ICIMOD

International Centre for Integrated
Mountain Development

# OPERATIONAL EXPERIENCES IN FOREST MANAGEMENT DEVELOPMENT IN THE HILLS OF NEPAL

G.B. Applegate and D.A. Gilmour

ICIMOD OCCASIONAL PAPER NO. 6

Kathmandu, Nepal
January, 1987

**ICIMOD Occasional Papers**

No. 1
**EROSION AND SEDIMENTATION PROCESSES IN THE NEPALESE HIMALAYA**
Brian Carson
August 1985.

No. 2
**INTEGRATED RURAL DEVELOPMENT PROJECTS IN NEPAL: A REVIEW**
Bharat B. Pradhan
December 1985.

No. 3
**SUSTAINING UPLAND RESOURCES: PEOPLE'S PARTICIPATION IN WATERSHED MANAGEMENT**
Anis Ahmad Dani and J. G. Campbell
July 1986.

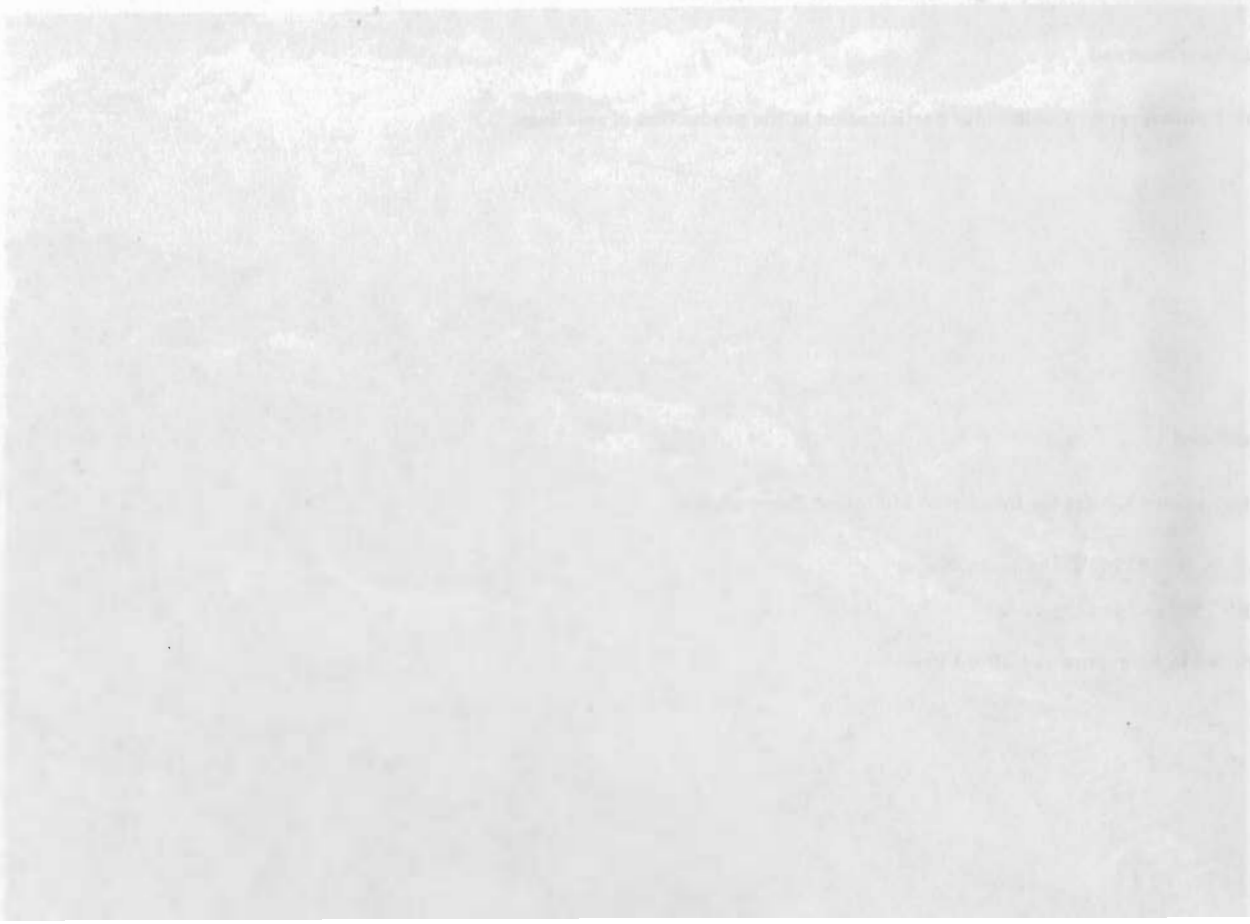
No. 4
**DECENTRALISED ENERGY PLANNING AND MANAGEMENT FOR THE HINDU KUSH-HIMALAYA**
Deepak Bajracharya
September 1986.

No. 5
**GLACIAL LAKE OUTBURST FLOODS AND RISK ENGINEERING IN THE HIMALAYA**
Jack D. Ives
November 1986.

No. 6
**OPERATIONAL EXPERIENCES IN FOREST MANAGEMENT DEVELOPMENT IN THE HILLS OF NEPAL**
G. B. Applegate and D. A. Gilmour
January 1987.

No. 7
**FORESTRY - FARMING LINKAGES IN THE MOUNTAINS**
T. B. S. Mahat
March 1987.

No. 8
**ROAD CONSTRUCTION IN THE NEPAL HIMALAYA: THE EXPERIENCE FROM THE LAMOSANGU - JIRI ROAD PROJECT**
Urs Schaffner
March 1987.



# OPERATIONAL EXPERIENCES IN FOREST MANAGEMENT DEVELOPMENT IN THE HILLS OF NEPAL

G.B. Applegate and D.A. Gilmour

ICIMOD OCCASIONAL PAPER NO. 6

Published by
International Centre for Integrated Mountain Development

Kathmandu, Nepal

Cover photograph : Community participation in the production of seedlings.

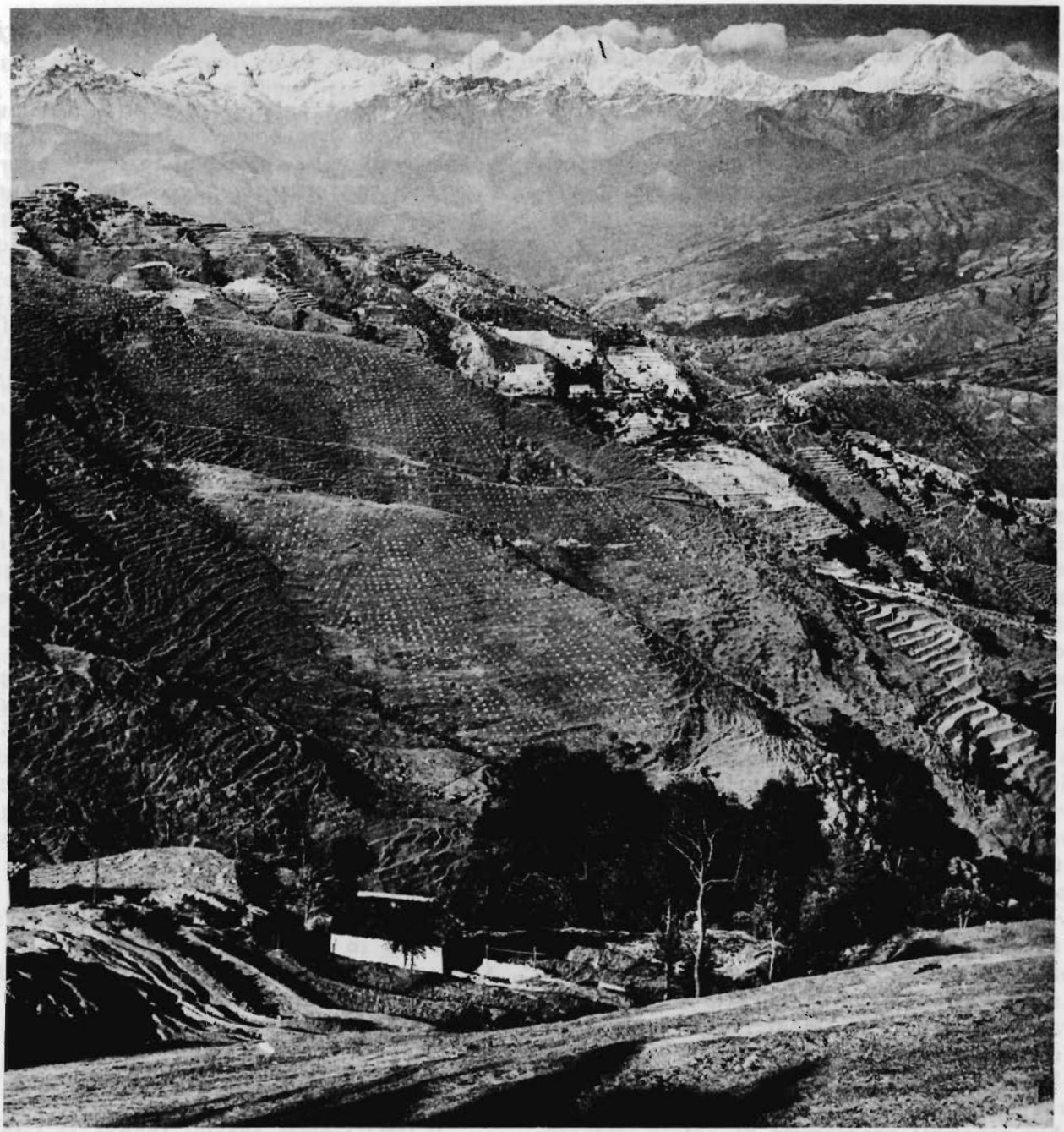
Published by

International Centre for Integrated Mountain Development,

G.P.O. Box 3226, Kathmandu, Nepal

ISBN 9971 – 84 – 757 – 4

Printed in Singapore at Kefford Press



"Protection, maintenance and development of forests scattered all over the Kingdom is neither possible nor even practical through government efforts alone".

Ministry of Forest 1978

Nepal's Community Forestry Programme has proved to be a very encouraging endeavour in the development of a constructive partnership in forestry between hill farmers and government. The origin in Nepal of this imaginative and much more promising approach to effective forest management in highly vulnerable mountain environments can be traced back to a single experimental farm and nursery established by an unusually perceptive Divisional Forest Officer (Dr. T.B.S. Mahat, now a member of the professional staff of ICIMOD) in Chautara Forest Division in the early 1970s. Confronted with the severe degradation of the forests of the two districts of the Chautara Forest Division, Sindhupalchok and Kabhre, and the related demoralisation of local communities heavily dependent on local forest resources, Dr. Mahat recognised that technical forestry practice alone could not reverse this situation of accelerating decline. What was needed was the active participation of the local village communities in systematic forest conservation and management.

From this fundamental insight (perhaps an unexpected enlightenment for traditionally trained forest officers used to a more confrontational relationship with the hill farmer) has developed one of the central themes of all rural development programmes in Nepal. With these tentative and experimental beginnings in the panchayat communities of Chautara Forest Division the 'theory and practice' of Community Forestry in Nepal has developed rapidly. In the mid 1970s, the concepts of community management of forests were incorporated in Nepal's National Forestry Plan and its related Forest Legislation. In 1978, with Dr. Mahat's participation, the Nepal-Australia Forestry Project began a sophisticated but highly practical programme of action-research in the same two districts of Chautara Division, Sindhupalchok and Kabhre. And by 1981, the World Bank and FAO/UNDP had joined HMG Nepal in the implementation of a major Community Forestry Development and Training Programme covering village panchayats in 29 Hill Districts - involving the establishment of 12,000 hectares of Panchayat Forests, the management of 40,000 ha. of Panchayat Protected Forests and the distribution to hill farmers of 900,000 tree seedlings for private planting.

The rapid expansion of the 'community forestry idea' has, however, left many questions unanswered with regard to this new approach to effective forest management in mountain watersheds - and, indeed, to the most constructive development of the necessary practical cooperation between farmer and forester. Given the obvious importance to integrated mountain development of a better understanding of this mutual learning process in this critical field of mountain forest management, we at ICIMOD are particularly pleased to publish in our Occasional Paper Series this important 'working report' by two very experienced foresters from the Nepal-Australia Forestry project. They describe the lessons of field practice in Community Forestry sensitively and scientifically developed over some eight years of intensive concentration on the panchayats of these two Districts in the 'Middle Hills' of Nepal.

It may be useful to add that we see this particular Occasional Paper as closely linked to two others in this Occasional Paper Series (designed for the dissemination throughout the Hindu Kush-Himalaya Region of practical knowledge on various aspects of integrated mountain development and mountain environmental management):

"Sustaining Upland Resources: People's participation in Watershed Management" by Anis Dani and Gabriel Campbell (ICIMOD Paper No. 3).

"Forestry-Farming Linkages in the Mountains" by T.B.S. Mahat (Paper No. 7).

ICIMOD owes special thanks to Grahame Applegate and Don Gilmour for this significant contribution to the exchange of knowledge in these mountains, and to HMG Nepal Department of Forests and the Nepal-Australia Project (and most particularly to Professor David Griffin, the Project Director) for facilitating this publication which will doubtless attract much interest among all concerned with the practical issues of mountain development.

Colin Rosser
Director
ICIMOD.

## PREFACE

Australian development assistance to the forestry sector in Nepal commenced over 20 years ago, but the first phase, to 1978, was small scale and geographically diffuse. Little tangible evidence of these early efforts can now be found. Since 1978, however, phases 2 and 3 of the Nepal-Australia Forestry Project (the latter began in 1986) have had a precise geographical focus and a clear purpose. The project, a bilateral enterprise of the Forest Department of His Majesty's Government of Nepal and the Australian Development Assistance Bureau, has operated in Sindhupalchok and Kabhre Palanchok districts. Here, its purpose has been to develop and implement a methodology for forestation for local community benefit in the Middle Hills of Nepal. The Project has had a pilot role, by agreement of both funding agencies, and such a role can be fulfilled only if its experiences are made widely available. Publications have been slow to appear, however, because methodologies need to be proven by successful implementation before they are worth reporting. Furthermore, many views of the Nepalese forestry situation developed by the Project staff and associated research workers were at considerable variance with widely held beliefs. Again, such views take time for validation. Sufficient experience has now been gained, albeit within only two districts, to warrant publication in forms easily available to an international readership and a considerable number of diverse articles are now in the process of publication or preparation.

As Project Director since 1975, my main roles have been in determining the underlying philosophy of the Project, in guiding its policy, and in some strategic planning. Project staff in Nepal (Nepalese and Australian) have carried the main responsibility for tactical planning and operations and have been partners in the determination of many strategic matters. In this paper, two Project staff members, variously Project Forest Officer, Acting Project Manager, and Project Manager/Team Leader during periods from 1981 to the present, set out with appropriate background, important aspects of the Project's methodology and operations as they have existed in these last few years. I believe they will be found of interest by a wide readership within and beyond Nepal.

