONSTRAINTS IN PLANNING

Often development planners have lost sight of the needs of the people when planning for long-term goals. No strategy, no matter how well thought out, can ever succeed unless it considers the desires and cultural habits of the people it concerns. A plan has little chance of acceptance if it does not involve community choice.

In their work with rural water supply in lesser developed nations, Whyte and Burton found that user choice is an important element in providing effective development programs.⁷⁷ Their findings may be useful in approaching Nepal's reforestation and fuelwood problems:⁷⁸

Two other aspects of community commitment to using, maintaining and even initiating rural water schemes which are as important as perception of health benefits are: (a) in selecting between alternative sources of supply. Communities and individuals provide their own frame of reference and criteria for calculating sets of tradeoffs; (b) choices 'delivered' to communities are accepted with less commitment than the choices they have made for themselves.

Lack of formal education should not be equated with ignorance. The villagers and townspeople of Nepal have a wealth of knowledge to be tapped and enhanced by development workers in trying to construct workable reforestation schemes. Yet serious roadblocks to progress exist in many villages and towns in Nepal.

Social Conflict

Caste conflict and long-standing differences among ethnic groups sometimes threaten any chance of cooperation in worthwhile development projects in Nepal. Factionalism is usually more prevalent in highly socially stratified and ethnically heterogeneous

communities. Nonetheless there are examples of cooperation within these types of communities as well.

Planners must be aware that no matter what the make-up of a community "poor people will meet today's needs as they must, even at the cost of long-run threats to their existence, and development policy must take account of this conflict."⁷⁹

Institutional Effectiveness

There is a complementary relationship between forestry and agriculture development. Often there are institutional problems of communication, not to mention coordination between and within forestry and agriculture departments of a government.⁸⁰

There is some controversy concerning the effectiveness of planning in Nepal in the past. There is also concern that indecision is inherent in the present structure and functioning of Nepal's governmental bureaucracy and that disincentives to innovation and progressive initiative exist within the system.⁸¹

Research in Nepal directed at finding forestry techniques and information that are useful for Nepal's unique situation have some preliminary results, but "a utilization program has been delayed because of policy indecision, a tightening of timber import control, and money transfer over the Indian border."⁸²

It is essential that a comprehensive policy be developed for Nepal which incorporates the complementarity of agriculture and forestry. The Chinese have administratively integrated forestry and agriculture from the Ministry level on down.⁸³ This is worth consideration for Nepal as well.

Present efforts by Nepal's government in fuelwood and fodder production, watershed protection and conservation, and in industrial development are not sufficient to meet the growing needs of the country.

SUMMARY AND CONCLUSIONS

Any approach to forest development in Nepal must consider all the production and conservation functions mentioned above. The demand created by these functions must be accurately addressed and the reasons for Nepal's rapid forest resource depletion understood. Then with community involvement and the cooperative efforts of the entire governmental apparatus, strategies for meeting the short- and long-term forest needs of the country can evolve.

Elements of a New Strategy

Various schemes integrating management of natural forests, fodder and fuelwood plantations, charcoal production, hydroelectric production, solar energy capture and biogasification can be developed within a larger framework of economic development for the nation.

Nepal must plan for its own unique assets and problems, yet examining the experiences of other nations is useful in this process. Village plantation schemes have been successful in Gujarat, India. China and South Korea have also had success in dealing with forest encroachment and reforestation problems similar to Nepal's.⁸⁴

With knowledgeable guidance from the Forest Department, village panchayats (village councils) should be encouraged to develop management plans for panchayat controlled forests to reverse the trend of forest resource depletion. Under strict supervision, it may be possible for panchayats or private concerns to contract with the Forest Department to manage state-owned lands for fuelwood or timber production.

A program of community involvement in forestry development for Nepal should be coupled with an education program that includes the teaching of environmental awareness and of basic reforestation

skills. Westoby states that the Chinese repeatedly tried to impress upon him their belief that after-care was twice as important as planting techniques in assuring success of afforestation.⁸⁵

"Initiating community forestry can require grappling with all the interlocking social, economic and political problems that add up to underdevelopment."⁸⁶

Research Needs

A variety of research is needed in the areas of forest production, conservation, and alternative energy supply to aid forest development efforts in Nepal.

Trial work is needed to identify suitable, fast-growing tree species for fuelwood and fodder plantations in all parts of the country. Trials are also needed to test the feasibility of controlled forest grazing in forest plantations. What are the best tree species to use in afforestation for erosion control and watershed conservation in Nepal? More research should be done with taungya cultivation to assess its usefulness in cutting the costs of establishing forest plantations.

There is particular need for a functional, low-cost biogas unit design for the higher elevation settlements in Nepal, which can be made from local materials and produce gas during all seasons. Applied research is still needed in designing efficient solar cookers and ovens which can be fabricated with locally available materials at a cost cheap enough to make them attractive to Nepal's villagers. Much research is also needed in determining the energy potential and technical feasibility of tapping another type of solar energy--wind power.

Finally, more needs to be known about the sociological and institutional problems of development planning in Nepal.

Nepal still has the opportunity to reforest and to replenish its eroding renewable resources and it has the experience of many other nations as a model. The opportunity will not last long.

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