Report on a

short term consultancy

on

FOREST RESOURCES MANAGEMENT

Project No. 92.2267.0-01.100

Bhutan-German Integrated Forest Management Project

Bhutan

Prepared for the

DEUTSCHE GESELLSCHAFT FÜR TECHNISCHE ZUSAMMENARBEIT (GTZ) GmbH, Eschborn

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Acronyms

AAC	Annual Allowable Cut
ACB	Austrian Coordination Bureau
API	Aerial Photo Interpretation Cell
BCCI	Bhutan Carbon Corp. Inc.
BG-IFMP	Bhutan-German Integrated Forest Management Project
BLC	Bhutan Logging Corporation
cbm	cubicmeters
dbh	diameter at breast height
DIWC	Druk Integrated Wood Complex
DFO	District Forest Officer
DOF	Department of Forestry (now FSD)
FMS	Forest Management Section
FMPD	Forest Management Planning Division
FMU	Forest Management Unit
FRDS	Forest Resources Development Section
FRMD	Forest Resource Management Division (now FMS)
FRPA	Forest Resource Potential Assessment
FSD	Forestry Services Division
FY	Financial Year
GIS	Geographic Information System
GOI	Government of India
GPS	Ground Positioning System
GWMC	Gedu Wood Manufacturing Complex
LUPP	Landuse Planning Project
MOA	Ministry of Agriculture
Nu	Ngultrum
NRTI	Natural Resources Training Institute
PIS	Preinvestment Survey
RGOB	Royal Government of Bhutan
RIM	Royal Institute for Management
SNV	Netherlands Development Organisation
sokshing	collection of leaf litter as manure
tsamdo	cattle browsing in forest areas

1 Introduction

The Bhutan-German Integrated Forest Management Project (BG-IFMP) was designed in view to contributing towards the conservation of natural resources and improving the living conditions of the local population in Punakha, Wangdue Phodrang and Gasa districts.

The BG-IFMP started in August 1994 and is at present in its Orientation Phase. To get a frame and some reference points for further concerted actions a short-term consultant was invited to work on various aspects of forest resource management. The terms of reference (see Annex 1) were set quite broad as at this stage only approximate assessments were required for the BG-IFMP in order to orient itself and to define its further strategy. During the mission it was decided to give priority to the analysis of the timber production/wood demand and to the assessment of the forest resources within the three districts. Emphasize was also given to the analysis of the existing forest inventory methods and management planning system. Due to time constraints a detailed assessment of the present forest management and the present forest organisation on forest-enterprise level had to be postponed.

The short-term consultancy took place from 15th of June to 7th of July, 1995 and was carried out by W. Schindele (see Annex 2: Time Schedule).

2 Wood Production and Demand Analysis

2.1 Objective and Methodology Applied

A comparison of the present wood consumption with the potential wood production capacity of the forest resources of Gasa, Punakha and Wangdue Dzongkhag will provide the basic and most essential information for forest policy formulation and for the definition of the further strategy and approach of the BG-IFMP.

For the three districts no wood consumption study was carried out so far. While on fuelwood consumption various studies have been undertaken in different regions of Bhutan (see RGOB/MOA/DOF 1991 (d)), information on the demand of construction timber is quite poor.

In Bhutan there is a dual economy in both of the main wood product markets: the fuelwood and the construction timber. The prices are set by the government and wood supply is controlled by the Forestry Department. Most of the firewood and a substantial portion of the construction timber is collected without money payment or for subsidised prices (e.g. sawnwood supply for rural market). The Divisional Forest Office is responsible for record keeping on timber production and wood supply.

At present there is no shortage of wood or timber being reported in Bhutan (RGOB/MOA/DOF 1991 e). Therefore in this analysis it is assumed that at least for the three concerned districts the demand of wood is equal to the supply.

Due to time constraints no own wood consumption assessments could be carried out. Taking this into consideration it was decided to analyse the timber production and the construction wood demand of Gasa, Punakha and Wangdue districts based on royalty payment and other statistics from the Divisional Forest Office which were available for 1993 and partly 1994. This was done in close cooperation with the divisional staff of the Forestry Department. The main problem by using these statistics was, that the units were different for each product. For example for the production of construction timber (rural supply) only trees are counted but not measured, roundwood is recorded in Hoppers' feet and sawnwood in cubic meters. For the calculation of the per capita production/demand all figures had to be transformed into standing volume equivalent in order to allow a comparison to the forest production potential (standing volume increment). The conversion factors used are based on estimates provided by BG-IFMP and own assumptions. They have not been verified by random measurements.