D.M. Griffin
Professor of Forestry, Australian National University and Project Director, Nepal-Australia Forestry Project.

TABLE OF CONTENTS

## TABLE OF ILLUSTRATIONS

## INTRODUCTION

This paper discusses relations between forests and the mixed farming system in the Middle Hills of Nepal, and reviews recent developments in forestry, particularly in light of the experiences of the Nepal-Australia Forestry Project. Since 1978, this project has been exploring ways of introducing effective forest management into two Middle Hills districts. While the experiment is a continuing one, a review of experience to date is felt to be valuable in contributing to the overall exchange of information. The lessons learned may have relevance for land managers and researchers in other areas.

The largely rural population in Nepal makes heavy demands on the forests for subsistence (Gilmour and Applegate 1984; Mahat, Griffin and Shepherd 1987a;b). Forests are the main source of fuelwood for cooking and heating, fodder for livestock, timber for building construction, and a range of minor products.

Nepal can .be divided into three broad geographic zones: the Terai, Middle Hills and high mountains, including the Himalaya (Figure 1). For administrative purposes the country is divided into a number of regions, development zones and districts. The districts are divided further on the basis of population into panchayats. A village panchayat is a political and administrative body made up of nine wards, usually containing 3000-4000 people living in several villages. A Pradhan Pancha (village leader) is elected from among the ward representatives.

## Physiography

The Middle Hills region of Nepal is situated immediately south of the world's tallest peaks --the Himalaya. This zone, which averages 60-100 km in width, ranges in altitude from 600-2000 m (using the limits set by Nield 1985), and much of the area is dissected by large north-south drainage systems.

## Climate

The region experiences a summer monsoon from June to September when 60 to 90 percent of the annual precipitation occurs. A small amount of winter rain in November and February is followed by pre-monsoon storms from March to May (Nayava 1980). The large altitudinal variation results in not only a range of forest types, and agricultural and pastoral practices, but also a spectrum of ethnic communities (Hagen 1980).

## Forests

The Middle Hills region once supported substantial forests with a large variety of plant species (Stainton 1972). Many of these forests are now reduced to small remnant stands or individual trees on agricultural land. These remnant forests often have little left that is undestroyed due to browsing and are frequently degraded by heavy lopping and coppicing (Plates 1 and 2). This loss of forest cover is not a recent phenomenon. There is evidence that the reduction in tree cover and forest area has been in progress for several centuries (Mahat, Griffin, and Shepherd 1986a,b, 1987a,b).

## Agricultural Land Use and Settlement

Nepal is mainly an agricultural country, 83 per cent of the population are rural dwellers farming small areas of land at near sub-

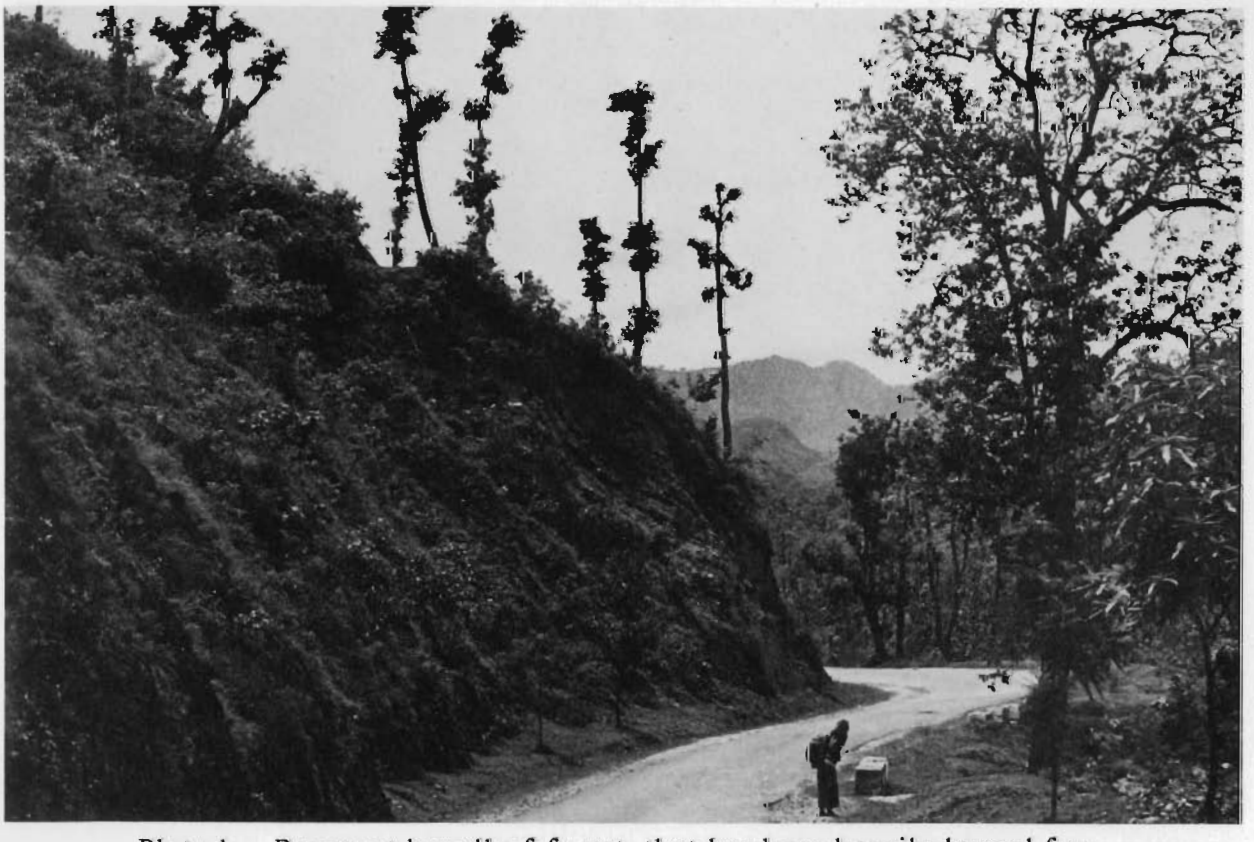


Plate 1. Remnant broadleaf forest, that has been heavily lopped for animal fodder.

Plate 2. Remnant stand of *Pinus roxburghii* with little understorey development and degraded shrub forest in the background.

sistence levels. The amount of agricultural land in the Middle Hills is only 27.5 per cent, (Table 1). Most capable land is already being cultivated. The remaining land is incapable of supporting cultivation due to limiting factors such as soil type and depth, aspect, slope and altitude.

Heavy land-use pressure has resulted in extreme terraced agriculture. Abandoned terraces are common in many areas, indicating the farmers' inability to maintain productivity at acceptable levels. There is very high and increasing pressure on a limited, almost completely utilized area of arable land.

The World Bank (1979) estimated that the ratio of persons/ha of arable land varied from 15.76 in the Middle Hills to 3.79 in the Terai, and that the average farm size per family is less than 0.4 ha.

Most arable land up to 2000 m is used for growing grain on irrigated or rainfed terraces. The majority of farmers also keep livestock. Studies in the central Middle Hills have estimated the number of large animals, cow and buffalo, per household to be between 3.7 - 9.4 (Table 2). Wyatt-Smith (1982), quoting studies in west-central Nepal, estimated there to be about one large animal per person (5-6 per household) in hill regions. Most households also keep about four small animals each, generally goats but sometimes sheep, (Mahat 1985). Large animals provide milk, manure and draught power for ploughing, while small animals are kept for meat and wool. Manure is very important as it is frequently the only form of fertiliser applied to agricultural land.

## ROLE OF FORESTS IN THE MIDDLE HILLS' ECONOMY

The pattern of occurrence and utilization of forests in the Middle Hills is intricately interwoven with the pattern of settlement and farming practices. Table 1 indicates that the Middle Hills of Nepal have a relatively large amount of forest cover at 40 per cent, but this is misleading as the land categorised as forest land in Table 1 includes all land which is at least 10 per cent covered by trees. Much of this forest land has only a scattering of trees due to heavy utilization.

His Majesty's Government of Nepal, through the Forest Department, exercises control over all forest land (which may include grassland and shrubland).

Permanent human habitation is largely confined to areas below about 2000 m due to the short growing season at higher altitudes. The forests up to 2300 m are generally under heavy pressure to provide a range of products necessary for subsistence agriculture.

The forest products in demand include firewood (Plate 3), fodder (Plate 4), leaf litter and grass for animal bedding and compost, construction timber, thatching material, edible fruits, vegetables, medicinal plants, and material for religious ceremonies. While many of these products are available from private lands they are rarely available in sufficient quantity to satisfy demand because of the generally small size of individual holdings. Consequently, off-farm sources of forest products are necessary to satisfy the demands of most hill farmers.

Almost all of Nepal's energy needs are derived from biomass fuel, which includes fuelwood and a range of woody weeds and agricultural residues. Of all wood utilized from the forests, 95 per cent is used in the form of fuelwood (Manandhar 1980). Campbell and Bhattarai (1984) estimated that the average annual consumption of fuelwood in the hill regions was 640 kg per person, although large regional variations have been reported (Donovan 1981; Mahat, Griffin, and Shepherd, 1987a,b).

**Table 1. Land Use in the Middle Hills of Nepal**

| Land Distribution | Area | Percent |
|---|---|---|
| Forest land* | 1,794,100 | 40.4 |
| Cultivated land | 1,222,500 | 27.5 |
| Non-cultivated inclusions | 665,400 | 14.9 |
| Grass land | 292,600 | 6.6 |
| Shrub land | 409,300 | 9.2 |
| Other land (ice, rock, water, and urban) | 60,600 | 1.4 |
| TOTAL | 4,444,500 | 100.0 |

* Land which is at least 10 per cent covered by trees.

Source: Land Resources Mapping Project (Nield 1985).

Plate 3.
The forests provide fuelwood for cooking and heating. Pruned branches from young chir pine plantations provide substantial amounts of fuelwood for the local people.

Plate 4 The agricultural system is heavily dependent on the forest for foliage collected for fodder and bedding material for stall-fed livestock.

As previously noted, the number of livestock kept per household is quite high. Arnold and Campbell (1985) report that in some areas the numbers of livestock are decreasing, but there remains a great demand for foliage, grass and litter for livestock production. The annual fodder consumption is as high as 16 tonnes f.w. per family in some communities (Brewbaker 1983), while the quantity of foliage litter used for bedding material amounts to 6.4 tonnes per family. Brewbaker (1983) estimated that 35 per cent of animal feed is derived from trees and that throughout Nepal, a staggering total of seven million tonnes of dry feed is required from trees each year.

**Farm-Forest Dependency**

There is a one-way flow of products from the forest to the farm (Figure 2), and the extent of this flow and the ability of the forests to sustain themselves in the long term is a subject of considerable concern. An indication of the dependence of the hill farming system on forests is gained by determining the amount of forest required to provide the essential inputs of fodder, fuelwood, and construction timber to the farms.

Wyatt- Smith (1982), in a study in west-central Nepal, estimated that an area of 2.8 ha of productive but unmanaged forest was required to sustain 1 ha of agricultural land for fodder. The equivalent ratios for fuelwood and timber were 0.36:1 and 0.32:1 respectively.

However, if forest land is taken to include forest, shrubland and grassland (i.e. all uncultivated vegetated land not in private ownership), the ratio for fodder is reduced to 0.97:1 (calculated by Mahat et al 1987a).

A similar study carried out in parts of Sindhupalchok and Kabhre Palanchok was undertaken to determine the amount of land needed to support the agricultural system. This study, reported by Mahat et al 1987a, indicated that the total leafy biomass taken from the forest requires 1.33 ha of forest land (forest shrub and grass) for 1 ha of agricultural land (cultivated and non-cultivated inclusions). This figure is reasonably similar to that developed from Wyatt - Smith's data.

When the situation is considered on a panchayat basis even the minimal ratio of 1.33:1 is found in only 22 out of 79 panchayats in Sindhupalchok and 27 out of 96 in Kabhre Palanchok. Thus in both districts, current use of forests, shrubland, and grassland for fodder and bedding probably exceeds sustained yield in about two-thirds of the panchayats (Mahat et al 1987a). In such areas degradation of the remaining forests must be proceeding rapidly. However, it must be stressed that a considerable degree of uncertainty still exists with regard to most of the data and the interpretations made from them.

In the past some confusion has surrounded the precise definitions of terms such as forest land and agricultural land. The recently completed land use survey conducted by the Land Resources Mapping Project (the results of which were summarised by Nield 1985), has clarified the situation to some extent. In this survey estimates were made of the area of non-cultivated land normally mapped within the agricultural boundaries. These non-cultivated inclusions amount to a substantial total area and while many of them already carry some forest cover, there may well be possibilities for improving their productivity. At this stage, uncertainty exists about the ownership of these small patches of land. No doubt many are under private ownership, but some may be considered as communal resources.

**Table 2. Family Size and Large Animal Numbers Estimated From Surveys in Various Parts of Sindhupalchok District in the Middle Hills of Nepal**

| | Units | New Era | Shrestha | Mahat Griffin,& Shepherd |
|---|---|---|---|---|
| Family size | Persons | 6.1 | 6.2 | 8.1 |
| Large animals household | no.per | 4.62 | 3.69 | 9.4 |

Source: (New Era 1980; Shrestha 1982; Mahat, Griffin, and Shepherd 1987b).

**Table 3. Composition of Various Land Use Categories in Two Districts (Sindhupalchok and Kabhre Palanchok) Northeast of Kathmandu.** (The High Himal physiographic region is excluded as it is generally inaccessible to most farmers.)

| | Sindhupalchok | | Kabhre Palanchok | |
|---|---|---|---|---|
| | Area (ha) | % | Area (ha) | % |
| Cultivated land | 41,588 | 20.0 | 36,444 | 25.9 |
| Non-cultivated inclusions | 22,313 | 10.8 | 25,155 | 17.9 |
| Forest land* | 87,577 | 42.2 | 39,565 | 28.2 |
| Shrubland | 33,771 | 16.3 | 34,236 | 24.4 |
| Grassland | 11,756 | 5.7 | 3,746 | 2.7 |
| Other (water, sand, rock) | 10,485 | 5.0 | 1,339 | 0.9 |
| **Total** | 207,490 | 100.0 | 140,485 | 100.0 |

* Land which is at least 10 per cent covered by trees

Source: Land Resources Mapping Project (R. Nield 1985)

Forest areas above the zone of permanent human settlement (i.e. above the extent of heavy influence from Middle Hills farmers -- about 2300 m) are in much better condition than those of lower areas because of decreased utilization pressures.

