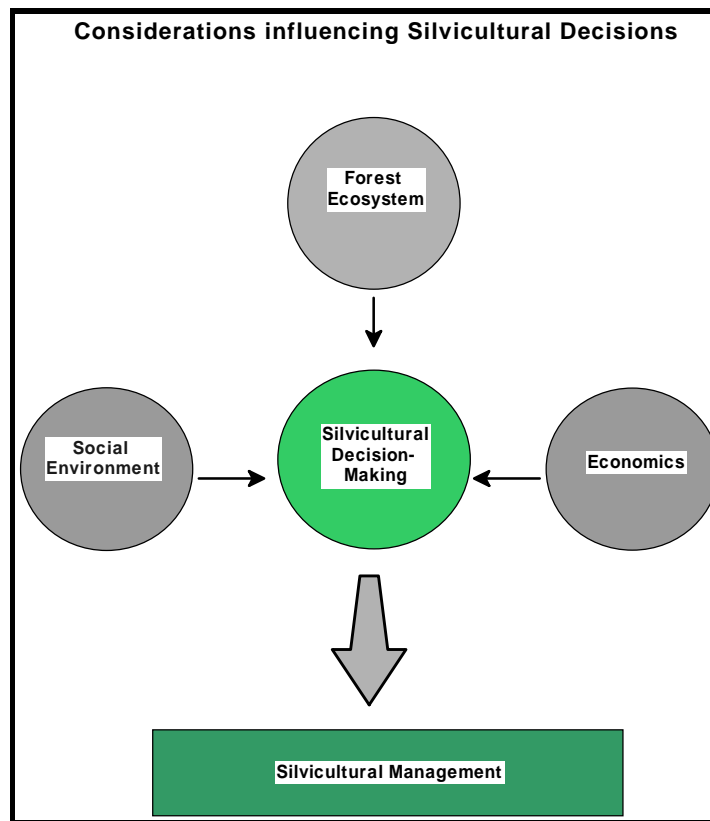


Silvicultural Management of Broad-leaved and Chir Pine Forests in the Punakha and Wangdue - Phodrang Districts of Bhutan

Final Report



Short-Term Consultancy to the Bhutan-German Integrated Forest Management Project

by M. Kleine

February 1996

1. Introduction

This consultancy was implemented within the framework of the Bhutan-German Integrated Forest Management Project. The project is a technical cooperation between the Forestry Services Division within the Ministry of Agriculture and Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) which provides expatriate advisory services.

The long-term purpose of the project is to contribute to the application of economically and ecologically sustainable land use systems in the Gasa, Punakha and Wangdue Phodrang Districts of Bhutan (B-G I.F.M.P., 1995). Almost half of the total project area is covered with forests of various types ranging from fir and mixed conifer forests at higher altitude to broad-leaved and chir pine forests at lower elevation in the immediate vicinity of permanent settlements. Integrating the management of these forests into overall sustainable land use systems requires new approaches to traditional forest management. Since the broad-leaved and chir pine forests are most affected by human activities, a study on appropriate silvicultural management concepts for these forests deemed necessary and lead to this short-term consultancy.

The results of a silvicultural assessment which was conducted by M. Kleine from 07. to 27.01.1996 are presented in this report. After a brief outline of objectives of the study, some general remarks are made on the approach towards and underlying philosophy of silvicultural decision-making within the framework of multiple-use forestry. This is considered important to later understand the findings of the study which are structured accordingly. The methodology applied in assessing the forest is explained in chapter 4 followed by a general description of the forest in chapter 5. The findings of the consultancy comprise a comprehensive silvicultural management concept which is presented separately for the broad-leaved and chir pine forests. The report concludes with recommendations to the Bhutan-German Integrated Forest Management Project containing important activities required to operationalize the proposed silvicultural concept. Additionally, a few topics for further in-depth studies are recommended.

2. Objectives of the Consultancy

The objective of this consultancy as given in the Terms of References (Annex 1) is to explore, develop and describe silvicultural management concepts for the broad-leaved and chir pine forests of the Punakha and Wangdue-Phodrang Districts. The management options should be designed in such a way that satisfies the local needs (i.e., grazing, fodder, firewood) and demands for commercial timber on a sustainable basis and at the same time integrates environmental considerations such as watershed protection and conservation of biological diversity. In addition to the silvicultural operations the management concept will have to encompass a monitoring and control system for which appropriate indicators are to be developed.

Originally, the terms of references also included a component dealing with growth and yield modelling in broad-leaved forests. Due to time constraints and the fact that comprehensive screening of existing research data are necessary this topic could not be dealt with in this consultancy.

Following a special request by the Joint Secretary, Ministry of Agriculture, a brief assessment of the silvicultural situation of the broad-leaved forests of Gedu (Chhukha District) was included.

3. Approach towards Silvicultural Decision-Making

Before discussing the possibilities for silvicultural management of the broad-leaved and chir pine forests in the project area some general remarks are made with regard to the philosophy and scope of silvicultural decision-making.

Silviculture is the design of steering processes in forest ecosystems, in such a way that maximizes the chances of survival of that forest.

Silviculture always leads to a “target forest” in the service of a human “target group” (Oldeman, 1990). Thus, silvicultural decision-making is always influenced by considerations related to the **Forest Ecosystem**, the **Social Environment** and, **Economics** as shown in Figure 1.

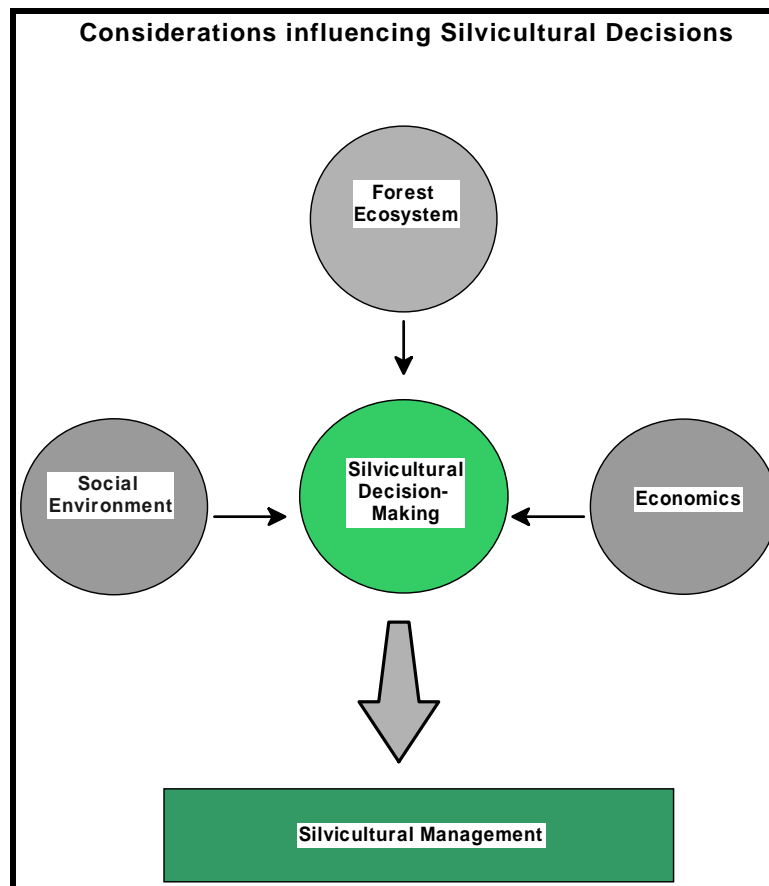


Figure 1.: Considerations influencing silvicultural decision-making

Traditional silviculture as developed and practiced in Central Europe and South Asia since the last century mainly focused on forest ecosystem aspects such as site conditions, stand dynamics and growth as well as natural or artificial regeneration. Based on extensive biological research many silvicultural strategies (so called “silvicultural systems”) have been developed (for details see Troup, 1921 and Champion et.al., 1965a). Due to high population pressure in many areas and the multiple functions which the forest have to fulfill today, many of the silvicultural systems, although biologically sound, have failed to achieve the desired results. Consequently, new approaches are required.

Within this consultancy it is **not** attempted to put forward a new silvicultural system for the broad-leaved and chir pine forests. It is rather the intention of the consultant to design a comprehensive silvicultural management concept including field operations which are tailored to the environmental, social and economic situation of a specific forest site. The proposed silvicultural concepts and strategies are based on conventional silvicultural knowledge, but, additionally, integrate the social reality surrounding the forest area and take into account the institutional and economic constraints of the implementing forestry agencies.

Silvicultural concepts and operational prescriptions are integral part of forest management planning. As such they depend on the overall management objectives selected for a particular forest area. Usually, the planning procedure follows a tiered approach and is separated into a strategic (Forest Management Unit) and an operational (forest stand or compartment/subcompartment) level with distinct different planning horizons and planning tools. Silvicultural decision-making is required at both levels as detailed in Table 1.

Table 1.: Forest management planning concept

Level of Planning	Area	Planning Horizon	Planning Tools
Forest Management Unit (FMU)	5000 ha and up	10-20 years	<ul style="list-style-type: none"> • management objectives • forest zoning acc. to functions • rapid rural appraisal • forest resource inventory • annual allowable cut • opening-up (infrastructure) • silvicultural concept/strategy • etc.
Forest Stand (Compartment)	1-50 ha	annual	<ul style="list-style-type: none"> • production goal • stand description • silvicultural prescriptions (incl. harvesting) • etc.

Note: The list of planning tools provided in this table is not exhaustive and serves as example only.

During the process of developing ideas for silvicultural management above two planning levels must be clearly separated. Beside well defined management objectives, a very general silvicultural concept is described at the FMU-level. In order to successfully translate this silvicultural concept into real field operations, detailed planning at the compartment-level (i.e., forest stand) is required. The approach towards silvicultural decision-making which is in line with the forest management planning procedure is illustrated in Figure 2. The suggestions by Seltzer (1991) and Schindele (1995) to incorporate standwise planning and standwise monitoring and evaluation into the existing forest management planning procedure in Bhutan are very relevant and important for silvicultural management. Within the region stand-level planning has so far been applied on a pilot basis in the Panjul Forests in Northern Pakistan (Khattak, 1992).