The firewood demand was calculated based on the results of the Master Plan, Annex Report No. 6 which were adjusted according to local informations.

Thus, the present wood production and consumption analysis is a rough estimate, the real figure may lay within a 30% range. However, for the present purpose, the absolute figures are not so much important. The relation of firewood/construction timber, import/export, rural/urban/industrial demand and the different sources where the wood comes from, will however provide valid information and allow valuable conclusions for further forest management strategies.

2.2 Calculation of Wood Production and Consumption

The results of the wood production analysis are presented in the following Table 1: "Wood consumption within Forest Division Wangdue for Gasa, Punakha and Wangdue Dzongkhags (including Bapisa, Thipu Dzongkhag) and resource of wood" and in Table 2 "Wood consumption (including industries, export, import) within Forest Division Wangdue".

Remark: The final result tables are different from those presented attached to the preliminary report (see Annex 4). Conversion factors were revised and fuelwood consumption was adjusted.

TABLE1.WK1

TABLE2.WK1

2.2.1 Fuelwood

Fuelwood comes from the following different sources: official allocation of trees by forestry staff, self supply (collection of branches, etc.), collection of logging residuals by contractors for the supply of the urban market.

For all of these fuelwood sources there were no valid statistics available for the three districts. Therefore, the estimate of the fuelwood demand had to be based on the results of Annex Report No. 6 "Wood Based Energy Demand and Supply in Bhutan", Master Plan (RGOB/MOA/DOF 1991 (d).

The Master Plan compared various different studies on fuelwood demand for domestic use and verified these figures with own assessments and by comparison with consumption figures of neighbouring countries (Nepal). It concluded, that the average consumption for cooking and related activities can be estimated to be around 1 cbm/capita. The fuelwood demand for space

heating depends largely on the altitude. The Master Plan assumed that per every 1 000 m altitude range an additional amount of 2.5 cbm of fuelwood per household is consumed. During the short-term consultancy this hypothesis was verified in the field and adjusted as follows: space heating is only carried out above 1 000 m with a consumption rate of 2.5 cbm per household and 1 000 m altitude range.

For every Gewog the average altitude range of human settlements was calculated based on landuse maps scale 1:100.000. In Annex 6 the calculation of the total fuelwood consumption on Gewog and Dzongkhag level is attached.

Official Supply:

According to Bhutanese regulations every rural household has the right to obtain altogether four trees for the production of fuelwood, two for the summer and two for the winter. The trees are marked by the Beat Officer and they are usually selected close to the household location. The conversion factor from tree into standing volume was calculated by the Project at 1.37 cbm/tree.

The official supply accounts to a total of about 28 050 cbm for all three districts which is equivalent to 0.67 cbm/capita.

Self Collection (Genuine):

Beside the official allocation a proportion of the required fuelwood comes from gathering of deadwood, branches and residuals from trees used for construction timber. This "self-supply" is calculated simply as the difference between the calculated demand and the official supply. The share of self supply most probably increases with remoteness of the settlement and the vicinity to the forest. Thus percentage of self supply of fuelwood varies from district to district. The highest rate of self supply has Gasa with 64%, then comes Wangdue with 60% and finally Punakha with 50%. The average percentage of self supply is 59%.

The total amount which is collected by the rural population is estimated at about 34 400 cbm which is equivalent to 0.8 cbm/capita. It has to be mentioned, that an unknown percentage of the wood collected for self supply is deadwood or wood below 10 cm diameter, which has not to be supplied from the standing volume of a forest.

Self Collection (Residuals):

The official fuelwood statistic only include the supply for the rural population. The fuelwood for the urban population, the army and for monastries comes usually from logging residuals which

are collected by contractors. For all the three districts the total amount of firewood from logging residuals is estimated at 5 100 cbm or 0.1 cbm/capita.