However, different patterns of utilization occur in these higher forests. Many of the communities living in the higher elevation areas are heavily dependent on grazing animals for a major part of their livelihood (Alirol 1979). Herds of animals (mostly sheep and various types of yak-cow crosses) are taken through the high forests at the end of each winter to graze in the alpine pastures up to an elevation of about 5000 m. The animals and their attendant families return to lower elevations at the onset of the following winter. This annual migration of stock has probably been in progress for many centuries.

## DEVELOPMENTS IN FORESTRY

### Historical Context

In recent years much has been written about the deforestation and subsequent land degradation in the Middle Hills of Nepal (Eckholm 1978; Pereira 1981; Nautiyal and Babor 1985). It is often inferred that this is a relatively recent phenomenon which has occurred due to the pressures placed on the forest by the increasing population. Mahat et al (1986a,b, 1987a,b) have documented evidence for a region, including Sindhupalchok and Kabhre Palanchok Districts, which indicates that the forest area in this part of the Middle Hills was reduced at least 100 years ago to the approximate boundaries which are evident today. Apart from minor encroachments, the amount of agricultural and forest land has remained relatively static since about the end of the 18th century.

In the west of Nepal a similar trend was reported by Strebel (1985) who found little alteration in the amount of farming land converted from forest between 1972 and 1984. Caplan (1970), Poffenberger (1980), and HMG (1983) have emphasised the relatively static condition of the arable land area since at least the early 1900s. Bajracharya (1983b) working in the far eastern part of Nepal found only 1.5 per cent of forest land had been taken over by agriculture between 1964 and 1977.

It is evident that in the past large-scale deforestation has occurred. However, most of the potential arable land in the Middle Hills was converted from forest long ago. The non-agricultural land is essentially land that is not capable of sustaining permanent agriculture. This is the land where remnant forests occur (often as depauperate shrubland or grassland) and which is available for forestry activities. In addition, changes in the political structure and legislative framework within Nepal during recent decades have removed the pressures on farmers to clear forests.

The need to increase the amount and quality of forest land was recognised in the 1950s, and in 1966 in the Trisuli River catchment and elsewhere, some tentative measures were taken to implement a reforestation programme. It was not until the 1970s, however, that there was serious effort by the government to address the deforestation problem (Bajracharya 1983a). During the stage when initial plantings of new forests were being attempted, the National Forestry Plan 1976 was published (NAFP 1979). This plan was designed to provide the guidelines for conservation management and the development of forests.

### The Beginnings of Local Community Involvement

In 1973, local leaders in Thokarpa panchayat in Sindhupalchok District called a meeting to discuss the concern they felt for the deteriorating condition of the forests in their panchayat. A Forest Management Committee was subsequently formed, and the Divisional Forest Officer (DFO) at Chautara (Mr. T.B.S. Mahat) provided assistance to this committee. Many formal and informal meetings and consultations took place during this period which marked the beginning of the consultative process between Forest Department staff and local communities (Mahat et al. 1987b).

Commencing in 1973, areas of natural forest were brought under protection (notably at Thokarpa, Banskarka, and Pipaldanda). In almost all cases, the majority of the labour was provided voluntarily, in spite of the fact that the land involved was HMG owned and controlled (in law if not in practice). Small areas of plantation were also established in the above panchayats and in other areas.

During this period, the general ideas and concepts underlying what was happening began to crystallise. It was postulated that without community awareness and participation in conservation, deforestation and consequential environmental degradation would continue. It was recognised that the local community needed to become involved in establishing forests and more importantly, protecting the forests from grazing and illegal cutting. The non-arable areas could be reforested, provided the people accepted the change in land use, and the operation could be carried out within the social and political framework existing in the community. There was a need to motivate communities, assist with technical expertise and above all, help the people to help themselves (Campbell and Mahat 1978). Plantation development over a large area depends on successful demonstration of community involvement. A focal point is required for con-

centrating activities such as workshops, films, and discussions with politicians and village leaders and to focus public attention.

The districts of Sindhupalchok and Kabhre Palanchok were seen to be such a focal point and from there the concept of community forestry could expand throughout the Middle Hills. People's attention had to be focussed and they had to be shown by example that not only did the products of the forest belong to them but also that they themselves had to participate in the management of these forests. It was also found that by working with and through local, motivated politicians many pitfalls could be avoided.

The reforestation efforts of the Chautara DFO and several local communities during the mid - 1970s proved to be extremely successful and the experiences gained assisted in the formulation of a legislative framework which could take account of this relatively new concept. The 1978 Panchayat Forest and 1978 Panchayat Protected Forest Legislation and the Leasehold Forest Legislation paved a legal path by which communities could have land transferred from the government to village panchayats for their own forestry activities. This legislation proved to be the cornerstone of community forestry in Nepal. It allowed the thoughts and hypotheses of the Chautara DFO and others regarding communities growing, protecting, and managing their own forests, to be put into practice under the umbrella of the Forest Department's district organization.

**The Nepal-Australia Forestry Project**

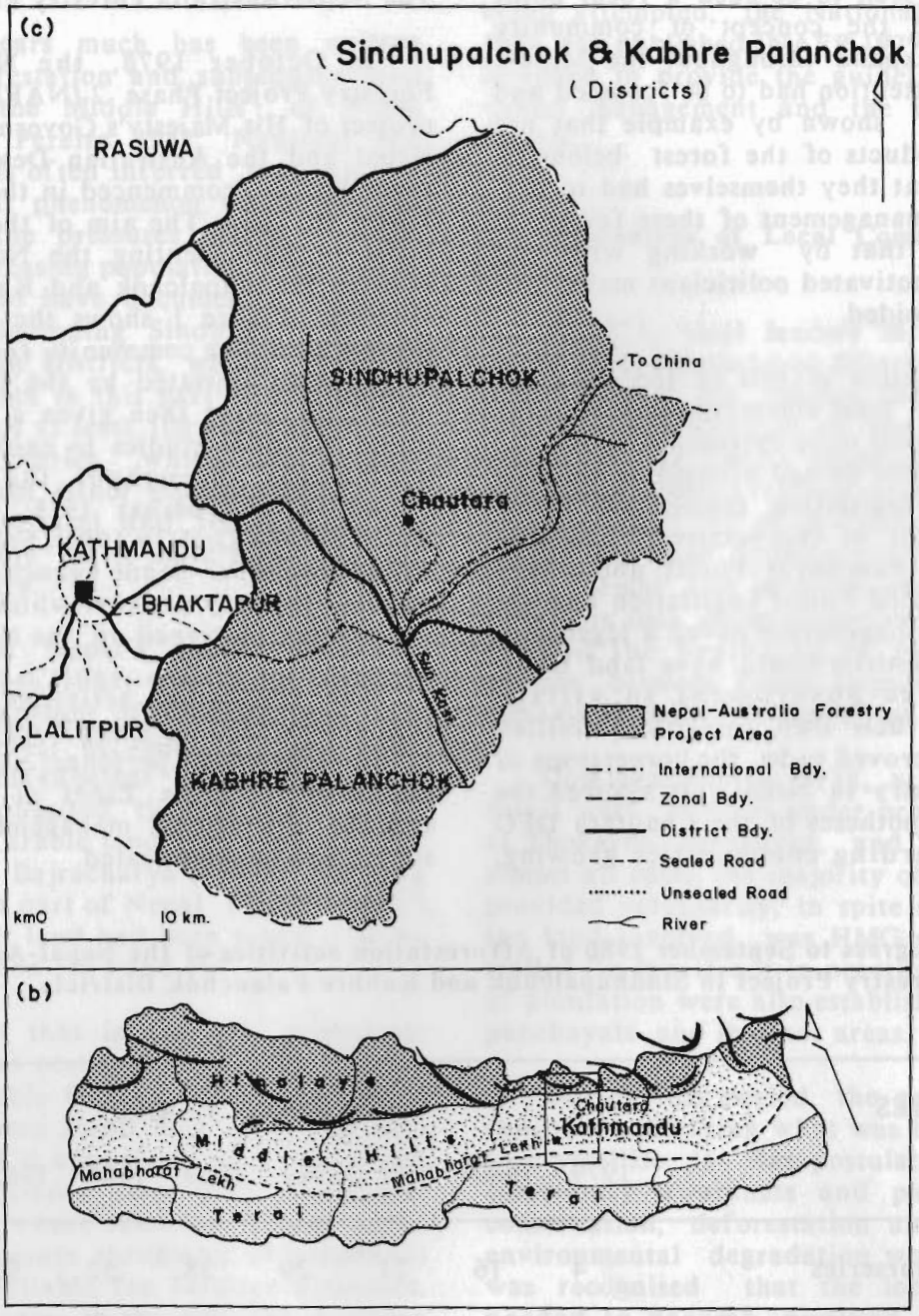
In October 1978, the Nepal-Australia Forestry Project Phase 2 (NAFP/2), a bilateral project of His Majesty's Government (HMG) of Nepal and the Australian Development Assistance Bureau, commenced in the then Chautara Forest Division. The aim of the project was to assist in implementing the National Forestry Plan in Sindhupalchok and Kabhre Palanchok Districts. Figure 1 shows the location of the project area. The community forestry activities which were initiated by the DFO during the mid-1970s were then given a boost which allowed his pilot studies to expand and become operational throughout the two districts (Campbell and Mahat 1978; Shepherd 1981; Shepherd and Griffin 1983). Following the 1978 legislation, other donor agencies initiated community forestry projects which were, to varying degrees, patterned on the NAFP.

The forestation activities in the project area commenced on a small scale using existing Forest Department personnel and limited funds and other resources. Lines of communication and the operational management system were simple and uncomplicated.

**Table 4. Progress to September 1986 of Afforestation activities of the Nepal-Australia Forestry Project in Sindhupalchok and Kabhre Palanchok Districts**

| ACTIVITIES | PLANTING YEARS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
| Number of nurseries | 4 | 16 | 21 | 29 | 38 | 52 | 92 | 114 |
| Annual seedling production(000) | 765 | 825 | 1210 | 1314 | 1900 | 2210 | 2346 | 4386 |
| Annual plantation establishment (ha) | 100 | 283 | 484 | 676 | 995 | 1199 | 1347 | 2082 |
| Number of panchayats in which NAFP is operating | 5 | 18 | 24 | 40 | 57 | 71 | 100 | 111 |
| Cumulative forest area (ha) established (PF, PPF and HMG) | 100 | 383 | 867 | 1543 | 2538 | 3737 | 5084 | 7166 |

**Figure 1. Map of Sindhupalchok and Nepal Australia Forestry Project.**



By the end of Phase 2 in 1985 the project had reached the stage where many of the technical and social problems of plantation establishment had been solved so that a large scale programme was feasible (Table 4). Current planting rates in Phase 3 (commencing in 1986) are in excess of 2000 ha per annum, and the area planted each year covers about 150 small planting blocks. The large programme necessitated the development of an administrative structure to coordinate the activities of the large, recently trained workforce.

During the past several years there has been a constant backlog of applications for assistance from village panchayats. In late 1986, 57 applications were outstanding. During most of the preceding six years the constraints on expansion were not the lack of interest or enthusiasm of local communities, but rather a lack of resources (largely, trained manpower) and administrative ability within the project and the Forest Department.

Commencing in three panchayats with three nurseries, the project has expanded to a stage where assistance is given to 114 nurseries (Plate 5) and 111 panchayats (Table 4). Though initial progress was slow, everyone involved in the programme developed experience, knowledge and confidence. There is a limit to the speed at which this can take place.

**Planting for Success**

The determination of success of community forestry must be carried out from a local viewpoint (Campbell and Mahat 1978). Given a legal framework in which to operate, the technical aspects of nursery and plantation establishment pose relatively few problems. Consequently, the success of the programme ultimately depends on community acceptance and involvement. It cannot be overstressed that, in order to establish and manage viable plantations and forests protected by the people, the mechanisms employed to undertake this must be within the established social framework. A recipe for success in development programmes summarised by Bunch (1981) is relevant to conditions in Nepal.

- the solution must be within their means;
- the people must have faith in the programme personnel;
- the challenge must be simple enough at first so that people can participate, yet become increasingly complex so they can grow in their ability to deal with problems and feel an increasing sense of achievement.

The NAFP experience has shown that large areas of land can be reforested through a community forestry programme. This is possible because the villagers actively participate in managing their land and establishing forests on community-owned land (Plates 6, 7 and 9) as well as on land belonging to HMG. The forests, irrespective of land tenure, are established without the use of fences and are protected by the local people. It has been demonstrated that technical problems can be more easily solved than those social and political problems which can exert a great influence on forestation activities.

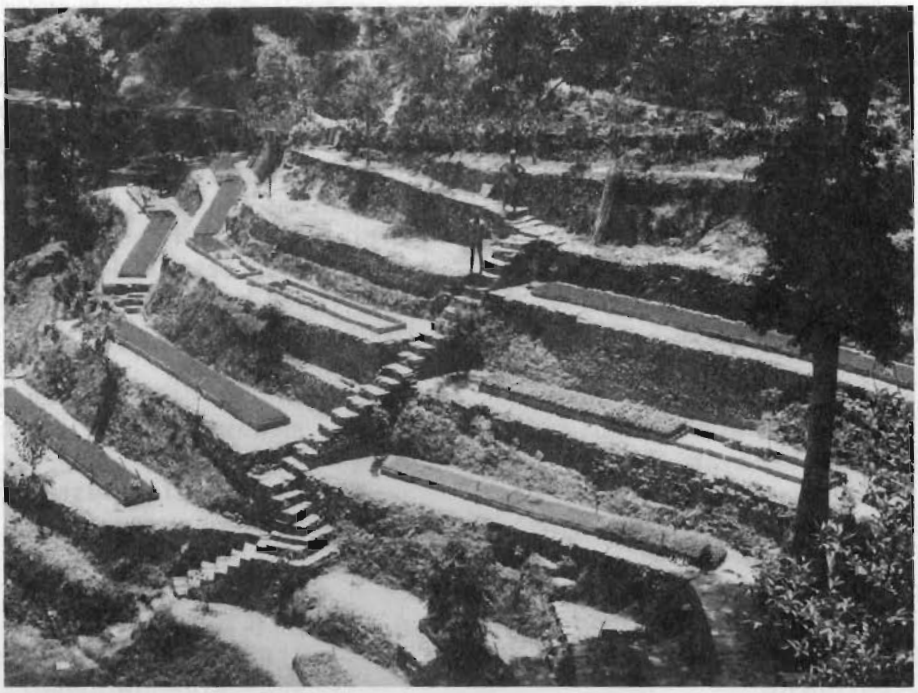


Plate 5 A community nursery provides a range of tree seedlings for planting on communal and private land.

Plate 6
Broad leaf species which have a multiplicity of uses are favoured by the rural communities for planting on their agricultural land.