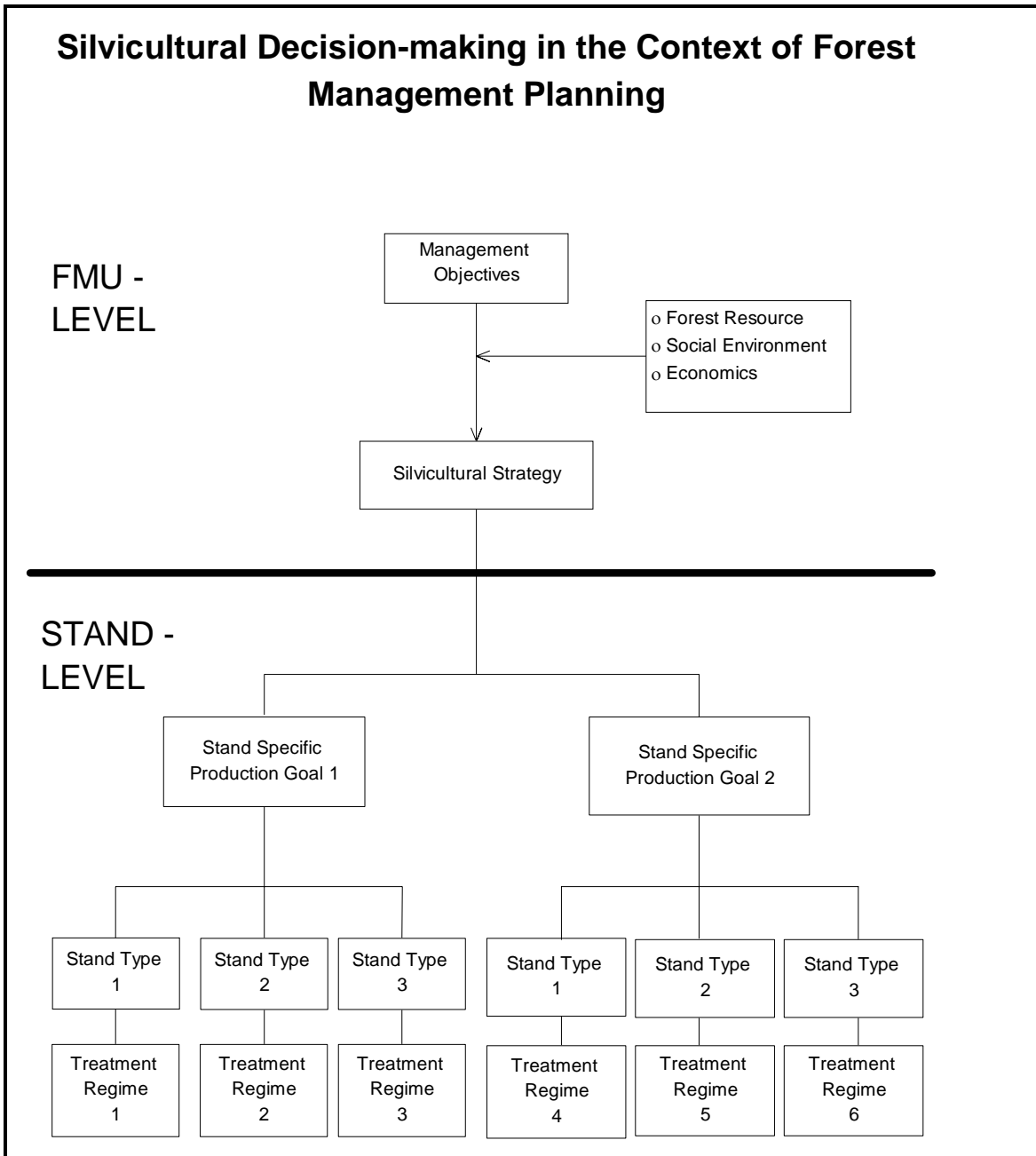


Figure 2.: Organization of silvicultural decision-making in the context of forest management planning

4. Methodology

Main activities during the consultancy comprised screening of the relevant literature, discussions with local forest officers and expatriate technical advisors as well as field visits to forest areas in the Punakha and Wangdue-Phodrang Districts (i.e., Nahi, Shabhel and Rimchu). During these field visits data of typical forest stands were collected employing the procedure of a **R**apid **S**ilvicultural **A**ssessment (**RSA**). With the help of this method site and stand conditions and the present uses of a particular forest locality (i.e., forest stand) were described following the format as provided in Annex 5.

The information obtained through the field assessment, literature studies and verbal communication with forest officers and local people allowed the formulation of silvicultural management directives at the FMU-level and site specific operational prescriptions at the stand-level. The feasibility of selected silvicultural options is evaluated against the above mentioned three main considerations influencing silvicultural decision making (i.e., ecosystem, social environment and economics).

For successful implementation of the proposed silvicultural operations in the field, the relevant socio-economic, organizational and institutional pre-requisites are discussed and necessary amendments and adaptations recommended.

5. The Broad-leaved and Chir Pine Forests

5.1 Geo-ecological Region

The project area covers some 10 100 km² in three districts (Gasa, Punakha and Wangdue-Phodrang) of western Bhutan. The area is made up of extensive valleys stretching from the borders of Tibet at altitudes of more than 6000 m in the north to low-altitude (below 500 m) areas in the south.

The huge range in altitudes and diverse physiography produce a wide range of climatic and vegetative types. The lower lying areas are covered with subtropical, warm broad-leaved and chir pine forests followed by cool broad-leaved, blue pine and mixed conifer forests at higher altitude. The timberline is made up of juniper/rhododendron and dry alpine scrub formations in elevations beyond 4000 m (for details see Grierson and Long, 1983).

5.2 Forest Types

The broad-leaved and chir pine forests can be classified as provided in Table 2 (adapted from Grierson and Long, 1983).

Table 2.: Types of broad-leaved and chir pine forests in Bhutan

Zone	Altitude (m)	Characteristic Timber Species (Genera)
Warm broad-leaved forest	1000-2000	Castanopsis, Bischofia, Engelhardia, Euodia, Macaranga, Schima
Chir pine forest	900-1800	Pinus roxburghii
Cool broad-leaved forest	2000-2900	Acer, Betula, Quercus, Symplocos
Evergreen oak forest	2000-2600	Acer, Castanopsis, Juglans, Quercus, Skimmia, Symplocos

The table provides a general description of the forest types in an altitude between 1000 and 2600m. It is noted that the actual species composition found at a particular locality in the project area can vary considerably. This can be attributed to variations in site parameters such as elevation, aspects and soil conditions but to a large extent also to influences by human activities. These activities have resulted in a substantially reduced area compared to the original (natural) distribution of the broad-leaved forests. Degraded warm broad-leaved forests have partly been colonized by chir pine and the cool broad-leaved forests have given way to blue pine on eroded slopes (Sargent, 1985).

5.3 Important Tree Species

The major focus of this silvicultural evaluation is on timber species within the broad-leaved and chir pine forests, because they

- form the majority of large trees in the forest,
- play the most important role in forest dynamics and growth and,
- provide the rawmaterial for human consumption such as timber, firewood and fodder.

The information on individual tree species or genera provided here is considered conventional knowledge of ecology, silvics and silviculture and is based on comprehensive accounts given in Grierson and Long (1984, 1987 and 1991) and Troup (1921).

Quercus

Oaks are important species of the broad-leaved and evergreen forests in Bhutan. In many localities they dominate the stands.

Q. griffithii is a large deciduous tree forming the top canopy. The species is a moderate light-demander and regenerates freely in gaps and open spaces. The wood is very hard and of excellent quality and ideal for the production of high-value products.

Q. glauca is a medium to large-sized evergreen tree typically found in moist site conditions, on sides of ravines and along streams. This oak can stand a considerable amount of shade during regeneration establishment but needs direct overhead light for maximum growth. The species coppices freely. Its wood is mainly used as fuel and the leaves are a preferred source of fodder.

Q. lamellosa and Q. lineata, are large evergreen trees with massive spreading crowns. They are widely distributed in the Eastern Himalayas and frequently found together in the same locality. Although both species are shade bearers they require overhead light to fully develop their growth potential. The wood is widely used as construction timber and fuel.

Castanopsis

Representatives of this genus occur in both, the warm broad-leaved and evergreen oak forests. Within the project area two species namely C. hystrix and C. tribuloides are commonly found as medium to large-sized evergreen trees. The nuts are edible. Natural regeneration is reported to be fairly good in some areas in India and the seedlings can tolerate a good deal of shade for some years. Both species coppice well. The wood is used for shingles and building material.

Juglans

The walnut, J. regia, is a large deciduous tree widely distributed throughout the Himalayas. In the project area the species is associated with oaks in elevations between 2000 and 2600 m (evergreen oak forests). It can also be found in the mixed conifer and fir forests at higher elevations. Although a light-demander the species can stand some shade in the initial seedling stage. For the production of straight clean boles it must be grown in denser stands, owing to its marked tendency to produce large spreading branches. It has a good ability for coppicing. The species is well known for its fruits and valuable timber which is used for furniture, cabinet-making, carving, veneer and gunstocks.

Engelhardia

E. spicata is a moderate-sized to large deciduous tree and frequently dominates stands of the warm broad-leaved forests. It is reported that the species' natural regeneration is excellent wherever the seedlings get sufficient light and are protected from grazing. The reddish gray wood is moderately hard and mainly used for tea boxes and carvings.

Schima

Associated with the warm broad-leaved forests S. wallichii is a large evergreen tree with a tall straight bole and dense round crown. The species is a moderate light-demander and regenerates abundantly where sufficient light is admitted to the ground. It coppices well. The wood is mainly used for construction purposes, but apt to warp and split.

Michelia

M. excelsa is a large evergreen or deciduous tree of the warm and cool broad-leaved forests associated mainly with *Quercus* and *Castanopsis* species. As a light-demander the tree requires overhead light for good growth performance. However, seedlings can establish well under a moderate though high canopy. It is reported that there are usually plentiful seedlings in the vicinity of seed bearers. Their further development depends primarily on sufficient light and protection from fire and grazing. The wood is an important timber for house building and other construction purposes.

Acer

A. campbellii, is a large deciduous tree of the cool broad-leaved and evergreen oak forests. The species regenerates freely if sufficient light reaches the forest floor. Its very uniform wood is suitable for joinery and ornamental works.