The total amount of firewood consumed in 1993 for all the three districts is estimated at about 67 600 cbm or 1.6 cbm/capita. It varies from district to district according to average altitude as follows:

Gasa: 2.2 cbm/capita
Punakha: 1.5 cbm/capita
Wangdi: 1.6 cbm/capita.

2.2.2 Local Construction Timber

The calculation of the production and the demand of construction timber is entirely based on the royalty payment statistics of the DFO. Rural construction material is provided on standing tree basis. As mentioned previously the conversion from number of trees provided into standing volume was done based on conversion factors estimated by BG-IFMP . These figures have not been checked in the field and can only be regarded as rough estimates.

2.2.2.1 Polewood

Polewood is produced from the stem of small trees or out of Bamboo. It is usually debarked but not further treated.

The total amount of polewood used in 1993 was estimated at about 1 030 cbm (0.025 cbm/capita), which is compared to the other wood demand (firewood, hewnwood, sawn timber) almost negligible.

Tshims:

Tshims are round poles which are used as rafters for roofing. They are produced out of different species with a dbh of 15-20 cm. The average length is 4 - 5 m; the conversion factor calculated by the Project is 0.067 cbm/tree.

Poles:

Poles are used as masts for prayer flags, temporary shelter houses and others. They are mainly produced from conifers but, if not available, any other species is used. The dbh is around 15-20 cm, the average length is 4 - 5 m; the conversion factor is 0.067 cbm/tree.

Dangchu:

Dangchu are very thin poles which are used as battens for roofing. They are often made out of Bamboo. Average DBH is 3-5 cm, length = 3 m. The conversion factor is around 0.004

cbm/Dangchu. These thin poles are not extracted from the standing volume as their diameters are below the limit of DBH 10 cm.

Posts:

Any tree species is used for the making of fence posts. The conversion factor calculated by BG-IFMP is 0.067 cbm per tree.

2.2.2.2 Hewnwood

Hewnwood is usually directly produced in the forest by the consumer itself. Out of the bole square timbers or shigles are hewn. This causes a high amount of wood waste. Hewnwood is used for the traditional house construction and for the renovation of Dzongs and other public buildings.

Compared to Table 1: "Wood consumption within Forest Division Wangdue for Gasa, Punakha and Wangdue Dzongkhags" the figures on hewnwood have been changed. Reason for this was, that it can most probably be assumed that offcuts (tops, bug branches, etc.) are used as firewood if the transport distance is not too far. Therefore, this amount of wood has already been considered in the firewood self supply figures. The conversion figures for hewnwood had to be adjusted accordingly.

The standing volume equivalent of trees converted into hewnwood was estimated based on the statistics of 1993 at about 31 800 cbm, which is equivalent to 0.76 cbm/capita. For the different districts it varied considerably as follows:

Gasa: 0.20 cbm/capita
Punakha: 0.71 cbm/capita
Wangdi: 0.89 cbm/capita

The consumption of hewnwood for construction purposes turned out to be fairly high as compared to the estimate of 0.30 cbm/capita given by RGOB/MOA/DOF 1991 (e). It has to be kept in mind, that in 1993 hewnwood was required for the renovation of Punakha Dzong and, in Wangdue District, for the construction of the NRTI building. In Gasa, where no extraordinary consumption was recorded, it is considerably lower and within the range of the Master Plan's estimate. Unfortunately, it was not possible to distinguish from the provided DFO statistics between the supply of ordinary households and the extraordinary supply for e.g. Dzong renovation and NRTI construction. To get a real picture of the ordinary household demand on hewnwood, these figures still have to be adjusted.

Trees:

This refers to stems of conifers used for construction purposes which are usually debarked but not further hewn. The conversion factor estimated by BG-IFMP is for 1 tree 1.52 cbm, it was adjusted to 1.3 cbm.

The total amount of trees in standing volume equivalent consumed in 1993 is estimated at about 3 370 cbm.

Shingleps:

Shingleps are large shingles used for roofing in traditional house construction. They are splitted out of the bole of conifers (mainly fir) and oaks. They have to be replaced every 7 years which leads to a quite high demand. The conversion factor estimated by BG-IFMP is for 1 tree = 3 cbm; this was adjusted to 1 tree = 2 cbm, as part of the unsplittable part of the stem is used for firewood.