## PROBLEMS TO BE OVERCOME BY NAFP

### Development of appropriate nursery techniques

One of the first tasks of the NAFP was to develop nursery techniques appropriate for use in the Middle Hills. Because of transportation problems, the nurseries needed to be small and located close to available planting land and to a perennial source of water. One overriding constraint was to apply "appropriate levels of technology" to the establishment and operation of the nurseries. External inputs were kept to a minimum so that the possibility of long-term sustainability in the absence of outside involvement was enhanced. Thus, chemicals (fertilisers, pesticides, and hormones) are not used even though their application would improve seedling quality. Local materials are used for nursery bed and house construction. The main external inputs are polythene seedling tubes, seed, polythene pipe for water supply, and a few bags of cement if a permanent water tank is deemed necessary.

It is expected that the local community will voluntarily assist with the construction of the nursery itself and often with the nursery house. One tangible and immediate benefit to local communities is an improved permanent water supply in the vicinity of the nursery, which is often used for domestic purposes.

### Seed

At present the shortage of seed in Nepal is one of the main limiting factors to expanding forestation activities. There are a large number of seed stands in Nepal from which collections could be made. However, few individual projects have systems operating to enable them to collect their own local seed requirements. The Integrated Hill Development Project (SATA) is one which has organized an efficient seed collection and handling unit. NAFP also has two local seed units but is not yet self-sufficient. Like most other projects in Nepal, NAFP has to rely on external suppliers of seed to meet its programme commitments. These sources are unreliable and the seed expensive. Further efforts need to be made to encourage local self-sufficiency in seed supplies, particularly for the highly favoured fodder and fuelwood species for use on private lands.

### Choice of species for plantations

The establishment of plantations or new forests presents problems with regard to choice of species due to ecological reasons associated with topography, altitude, soils, climate, and the preference of the potential users of the forest. The land available for planting in the hills is often vacated farming or grazing land varying in elevation from 600 to 2000 m.

Chir pine (*Pinus roxburghii*) is well adapted to harsh degraded sites in the Middle Hills, but it has low societal preference because the leaves have no fodder value and the wood has less fuel value than that of most broadleaf species. However, the more highly favoured broadleaf species are not established readily in open plantations on the sites available. Where chir pine is established as the initial plantation crop, the site protection afforded it allows the regeneration of native broadleaf species to occur, either from seedlings or from residual root stocks.

Consequently, initial plantation establishment with chir pine does not infer that the area will be managed entirely for chir pine. It is feasible to manage such areas as mixed pine-broadleaf stands or even to convert them eventually to broadleaf- dominated forests.

One of the most vigorous naturally occurring broadleaf species is chilaune (*Schima wallichii*) which regenerates readily from seed, root suckers, and coppice at elevations around 1400 m. It produces good quality fuelwood and construction timber and the leaves are useful for bedding and fodder.

One of the great difficulties has been to successfully establish good quality fodder species in plantations, despite continuing efforts over many years. At this stage it seems that the best option for increasing the number of fodder trees in the hills is to encourage increased planting of such species on private land where better quality soils are generally available and where additional care and attention can be applied. For this reason, most nurseries raise a wide range of species to provide for the needs of local farmers. These include trees for fuelwood, fodder, fruit, construction timber, religious, and ornamental purposes. While the majority of seedlings are planted in plantations, a substantial number are given

(free of cost) to local villagers for establishment on private land.

One promising plantation species, particularly at elevations above 1300 m, is patula pine (*Pinus patula*). It grows faster than chir pine and while the needles are of no value for fodder, the wood is considered by many local villagers to be equal in quality to that of many broadleaf species, although it burns somewhat faster.

**Protection of plantations**

In many parts of Nepal it is considered impossible to establish plantations successfully without fencing to afford protection from animal grazing and illicit cutting. Fencing is a very expensive item generally dependent on external funding. Consequently, for anything other than small-scale operations the cost is prohibitive. In addition, experience has shown that even good quality fencing does nothing more than delineate an area; it has little real effect in preventing people or animals from entering a plantation area.

Effective protection can occur only if the local community is fully committed to the forestation programme and agrees to prevent animals from grazing on newly planted areas. This is normally achieved by discussion between the staff of the district forest office and representatives of the local community, ideally members of a forest committee, who will establish rules of conduct for the forests. It is unrealistic to prevent people from entering the new forests as they still need to collect fodder (grasses and other herbs) and bedding material for livestock.

As more open grazing lands become planted, there has been a change from open range grazing to stall feeding of animals. This was initially seen by villagers as a negative aspect of the forestation programme because of the additional time required to cut and carry fodder. However, it is now generally viewed as being a better way of managing livestock for a number of reasons: the grazing lands are more productive once close grazing and heavy trampling are removed; the stock are more productive because they are confined and do not have to spend their time climbing on steep slopes; manure (an essential fertiliser input for agricultural land) is more effectively collected from stall fed animals; and some family members are freed from the need to continually tend open range-grazed animals and can carry out other tasks or, in the case of children, attend school.

While fencing is not practised in the NAFP areas, local villagers are employed as forest watchers to protect the forests. On average, one watcher is employed per 15 ha of plantation, but efforts are being made to increase the area per watcher.

**Trained manpower**

A cadre of motivated, well-trained managers and field supervisors, who are sympathetic toward community forestry, is required to assist the expansion of forestry activities in the Middle Hills. The lack of suitable people has been a constraint to the rapid expansion of activities. Most forest officers received their training some time ago in traditional disciplines designed to fit them for work in commercial forestry operations. This frequently makes it difficult for them to develop innovative solutions to the non-traditional problems facing them in community forestry programmes.

A further complication is the dual role played by the forest officers in the hill districts. On the one hand, a rigid approach is required for upholding and enforcing forest law and carrying out judicial responsibilities associated with bringing wrongdoers to justice. On the other hand, there is the need to be empathetic to the needs of local people and to encourage a participatory approach to forest development. Some people may find these dual roles incompatible.

Most of the older forest rangers received their formal training long before the community forestry concept was developed. The general level of their technical training was rather low and their major responsibilities revolved around upholding forest law, apprehending and initiating legal proceedings against wrongdoers, and processing sales of timber from government forest. Neither their training nor subsequent work experience have fitted them for a role working in consultation and cooperation with local villagers. In many cases the presence of such people continues to be detrimental to the development of good working relations between the Forest Department and the villagers.

During recent years the training received by forest rangers and forest officers at the Institute of Forestry at Hetauda has steadily improved. Recent graduates have greatly improved technical skills and knowledge and experience of some of the issues involved in community forestry. It will take time for this

new group to move through to influential positions in management.

A further manpower deficiency was in the area of trained technical staff such as nursery foremen, *naikes* and plantation workers. One of the big tasks facing NAFP was the need to train local villagers in the technical skills necessary to build and operate small forest nurseries and to establish and protect plantations. Substantial effort went into developing and operating appropriate training courses. Between 1978 and 1986 a total of 222 people took part in four to five-week long nursery *naike* training courses and many hundreds of people received short-term training in plantation establishment and protection techniques.

The forest guards of HMG staff remain something of an anomaly. These people are permanent HMG employees who received a three-month training course in various aspects of forestry, largely to do with enforcing forest law. Observations suggest that this large group of people (44 in Sindhupalchok and 33 in Kabhre Palanchok) is something of an anachronism, a legacy from when forestry meant something different from what it is coming to mean today. It is clear that in many instances forest guards have little empathy with the needs of local villagers and that they enjoy little trust and respect. There could be considerable value in critically reviewing the work role and performance of this group and integrating them into the community forestry programme. A degree of re-training and reorientation would be required.

**Administrative procedures**

Difficulties are often experienced transferring land from HMG ownership to Panchayat Forest and Panchayat Protected Forest. This is often due to property boundary disputes occurring during the surveying and subsequent forest boundary demarcation. These disputes are usually between private individuals who claim that a certain part of the land belongs to them and the forest officers who claim that the forest land belongs to the state and can legally be transferred to the panchayat. This problem is usually exacerbated where no cadastral survey has been carried out.

Prior to the advent of community forestry programmes in the hills, the Forest Department operated largely as an organisation to administer the sale of forest products (mainly construction timber) and to exercise protection over the natural forests (including apprehending and bringing to justice anyone caught breaking forest law). There was no effective organization to carry out forest development activities. The need to train staff for these activities has already been mentioned, but equally important was the need to develop an organizational structure within the districts which could effectively plan for and control a large-scale plantation programme with associated activities. This has been carried out by encouraging the development of a process whereby key district staff meet on a monthly basis to report on and to plan for activities. This allows the DFC to check on progress and to delegate authority and responsibility for various operations.

Acceptance of increased authority by field staff, along with a commitment to a changing work ethic (from being forest policemen to people who work with local communities in a participatory fashion), has been one of the key elements which has allowed the programme to expand. This area of organizational reform is one which still needs continual attention in order to further improve the efficiency of the operations.

**Communications**

One of the great difficulties with implementing any development project in the hill regions of Nepal is communications. Few roads exist, so messages have to be carried to their destination by hand. This means that all communications are slow and frequently imprecise. This is a major constraint in a large operational forestry project covering half a million hectares of steep and rugged country. The installation of a small radio network has done much to alleviate this problem, but it will never be entirely eliminated.

**Land availability**

One serious problem in establishing large areas of plantation quickly concerns the availability and accessibility of plantable land. Although there is frequently common grazing land which is suitable for planting, it is not necessarily available for planting. On many occasions the local people have indicated during discussion and consultation that certain land is in fact not available for planting. Land may be rejected due to a number of reasons, including the need to have space for open range grazing, living and recreational activities, and a common meeting ground. If these areas are summed up on a panchayat

basis, they could be large enough to have an impact on the available land to plant. The experience from Sindhupalchok suggests that most of the large tracts of land close to habitation have been or are rapidly being planted, so the area remaining comprises a large number of small non-contiguous blocks. This makes the management involved in getting nurseries operational and plantations established and protected more difficult, and may be a constraint to continued expansion.

**Remnant natural forests**

The remaining natural forests are usually heavily utilized and have often been reduced to scattered trees and depauperate shrubland. They are sometimes on land cleared for agriculture and subsequently abandoned and left to regenerate. These forests, which are often heavily lopped or coppiced, have low-density canopy cover and are low in height. The approach taken with such areas has been to encourage conversion of tenure to PPF and undertake enrichment planting and protection. It has been found that even low-density enrichment planting can assist in improving protection. The villagers recognise that effort has been expended to improve the forest and they exercise more restraint in their use of the forest, particularly in controlling grazing animals. However, to date, development work has concentrated on the establishment of new forests rather than on the management of remnant natural forests. The large area and the generally poor condition of most of these stands requires that more effort be expended on them in the future.

Plate 7 Community participation is essential in all forestry operations including the production of tree seedlings.

Plate 8
Young people from the community also participate in seedling distribution.

The recently promulgated Decentralization Act (1984) empowers the District Panchayat Assembly to carry out all district level planning. This means that forestry development activities carried out under the supervision of the District Forest Controller require the approval of the District Assembly. Consequently, attention to planning activities is an important district function.

During the past decade considerable effort has been expended in developing systems which will enable forestry development work to proceed with active cooperation between government and villagers. By and large, plantations have been (and are being) established wherever land is available on the implicit assumption that more forests are required. The stage has now been reached where thought needs to be given to major planning issues so that future actions are appropriate to the needs of the people. These planning issues can be considered on two levels: strategic and tactical.

**Strategic Planning Issues**

Strategic planning deals with the long-term goals for a large area and ideally, serious thought and effort should go into strategic planning prior to the initiation of any major forestry development programme. Strategic issues that need to be raised include:

- Why are forests required ? (fuelwood, fodder, animal bedding, construction timber, local use, industrial use)
- What is the demand for the various forest components ?
- How much forest is required ?
- What are the ownership categories of the forests ?
- What is the productivity of the various forest types?
- What land is available ? (past history, area, tenure, abiotic and biotic factors)
- What are the characteristics and attitudes of the local people?
- How is forest management to be carried out?

Ideally, planners need to answer all these questions, and possibly many more, before decisions are taken and plans made to implement forest development activities.

Unfortunately, in many instances answers are not available and frequently decisions need to be made on limited and inadequate information (Thompson and Warburton 1985a, b). However, it is often preferable to initiate development and proceed at a relatively slow pace while improving the information base, rather than wait until adequate information is available. In this way, experience can be gained and the opportunity becomes available to feed new information into the decision-making process so that attitudes and practices can respond to the new information. However, this requires a flexible management system. For example, at the time the Nepal-Australia Forestry Project commenced in 1978, official concern was expressed at the progressive deforestation of the Middle Hills area and at its impact on the lifestyle of the rural dwellers. Almost no data was available and the project went ahead on the premise that people needed fuelwood and fodder.

The primary objective of the project was "to assist with the implementation of the National Forestry Plan in the Chautara Forest Division," a purposefully broad aim which reflected the lack of information and the inability to make sound strategic plans. Any attempt to make detailed strategic plans at that stage would probably have arrived at inadequate solutions. Few of the questions posed above could be answered. It soon became evident that there was a need to know more about the following:

- Productivity of existing natural forest and proposed plantations;
- Consumption rates of various forest components;
- The role of forests in the subsistence farming system;
- The amount and category of land available; there was virtually a complete lack of maps and aerial photos;

no cadastral survey had been carried out;

- Precise location of boundaries between various categories of land (particularly farming, grazing, and forest land);
- Attitudes of local villagers towards forestry activities;
- Appropriate techniques for raising seedlings and establishing plantations;
- Performance of various tree species on the land available.

A good deal of information has been derived since the project commenced, gradually giving the project a more defined focus and direction. Surveys have been carried out in Sindhupalchok to determine attitudes towards forestry development (New Era 1980). Studies have been commissioned to report on land use in the area (NAFP 1982). Post-graduate students have been encouraged to work in the project area on a range of issues of concern, including historical aspects (Mahat 1985) and the interaction of the forest and farming systems (Shrestha 1982 and Byrne 1985). Biomass and productivity studies have been carried out by both project staff and post-graduate students. Information is now being collated to assist with more meaningful application of strategic planning in the future.

**Tactical Planning Issues**

Tactical planning refers to the "here and now" of actually getting things done. Once the major strategic decisions have been made, district staff have the task of implementing those decisions. Soundly based tactical plans will ensure that implementation is carried out smoothly and efficiently. While strategic planning has many common elements which are independent of location and forest type, tactical planning issues will be more location-specific. Consequently, it is difficult to make many generalizations.

It is extremely important that staff at all levels clearly understand what is expected of them. The best way for this to occur is to have some sort of local tactical planning document. This should be flexible enough to allow for change if the situation requires it, yet rigid enough so that everyone knows what is expected. Such plans should include specific action statements and also reminders to encourage forward planning for future action. One such plan developed by Applegate, Joshi, and Tripathi (1985) has been successfully used in the NAFP districts.

The progress made by the project in plantation establishment is shown in Table 4. This indicates slow growth during the early years; experience was gained with new techniques and systems as people were trained, and tactical planning was refined to the stage where it could be clearly understood and applied at the appropriate levels. The current annual plantation establishment rate is about 2000 ha and in both districts many of the 114 nurseries are three to five days walking distance from the district headquarters. Only with a considerable degree of administrative skill can a task of this magnitude and complexity be co-ordinated.