Alnus

A. nepalensis, a large deciduous tree, occurs sporadically in the broad-leaved forests, mainly in shady ravines near water, landslips and newly exposed soils. Provided there is sufficient light *Alnus* displays the habit of springing up gregariously on new ground such as landslips and abandoned cultivation.

Betula

B. alnoides, a moderate-sized to large deciduous tree, sporadically occurs in the cool broad-leaved forests, especially on exposed soils (e.g. land slips etc.), but is also associated with conifers at higher elevations. Natural regeneration is only possible in open gaps with patches of new soil. The species prefers moist site conditions. There is only a limited use of the wood.

Macaranga

Within the project area M. pustulata occurs in the warm broad-leaved forests. The species is a fast growing pioneer and rapidly colonizes open gaps after disturbances such as logging. Although comparatively short-lived it can negatively affect natural establishment and growth of more valuable timber species.

Pinus roxburghii

Chir pine is a large evergreen tree, sometimes nearly deciduous in dry localities and seasons. The species is widely distributed in the outer range and principal valleys of the Himalayas. It is a gregarious tree, forming pure forests of considerable extent, though it often occurs mixed with other species. At its upper limits chir pine in Bhutan is associated with the broad-leaved forests in particular with Q. griffithii. Since chir pine is a strong light-demander it requires open canopies in order to regenerate freely. Its wood is used for multiple purposes such as construction and, if no hardwoods are available even as fuel.

5.4 Forest Dynamics and Growth

Available literature on broad-leaved forests in the Himalayas is mostly confined to the silvics of tree species and the description of habitat and distribution of the forest types (Brandis, 1972, Champion et.al., 1965b, Troup, 1921, Sheikh, 1987). Some research work on forest succession revealed that these forests represent a climax stage which earlier had a much wider distribution (Glover, 1931, Gupta et al 1962 both cited in Doerffel, 1990). Human activities have reduced the area considerably and facilitated the invasion by conifer species (Mohan et.al., 1956).

Little is known about the growth dynamics of the broad-leaved forests. Some of the literature provides information on growth rates of individual trees which can only be indicative due to the lack of site and competition parameters. The Forest Research Institute in Dehra Dun did publish a yield table for *Q. incana* in 1967 (Doerffel, 1990). Due to the high variation of site conditions and forest structure which has intensively been modified by human interference no attempts are made here to extrapolate results of this yield table to the conditions in Bhutan.

5.5 Socio-economic Importance of the Forest

The habitat of the broad-leaved forests ranging from altitudes of about 1700 to 2500 m coincides partly with the area of permanent settlements. Results from two Rapid Rural Appraisals (RRA) recently conducted in the project area show that, in general, the local people are highly dependent on the forest for their survival (Gyeltshen et.al. 1994, Kievelitz, 1995). Direct dependency includes the extraction of various commodities such as timber for construction, shingles, firewood, animal feed and fodder as well as food. Leaf litter and animal manure for maintaining soil fertility, water for drinking and irrigation are indirect services of the forest which are considered equally important. The studies also revealed that the priorities set by the villagers are primarily related to issues such as road access, cultivation and health (other social) services. Since the demand for commodities from the forest could be satisfied in the past with reasonable efforts, a long-term interest in forest management has not yet fully developed among the local farmers.

6. Silvicultural Management of Broad-leaved Forests

6.1 Results of the Rapid Silvicultural Assessment (RSA)

Forest areas of FMU Nahi, Rimchu (working scheme) and Shabhel (vicinity of the slate mine) were visited. A total of 9 stand situations, which were found typical for the broad-leaved forests of the region, have been assessed with the help of the RSA method. The respective records are given in Annex 5. An evaluation of this information resulted in a classification and description of stands according to their successional development stage (chapter 6.1.1). In a second step the present forest utilization as recorded in the RSA was analyzed and grouped into major types of forest uses (chapter 6.1.2).

6.1.1 Stand conditions

The stand conditions found at various localities showed significant differences with respect to the forest structure and regeneration. This is a clear indication for different developmental stages (or age classes). The following three successional development phases are distinguished.

Table 3: Silvicultural classification of forest stands recorded during the RSA

Successional Development Phase	Stand Features		Stand recorded in the RSA (refer to Annex 5 for details)
	Structure	Natural Regeneration	
Old-age Phase	<ul style="list-style-type: none"> mature top canopy crown cover greater than 75% 	<ul style="list-style-type: none"> seedling stage sporadic, few in number 	2, 3, 4, 8
Fragmentation Phase	<ul style="list-style-type: none"> overmature top canopy crown cover 25-75% 	<ul style="list-style-type: none"> seedling and sapling stage numerous to abundant 	5, 9, 10
Building Phase	<ul style="list-style-type: none"> few scattered top canopy trees crown cover less than 25% 	<ul style="list-style-type: none"> fully developed saplings and young trees of 4m height sufficient in number 	1, 7,

Large areas within the broad-leaved forests are stocked with stands in the old-age phase which consists of large mature trees forming a dense top canopy. Due to limited light available in the stand, the mid canopy trees and the shrub layers are not very pronounced. Regeneration is only in its initial stage, whereby seedlings and saplings occur sporadically.

Stands classified as fragmentation phase have a more open top canopy, either caused by natural mortality or harvesting operations. Due to the more favourable light regime for natural regeneration abundant seedlings and numerous saplings (up to 3 m height) can be found.

The building phase is characterized by a very open to absent top canopy and well established natural regeneration. Medium-sized residual trees are found scattered intermixed with saplings of 4-5 m height.

6.1.2 Present forest utilization

During the RSA it was attempted to describe the type of utilization of a particular stand in terms of extraction activities and its intensity. The information was obtained from local villagers living near to the forest stand which was subject to the assessment.

Table 4: Classification of actual forest utilization of the stands recorded during the RSA

Type of Utilization	Uses	Intensity	Stand recorded in the RSA
Local multiple-use	<ul style="list-style-type: none"> • grazing • firewood collection • fodder collection • wood extraction for farm implements 	moderate to very high throughout the year	1, 7
Local single-use	<ul style="list-style-type: none"> • grazing 	low to very high	2, 3, 4, 5,
Commercial cum local use	<ul style="list-style-type: none"> • timber harvesting • grazing 	low to moderate	8, 9, 10

Local multiple-use are areas usually located in close vicinity of farm houses or villages. Extraction intensities for general utility wood, firewood and fodder are very high. The stands never reach maturity and remain in a permanent stage of recovery because of lopping and pollarding activities as well as continuous collection of firewood and leaf litter.

Local single-use as recorded during this RSA is exclusively confined to grazing. Areas which are located further away from the settlements are grazed mainly by cattle. Considerable differences in the intensity of grazing was found, ranging from sporadic visits by migratory herds to continuous heavy grazing throughout the year.

Stands which are presently under commercial timber extraction schemes or will come under regulated forest management are largely influenced by grazing (This is the combined forest and forest grazing zone identified in the Nahi FMU by the RRA in 1995; for details see Kievelitz, 1995). These stands have been classified as commercial cum local use. The intensity of grazing seems to be light to moderate.

Above classification captures the most important uses only. There might be others which, in certain areas, are important but have not been encountered during the RSA.

6.1.3 Silvicultural problem analysis

From the analysis of the stand conditions (chapter 6.1.1) and present forest utilization (chapter 6.1.2) the following silvicultural problems can be identified:

Most of the broad-leaved stands are overmature and show insufficient natural regeneration which, at the most, is in its initial stage. Grazing of various intensities and the limited light reaching the forest floor are the two main factors hampering the natural

rejuvenation of the forests. The forest stands are influenced by different user groups for multifold purposes ranging from migratory grazing to firewood collection and commercial timber extraction. The main problem faced today is: “How to successfully regenerate these over-mature stands and build future forests of improved stocking and timber quality while maintaining a high level of biological diversity”.

The analysis clearly reveals that the problems are not confined to biological aspects of silviculture alone. Any solution to be workable must take into account the existing land-use conflicts between forestry and agriculture/animal husbandry as well as issues related to resource allocations (resource sharing between Government and local population), funding and organization of forest management.

6.2 Silvicultural Management

As already elaborated earlier (see chart on “silvicultural decision-making in the context of forest management planning), silvicultural decisions are required at the strategic (Forest Management Unit) and operational level (forest stand or compartment). Accordingly, a full account of the silvicultural management strategies and prescriptions at both levels are presented, followed by the underlying rationale and a brief discussion on necessary pre-requisites, advantages and disadvantages of the selected options.

6.2.1 Strategic level (forest management unit)

Appropriate **management objectives** which are compatible with the socio-economic environment of the project area are taken from the existing management plan for FMU Nahi (adapted from Dhital, 1993):

It is the objective to manage and improve the forest for the production of hardwoods (i.e., timber, firewood, household implements etc.) as well as fodder (i.e., leaves and grass) on a sustained yield basis while maintaining the protective functions (i.e., water, soil) and rich biological diversity.

Under the given management objectives the following silvicultural management strategy is proposed:

- **Generally, the broad-leaved forests have the potential to be managed for multiple-uses (timber, firewood, fodder, environmental services) relying primarily on natural regeneration. This can efficiently be achieved by manipulating the main canopy through harvesting of mature trees in combination with temporary protection from grazing. Planting is considered a supplementary measure at small scale only. Silvicultural treatments (i.e., weeding, cleaning, thinning) of the natural regeneration and pole-sized advanced growth will ensure improved stand conditions in terms of commercial species composition and stocking.**
- **In order to operationalize the technical strategy given above, an integrated approach towards forest management is required. Participation of local forest users will have to be secured by provision of substantial incentives and close cooperation between the relevant forest stakeholders. This ultimately will lead to a more sympathetic attitude of local people towards regulated forest management.**

- Under the proposed silvicultural management strategy, planning and monitoring at the stand level is required. The operational guidelines do not follow a rigid schedule, but leave room for flexible decision-making based on the actual progress of stand development and responses of collaborating local users.

6.2.2 Operational level (compartment, forest stand)

The silvicultural management concept outlined at the strategic level is translated into actual field operations with the help of planning at the stand-level. This planning step which is usually part of an annual (biannual) operating plan is guided by

- a specific production goal assigned to each stand and,
- the actual stocking conditions of the stand.