For shingleps in 1993 a total of about 7 860 cbm standing volume equivalent were consumed.

Charms:

Charms are splitted square timbers of an approximate size of 5x6" and 4 - 6 m length. They are used as ceiling joists. Out of a coniferous tree 2-4 charms are produced. The conversion factor estimated by BG-IFMP is for 1 tree = 1.3 cbm, it was adjusted to 1.1 cbm.

For Charms production a total of about 20 570 cbm standing volume equivalent were utilized. The per capita consumption in 1993 varied considerably from district to district as follows:

Gasa:	0.13 cbm/capita
Punakha:	0.49 cbm/capita
Wangdi:	0.55 cbm/capita

2.2.2.3 Sawn Timber

Statistics on sawn timber were only be available at Dzonkhag level. Sawn timber is produced by local sawmills for the supply of the rural and urban demand. Most of the required logs are imported from Haa Thimpu and Paro. Sawn timber produced by Druk Integrated Wood Industry is mainly exported to India.

The statistic figures on sawn timber had to be converted from meter cubic solid into roundwood equivalent. Roundwood is measured in Bhutan according to the Quarter of Girth Formula (Hopper's Feet). The following conversion factors were used:

Sawnwood to roundwood (Hopper's Feet): 1.33
Roundwood (Hopper's Feet) into standing volume equivalent: 2

Rural Supply:

Rural supply of sawnwood is provided by the Forestry Department on subsidized rates (50% of the urban rate). Altogether about 620 cbm of sawnwood was supplied to the rural population (0.016 cbm/capita) wihich is equivalent to 1 660 cbm of standing volume (0.043 cbm/capita).

Urban Supply:

In 1993 a total of about 4 110 cbm of sawnwood was delivered to the urban market. The total urban population within the three districts is only 3 535 persons. The calculated per capita consumption related to the urban population would be 1.16 cbm/capita sawnwood equivalent or 2.91 cbm/capita standing volume equivalent (10 290 cbm). This, of course, cannot be the real consumption for an ordinary urban citizen. In this figure the sawnwood demand for public buildings (Dzong renovation, NRTI construction and others) are included. Therefore this figure still has to be adjusted, too.

Export:

Altogether 6 000 cbm (Hoppers' Feet) of roundwood equivalent were exported to India of which 80% were sawn timber and 20% were logs. Thus, the sawnwood exported is equivalent to 9 600 cbm standing volume.

2.2.2.4 Roundwood

Industries:

In 1993 a total of 3 400 cbm roundwood (Hopper's Feet) was delivered to the Druk Integrated Wood Industry. This is equivalent to about 6 800 cbm standing volume.

Export:

As mentioned earlier of the 6 000 cbm roundwood produced for export to India, 20% were delivered in form of logs. The total equivalent in terms of standing volume was about 2400 cbm.

2.2.3 Per Capita Consumption

The wood consumption per capita for rural households is calculated in Table 3 and for rural and urban households in Table 4 below:

Table 3: Wood consumption 1993 of rural population in standing volume equivalent.

District	Population	Firewood		Construction	Total	
		total	per cap.	total	per cap.	
	capita	cbm	cbm	cbm	cbm	cbm
Gasa	2400	5518	2.30	582	0.24	2.54
Punakha	13125	19640	1.50	11597	0.88*	2.38
Wangdue	21175	34975	1.65	21672	1.02*	2.68
Total	36700	60133	1.64	33833	0.92	2.56

* This however most probably includes hewnwood produced for NRTI construction and Dzong renovation.

Table 4: Domestic wood consumption per capita (without industry and export) in standing volume equivalent.

District	Population	Firewood		Construction	Total	
		total	per cap.	total	per cap.	
	(capita)	(cbm)	(cbm)	(cbm)	(cbm)	(cbm)
Gasa	2755	6173	2.24	582	0.21	2.45
Punakha	14835	22063	1.49	13037	0.88*	2.37
Wangdue	22645	37058	1.64	30522	1.35*	2.99
Total	40235	65294	1.62	44141	1.10	2.72

* This however most probably includes hewnwood and sawnwood produced for NRTI construction and Dzong renovation

The firewood consumption estimated in this analysis is almost at the same level as the fuelwood consumption calculated in the Nahi Management Plan for Wangdue Phodrang Dzongkhag which was estimated at 1.664 cbm/capita and year. It is however below the figures estimated by RGOB/MOA/DOF 1991 (d), which estimated the annual fuelwood consumption for Punakha at 2.15 cbm/capita and for Wangdue Phodrang at 2.21 cbm/capita.