**Panchayat Involvement**

Many strategic and tactical decisions are made by forest officers and rangers at the district level. However, these decisions often affect the local villagers who frequently depend on surrounding open land and forest land for part of their subsistence farming needs (such as fodder and fuelwood). Consequently, decisions affecting local people should not be taken in isolation. Both strategic and tactical planning need to consider the viewpoints of local people.

## FOREST MANAGEMENT

### Background

The concept of community involvement in forestry to supply products on a managed and sustainable basis is not new. Three hundred years ago in Germany and other parts of Europe, communities assigned user groups to certain parts of the forests. These user groups were responsible for managing and regulating the amount of produce which would come from certain components of the forest (Henschel 1976; Linnard 1980). Likewise, communal ownership and management of forests is common in many parts of Asia. However, this form of ownership was often sublimated by changing national and local power structures, particularly where colonial influence was involved. The concept of community forestry was reintroduced to the forestry profession in the late 1950s when many recognized that this was one of the few options available to successfully manage forest resources in areas where traditional ownership and use of forests had prevailed.

Forest management involves the integration of plans for both the utilization and protection of forests. It must not only ensure the viability of forests and the health of the trees, but must also ensure utilization of the tangible and non-tangible products of the forest according to sound ecological principles (Young 1978). The management of forests for multiple use requires that a thorough understanding of the functioning of the ecosystem is acquired so the management formulated for the forest ensures that it remains a productive entity. This necessitates a knowledge of the amount of organic material in the forest, the forest's productivity, and the impact of management practices on biological and edaphic processes, to enable the determination of the possible level of utilization of the forest.

Wyatt-Smith (1982) and Mahat et al (1987a) made estimates of the amount of forest area and the products required to sustain the mixed farming system. It seems clear that virtually all of the forest resource, both actual and potential, irrespective of tenure, will be needed to maintain the existing subsistence lifestyle.

In the initial stages of forest establishment and protection, the local people have seen that produce in the form of grasses, dead stems, and branches have been available to them from both panchayat and government owned land. Consequently they have applied the same degree of protection to both land tenures. This has been well demonstrated in Sindhupalchok where, from the very start of afforestation activities, the people were assured access to forest products from HMG land (Mahat pers. comm.).

Although it can be said with some confidence that all the forest products will be used by local people, there need to be different options and strategies applied to each forest type and land tenure; management input levels will vary accordingly. The level of management, as reflected in the degree of training of the decision makers, may well be greater on HMG land than on communal land. Nevertheless, some form of HMG participation will be necessary in the management of community forests. This will be particularly necessary when forest boundaries cut across political panchayat boundaries. The management plan, which is the legal agreement between the government and the panchayat, needs to be easily understood by the layman. This means that utilization schedules need to be translated into a language which the hill farmer can understand. An example of such a schedule is given in Table 9.

### Forest Categories

Legislation has been passed to establish and manage forests under different tenures (Manandhar 1982): HMG Natural Forests, HMG Plantations, Panchayat Forests, Panchayat Protected Forests, Private Forests and Lease Forests. To contemplate a separate management plan for each of these forest categories in all panchayats in the Middle Hills is an impossible exercise, as the number of forests belonging to each tenure category in each of the 53 districts in the Middle Hills is enormous. Hence, an alternative system of classification for the purpose of forest management is required.

The ecological characteristics of forest structure and floristics are the factors which determine the components and fractions available as produce from the forest and hence, they should form the basis of the management of these forests. Reference has been made in this

paper to the floristic diversity of the forests in the hills and the dramatic man-induced changes to forest structure. Nevertheless, it is still possible to group forests which have similar floristic composition and structure.

The purpose of grouping is to simplify the management process. Instead of developing separate plans for each patch of forest of different tenure, it would be more practical to develop plans for ecologically similar forest categories and to compile a small number of management options for each of them. An example using the forests in Sindhupalchok below about 2000 m elevation is given as an indication of grouping of forest categories:

- **Mixed broadleaf forest** comprises all degraded forest lands which are often remnants of original forests. They are usually heavily utilized, often coppiced, have low-density canopy cover and are low in height. The tenure of these forests is usually HMG Natural Forests, PF, Private, or Lease Forests.

- *Pinus sp.* **broadleaf forest** has been planted, usually with pines, and the subsequent protection has allowed the growth of a broadleaf fraction. The resulting stand often comprises roughly equal numbers of broadleaf trees and pine. The tenure of this land is usually HMG Forests, PF, or Private Forests.

- *Pinus sp.* **dominated forest** was established using *Pinus sp.* and this species has continued to dominate the site both spatially and temporally. These forests are often located on sites which contained only grass or were degraded or eroded, and often in zones which originally supported natural forests of the native pine. The pine-dominated forests are usually HMG Forests, PF, Private, or Lease Forests. Also included in this category are natural stands of *Pinus* where there is little or no broadleaf regeneration.

- **Sal forest** is dominated by naturally occurring sal (*Shorea robusta*). These forests are found in the lower altitudes of the Middle Hills along the lower slopes of the major drainage systems. They are heavily utilized and generally have very few large trees remaining. Coppicing or pollarding is commonly practised and the forest floor is often swept clean during litter collection. These forests are generally HMG Natural Forests or PPF.

In other areas of the Middle Hills, different groupings of forests or tree species may be necessary.

**Mensurational Requirements**

Forest inventory is the information-gathering stage of forest management and in conventional forestry is usually concerned with obtaining data on the volume of the merchantable bole of commercial species (Young 1978). This has ensured that the quantifying of stem volume involves simple measurements which can be carried out with a relatively high degree of accuracy. Inventory data involving diameters and tree heights have been traditionally used for estimating the volume of sawn timber and veneer, both of which come from the merchantable bole. It was probably for this reason that initially foresters and forest ecologists looked only at the volume of the stems as the unit of measurement. Until recently this has prevented the development of methods designed to assess total biomass production.

Traditional forest volume tables do not incorporate all the forest components and fractions such as branches, foliage, roots, understorey species and forest floor litter. Nor do they take account of the habit of the "unconventional" forest species such as fodder trees or bamboo.

The management of community forests requires the development of mensurational techniques which are applicable to such multi-faceted forest components and unconventional fractions. Biomass estimations in the form of tables can be used to measure productivity or the changes in the forest over time and are well suited to provide the information required for management. Although biomass estimations are generally expressed as an oven dry weight basis per unit area of land, a correction factor can be applied to allow for the moisture content of the components when fresh produce is harvested.

Estimates of forest productivity, in combination with the area of forest, can be used to schedule forest utilization. Many young forests contain a range of fractions and species whose components have different growth rates. Hence, their production must be estimated to enable utilization to be carefully scheduled to provide a sustainable yield while

adhering to sound silvicultural principles to maintain forest productivity.

**Management Aims and Options**

The primary decision to be made before forest management is taken up is the determination of its aims. This is a vital step and must be carried out in consultation with all interested parties. In all but a few situations in the Middle Hills, the aims of management will be to provide the tangible benefits of fodder, fuelwood, construction timber, and minor forest products, while ensuring the intangible benefits which the forests afford to watersheds.

Because of the variable ecological conditions of the forests, it may be possible to manipulate the stand structure to better achieve the primary aims of management. Thus, a pine plantation with a developing understorey of *chilaune* could be subjected to three possible management options:

- o Maintain the stand as a predominantly pine forest;
- o Convert the stand to a mixed pine/broadleaf forest;
- o Convert the stand to a predominantly broadleaf forest.

At this early stage in the development of workable management plans for the hills it is suggested that the number of options be limited to reduce implementation problems, making the task of the forest manager much easier, irrespective of whether the manager is a panchayat forest committee or government forest officer. The options would not necessarily be static. As more information relating to forest productivity, floristic and structural composition, and user group preference becomes available, modifications could be made to refine, improve, and make management more acceptable to the local user communities. Once a number of options are developed for forest categories, it would then be up to the forest manager to choose which option would be suitable for the particular user group. However, it is important that the options reflect social attitudes and are compatible with the social framework in which they must operate. Examples are given in Tables 5a and b.

**Management Objectives and Strategies**

The management objectives are divided into two categories: the silvicultural objectives and the utilization objectives. The silvicultural objectives must be fulfilled to enable the productivity of the stand to be maintained. These objectives require information on regeneration, on which forest fractions and components of the biomass should be maximized, and on timing treatments to ensure that there is no deleterious effect (e.g. coppicing stems should be done in the late winter to maximize the number of new coppice shoots on the stump).

The utilization objectives will reflect the people's aspirations, taking full account of the implications that tenure of the forest will have on utilization. This is important when looking at the type of product and its end use. It is impractical, for example, to state that good quality fodder must come from a forest if it is to remain a pure pine stand. The stand will need to be manipulated by silvicultural treatments over a number of years to provide the required product. Similarly, it is unsound to provide the villagers with a 'shopping list' of the species they require. The possible products are dependent on the floristic and structural composition of the stand, altitude, climate, and soil conditions.

Once the objectives are determined for a small number of options, the details of the strategies can be formulated. Details of the techniques required to meet the objectives must be developed and recorded in the plan. The plan will also contain the level of utilization to be undertaken to facilitate and control the harvesting and provide some guidelines to maintain the productivity of the forests. At this early stage in the development of management schemes for community forests, it is desirable to plan for a utilization pattern that yields a relatively constant amount of produce annually. Examples are given in Tables 5a and 5b of management schemes for two forest categories: mixed broadleaf and *Pinus sp.* dominated forest.

**A Case Study from Sindhupalchok District**

**Demonstration of management options.** The natural forests and plantations which were planted and protected in the early 1970s in Sindhupalchok have reached a stage where some form of active management is possible. To date, these forests have been protected from grazing and lopping while providing grass and dead material to the local villagers who collect the produce by hand. A more active form of management is required where

## Table 5a. Forest Management Aims and Objectives

Forest Type: Mixed Broadleaf Forest

Management Aims: To maximize foliage for livestock production, fuel wood and construction timber for the local village people

| Option 1 (Coppice with standards) | | | Option 2 (To maintain mixed broadleaf stand) | | |
|---|---|---|---|---|---|
| Silvicultural Objectives | Utilization objectives | Management strategies | Silvicultural objectives | Utilization objectives | Management strategies |
| Maintain biomass on the stand irrespective of species. | Remove only grass and litter for livestock and dead material for fuelwood. | Ensure maximum protection of the trees until they reach 4 m in height. | Maintain biomass on the stand irrespective of species. | Remove only grass and litter for livestock and dead material for fuelwood. | Ensure maximum protection of the trees until they reach 4 m in height. |
| Maximize foliage biomass on coppice shoots while maintaining biomass on standards. | Provide a yield of fodder, small size construction material and some fuelwood. | Coppice most stems retaining 300 per hectare as standards in year 1. | Maintain biomass on all species. | Provide a yield of fodder, bedding material and some fuelwood. | Prune to 20% of stem height when trees have reached 4m (all species). |
| | | | Maintain biomass on all species. | Provide a yield of fodder, bedding material and some fuelwood. | Prune to 40% of stem height when trees have reached 7m (all species). |
| Maximize foliage biomass on coppice shoots while maintaining biomass on standards which provide seedling regeneration. | Provide a yield of fodder, small size construction material and some fuelwood. | Coppice in year 4 while retaining new set of standards. Remove small & large standards depending on requirements to maintain 300 per hectare. | Maintain biomass on well formed stems while promoting foliage growth on coppice shoots. | Provide a yield of fodder, construction timber and some fuelwood. | Reduce multistems to single stems. |
| | | | Maintain biomass on broadleaf species while promoting foliage growth on coppice shoots. | Provide a yield of bedding material, fodder and construction timber. | Thin broadleaf species to a stocking of 1500 stem per hectare. |
| | | | Maintain biomass on broadleaf species while promoting foliage growth on coppice broadleaf shoots. | Provide yields of fodder, bedding material, construction timber and some fuelwood. | Thin broadleaf species to a stocking of 700 stems per hectare. |
| | | | Maintain biomass on broadleaf species while promoting foliage growth. | Provide yields of fodder, bedding material and construction timber. | Thin broadleaf species to a stocking of 300 stems per hectare. Remove coppice shoots every 4 years, while retaining standards. |

## Table 5b. Forest Management Aims and Objectives

Forest Type: Pinus sp. Dominated Forest

Management Aims: To maximize foliage for livestock production, fuel wood and construction timber for the local village people

| Option 1 (To maintain pine forest) | | | Option 2 (To manipulate pine forest towards a broadleaf stand) | | |
|---|---|---|---|---|---|
| Silvicultural Objectives | Utilization objectives | Management strategies | Silvicultural objectives | Utilization objectives | Management strategies |
| Maintain biomass on the stand irrespective of species. | Remove only grass and litter for livestock and dead material for fuelwood. | Ensure maximum protection of the trees until age 6 years. | Maintain biomass on the stand irrespective of species. | Remove only grass and litter for livestock and dead material for fuelwood. | Ensure maximum protection of the trees until age 6 years. |
| Maintain biomass on the stand irrespective of species. | Provide bedding material for livestock and some fuelwood. | Prune to 10% of the stem height (age 6 years). | Maintain basic stand structure and biomass. | Provide foliage, fuelwood and some construction timber. | Coppice broadleaf fraction retaining 500 standards per hectare. Thin pine to favour dominant broadleaf fraction. |
| Maintain biomass on the stand irrespective of species. | Provide bedding material for livestock and some fuelwood. | Prune to 20% of the stem height (age 7 years). | Maintain biomass but concentrate it on the broadleaf fraction. | Provide foliage for bedding material, some construction timber and fuelwood. | Thin pine to a stocking of 1000 stems per hectare. |
| Maintain biomass of the stand irrespective of species. | Provide bedding material for livestock and some fuelwood. | Prune to 40% of the stem height (age 8 years). | Maintain biomass but concentrate it on the broad-leaf fraction. | Provide foliage for bedding material and some construction timber. | Thin pine to 700 stems per hectare. |
| Maintain biomass on the pine fraction of the stand. | Provide bedding material for livestock, fuelwood and construction timber. | Reduce multistems to single stems on all species, then remove broad -leaf fraction. Thin pine to a stocking of 1300 stems per hectare (age 9 years). | Maintain biomass but concentrate it on the broad-leaf fraction. | Provide foliage for bedding material, fodder, some construction timber and fuelwood. | Thin pine to 400 stems per hectare and recut coppice shoots and standards leaving a total number of 500 standards. |
| Maintain biomass on the pine fraction of the stand. | Provide bedding material for livestock, some fuelwood and construction timber. | Thin to 1190 stems per hectare (age 10 years). | Maintain biomass on the broadleaf (standards) as well as the foliage component of the coppiced shoots. | Provide foliage for bedding material, some construction timber and fuelwood. | Remove pine and thin standards to 300 per hectare. |

some major utilization can take place. In order to facilitate and control the utilization of produce a management scheme is needed. However, there is little information available on the silvicultural and utilization objectives, productivity, and societal requirements relating to the new forests. In addition, there was little perception among the local villagers, or the Forest Department staff, of the various possibilities that exist for managing forests in different ways. In order to develop suitable guidelines and to gain practical experience, a demonstration trial was established in one of the older plantations near Chautara. The purpose of the trial was:

- To provide demonstration areas to show different forest management options;
- To provide basic data which would assist in the development of management plans and facilitate yield prediction for various forest products;
- To gain practical experience in the implementation of a range of management options, including the distribution of forest products.