Stand specific production goals are derived from the various types of forest utilization based on actual demand for goods and services as described in chapter 6.1.2. Two production goals have been identified as most relevant to the project area, namely

(1) commercial cum local use:

- to produce marketable hardwood,
- to provide firewood as by-product of commercial harvesting and,
- to support grazing on a rotational basis, allowing for proper natural regeneration.

(2) local multiple-use:

- to produce firewood and wood for farm implements,
- to provide fodder and,
- to support grazing.

The actual stocking conditions is the second important consideration for designing silvicultural operations. Three different types of successional development phases (stand types) which are commonly found in the broad-leaved forests of the project area, have been described in chapter 6.1.1.

(1) Old-age Phase

(2) Fragmentation Phase

(3) Building Phase.

Since the sequence of operations depends primarily on the progress of stand and regeneration growth, close monitoring through field inspections and proper record keeping are required. In order to facilitate the monitoring, indicators for each silvicultural operation have been formulated. These indicators describe the desired future situation which is to be obtained through successful implementation of the respective operation.

Silvicultural Management Regimes for Commercial cum Local Use

Under this production goal three different treatment regimes (one each for the individual stand types) are described.

Treatment Regime 1		
Production Goal:	Commercial cum local use	
Stand Type:	Old-age Phase	
Description of treatment regime: The stands, in general, exhibit a dense crown cover of mature trees. Due to insufficient light and influence of grazing the natural regeneration remains in an initial stage and only seedlings can be found. Protecting the stand from grazing for about 4 years will lead to a pool of young regeneration in the seedling stage which is expected to sufficiently cover the stand area. Subsequently, opening of the canopy in a single felling operation (removal of at least 60% of the crown cover) by harvesting all mature trees will provide favourable growth conditions for the regeneration. Protection from grazing and weeding operations should continue until the saplings have reached a height of about 2-3 m. If by then larger areas (>30% of stand area) do not have sufficient natural regeneration, supplementary planting of these areas is to be done using the most valuable commercial species (e.g., <i>Q. griffithii</i> , <i>Juglans</i> , <i>Acer</i> , <i>Castanopsis</i> etc.). Further stand treatment follows the Treatment Regime 3 (buildingphase) under the same production goal (see below).		
Schedule of Silvicultural Operations		
Silvicultural Prescription		Silvicultural Monitoring
Type of Operation/ Assessments	Time Frame	Indicator for successful completion
Protect stand from grazing through demarcation and proper contractual arrangements with actual local users (fencing to be avoided)	Year 1 to 4	seedlings of timber species (> 30 cm height) are +- equally distributed over the stand area
harvest all mature trees by cable crane; retain timber trees of dbh < 30cm	Year 5	all logs and firewood are removed from the area
Protect stand from grazing until regeneration is fully established	Year 5 onwards	majority of saplings have reached height of 2-3 m
Assess regeneration for number and degree of competing vegetation; identify areas where regeneration is absent.	Year 6	if more than 30% of the regeneration is under heavy competition carry-out weeding; in case there are gaps without any natural regeneration (>30% of the stand area) planting of these areas is required
Carry-out weeding	Year acc. to regeneration assessment	at least 2500 saplings/ha are liberated from competing, non-commercial vegetation
Carry-out supplementary planting	Year acc. to regeneration assessment	plants are fully established

Treatment Regime 2		
Production Goal:	Commercial cum local use	
Stand Type:	Fragmentation Phase	
<p>Description of treatment regime: The stands of the fragmentation phase are more open compared to the old-age phase. Gaps in the canopy were created by natural mortality or previous harvesting. Natural regeneration is generally more advanced (e.g., larger saplings) compared to the old-age phase. Initial protection of the regeneration from grazing is, therefore, only required for about 2 years followed by harvesting of all mature trees. Once the regeneration is established the same treatment schedule as for Regime 1 can be applied. In areas with vigorous growth of pioneers species a substantial amount of young regeneration of commercial species was found (e.g., Rimchu area). The weeding operation, therefore, will have to include the removal of this dense pioneer growth.</p>		
Schedule of Silvicultural Operations		
Silvicultural Prescription		Silvicultural Monitoring
Type of Operation/ Assessments	Time Frame	Indicator for successful completion
Protect stand from grazing through demarcation and proper contractual arrangements with actual local users (fencing to be avoided)	Year 1 - 2	seedlings of timber species (> 30 cm height) are +- equally distributed over the stand area
harvest all mature trees by cable crane; retain timber trees of dbh < 30cm	Year 3	all logs and firewood are removed from the area
Protect stand from grazing until regeneration is fully established	Year 3 onwards	majority of saplings have reached height of 2-3 m
Assess regeneration for number and degree of competing vegetation; identify areas where regeneration is absent.	Year 4	if more than 30% of the regeneration is under heavy competition carry-out weeding; in case there are gaps without any natural regeneration (>30% of the stand area) planting of these areas is required
Carry-out weeding and removal of advanced growth of pioneer species (Macaranga)	Year acc. to regeneration assessment	at least 2500 saplings/ha are liberated from competing, non-commercial vegetation/pioneer trees
Carry-out supplementary planting	Year acc. to regeneration assessment	plants are fully established

Treatment Regime 3		
Production Goal:	Commercial cum local use	
Stand Type:	Building Phase	
<p>Description of treatment regime: Once a stand has reached the building phase the problems dealt with under Treatment Regime 1 and 2 are already solved. The type and intensity of stand treatment depends on the progress of stand development. There are very limited experiences with the silvicultural management of young broad-leaved stands in the region. Since the prime objective here is to produce quality timber, the main focus should be on selective thinning to promote the growth of potential crop trees and regulate the species composition (i.e., promotion of valuable species). It is envisaged that a realistic target would be, to obtain 60-80 harvestable trees per ha (50-70 cm dbh) at the end of a rotation period of between 100 - 140 years</p>		
Schedule of Silvicultural Operations		
Silvicultural Prescription		Silvicultural Monitoring
Type of Operation/ Assessments	Time Frame	Indicator for successful completion
Assess status of young stand	Year 1	if more than 50% of the potential crop trees are suppressed carry-out cleaning or thinning
Carry-out cleaning or thinning operation to liberate potential crop trees	Year 2	There is sufficient growing space for the potential crop trees
The decision on the next thinning operation depends on stand growth and competition		

Silvicultural Management Regimes for Local Multiple-Use

Under this production goal two different treatments regimes, one for the Old-age/Fragmentation Phase and one for the Building Phase, are described.

Treatment Regime 4		
Production Goal:	Local multiple-use	
Stand Type:	Old-age/Fragmentation Phase	
Description of treatment regime: Since the objectives here focus exclusively on local uses with no pressure for commercial timber exploitation, a small scale silvicultural management (i.e. a sort of group selection felling) can be pursued. In order to naturally regenerate the stand, gap areas (2-3 mature trees) are initially protected from grazing. Once these gaps are stocked with sufficient seedlings or saplings, removal of the gap's top canopy can be carried out. Further protection from grazing and some weeding should follow the same principles as given under Regime 1 and 2. After successful rejuvenating of the gaps the same procedure can be repeated in other parts of the stand. Since the regeneration activities concentrate on individual gaps, the extraction of firewood and fodder as well as grazing can continue in the remain stand area. Under the local multiple-use objectives artificial regeneration (planting) to create long-rotation broad-leaved forest is not recommended.		
Schedule of Silvicultural Operations		
Silvicultural Prescription		Silvicultural Monitoring
Type of Operation/ Assessments	Time Frame	Indicator for successful completion
Protect gap areas from grazing through demarcation and proper contractual arrangements with actual local users	Year 1 to 4	seedlings of desired species (> 30 cm height) cover the gap area
harvest individual trees in gaps with sufficient regeneration	Year 5	all logs and firewood are removed from the gap areas
Assess regeneration for number and degree of competing vegetation	Year 5	results are entered into stand register
Protect gap areas from grazing until regeneration is fully established	Year 5+	majority of saplings have reached 2-3 m of height
Carry-out weeding	Year acc. to regeneration assessment	in the gap area sufficient saplings are liberated from competing, non-commercial vegetation

Treatment Regime 5	
Production Goal:	Local multiple-use
Stand Type:	Building Phase
<p>Description of treatment regime: There is a substantial difference in terms of initial stand conditions between the building phase Regime 3 (commercial cum local use) and Regime 5 (local multiple-use). Although both stands have regeneration and/or young trees, the one exclusively for local use exhibits a high proportion of bushy trees due to repeated lopping and pollarding activities. Silvicultural treatment must therefore address the needs of the local user by accepting that such a stand will remain in the stage of constant recovery of its growing stock. Initiating natural regeneration can be done by temporarily protecting some parts of the stand from grazing, leaf litter collection and spare some good mother trees from lopping. Since this type of treatment must be very flexible to meet the local requirements (i.e., heavy use for multiple commodities) a definite schedule of operations can only be given after an intensive dialogue and participatory planning with respective local users have taken place.</p>	

6.3 Rationale and Discussion

As outlined earlier, silvicultural decision-making is based on information related to the forest ecosystem, social environment and economics. By selecting and weighing this information a concept can be developed. The following discussion attempts to provide evidence that the suggested silvicultural management concept is feasible under the ecological and socio-economic circumstances prevailing in the project area. For purposes of comparison, frequent references are made to a clear-felling cum artificial regeneration system which is presently under discussion in the course of preparation of management plans for new forest management units (see Dhital, 1993; Chamling, 1995).

Forest Ecosystem

The silvicultural management concept described here is based on conventional knowledge with regard to the silvics of tree species and results of ecological research on stand and regeneration dynamics. This is complemented by own observations made during the field visits. It should be noted that this concept is not to be construed with a traditional selection felling system, although some elements of this system are incorporated.

- Natural regeneration, although in some areas in its initial stage, was present in all stands recorded in the RSA.
- In areas which are little affected by grazing either sufficient natural regeneration or even a young stand of commercial broad-leaved species was found.
- Except for *Alnus* and *Birch* most of the important timber species are able to naturally regenerate under a canopy cover. However, after their establishment either full overhead or sufficient lateral light must be provided to create favourable growth conditions.
- Research studies elsewhere in the region suggest that regeneration growth in over-mature stands is hampered primarily by insufficient light reaching the ground and by influence of grazing (Ijssel, 1991; Thadani et.al., 1995).

- The desired maintenance of biological diversity as outlined in the objectives can best be achieved at minimum cost by fully utilizing the natural regeneration capacity of the forest.

From the ecological point of view, the evidence suggest that it is, in principal, a realistic option to base the management of the broad-leaved forests on natural regeneration. However, there are also some disadvantages especially with regard to the speed of initial establishment of the natural regeneration, which is slower than that of plantation grown species. In order to partly mitigate this, the management concept provides for planting of those areas where natural regeneration has failed. This is expected to be on a small scale only.

Social Environment

The prevailing socio-economic situation in the project area as described in chapter 5.5 makes it necessary to opt for an **integrated approach** towards forest management. In order to successfully implement regulated forest management, it is an indispensable pre-requisite to obtain the cooperation from the local people. Successful cooperation is measured within the proposed treatment regimes in terms of regeneration progress which is conditional in order to proceed with harvesting. In this respect it is immaterial if the silvicultural (i.e. technical) concept advocates natural or artificial means of regeneration. In both cases, e.g., grazing must, in one way or another, be regulated. This is also provided for in the Bhutan National Forest Policy: "forest grazing is to be streamlined by reconciling the herder's needs with the technical requirements for sustainable use of (forest) resources".

The above described approach of managing the broad-leaved forests attempts to solve the rather complex overall problem by reaching right down to the individual stand. This also includes to reconcile the conflicting user interests in a particular stand and reach an agreement between the stakeholders for joint implementation. One option to initiate closer cooperation could be to use the management committee approach as provided for in the Community Forest Management Plan for Dawakha (Gyeltshen, 1995).

It is understood that the silvicultural management concept will only work if a well designed incentive scheme is created which provides incremental benefits to those farmers who collaborate. These benefits given to the local people such as provision of firewood to their homes, construction of access roads, improvements of pastures outside the regeneration areas as well as other social forestry activities and employment as caretakers and forest workers should be seen as direct investments into both, regeneration of the forests and social welfare.

Another important aspect concerns the institutional strenght of the implementing forestry agencies. Since it is expected that a drastic manpower increase will not take place in the near future, effective implementation and control of forest management can only be achieved with full participation of the local people residing in the close vicinity of the forests.

Beyond doubt, substantial efforts with respect to shaping the social environment are required to implement the concept. However, due to the fact that it is a low-input system especially with regard to regeneration costs and very flexible with respect to the time and sequence of operations (see indicators), large scale failure will be avoided.

Economics

One of the core economic questions to be answered in the course of promoting a certain silvicultural management concept involves the relationship between investment requirements and expected income from forestry activities. The concept advocated here

is a low-input silviculture aiming at minimizing investment and operating costs. Economic justification is discussed opposite the clear-felling cum artificial regeneration option:

- broad-leaved forests require long rotation periods (> 100 years) for the production of quality hardwoods. Only future generations will be able to market these products. If this hardwood can be produced through natural regeneration management at low risks then this is definitely cheaper than to promote an expensive artificial regeneration programme.
- many different user groups exist in the project area which have conflicting views on how to utilize the forest. There again is great risk of economic failure if high investments are involved.
- if in some stands natural regeneration fails, the mature forest or parts of it is still in place to fulfill most of the important social functions. There is by far not such a high pressure for immediate regeneration success as required under the clear-felling option.
- basically, natural regeneration is considered cheaper compared to planting, especially if the manpower and infrastructure requirements for large scale plant production are taken into account.

7. Silvicultural Management of Chir Pine Forests

The main emphasis of this short-term consultancy was put on broad-leaved forests. Therefore, little time could be spent on the assessment of chir pine stands. The results of the findings are briefly discussed below.

The chir pine forests throughout the Himalayan region represent a zone most heavily influenced by human activities such as cultivation, grazing and firewood collection. This holds also true for the project area in the Districts of Wangdue-Phodrang and Punakha.

Most of these forests are pure chir pine stands with very open canopy. Due to heavy grazing and frequent incidents of fire, there is almost no shrub layer except for some *Berberis* bushes. The forest floor is covered with grasses throughout the stand area and natural regeneration is largely absent.

It belongs to established silvicultural knowledge that chir pine, a light-demander, regenerates very well by natural means (e.g., Khan and Kleine, 1990). This is also documented in the silvicultural assessment of one stand in FMU Nahi (see Stand No 6 of the RSA in Annex 5), where abundant seedlings (20-40 cm height) and saplings (1-4 m height) are growing under a light canopy of mature trees.

The basic approach for managing the chir pine forests follows that elaborated already for the broad-leaved forest. Exclusion from grazing and fire for a couple of years will initiate the natural regeneration, so that subsequent removal of the entire mature canopy in one felling operation can be carried-out. Precondition is that arrangements with local users for particular stands can be made which allow for initial establishment of the natural regeneration. It is expected, that the regeneration establishment and growth of chir pine is much faster than that of the broad-leaved species. It is pointed out that felling of mature trees is only allowed if sufficient regeneration has been established in the stand. The procedures for stand-level planning and monitoring are the same as explained under the silvicultural management concept for the broad-leaved forests.

Other important issues related to thinning operations, growth performance and possibilities for resin tapping should be dealt with in further studies.

8. Recommendations to the Bhutan-German Integrated Forest Management Project

8.1 Pilot Areas for Silvicultural Management

Establishment and implementation:

As stated earlier, there are various uncertainties in implementing the silvicultural management concept, especially with regard to the acceptance by the local people and their willingness to participate. It is, therefore, recommended to start with some pilot studies in the project area to test and clarify the following issues:

- What type of incentives are required to motivate local farmers to participate in regulating grazing and temporarily protecting individual stands?
- What are the best methods to demarcate and guard the stand (manpower requirements)?
- How long does it take until sufficient regeneration is established (see indicator in treatment regimes) and harvesting of mature tree can commence?
- How much commercial timber and firewood volume can be obtained from the stand?
- How high are the initial costs for protection and provision of incentives until regeneration is established?

The pilot studies areas should be carefully selected on the basis of the following considerations:

- With respect to the management objectives, it is suggested to select at least one area each for the commercial cum local and the local multiple-use objectives within each of the broad-leaved and chir pine forests.
- The stand should preferably belong to the fragmentation phase with some established regeneration in gaps (similar to Stand No 5 in FMU Nahi as recorded in the RSA).
- Since the study is of operational nature, the size of the area should be according to prescribed annual felling coupes, presumably not exceeding 20-30 ha.
- Before any decision on the area is made the actual local users are to be identified and an intensive dialogue be initiated. (Preference should be given to the areas of those farmers who are most sympathetic to the new ideas and willing to participate).

It is further suggested to incorporate the pilot areas into the operating plans which are to be prepared annually. In this way the respective forest officers can be familiarized with the new planning procedure at the stand-level.

It should be noted that the proposed treatment regimes (chapter 6.2.2) need to be verified and, if deemed necessary, be amended based on actual field implementation.

Research requirements in the pilot areas:

While implementing the silvicultural management concept in the pilot areas, it is recommended, to simultaneously study the following aspects in detail:

- Natural regeneration establishment and growth
- Methods to induce natural regeneration through site preparation
- Methods of weeding, cleaning and thinning
- Procedures for regulating grazing and fully protecting stands under regeneration
- Quantification of local needs in terms of firewood and fodder

- Comprehensive financial analysis of the proposed silvicultural management concept

8.2 Other Issues related to Silviculture

It is further recommended to incorporate the following issues into the project activities:

- Silvicultural (stand-level) planning for the preparation of operating plans
- Growth and yield studies of broad-leaved forests
- Management of firewood plantations (woodlot) with indigenous species
- Methods of pasture improvements
- Possibilities and methods of resin tapping in chir pine forests

9. Evaluation of Mixed Broad-leaved Forests of Gedu

A two days field inspection was carried-out in the plantation and natural mixed broad-leaved forests which are located in the vicinity of two wood processing factories in Gedu, namely Gedu Wood Manufacturing Corporation (GWMC; operations ceased as per Nov. '95) and Bhutan Board Products Limited.

Compared to the forests in the Punakha and Wangdue-Phodrang Districts considerable differences exist in terms of

- geo-ecological region and,
- economic objectives.

The broad-leaved forests are of higher species richness and growth dynamics due to high annual precipitation and foggy weather which prevails almost throughout the year. The forests have been utilized mainly for rawmaterial supply to above mentioned two factories. It is noted that the products, namely plywood and particleboard, are considered only of low to medium value and require substantial volumes to be economically feasible.

Due to the limited time within this consultancy a detailed analysis and evaluation of the present forest conditions and recommendations for future management strategies cannot be given. However, some preliminary findings and general remarks which are based on the information obtained during the visit to Gedu are summarized as follows:

9.1 Wood Supply for the Particleboard Factory

Since particleboard manufacturing requires large quantities of wood chips, only residual timber from natural forests such as tree tops and branches or wood from fast growing plantations should be used. It can be expected that the natural broad-leaved forest cannot sustain the wood requirements on a sustainable basis.

9.2 Wood Supply for Wood-based Manufacturing in Gedu

Until November 1995 a plywood mill operated in Gedu. The rawmaterial was supplied from the surrounding broad-leaved forests. The management system applied involved clearfelling and replanting with mostly indigenous broad-leaved species. After closing down of the plywood mill and the clearing cum replanting of about 800 ha the question arises how best to continue the management of these broad-leaved forests.

Based on the two days field visit to the area and some discussions with the forest officers incharge the following general comments can be made.

Management Objectives: As elaborated for the forests in the Project area, a meaningful silvicultural evaluation of the present forest management including the plantation activities can only be done if overall management objectives have been defined. In general, there is a strong relationship between the final product (to be manufactured by the industry) and the type and status (stocking, quality) of available forests and intensity of management. The higher the value-added to the final product (e.g., furniture) the more can be invested into intensive forest management.

In general, relatively slow growing hardwood forests which are managed as natural mixed forests are exclusively apt to support manufacturing of **high-quality products in small quantities**. Once the overall objectives of forest management for the "Gedu Forests" have been defined, detailed technical and financial planning of sustainable forest utilization including decisions on investments into silvicultural management can be undertaken.