A series of five 20 m x 20 m plots was established in a forest which had been planted with chir pine nine years previously. The pine was planted on land that was degraded grassland with scattered remnants of the original broadleaf forest. The resultant forest consists primarily of pine with a strong secondary development of broadleaf species dominated by *Schima wallichii*. In some areas dense coppice regeneration of broadleaf species occurred and this has effectively dominated the pine component. One such area was included in the trial.

In deciding upon relevant and practical treatments for the demonstration plots, two overriding considerations applied:

- The trial needed to reflect societal aspirations as much as possible, one of which was the need to ensure an early return of produce to local people;
- The treatments needed to ensure that the forest was left in a sound silvicultural condition so that a variety of management options could be considered in the future.

**Table 6. Stand Characteristics Prior to Treatment**

| | Treatments | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Stems/ha | | | | | |
| pine | 1500 | 1600 | 1400 | 1600 | 225 |
| broadleaf | 1450 | 1375 | 1725 | 700 | 17050 |
| Total | 2950 | 2975 | 3125 | 2300 | 17275 |
| Estimated standing biomass (t/ha) | | | | | |
| pine | 41.6 | 36.0 | 27.0 | 36.1 | 3.2 |
| broadleaf | 8.6 | 12.6 | 15.6 | 6.6 | 46.3 |
| Total | 50.2 | 48.6 | 42.6 | 42.7 | 49.5 |
| Basalarea (m/ha) | 14.5 | 13.2 | 11.9 | 12.1 | 10.9 |
| Predominant height (m)* | 8.1 | 8.0 | 8.4 | 8.6 | n/a |

* Predominant height is the average height of the tallest 50 trees per hectare.

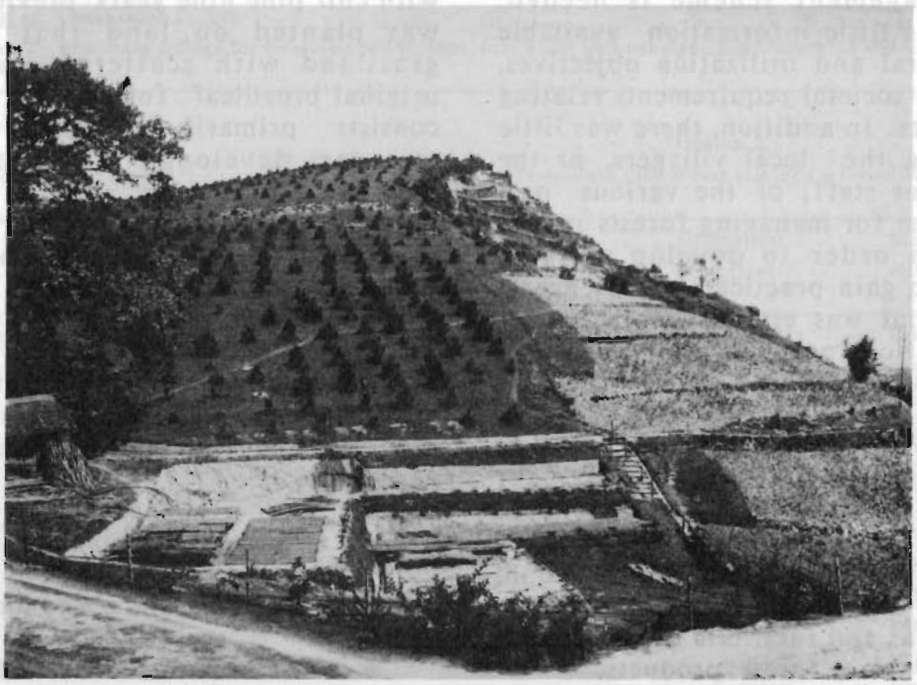


Plate 9 Former grazing land planted with chir pine adjacent to a panchayat nursery and agricultural terraces.

Plate 10 Utilization from the demonstration plots at Chautara.

The societal information was obtained by holding discussions with the Pradhan Pancha and members of the village who had traditional access to the land on which the demonstrations were to be carried out.

The first step in providing inventory data was to carry out biomass studies on the species comprising the forest. Biomass regression equations were established and biomass tables developed for the major species on the site. Secondly, diameter at breast height (dbh) by species of all stems greater than 2 m in height was recorded.

After careful consideration of the potential of the forest and the needs of the people, it was concluded that the product which can be derived earliest from silvicultural treatment is branch material from low pruning. Low pruning can be considered a universal treatment which will assist in the supply of fuelwood and give improved access to the forest. This treatment can be followed by a second pruning to a higher part of the stem and later by a treatment which will reduce all multi- stemmed individuals to the best single stem. These treatments, whether carried out simultaneously or sequentially, will not jeopardize th stand structure or composition and yet will provide a substantial amount of fuelwood (Plate 3) and fodder (Plate 10). Various types of thinnings (Plate 11) can then follow depending on the management objectives applied to the stand.

**Treatments applied**

**Treatment 1 -- Pruning and reduction of multistems to single stems.** This was the first utilization operation carried out. All stems above 3 m in height, regardless of species, were pruned up to 1 m or one-third of the height of the green crown, whichever was the lower. Large curved knives and sickles were used to cut the branches flush with the stem ensuring that no damage was done to the cambium. The use of such tools, once a suitable technique was devised, proved to be satisfactory and is more appropriate than using imported pruning saws. Conventional pruning saws are not necessary in the community forestry context, due to problems of cost and maintenance, and locally available tools can be readily used for this operation. The amount of pruned material removed was determined from previously established regression equations. Following pruning all low value stems greater than 2 m in height were removed and their biomass determined.

The reduction of multistemmed clumps to the best single stem was then carried out. Only clumps greater than 2 m in height were cut, leaving a stump height of 10 cm. The species and dbh were recorded. This information enabled the biomass of the various fractions removed (foliage, branchwood, and stem) to be determined by regression analysis.

Treatment 1 was applied as a base treatment to treatments 2, 3, and 4.

**Treatment 2 -- Thinning to favour chir pine.** Thinning was designed to favour the pine fraction and to encourage biomass production of this fraction. If a broadleaf species was greater than three- quarters of the height and within the crown of an adjacent chir pine tree, the broadleaf was removed in favour of the pine, unless the pine was a suppressed stem and would not respond to release. The dbh and species of the stems removed were recorded for subsequent biomass determination.

**Treatment 3 -- Thinning to favour high-value broadleaf species.** Thinning was designed to favour the broadleaf fraction and to encourage biomass production of this fraction. If a pine tree was greater than three-quarters of the height and within the crown of an adjacent broadleaf species, the pine was removed, unless the broadleaf was suppressed and would not respond once released. No further thinning of the remaining pines was carried out. The dbh and species of the stems removed were recorded for subsequent biomass determination. At this early stage of stand development, the broadleaf species appeared to be shade-tolerant so that thinning was not carried out on the broadleaf component in an endeavour to maintain high stocking levels and biomass production.

**Treatment 4 -- Thinning to favour dominant high value stems, irrespective of species.** Thinning was designed to favour the dominant stems in the stand and to concentrate the biomass production on these stems. If any stem was greater than three-quarters of the height and within the crown of an adjacent dominant stem, then the competing stem was removed. The dbh and species of the stems removed were recorded for subsequent biomass determination.

**Treatment 5 - Coppice with standards** Coppicing with standards is a viable method of management in densely stocked broadleaf stands which have the ability to coppice after being cut. If a stand is to be managed as a coppice system it is important to maintain a

## Table 7. Standing Biomass and Biomass Yield

Biomass ($t\ ha^{-1}$)

| | Treatment 1 Prune, reduce multi-stems to single stems | | Treatment 2 Treatment 1 plus thin to favour the conifer fraction | | Treatment 3 Treatment1 plus thin to favour the broadleaf fraction | | Treatment 4 Treatment 1 plus thin to favour the dominant stems | | Treatment 5 Coppice with standards | |
|---|---|---|---|---|---|---|---|---|---|---|
| | conifer | broadleaf | conifer | broadleaf | conifer | broadleaf | conifer | broadleaf | conifer | broadleaf |
| Standing Biomass Before Treatment | | | | | | | | | | |
| wood (stem & branch) | 33.88 | 7.35 | 29.18 | 10.87 | 21.97 | 13.65 | 29.95 | 5.85 | 2.58 | 39.44 |
| foliage | 7.75 | 1.25 | 6.82 | 1.78 | 5.08 | 1.93 | 6.51 | 0.80 | 0.66 | 6.92 |
| Total | 41.63 | 8.60 | 36.00 | 12.65 | 27.05 | 15.58 | 36.10 | 6.65 | 3.24 | 46.36 |
| | 50.23 | | 48.65 | | 42.63 | | 42.75 | | 49.60 | |
| Biomass Removed | | | | | | | | | | |
| Pruned Material | | | | | | | | | | |
| branches | 5.46 | 0.21 | 4.09 | 0.04 | 2.58 | 0.63 | 3.12 | 0.24 | - | - |
| foliage | 1.26 | 0.10 | 1.02 | 0.02 | 0.64 | 0.28 | 0.84 | 0.11 | - | - |
| Total | 6.72 | 0.31 | 5.11 | 0.06 | 3.22 | 0.91 | 3.96 | 0.35 | - | - |
| | 7.03 | | 5.17 | | 4.13 | | 4.31 | | - | |
| Thinned Material | | | | | | | | | | |
| wood (stem & branch) | 0.98 | 4.00 | 0.48 | 9.35 | 4.20 | 5.00 | 2.90 | 1.30 | 1.54 | 34.62 |
| foliage | 0.25 | 0.70 | 0.12 | 1.42 | 1.02 | 0.70 | 0.75 | 0.20 | 0.44 | 6.28 |
| Total | 1.23 | 4.70 | 0.60 | 10.79 | 5.22 | 5.70 | 3.65 | 1.50 | 1.98 | 40.90 |
| | 5.93 | | 11.37 | | 10.90 | | 5.15 | | 42.88 | |
| Total Yield | | | | | | | | | | |
| wood (stem & branch) | 6.44 | 4.21 | 4.57 | 9.39 | 6.78 | 5.63 | 6.02 | 1.54 | 1.54 | 34.62 |
| foliage | 1.51 | 0.80 | 1.14 | 1.44 | 1.66 | 0.98 | 1.59 | 0.31 | 0.44 | 6.28 |
| Total | 7.95 | 5.01 | 5.71 | 10.83 | 8.44 | 6.61 | 7.61 | 1.85 | 1.98 | 40.90 |
| | 12.96 | | 16.54 | | 15.05 | | 9.46 | | 42.88 | |
| Coppice Standards Remaining | | | | | | | | | | |
| wood (stem & branch) | | | | | | | | | 1.04 | 4.82 |
| foliage | | | | | | | | | 0.22 | 0.64 |
| Total | | | | | | | | | 1.26 | 5.46 |
| | | | | | | | | | | 6.72 |
| Percentage of Standing Biomass Removed | 26 % | | 34 % | | 35 % | | 22 % | | 86 % | |

very high stocking rate to maximize productivity. Stocking rates of 8000-10,000 stems per hectare are not excessive for this type of forest management. All desirable species (broadleaf) which were greater than 2 m were coppiced. The stems were cut cleanly, about 3 cm above ground level. Standards were left at a stocking rate of 250 good vigorous stems per hectare. Standards remain to provide for seed production, protection, and for producing large stems of good form to be used for construction timber and poles. The dbh and species of the stems were recorded prior to coppicing to enable the biomass of the various fractions to be calculated by regression analysis.

**Results of trials**. The standing biomass and biomass yield from the five plots are shown in Table 7. Although the plots are unreplicated, they nevertheless serve as a valuable demonstration, as the results provide an indication of the relative effects of treatment. The plots on which the treatments were carried out had a similar standing biomass before treatment, varying from 43 to 50 t/ha. Treatment 1 involved removing a quarter of the standing biomass which was less than that removed from either Treatment 2 or Treatment 3 where about one-third was removed. Treatment 5, the most drastic of all the treatments, resulted in 86 percent of the standing biomass being removed. From this treatment a large amount of foliage for bedding material and fodder (0.4 and 6.2 t/ha respectively) was removed while 6.7 t/ha (14 percent) remained on the standards in the plot. Treatment 4 produced the lowest total yield, primarily due to the relatively low number of broadleaf stems prior to treatment (700 /ha). Consequently, there was only limited opportunity for thinning among competing stems.

It is apparent from a consideration of the treatment selected that many other possibilities could have been tried. In determining these prescriptions, care was taken to ensure that they were as simple as possible. This allows them to be easily understood and will hopefully promote a greater degree of acceptance by panchayat people and forestry staff who will generally be responsible for their implementation.

**Distribution of forest products**.The total yield of forest products harvested from the five demonstration plots amounted to 19.78 tonnes (calculated from the data in Table 7) made up of 16.15 tonnes of wood and 3.23 tonnes of foliage. Assuming that the pine foliage was not required for animal bedding purposes, the amount of usable foliage would be reduced to 1.96 tonnes and the total usable products to 18.11 tonnes. As these figures are expressed on an oven dry weight basis, the green weight equivalent would approximate 36 tonnes. Thus, even though the plots were small in area, there was still a substantial amount of material harvested and decisions had to be made on the way in which this material would be distributed.

Discussions were held with the local leaders who indicated that 18 families surrounding the forest traditionally had access to the forest. It was these families who had effectively protected the forest during the preceding nine years so they were the families who should receive the benefits from the forest. As a result, a representative of each of the families was called to the forest at a predetermined time and the products (wood and leaves) were distributed equally. Because the forest involved is HMG forest, the wood was sold at the government royalty rate of half a rupee per headload for fuelwood. No charge was levied for the leaf material.

**Possible future yields**. The trends and results from the demonstration plots provided valuable information on suitable treatment options which could be implemented in community forests. To illustrate the use of such information, productivity and biomass estimations were used to determine treatment schedules and product yields in a chir pine plantation of high site quality (corresponding to Site Quality I in the Indian Yield Tables) at an altitude of 1550 m, near Chautara. The land prior to planting was heavily grazed grassland and contained few broadleaf individuals. After nine years the stand had a predominant height of 8.7 m, a mean dbh of 11.4 cm and a stocking of 1400 stems per ha.