Plantation Area: The areas of mixed hardwood plantations visited during the field trip are generally in good conditions with appropriate local, high-value species planted. There seemed to be very high grazing pressure which endangers the survival of planted trees. In order to achieve good results, considerable financial efforts in terms of replanting and protection from grazing are required. In the long term such investments are only justified if the returns from manufacturing are high enough to pay for this type of intensive silviculture. It should be the aim to fully internalize the costs of forest management so that the timber operations become economically sustainable. Due to the topography (partly steep terrain) it is assumed that the forest in the long term has also to fulfill multifold social functions such as watershed protection and maintenance of biological diversity. It is suggested to fully explore the possibilities of a sort of natural forest management with limited enrichment planting of valuable species.

Annex 2: Schedule of Activities

Date	Time	Activities
Sat. 06.01.96		Travel from Sandakan (Malaysia) to Bhutan
Sun. 07. 01.96		Arrival in Thimphu
Mon. 08. 01.96	morning	Preparatory meeting with Mr. Krezdorn (TL) and Mr. Maier of B-G IFMP
	afternoon	Literature study, Discussions with GTZ-team
Tues. 09. 01.96	morning	Courtesy call to Dasho Sangay Thinley (Joint Secretary, MOA) Courtesy call to Mr. D.B. Dhital (FRDS)
	afternoon	Literature study
Wed. 10. 01.96	morning	Preparations for field trip to Project area
	afternoon	Literature study
Thurs. 11. 01.96	morning	Travel from Thimphu to Lobesa
	afternoon	Walk from Wangdue to Nahi accompanied by Messrs. E. Maier, P. Namgyel, Chitra Giri, T. Dorji, B. Singh
Fri. 12. 01.96	whole day	Field trip to broad-leaved forests within the Nahi FMU for conducting RSA; accompanied by forestry staff as above and one representative of the local villagers
Sat. 13. 01.96	whole day	Field trip to broad-leaved forests within the Nahi FMU for conducting RSA; accompanied by forestry staff as above and one representative of the local villagers
Sun. 14. 01.96	morning	Walk from Nahi to Wangdue; on the way conducting RSA in chir pine stands
	afternoon	Compilation of collected data and discussions of field assessment (Messrs. E. Maier, P. Namgyel, Chitra Giri)
Mon. 15. 01.96	morning	Screening of relevant project documents and literature at B-G IFMP Office Lobesa
	afternoon	preparation of field trips
Tues. 16. 01.96	whole day	Field visit to Shabhel, Wangdue-Phodrang District (Messrs. Chitra Giri, T. Dorji and E. Maier) for conducting RSA in the broad-leaved forests in the vicinity of the slate mine
Wed. 17. 01.96	morning	Field visit to Rimchu FMU, Punakha District with (Messrs. Chitra Giri, B.B. Gurung, H.B. Chetri and E. Maier) for conducting RSA in primary and recently logged broad-leaved forests.
	afternoon	Meeting with Mr A. Baskota (DFO Wangdue Division) Return to Thimphu
Thurs. 18. 01.96	whole day	Compilation of collected data Report writing
Fri. 19. 01.96	morning	Travel from Thimphu to Gedu (Chhukha District) accompanied by Mr Chitra Giri and Mr E. Maier
	afternoon	Visit to FSD and private nursery at Gedu accompanied by Mr N. Tshering

Schedule of Activities cont'd

Date	Time	Activities
Sat. 20. 01.96	morning	Field visit to mixed hardwood plantations in the Gedu area accompanied by Mr. N. Tshering
	afternoon	Visit to the Bhutan Board Products Limited (a particleboard factory at Tala near Gedu)
	evening	Discussion with Mr. K. Dorji (DFO Gedu Division) on the findings of the visit
Sun. 21. 01.96	morning	Return to Thimphu
	afternoon	Report writing
Mon. 22. 01.96	morning	Meeting with Messrs. P. Namgyel L. Norbu of FRC (Taba) and discussions on scientific aspects of broad-leaved forest management; collection of information on species and screening of relevant literature
	afternoon	Drafting of Preliminary Report
Tues. 23. 01.96	morning	Drafting of Preliminary Report
	afternoon	Discussion with Mr. Krezdorn (TL) on Preliminary Report Finalizing of Preliminary Report
Wed. 24. 01.96	morning	Presentation of preliminary findings to Dasho Sangay Thinley (Joint Secretary, MOA)
	afternoon	Drafting of Consultancy Report
Thurs. 25. 01.96	whole day	Drafting of Consultancy Report
Fri. 26. 01.96	morning	Presentation of preliminary findings to Mr. K.J. Suba (Joint Director, FRDS)
	afternoon	Wrap-up meeting with Messrs. Krezdorn and Maier
Sat. 27. 01.96		Travel from Thimphu to Malaysia via Bangkok
Sun. 28. 01.96		Arrival in Sandakan

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Annex 4: Preliminary Report
Silvicultural Management of Broad-leaved and Chir Pine Forests
in the
Punakha and Wangdue - Phodrang Districts
of Bhutan

Preliminary Report

Short-Term Consultancy to the Bhutan-German Integrated Forest Management Project

by
M.Kleine

Thimphu, January 1996

1. Objectives of the Consultancy

The objective of this study is to explore, develop and describe silvicultural management concepts for the broad-leaved and chir pine forests of the Punakha and Wangdue-Phodrang Districts. The management options should be designed in such a way that satisfies the local needs (i.e., grazing, fodder, firewood) and demands for commercial timber on a sustainable basis and at the same time integrates environmental considerations such as watershed protection and conservation of biological diversity. In addition to the silvicultural operations the management concept will have to encompass a monitoring and control system for which appropriate indicators are to be developed.

2. The Approach

The consultancy which was limited to a 3 weeks stay in Bhutan comprised screening of the relevant literature, discussions with local forest officers and expatriate technical advisors as well as field visits to forest areas in the Punakha and Wangdue-Phodrang Districts (i.e., Nahi, Shabhel and Rimchu). During these field visits data of typical forest stands were collected employing the procedure of a **Rapid Silvicultural Assessment (RSA)**. With the help of this method site and stand conditions and the present uses of a particular forest locality (i.e., forest stand) were described following the format as provided in Annex 2.

The information obtained through the field assessment, literature studies and verbal communication with forest officers and local people was then synthesized and basic silvicultural management directives and operational prescriptions formulated. In order to successfully implement the proposed silvicultural operations in the field, the relevant socio-economic, organizational and institutional pre-requisites are discussed and necessary amendments and adaptations recommended.

3. Silvicultural Decision-Making

Silviculture is the design of steering processes in forest ecosystems, in such a way that maximizes the chances of survival of that forest.

Silviculture always leads to a “target forest” in the service of a human “target group”. Therefore, silvicultural decision-making (see Annex 1) is influenced by considerations related to the

- Forest Ecosystem
- Social Environment and,
- Economics.

Silvicultural concepts and operational prescriptions are integral part of forest management planning. As such they depend on the overall management objectives selected for a particular forest area. Usually, the planning procedure follows a tiered approach and is separated into a strategic (Forest Management Unit) and an operational (forest stand or compartment/subcompartment) level with distinct different planning horizons and planning tools. Silvicultural decision-making is required at both levels as detailed in Table 1.

Table 1.: Forest Management Planning Concept

Level of Planning	Area	Planning Horizon	Planning Tools
Forest Management Unit (FMU)	5000 ha and up	10-20 years	<ul style="list-style-type: none"> • management objectives • forest zoning acc. to functions • rapid rural appraisal • forest resource inventory • annual allowable cut • opening-up (infrastructure) • silvicultural concept
Forest Stand (Compartment)	1-50 ha	annual	<ul style="list-style-type: none"> • production goal • stand description (e.g., RSA) • silvicultural prescriptions (incl. harvesting)

Note: The list of planning tools provided in this table is not complete and serves as example only.

During developing ideas for the silvicultural management of the broad-leaved and chir pine forests above two planning levels are clearly separated. In order to systematically investigate the feasibility of a selected silvicultural option, the merits and demerits are discussed against the already mentioned main considerations influencing silvicultural decision making such as forest ecosystem, social environment and economics.

4. Preliminary Findings

Following a special request by the Joint Secretary, Agriculture Ministry, also to include an assessment of the silvicultural situation of the broad-leaved forests of Gedu (Chhukha District), the preliminary results of this consultancy are divided into two parts. The former deals with the forest in the Punakha and Wangdue-Phodrang Districts, the latter contains some basic remarks on the Gedu forests.

Part 1: Mixed Broad-leaved Forests of Punakha and Wangdue-Phodrang Districts

These findings are only valid for the silvicultural conditions of those forests visited and evaluated during this consultancy. However, attempts were made to capture those forest areas which represent the most important forest conditions of the two districts.

4.1 Mixed Broad-leaved Forests

As discussed earlier, developing a silvicultural concept requires the definition of specific management objectives. Accordingly, the Management Objectives already defined for FMU Nahi which are considered appropriate for the area of the two districts, serve as basis and read as follows (adapted from DHITAL, D.B., 1993):

It is the objective to manage and improve the forest for the production of hardwoods (i.e., timber, firewood, household implements etc.) as well as fodder (i.e., leaves and grass) on a sustained yield basis while maintaining the protective functions (i.e., water, soil) and rich biological diversity.

4.1.1 Strategic Level (Forest Management Unit)

Result 1:	Generally, the broad-leaved forests have the potential to be managed for multiple-uses (timber, firewood, fodder, environmental services) relying primarily on natural regeneration. Broad-leaved forests composed of the natural species can be maintained.
Result 2:	Adequate natural regeneration can efficiently be established by manipulating the main canopy through harvesting of mature trees in combination with temporary protection from grazing. Planting is considered a supplementary measure at small scale only.
Result 3:	Silvicultural treatments (i.e., weeding, cleaning, thinning) of the natural regeneration and pole-sized advanced growth will ensure improved stand conditions in terms of commercial species composition and stocking.

Above three strategic results are evaluated as provided in Table 2.

Table 2.: Evaluation of the silvicultural concept at the strategic level.