Past diameters (dbh) of the stand were required in order to determine productivity. Stem analysis techniques using increment corings and discs removed from standardised positions on the stem provided this information. These measurements enabled the mean annual increments (MAI) to be determined and used to predict future growth (Mawson 1982). These data were then used in conjunction with biomass regression equations and predicted stocking rates to provide estimations of stand biomass for a range of ages. Table 8 shows predicted above-ground biomass for this chir pine stand aged from six to fourteen years.

Table 9 shows one possible utilization schedule from the sixth to the tenth year for this same chir pine plantation near Chautara.

**Table 8. Biomass of Chir Pine stands aged 6 - 14 years.**

Standing Biomass (t $ha^{-1}$)[4]

| Approx. age (years) | Mean dbh[1] (cm) | Pre. Ht[2] (m) | Probable Stocking[3] (stems $Ha^{-1}$) | Foliage and branchwood by stem | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 - 10 % | | 10 - 20 % | | 20 - 40 % | |
| | | | | Foliage | Branch wood | Foliage | Branch wood | Foliage | Branch wood |
| 6 | 6.6 | 4.0 | 1400 | 0.30 | 0.92 | 0.17 | 0.38 | 0.94 | 1.15 |
| 7 | 8.2 | 5.5 | 1400 | 0.42 | 1.59 | 0.32 | 0.91 | 1.42 | 2.07 |
| 8 | 9.8 | 7.0 | 1400 | 0.48 | 1.99 | 0.41 | 1.31 | 1.69 | 2.64 |
| 9 | 11.4 | 8.7 | 1300 | 0.57 | 2.72 | 0.58 | 2.26 | 2.11 | 3.74 |
| 10 | 12.8 | 9.5 | 1190 | 0.58 | 2.95 | 0.64 | 2.72 | 2.40 | 4.10 |
| 11 | 13.2 | 10.3 | 1100 | 0.59 | 3.19 | 0.70 | 3.22 | 2.29 | 4.48 |
| 12 | 14.6 | 11.1 | 1000 | 0.58 | 3.35 | 0.75 | 3.70 | 2.32 | 4.76 |
| 13 | 16.0 | 11.9 | 900 | 0.62 | 3.91 | 0.90 | 5.09 | 2.55 | 5.69 |
| 14 | 17.4 | 12.7 | 800 | 0.59 | 3.92 | 1.15 | 5.47 | 2.48 | 5.75 |

| Approx. age (years) | Foliage and branchwood by stem | | | | | | Complete tree | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 40 - 60 % | | 60 - 80 % | | 80 - 100 % | | | | | |
| | Foliage | Branch wood | Foliage | Branch wood | Foliage | Branch wood | Foliage | Branch wood | Stem | Total |
| 6 | 0.68 | 0.68 | 0.45 | 0.31 | 0.17 | 0.11 | 2.58 | 3.54 | 4.9 | 10.96 |
| 7 | 1.21 | 1.46 | 0.74 | 0.65 | 0.26 | 0.17 | 4.15 | 6.68 | 8.51 | 19.43 |
| 8 | 1.53 | 2.01 | 0.91 | 0.88 | 0.32 | 0.20 | 5.05 | 8.69 | 10.80 | 24.64 |
| 9 | 2.15 | 3.23 | 1.20 | 1.39 | 0.40 | 0.26 | 6.58 | 11.67 | 15.10 | 34.39 |
| 10 | 2.35 | 3.76 | 1.29 | 1.61 | 0.41 | 0.27 | 6.99 | 14.12 | 16.52 | 37.61 |
| 11 | 2.56 | 4.34 | 1.37 | 1.84 | 0.43 | 0.28 | 7.41 | 15.66 | 18.01 | 40.99 |
| 12 | 2.72 | 4.84 | 1.43 | 2.04 | 0.44 | 0.29 | 7.64 | 16.85 | 19.08 | 43.38 |
| 13 | 3.22 | 6.31 | 1.64 | 2.62 | 0.48 | 0.32 | 8.65 | 20.58 | 22.64 | 51.44 |
| 14 | 3.26 | 6.64 | 1.62 | 2.74 | 0.74 | 0.31 | 8.54 | 21.03 | 22.83 | 51.84 |

1 dbh for ages greater than 9 years conservatively estimated using a MAI of 1.4 cm $yr^{-1}$ (based on the estimated MAI from years 6 to 10 of 1.6 cm $yr^{-1}$).

2 Predominant height for ages greater than 9 years conservatively estimated using a MAI of 0.8 m $yr^{-1}$.

3 Stocking based on a planting rate of 1750 $ha^{-1}$, a survival of 80 %, and a probable thinning schedule.

4 Component biomass determined from tables calculated from regression equations.

5 The biomass shown below the dotted line would normally be removed during pruning operations.

**Table 9. Possible Utilization Schedule for Chir Pine Stand aged 6 - 10 years.**

| Predominant Height (m) | Approx. Age[4] (Years) | Mean dbh (cm) | Silvicultural objectives | Utilization objectives | Management strategies | Biomass harvested (t ha$^{-1}$)[3] Foliage | Branch wood | Stem | Total |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 6 | 6.6 | Maintain biomass on the stand irrespective of species. | Provide bedding material, fodder for livestock and some fuelwood | Prune to 10 % of stem height (to approx. 0.4). | 0.30 | 0.92 | - | 1.22 |
| 5.5 | 7 | 8.2 | Maintain biomass on the stand irrespective of species | Provide bedding material and fodder for livestock and some fuelwood. | Prune to 20 % of stem height (to approx. 1.1 m). | 0.32 | 0.91 | - | 1.23 |
| 7.0 | 8 | 9.8 | Maintain biomass on the stand irrespective of species | Provide bedding material, fodder for livestock and some fuelwood. | Prune to 40 % of stem height (to approx. 2.8 m). | 1.69 | 2.64 | - | 4.33 |
| 8.7 | 9 | 11.4 | Maintain biomass on the pine fraction of the stand. | Provide bedding and fodder for livestock, fuelwood, and construction timber. | Reduce multistems to single stems on all species and coppice broadleaf fraction. Thin pine to a stocking of 1300 stems per ha. (remove 1 in 15 trees). | .30[1] | .56[1] | 1.16 | 2.10 |
| 9.5 | 10 | 12.8 | Maintain biomass on the pine fraction of the stand. | Provide bedding for livestock, fuelwood, and construction timber. | Thin to 1190 stems per ha. (remove 1 in 12 trees). | 0.52[2] | .79[2] | 1.53 | 2.84 |
| | | | | | Total yield up to age 10 years: | 3.21 | 5.72 | 2.69 | 11.72 |

1 Calculated on a proportional basis assuming 68 % of the height of the trees thinned is unpruned.

2 Calculated on a proportional basis assuming 70 % of the height of the trees thinned is unpruned.

3 Expressed as oven dry weight.

4 Refilling of seedlings was carried out for up to 4 years following initial establishment because of poor survival.

Additional information on the silvicultural and utilization objectives and options which are required to compile the schedule are included from Tables 5a and 5b. Table 9 indicates that utilization of the forest can commence as early as six years by removing the lower branches (up to 10 per cent of the height of the stem). Such an operation would yield 1.2 t/ha of which 300 kg is foliage and 900 kg is small branch material for fuelwood. A series of consecutive management strategies can then be applied which are designed to meet the overall management aims and satisfy the silvicultural and utilization objectives. By ten years, a total of 3.2 t/ha of foliage for bedding material, 5.7 t/ha of fuelwood, and 2.7 t/ha of poles suitable for construction timber or fuelwood would be harvested.

The schedule outlined in Table 9 could be readily extended up to rotation age as depicted in Table 5 b. In many cases, particularly in the community-owned forests, rotation age will probably be determined by the structure of the stand and on the size of the material required by the user group. In other words, the rotation length may not be determined by age alone or by the MAI/PAI curves. A more important criterion may be the time required to grow a product to the maximum size required by local communities. For example, it makes little sense to grow a stand for 40 years to a mean dbh of 45 cm when the villagers only require trees of 20 cm dbh which can be produced in 15 years.

**Applying Forest Management.** To date, few if any formal management schemes are operating in community forests in the Middle Hills. This is partly because most of the plantation forests are quite young (less than five years old). However, it is also partly because most of the management plans that have been compiled depend on a reasonably sound technical background for both their development and application.

The existing district staff of the Forest Department can barely cope with the modest forest development programmes operating at present. However, if the community forestry concept is to be successful and result in an adequate supply of forest products for village people, it must ultimately undergo enormous expansion. The staff will find it very difficult to deal with a greatly expanded programme, even if a substantial increase in staff numbers occurs.

In addition to the new plantation forests, the existing natural forests (40 per cent of the land area) must also be brought under better management. Consequently, forest management decisions must ultimately rest with the local community. This is quite a radical departure from conventional forest management and one that will take a good deal of patience and perseverance to implement. However, there are a number of leads which can be taken from the way in which villagers currently utilize produce from their existing forest resources.

In many areas, the traditional systems for the collection of various forest products reflect a combination of need, availability of produce, and season of the year (and hence time available to carry out the collection). There are also a number of models of traditional methods of management of natural forest (Arnold and Campbell 1985) which can provide guidance on the sort of system which may be socially acceptable.

Practical forest management must be a blend of **sound silvicultural practice, and social need and acceptability.** The development of a small range of options (examples of which were outlined in Tables 5 a,b), which can be readily understood by village people, simplifies the whole process. These options can be used to develop a series of utilization schedules which can be implemented under the control of the panchayat leadership (either at panchayat or ward level) and probably through the operation of the forest committee. This committee usually comprises villagers and a representative from the Forest Department. The administration of the utilization itself could be under the direct control of the panchayat secretary as one of his normal administrative functions.

One of the major problems to be solved in developing a self-sustaining system is that of payment for forest watchers. At present in the NAFP area forest watchers are employed at the rate of one per 15 ha of plantation forest. They ensure that straying animals are kept out of the forest and that people confine their harvesting activities to the removal of grass and dead material. In the two NAFP districts, most watchers are paid from project funds. This cost a total of 559,000 rupees (approximately US$ 32,500) in 1985/86 for the 415 watchers involved. This recurrent cost is a heavy burden to carry and one which ultimately must be passd, if only in part, to the panchayats. The rationale for the project continuing to pay for the recurrent cost of the watchers is that it is part of the capital cost of establishing the forests and getting them to the stage where utilization is feasible.

Once utilization commences, the return received by the panchayats from the sale of forest products will go, in part, towards the cost of operating the forestry enterprise, including paying the costs associated with employing forest watchers. C.D. Hamilton (pers. comm.), in a cost-benefit analysis of community forestry in Sindhupalchok estimated that a price of 5 rupees per headload (approximately 22 kg) of forest produce will be needed to cover the full recurrent cost of employing forest watchers, (at the rate of one watcher per 10 ha). This is a substantial sum in the local economy and the cost of the forest watcher is only one of the costs involved in running the community forestry enterprise. As the forests mature and begin yielding produce, methods of rationalizing forest protection and the associated costs need to be investigated.

A great number of practical issues need to be addressed as utilization commences and as more forest areas are brought under effective management, including:

- the area to be utilized each year;
- an identification of the user group for each forest area (i.e. the group of people who should share in the benefits coming from the forest, and who should also share in the management responsibilities);
- the price to be paid for various forest products;
- the time of year for the utilization of various forest components;
- a method for the distribution of forest products;
- any penalties to apply to wrongdoers.

Many of these issues can be resolved by discussion with the panchayats themselves with advice from Forest Department staff. The actual application of management schemes will be a new experience for most communities (as well as for the Forest Department). Consequently, it is bound to be accompanied by a great deal of discussion. Like most new ventures there will also be many uncertainties and doubtless many mistakes will be made as systems are implemented, tested, refined, and reimplemented. However, it is only in this way that a final solution will be achieved.

## CONCLUDING COMMENTS

The preceding sections have described a small, highly populated, underdeveloped, mountainous country which is undergoing active growth and evolution. Parts of the mountain range are unstable and this instability is exacerbated by man's use of it, particularly by heavy use of the forests, which has, over many centuries, led to large-scale deforestation.

The dependence of the mixed farming system on the forest in the Middle Hills has become increasingly evident during recent years. At the present time, the system runs largely on a substantial 'capital resource' of forest which accumulated over centuries. However, that capital is being depleted rapidly and the whole system appears to be in danger of running down. It is clear that the long-term sustainability of the farming system in its present form depends on a very substantial increase in the area of land under some form of tree cover. Precisely how this increase should take place is far from clear. The community forestry programmes established during recent years have produced heartening results. However, the scope and vision of these programmes must be greatly expanded if they are to have any real impact. Almost all uncultivated land capable of supporting trees, irrespective of tenure, will need to be managed for tree crops, with the emphasis shifting to planting fodder trees and multipurpose trees on private land.

The work of the project has shown that it is possible to establish a large-scale forestation programme by working in consultation with local villagers. Many of the forests established to date have been based on *Pinus sp.*, frequently *P. roxburghii*. While this species produces no worthwhile fodder and only second-rate fuelwood, it is important ecologically as the first step on the path to returning to a broadleaf forest. It has been shown that it is possible to actively manage stands of trees to encourage the transition from conifers to conifer/broadleaf, to mixed broadleaf stands. This ecological shift should be possible within 20 years in most areas and within a much shorter time in certain places.

The plots, which illustrate different ways of treating the forests to achieve different objectives, have provided a very powerful demonstration for local villagers and visitors alike. This has enabled more meaningful discussion of forest management issues to take place, not only in the project area itself, but throughout Nepal.

While considerable success has been achieved in forestation in Sindhupalchok and Kabhre Palanchok, a degree of caution should be adopted in translating this experience directly to other districts. There is little doubt that the principles will remain the same, but the detailed implementation of a programme in any particular place will need to take account of the unique blend of biophysical (vegetation, soil, climate, altitude, etc.) and social (ethnic groupings, social structure, history, etc.), elements which exist.

Active management of forests to supply the needs of the rural population in the hill regions of Nepal is a new venture and only the first tentative steps have been taken. However, if forest management is to be carried out directly for the local people, it is only logical that management is carried out by the local people, albeit with guidance from those with technical expertise.

The practical reality is that in any one district there will probably be several hundred patches of forest with many combinations and permutations of altitude, species mix, past history, etc. At present, there are only a few forest rangers located in each district. It is clearly beyond their ability to develop, implement, and supervise management plans or working schemes in each of the individual forest areas. In this situation the local people themselves must become intimately involved in the management of their own forests. Management plans need to consider, among other things, the necessity of having the local operations financially self-sustainable. To eliminate the need for government financial subsidies, costs associated with the forest operations (such as wages of watchers) should be covered by the sale of forest products. Plans and working schemes capable of being implemented by local communities need to be developed. These will need to be designed so that only limited inputs from trained forestry professionals and technicians will be required.