Considerations (Factors)	Justification
Forest Ecosystem:	<ul style="list-style-type: none"> • Natural regeneration, although in some areas only in its initial stage, was present in all stands recorded in the RSA. • In areas only little affected by grazing either sufficient natural regeneration or even a dense stand of commercial broad-leaved species was found during the RSA. • Research studies and observations in the RSA suggest that regeneration establishment and growth in over-mature stands is hampered due to insufficient light reaching the ground and by influence of grazing (see VAN IJSSEL, 1991).
Social Environment	<ul style="list-style-type: none"> • As stipulated in the Bhutan National Forest Policy (1974) "forest grazing is to be streamlined by reconciling the herder's needs with the technical requirements for sustainable use of (forest) resources". This applies to both, artificial plantation and natural regeneration. This silvicultural concept favours the latter. • In order to operationalize the stipulation of the National Forest Policy an integrated approach towards forest management is indispensable. • Regenerating the forest will only be successful if increased benefits are provided to the local people (see Economics) • It is expected that for achieving the objectives the manpower requirements on the part of the government are lower in an reconciliatory environment with the locals and low-input natural forest management compared to protecting artificial plantations with high investments. Appropriate contractual arrangements between the Forest Department and the local people describing clearly rights and obligations of each party are necessary.

Table 2: cont'd

Considerations (Factors)	Justification
Economics	<ul style="list-style-type: none"> • Since the management objectives focus on multiple commodities, many of them provided free of charge (grazing, firewood, fodder etc.), a low-input silviculture attempting to utilize as much as possible the natural reproduction capacity is favoured. In contrary, in a high-input silviculture investment requirements are substantial, so are risks of failure, inter alia, due to the long gestation period of the broad-leaved species. • Benefits to the local people such as provision of firewood to their homes, improvements of pastures outside the regeneration/harvesting areas as well as other social forestry activities and employment as caretakers and forest workers should be seen as direct investment into both, natural regeneration and social welfare.

4.1.2 Operational Level (Forest Stand, Compartment)

Since a particular stand cannot fulfill all the multiple uses at all times as broadly spelt out in the management objectives, a clear subdivision (i.e. zoning) of the forest is required. In order to translate a silvicultural concept into actual field operations, planning at the stand-level is carried out. This planning step which is usually part of an annual (biannual) operating plan is guided by

- the specific production goal assigned to each stand and,
- the present stocking conditions.

Considering this goal and the present stocking conditions of the stand which is assessed with the help of the RSA allows for detailed prescriptions of the silvicultural operations to be implemented during the planning period. Since the sequence of operations depends primarily on the progress of stand and regeneration growth, close monitoring through field inspections and proper record keeping are required.

An example is given as follows:

Production Goal:

The objective of this stand is

- to produce marketable hardwood,
- to provide firewood as by-product of commercial harvesting and,
- to support grazing on a rotational basis, allowing for proper natural regeneration.

Stocking Conditions: (for details see RSA result in Annex 2):

Over-mature oak forest with regeneration mainly in the seedling stage.

(Note: This type of stocking condition is a very common feature of the forest in the district. The main problem faced today is: "How to successfully regenerate these over-mature stands and build future forests of improved stocking and timber quality.")

Silvicultural Operations:

The following table contains the sequence of silvicultural operations and associated monitoring activities which are designed to achieve the long-term production goal assigned to the stand.

Table 3.: Schedule of silvicultural operations

Silvicultural Prescription		Silvicultural Monitoring
Type of Operation/ Assessments	Time Frame	Indicator for successful completion; next operation can be implemented
Protect stand from grazing	Year 1 and 2	seedlings of timber species (> 30 cm height) are +- equally distributed over the stand area
harvest selectively all mature trees by cable crane; retain timber trees of dbh < 30cm	Year 3	all logs and firewood are removed from the area
Assess regeneration for number and degree of competing vegetation	Year 3	result are entered into stand register
Protect stand from grazing until regeneration fully established	Year 3+	majority of saplings have reached 2 m of height
Carry-out weeding	Year acc. to regeneration assessment	at least 2500 saplings/ha are liberated from competing, non-commercial vegetation
Carry-out supplementary planting	Year acc. to regeneration assessment	in case there are gaps without any natural regeneration (>30% of the stand area) planting of these areas is required

The above silvicultural prescriptions represent one of the possible alternatives for silvicultural treatment. In the final report of this consultancy a full account of the most common production goals and stocking conditions found in the broad-leaved forest of the two districts will be given.

4.2 Chir Pine Forests

The findings for the chir pine forests follow the same approach of natural forest management as already elaborated for the broad-leaved forests. Detailed results will be presented in the final report.

Part 2: Mixed Broad-leaved Forests of Gedu

A two days field inspection was carried-out in the plantation and natural mixed broad-leaved forests which are located in the vicinity of two wood processing factories in Gedu, namely Gedu Wood Manufacturing Corporation (GWMC; operations ceased as per Nov. '95) and Tala Particleboard Factory.

Compared to the forests in the Punakha and Wangdue-Phodrang Districts considerable difference exists in terms of

- geo-ecological region and,
- economic objectives.

The broad-leaved forests are of high species richness and growth dynamics due to high annual precipitation and foggy weather which prevails almost throughout the year.

The forests have been utilized mainly for rawmaterial supply to above mentioned two factories. It is noted that the products, namely plywood and particleboard, are considered only of low to medium value and require substantial volumes to be economically feasible.

Due to the limited time within this consultancy a detailed analysis and evaluation of the present forest conditions and recommendations for future management strategies cannot be given. However, some preliminary findings and general remarks which are based on the information obtained during the visit to Gedu are summarized as follows:

Plantation Area: The areas of mixed hardwood plantations are generally in good conditions with appropriate local, high-value species planted. In order to achieve good results, considerable efforts in terms of replanting and protection from grazing are required.

Management Objectives: As elaborated for the forests in the Project area a meaningful silvicultural evaluation of the present plantation activities can only be done if overall management objectives have been defined. In general, there is a strong relationship between the final product (to be manufactured by the industry) and the type of available forests and intensity of management. The higher the value-added to the final product (e.g., furniture) the more one is able to invest into intensive forest management.

Future Directions: In general, slower growing hardwood forests which are managed as natural mixed forests are exclusively apt to support manufacturing of **high-quality products in small quantities**.

Once the overall objectives of forest management for the "Gedu Forests" have been defined and appropriate contractual arrangements made between the Government and the private industry aiming at sustainable resource utilization, detailed technical and financial planning deciding on investments into silvicultural management can be undertaken.

Annex 1:

Annex 2:

Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wangdue-Phodrang	Compartment: Stand No.6
Area (ha):?	Sub-Compartment:

1. Site Conditions

Elevation (m.a.s.l.):	2200	Slope (%):	50-60
Aspect:	SE	Topography:	medium slope
Soil:	deep soil, moder humus, no rocks visible		

2. Stand Conditions

2.1 Main Canopy			
Stand Type:	Over-mature oak forest with regeneration		
Crown Cover (%):	1/2 of area: 100%; 1/2 of area 60%		
Basal Area (m ² /ha):	32-36		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	60-90	25-30	medium
Q. lanata Smith	60-80	25	medium
Michelia	30-40	15-20	good
Remarks:			
2.2 Understorey:			
Description (main species, cover percentage): 30% cover of Michelia, Rhododendron and Myrica			
2.3 Shrubs:			
Description (species, cover percentage): Rhododendron, Berberis			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment):			
<ul style="list-style-type: none"> seedlings of oak and blue pine abundant (< 50 cm height) scattered saplings of oak (max. height of 3 m) largely under crown cover but with sufficient lateral light 			

3. Present Uses

Type of Use	Intensity	Remarks
Grazing	moderate, throughout the year	bulls are set free stand far away from village

Annex 5: Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wangdue-Phodrang	Compartment: Stand No. 1
Area (ha): ?	Sub-Compartment:

1. Site Conditions			
Elevation (m.a.s.l.):	1700	Slope (%):	<20
Aspect:	NE	Topography:	bottom of slope
Soil:	deep soil, no rocks visible		

2. Stand Conditions			
2.1 Top Canopy			
Stand Type:	Mixed oak, chir and blue pine stand; building phase		
Crown Cover (%):	10%		
Basal Area (m ² /ha):	< 10		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	20-30	15	medium
P. wallichiana	30	17	good
P. roxburghii	30	17	medium
Remarks:			
2.2 Mid Canopy:			
Description (species, cover percentage): 40% cover of Castanopsis, Quercus, Rhododendron, Schima, Lyonia, Endospermum			
2.3 Shrubs:			
Description (species, cover percentage): 50% cover of different species			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment): seedlings of Oak, Chir, Blue Pine, Castanopsis sufficient in number but not established			

3. Present Uses		
Type of Use	Intensity	Remarks
Grazing	heavy, throughout the year	local cattle
Firewood	heavy in Mar-Apr & Oct-Dec	bushy forests for firewood
Fodder	heavy in Mar-Apr	pollarding of oaks
Farm implements	throughout the year	oaks cut for horsesaddle and house implements

Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wangdue-Phodrang	Compartment: Stand No. 2
Area (ha): ?	Sub-Compartment:

1. Site Conditions			
Elevation (m.a.s.l.):	2020	Slope (%):	40
Aspect:	NNE	Topography:	mid slope
Soil:	humus rich, deep soil, moist and cool site conditions		

2. Stand Conditions			
2.1 Top Canopy			
Stand Type:	Over-mature Oak-Birch-Alnus stand; old-age phase		
Crown Cover (%):	80%		
Basal Area (m ² /ha):	20-28		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	40-60	25-30	good for furniture
Betula	50-60	25-30	good for woodcraft
Alnus	30-40	20-25	good
Juglans	40	25-30	good for furniture
Remarks:			
2.2 Mid Canopy:			
Description (species, cover percentage): 20% cover of Lyonia (scattered)			
2.3 Shrubs:			
Description (species, cover percentage): 50-60% cover of Daphne, Berberis			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment): sporadic oak seedlings of < 30cm height (insufficient number)			

3. Present Uses		
Type of Use	Intensity	Remarks
Grazing	medium Sept-Mar	
Wood extraction by villagers	light	for shingle-production from oak

Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wandue-Phodrang	Compartment: Stand No. 3
Area (ha): ?	Sub-Compartment:

1. Site Conditions			
Elevation (m.a.s.l.):	2050	Slope (%):	60%
Aspect:	NNE	Topography:	upper slope/ridge
Soil:	medium deep to shallow soil with thick moder humus layer, moisture medium		

2. Stand Conditions			
2.1 Top Canopy			
Stand Type:	Mature oak forest; old-age phase		
Crown Cover (%):	90		
Basal Area (m ² /ha):	32		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	40-50	15-17	good to medium
Michelia	30-40	15-17	good
Q. glauca	40-50	15-17	medium
Q. lanata	40-50	15-17	poor
Remarks:			
2.2 Mid Canopy:			
Description (species, cover percentage): 10-20% cover of Exbucklandia (scattered)			
2.3 Shrubs:			
Description (species, cover percentage): light (< 20%) cover of Berberis, Bamboo			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment): few to patchy numerous seedlings of oak (insufficient)			

3. Present Uses		
Type of Use	Intensity	Remarks
Grazing	light	

Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wangdue-Phodrang	Compartment: Stand No. 4
Area (ha): ?	Sub-Compartment:

1. Site Conditions			
Elevation (m.a.s.l.):	2050	Slope (%):	15-20
Aspect:	NE	Topography:	plain, near river
Soil:	shallow, partly rocky, good humus, thick layer of oak leaves		

2. Stand Conditions			
2.1 Top Canopy			
Stand Type:	Mature mixed broad-leaved forest dominated by oak; old-age phase		
Crown Cover (%):	90		
Basal Area (m ² /ha):	32 (appr. 70 mature trees/ha)		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	60-80	25-32	good
Alnus	50	25	good
Juglans	60-90	25	good
Castanopsis	30	12-15	good
Remarks:			
2.2 Mid Canopy:			
Description (species, cover percentage): none			
2.3 Shrubs:			
Description (species, cover percentage): 10% cover of Berberis			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment): sporadic (< 10% cover) 1-2 years old oak seedlings, not established, many acorns found of which the majority is affected by predators			

3. Present Uses		
Type of Use	Intensity	Remarks
Grazing	light	stand is far away from village

Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wangdui-Phodrang	Compartment: Stand No.5
Area (ha):?	Sub-Compartment:

1. Site Conditions

Elevation (m.a.s.l.):	2200	Slope (%):	50-60
Aspect:	SE	Topography:	medium slope
Soil:	deep soil, moder humus, no rocks visible		

2. Stand Conditions

2.1 Top Canopy			
Stand Type:	Overmature oak forest with regeneration; fragmentation phase		
Crown Cover (%):	1/2 of area: 100%; 1/2 of area 60%		
Basal Area (m ² /ha):	32-36		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	60-90	25-30	medium
Q. lanata Smith	60-80	25	medium
Michelia	30-40	15-20	good
Remarks:			
2.2 Mid Canopy:			
Description (main species, cover percentage): 30% cover of Michelia, Rhododendron and Myrica			
2.3 Shrubs:			
Description (species, cover percentage): Rhododendron, Berberis			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment):			
<ul style="list-style-type: none"> seedlings of oak and blue pine abundant (< 50 cm height) scattered saplings of oak (max. height of 3 m) largely under crown cover but with sufficient lateral light 			

3. Present Uses

Type of Use	Intensity	Remarks
Grazing	moderate, throughout the year	bulls are set free stand far away from village

Rapid Silvicultural Assessment (RSA)

FMU: Nahi, Wangdue-Phodrang	Compartment: Stand No.6
Area (ha): ?	Sub-Compartment:

1. Site Conditions

Elevation (m.a.s.l.):	1600	Slope (%):	20-30
Aspect:	S	Topography:	upper slope
Soil:	shallow and sandy		

2. Stand Conditions

2.1 Top Canopy			
Stand Type:	Regenerating chir pine forest; fragmentation phase		
Crown Cover (%):	30-40		
Basal Area (m ² /ha):	12-16		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
P. roxburghii	20-30	17-20	good to medium
Remarks:			
2.2 Mid Canopy:			
Description (species, cover percentage): none			
2.3 Shrubs:			
Description (species, cover percentage): none			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment):			
<ul style="list-style-type: none"> 60-70% cover of chir pine seedlings (20-40 cm height), most of them show thick stumps from which resprouting after damage from trampling and fire takes place 20-30% patches of chir pine patches (1-4 m height) well established 			

3. Present Uses

Type of Use	Intensity	Remarks
Grazing	heavy throughout the year	site very near to village

Rapid Silvicultural Assessment (RSA)

FMU: Schabhel, Wangdue-Phodrang	Compartment: Stand No.7
Area (ha): ?	Sub-Compartment:

1. Site Conditions

Elevation (m.a.s.l.):	2150	Slope (%):	30
Aspect:	W	Topography:	lower slope
Soil:	medium deep to shallow soil		

2. Stand Conditions

2.1 Top Canopy			
Stand Type:	Regenerating oak stand; building phase		
Crown Cover (%):	20%		
Basal Area (m ² /ha):	<10		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Q. griffithii	15-25	10-15	good
Rhododendron spp.	15-25	10	medium
Remarks:			
<ul style="list-style-type: none"> big gaps without top canopy!! Southern part of stand area: young oak stand (60% crown cover); trees with dbh of 15cm and height of 10m 			
2.2 Mid Canopy:			
Description (species, cover percentage): none			
2.3 Shrubs:			
Description (species, cover percentage): 30% cover of Berberis, different species of Rosaceae			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment):			
<ul style="list-style-type: none"> In open gaps: established oak saplings (1-4 m height) and abundant oak seedlings (<1 m height) Under top canopy: oak seedlings abundant (< 1 m height) 			

3. Present Uses

Type of Use	Intensity	Remarks
Grazing	light	local villagers were not present for inquiry on uses
Firewood	?	
Leaf litter	?	

Rapid Silvicultural Assessment (RSA)

FMU: Rimchu (working scheme), Punakha	Compartment: Stand No. 8
Area (ha): ?	Sub-Compartment:

1. Site Conditions			
Elevation (m.a.s.l.):	1800	Slope (%):	40-50%
Aspect:	E	Topography:	upper slope
Soil:	deep soil, moder humus with leaf-layer, no rocks visible,		

2. Stand Conditions			
2.1 Top Canopy			
Stand Type:	Primary mixed broad-leaved forest; old-age phase		
Crown Cover (%):	95-100%		
Basal Area (m ² /ha):	40		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Engelhartia spicata	80-100	35-40	good
Castanopsis	40-60	30	straight boles, few forks
Michelia	50-60	30-35	good
Carpinus	20-30	25	good
Remarks: This forest has not been subject to any timber extraction in the past			
2.2 Mid Canopy:			
Description (species, cover percentage): 30-40% cover of Castanopsis (15-20 cm dbh; 15 m height); Engelhartia (15-20 cm dbh; 15 m height) and Q. glauca (10 cm dbh; 10 m height)			
2.3 Shrubs:			
Description (species, cover percentage): 30% cover of Ginger, Rotan, climbers			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment): <ul style="list-style-type: none"> • Castanopsis saplings (1-2 m height) abundant • established seedlings of Castanopsis, Daphniphyllum himalensis cum sillimensis no damage from grazing			

3. Present Uses		
Type of Use	Intensity	Remarks
No uses reported!!!!		

Rapid Silvicultural Assessment (RSA)

FMU: Rimchu (working scheme), Punakha	Compartment: Stand No. 9
Area (ha): ?	Sub-Compartment:

1. Site Conditions

Elevation (m.a.s.l.):	1750	Slope (%):	40-60%
Aspect:	NE	Topography:	upper slope
Soil:	deep soil, moder humus with leaf-layer, no rocks visible,		

2. Stand Conditions

2.1 Top Canopy			
Stand Type:	Mixed broad-leaved forest (residual stand 1 yr after logging); fragmentation phase		
Crown Cover (%):	50%		
Basal Area (m ² /ha):	18		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Engelhartia spicata	80-100	35	good
Michelia	20-40	25-30	good
Castanopsis	50-60	25-30	straight boles, few forks
Remarks: Felling was carried out 1 year ago, mature trees were retained as seed source (tree marking)			
2.2 Mid Canopy:			
Description (species, cover percentage): 20-30% cover of Cinamomum (15 cm dbh) Castanopsis, Michelia and Mangifera (10-20 cm dbh; 15 m height)			
2.3 Shrubs:			
Description (species, cover percentage): 30% cover of Ginger, Rotan, climbers			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment):			
<ul style="list-style-type: none"> in felling gaps (size: 20 x 40 m): abundant seedlings of Castanopsis and Macaranga (<50cm height) in unlogged patches: numerous saplings (3-4 m height) of Engelhartia, Castanopsis and Cinamomum 			

3. Present Uses

Type of Use	Intensity	Remarks
Timber harvesting	40-50% of basal area removed	logging completed 1 year ago
Grazing	very rare	migratory cattle, wildlife

Rapid Silvicultural Assessment (RSA)

FMU: Rimchu (working scheme), Punakha	Compartment: Stand No. 10
Area (ha): ?	Sub-Compartment:

1. Site Conditions

Elevation (m.a.s.l.):	1650	Slope (%):	30%
Aspect:	NW	Topography:	upper slope
Soil:	deep soil, moder humus with leaf-layer, no rocks visible,		

2. Stand Conditions

2.1 Top Canopy			
Stand Type:	Mixed broad-leaved forest (residual stand 2 yrs after logging); fragmentation phase		
Crown Cover (%):	30%		
Basal Area (m ² /ha):	20		
Main Tree Species	Dia-Range (cm)	Average Height (m)	Timber Quality
Castanopsis	40-60	25-30	good
Q. glauca	30	25	good
Carpinus	40	20	prohibited for felling
Remarks: Felling was carried out 2 years ago, few mature trees were retained as seed source, very open canopy; logging heavier than in Stand No.9			
2.2 Mid Canopy:			
Description (species, cover percentage): Few trees of Castanopsis, Schima (10-20 cm dbh; 15 m height),			
2.3 Shrubs:			
Description (species, cover percentage): 30% cover of Ginger, Ferns			
2.4 Regeneration:			
Description (species, size, abundance, damage, status of establishment):			
<ul style="list-style-type: none"> 50-60% of stand area covered by 2 years old Macaranga (1-4 m height): regeneration of Castanopsis, Schima, Daphne abundant and partly established outside the Macaranga patches established Castanopsis and Schima (0.5-1.5 m height) partly heavily browsed 			

3. Present Uses

Type of Use	Intensity	Remarks
Timber harvesting	60-70% of basal area removed	heavy logging completed 2 years ago
Grazing	moderate	migratory cattle, wildlife