There is no doubt that Nepal is a long way from achieving this goal of self-sustainable forest management. One of the major objectives of the Nepal-Australia Forestry Project during the next five years is to develop and implement

technically and socially sound management schemes within the forests of Sindhupalchok and Kabhre Palanchok. Due to the lack of previous experience and to the presence of so many unknown elements, the pace of progress will necessarily be slow, but this is the challenge for the immediate future.

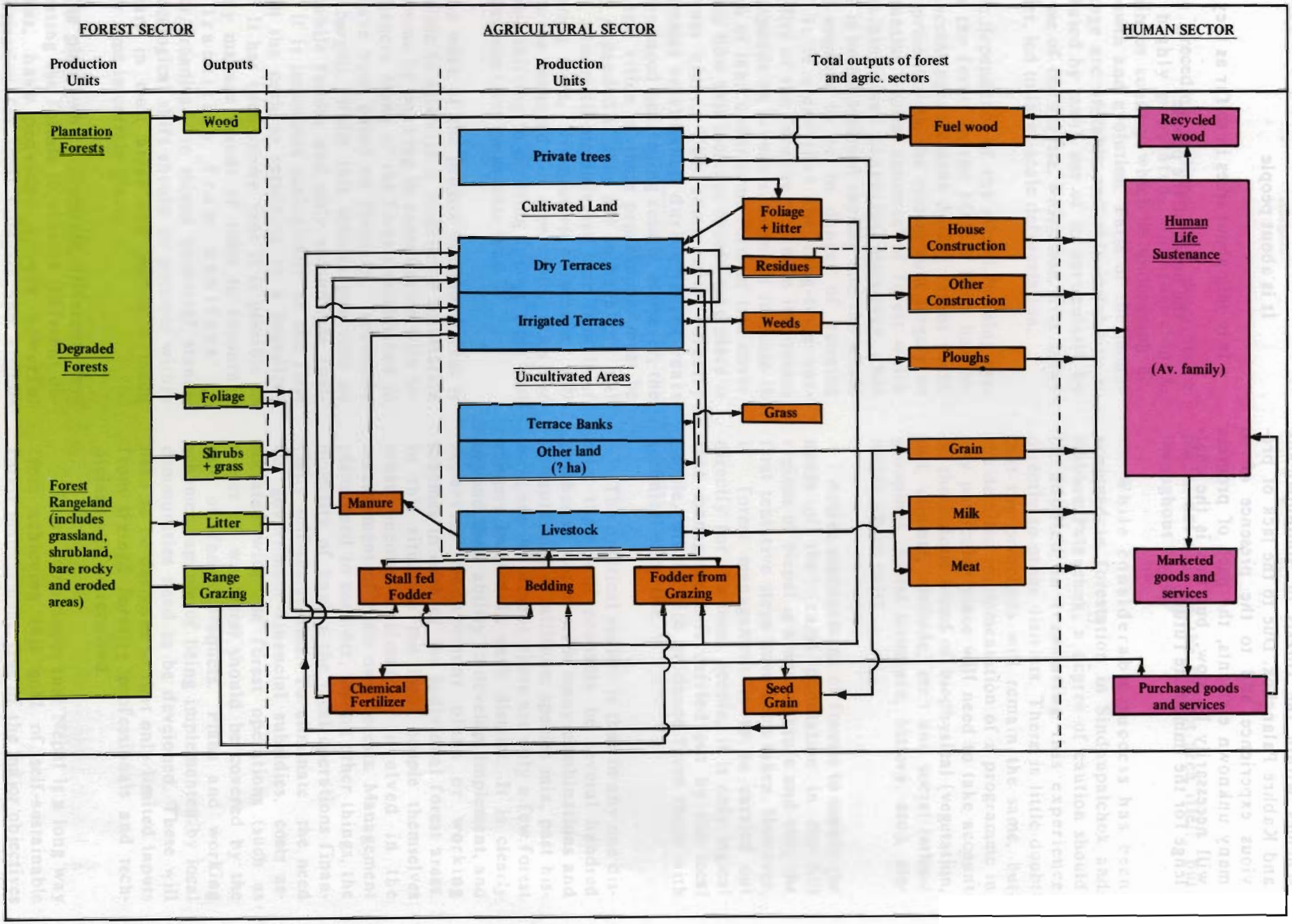
Forestry is not in essence about trees

It is about people

It is only about trees in so far as they serve

the needs of the people.

# Biomass Flow Chart of Agricultural Production in the Chautara Area of Nepal



## REFERENCES


Alirol, P.
1979 Transhuming animal husbandry systems in the Kalingchowk Region (Central Nepal). Integrated Hill Development Project, Swiss Association for Technical Assistance, Kathmandu, 355p.

Applegate, G.B., Joshi, A.L. and Tripathi, R.R.
1985 Planning framework for forest development activities in the Nepal-Australia Forestry Project. Nepal-Australia Forestry Project, Technical Note 1/85.

Arnold, J.E.M., and Campbell, J.G.
1985 Collective management of hill forests in Nepal: The Community Forestry Development Project. Paper presented at the Common Property Resources Management Conference, Annapolis, 21-27 April 1985.

Bajracharya, D.
1983a Deforestation in the food/fuel context, historical and political perspective from Nepal. *Mountain Research and Development* 3, 227-40.

Bajracharya, D.
1983b Fuel, food or forests ? Dilemmas in aNepali village. *World Development* 11, 1057-74.

Brewbaker, J.L.
1983 Fodder and fuelwood N-fixing trees for Nepal. Consultant's report for Integrated Cereal Project, Ministry for Food and Agriculture, Kathmandu, Nepal 18p.

Bunch, R.
1981 The alchemy of success. *New Internationalist*, December 1981.

Byrne, K.J.
1985 A socioeconomic analysis of the small farming systems in the middle hills of Nepal - implications for forestry development. B.Sc. (Hons.) Thesis. University College of North Wales, Wales.

Campbell, R.G. and Mahat, T.B.S.
1978 A practical approach to the development of community forestry in Nepal. *Nepal Journal of Forestry* 1,25 - 33.

Campbell, G.J. and Bhattarai, T. N.
1984 People and forests in hill Nepal. Preliminary presentation of findings of Community Forestry, household and ward leader survey. Project Paper No. 10. HMG/UNDP/FAO Community Forestry Development Project, Nepal.

Caplan, L.
1970 *Land and Social Change in East Nepal*, Routledge and Kegan Paul, London.

Donovan, D.G.
1981 Fuelwood, how much do we need ? *Nepal Forest Technical Information Bulletin* 1, 2-6.

Eckholm, E.D.
1978 *Losing Ground: Environmental Stress and World Food Prospects*, Oxford Geographics Series Pergamon Press.

Gilmour, D.A. and Applegate, G.B.
1984 Community forestry as an option for containing environmental degradation - a case study from Nepal. In Symposium on Effects of Forest Land Use on Erosion and Slope Stability, eds. C.L. O'Loughlin and A.J. Pearce. pp 41-46. University of Hawaii, Honolulu, Hawaii, 7-11 May 1984.

Hagen, T.
1980 *Nepal. The Kingdom in the Himalayas.* IBH Publishing Co., Bombay, Calcutta, New Delhi and Oxford, 264p.

Henschell, G.
1976 The grass forest or lopping forestry of high altitude areas in Stoiermark, *Austrian Central f.d. ges Forest* 2, 613 - 20.

HMG
1983 The forests of Nepal - A study of historical trends and projections to 2000. A report to His Majesty's Government of Nepal, Ministry of Water Resources and Energy Commission Report No. 4/2/200783/1/1, July 1983.

Linnard, W.
1980 Coppicing, lopping and natural high forest in Medieval Wales. *Quarterly Journal of Forestry* 74, (4), 225-28.

Mahat, T. B. S.
1985 Human impact on forests in the Middle Hills of Nepal. Ph.D. Thesis, Australian National University, Canberra, Australia. Two Vols. 490 pp.

Mahat, T. B. S., Griffin, D. M. and Shepherd, K. R.
1986a Human impact on some forests of the Middle Hills of Nepal. 1. Forestry in the context of the traditional resources of the state. *Mountain Research and Development* 6, 233-232.

Mahat, T. B. S., Griffin, D. M. and Shepherd, K. R.
1986b Human impact on some forests of the Middle Hills of Nepal. 2. Some major human impacts to 1950 AD on the forests of Sindhu Palchok and Kabhre Palanchok. *Mountain Research and Development* 6 (4).

Mahat, T. B. S., Griffin, D. M. and Shepherd, K. R.
1987a Human impact on some forests of the Middle Hills of Nepal. 3. Forests in the subsistence economy of Sindhu Palchok and Kabhre Palanchok. *Mountain Research and Development* 7 (1), in press.

Mahat, T. B. S., Griffin, D. M. and Shepherd, K. R.
1987b Human impact on some forests of the Middle Hills of Nepal. 4. A detailed study in South East Sindhu Palchok and North East Kabhre Palanchok. *Mountain Research and Development.* 7. in press.

Manandhar, P.K.
1980 Introduction to policy, legislation and programmes of community forestry development in Nepal. Field Document No.1, NEP/80/030, HMG,/UNDP/FAO, 1980.

Manandhar, P.K.
1982 Introduction to policy, legislation and programmes of community forestry development in Nepal. Field Document No 19, HMG/UNDP/FAO Community Forestry Development Project, Nepal.

Mawson, J.C.
1982 Diameter growth estimations on small forests. *Journal of Forestry* 80, 217-19.

NAFP
1979 Nepal's National Forestry Plan 1976 (2033), unofficial English translation, Nepal-Australia Forestry Project, Kathmandu, Nepal.

NAFP
1982 Forestry - Land use report for Chautara Forest Division, Nepal. Report prepared by Forestry Services, Kathmandu, Nepal. Nepal-Australia Forestry Project, Occasional Paper, Kathmandu, Nepal.

Nayava, J.L.
1980 Rainfall in Nepal. *The Himalayan Review* 12.

Nautiyal, J. C. and Babor, P. S.
1985 Forestry in the Himalayas - how to avoid an environmental disaster. *Interdiscriptionary Science Reviews* 10,27-41.

New Era
1980 Community and forestry development. A Study of villagers' attitudes towards forest and forestry development in Sindhupalchowk District of Nepal. Report to Nepal-Australia Forestry Project, Kathmandu, Nepal.

Nield, R. S.
1985 Fuelwood and fodder - Problems and Policy. Working paper for the Water and Energy Commission Secretariat, Kathmandu, Nepal.

Pereira, C.
1981 Feasibility for high altitude agricultural research. FAO Rome.

Poffenberger, M.
1980 *Patterns of Change in the Nepal Himalaya*, Delhi, Macmillan and Co. of India.

Shepherd, K.R.
1981 The Nepal-Australia Forestry Project. *Australian Journal of Forestry* 44, 210-21.

Shepherd K.R. and Griffin, D.M.
1983 The Nepal-Australia Forestry Project, a case study of research and development. In *Technology Transfer in Forestry* eds. G. H. Mooller and D. T. Seal. For. Comm. Bull. No. 61, 16-23.

Shrestha, R. L.
1982 The relationship between the forest and the farming system in Chautara, Nepal, with special reference to livestock production. Degree of Master of Agricultural Development Economics Thesis, Australian National University, Canberra, Australia.

Stainton, J.D.A.
1972 *Forests of Nepal*, Hafner Publishing Company, New York, 181p.

Strebel, B.
1985 Recent land changes in Palpa (Nepal). An interpretation of a sequence of aerial photos from 1972-1984. A report prepared for the Mid Term Evaluation of the Tinau Watershed Project. (Palpa, Nepal) 59p.

Thompson, M., and Warburton, M.
1985a Uncertainty on a Himalayan scale. *Mountain Research and Development*. 5, 115-135.

Thompson, M., and Warburton, M.
1985b Knowing where to hit it: a conceptional framework for the sustainable development of the Himalaya. *Mountain Research and Development*. 5, 203-220.

World Bank
1979 Nepal Agricultural Sector Review, Report No. 2205-NEP, World Bank, Washington.

Wyatt-Smith, J.
1982 The agricultural system in the hills of Nepal: The ratio of agricultural to forest land and the problem of animal fodder. APROSC Occasional Papers: 1 Agricultural Project Services Centre, Kathmandu, Nepal.

Young, H.E.
1978 Forest biomass inventory: the basis for complete tree utilization. *Forest Products Journal* 28, 38-41.

## The Authors

Grahame Applegate has been working for the past three and a half years as a forester in Nepal with the Nepal-Australia Forestry Project. Mr. Applegate holds a B.Sc. (Forestry) from the Australian National University and a M. Nat. Res. from the University of New England, Australia. The subject of his master's thesis was biomass estimations and management of natural forest ecosystems on Fraser Island, Australia. Prior to coming to Nepal, he worked in Australia as a Forest Ecologist on biomass and productivity studies in native forests. He also has experience in aspects of establishment and management of tropical pine plantations and the management of native forests in the sub-tropical regions of Australia.

Don Gilmour worked in Nepal during 1982 and 1983 as Project Manager with the Nepal-Australia Forestry Project and returned again in mid-1985 for a further term with the Project. Dr. Gilmour holds a B.Sc. (Forestry) from Queensland University, a M.Sc. from the Australian National University, and a Ph.D. from James Cook University of North Queensland. His previous experience included thirteen years as a Forest Hydrologist in rainforest areas of North Queensland, three years as the Principal of the Forestry Training Centre at Gympie, Queensland, and eighteen months as the Principal Research Officer in charge of the Forest Research Centre at Gympie, Queensland.

The views expressed are those of the authors and do not necessarily represent the views of ICIMOD or the organizations concerned.

## Founding of ICIMOD

ICIMOD is the first International Centre in the field of mountain area development. It was founded out of widespread recognition of the alarming environmental degradation of mountain habitats, and consequent increasing impoverishment of mountain communities. A coordinated and systematic effort on an international scale was deemed essential to design and implement more effective development responses in each of the countries concerned.

The establishment of the Centre is based upon an agreement between His Majesty's Government of Nepal and the United Nations Educational, Scientific and Cultural Organization (UNESCO) signed in 1981. The Centre was inaugurated by the Prime Minister of Nepal in December 1983, and began its professional activities in September 1984.

The Centre, located in Kathmandu, the capital of the Kingdom of Nepal, enjoys the status of an autonomous international organisation.

## Participating Countries of the Hindu Kush-Himalaya region

- Nepal
- India
- Bhutan
- Bangladesh
- China
- Pakistan
- Burma
- Afghanistan

Director: Dr. K.C. Rosser

Deputy Director: Dr. R.P. Yadav

**INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT (ICIMOD)**

4/80 Jawalakhel, G.P.O. Box 3226, Kathmandu, Nepal

Telephone: 521575, 522819, 522839

Telex: 2439 ICIMOD NP
Cable: ICIMOD NEPAL