RGOB/MOA/DOF 1991 (e) estimated the domestic demand on construction timber at 0.15 cbm/capita which is equivalent to 0.40 cbm/capita standing volume. This figure is double as high as the consumption calculated for Gasa, but much lower than those calculated for Wangdue Phodrang and Punakha Dzongkhags. As mentioned earlier, this might be due to the fact that in 1993 a considerable amount of construction timber was produced and supplied for the renovation of the Punakha Dzong and the NRTI construction.

2.3 Wood Flow

Table 5 shows the sources of wood which is consumed within Gasa, Punakha and Wangdue Dzongkhags:

Table 5: Sources of wood

Source of Wood	(cbm)	(%)
Forest Management Units	24000	18
Other forests	95000	73
Import	12000	9
Total	131000	100

Forest Management Units:

Table 6 lists the forest management units in Gasa, Punakha and Wangdue Phodrang Dzongkhags and describes their present management status:

Table 6: Management Units within Project area

Name of FMU	**AAC**	**Status**
Kothoka	6000	new plan in preparation
Nahi	10000	plan ready, not yet in operation
Rimchu	nil	already exploited, new management plan in preparation
Kame Chhu	unknown	reconnaissance survey ongoing

Timber produced in forest management units is at present mainly used for the supply of the wood industry (Druk Integrated Wood Complex) or exported to other Divisions in Bhutan (e.g. GWMC Gedu Wood Manufacturing Complex) or to India. This refers to sawn timber as well as to roundwood. The logging residuals are used as firewood (e.g. at Rimchhu) or are carbonized as charcoal (e.g: Kothoka). Firewood is extracted by local contractors and sold to the urban markets. Charcoal is sold by BLC to BCCI (Bhutan Carbon Corp. Inc).

The present production capacity of Nahi and Kothoka FMU is estimated at about 16 000 cbm per year. It has, however, to be mentioned, that the AAC of Nahi might be overestimated due to a calculation error. Also the production potential of Kame Chhu seems to be fairly low, as the terrain has a high proportion of protection forests and inoperable areas. Also broadleaved and chirpine forests dominate which are of low production potential.

According to Table 1 the timber production for export and the supply of the wood industry was estimated at about 24 000 cbm. Compared with the present potential of the FMU's it is obvious that the future demand can only be supplied in a sustainable way, if additional FMU's are opened. As a result of the forest resource potential assessment (see chapter 3) one suitable

forest area of about 6 000-7 000 ha was identified at Gogona and a smaller area at Sephu (about 2 000 ha). If this area would be taken under management, the future demand could most probably be supplied.

Other Forests:

One of the most important results of this analysis is, that 73% (about 95 000 cbm) was exploited in 1993 in forest areas outside of sustainable managed FMU's. This refers to the whole supply with fuelwood, polewood and hewnwood which is required within the three concerned districts.

Trees to be exploited are marked by the Beat Officer taking into consideration silvicultural aspects. However, as transport from the forest to the consumption place is the main bottle neck, forests close to settlements or on both sides of roads are overexploited. This in particular refers to the self supply with firewood. Additionally they are usually subject of browsing, sokshing and bushfire.

For how long these accessible forests can supply the demand on fuelwood and local construction timber cannot be predicted at this place (see also chapter 2.5 Conclusions).

Import:

The roundwood required for the production of sawnwood for the rural and urban market is in most cases imported from Haa at Thimpu or Paro. Roundwood is converted by private sawmills and sold to the consumer at fixed rates (determined by the Central Government). The rural rate is subsidized (50% of the urban rate). The sawmillers are refunded with roundwood. The supply with sawnwood is regulated by the Divisional Forest Officer.

The total amount of roundwood imported in 1993 was about 12 000 cbm standing volume equivalent. Almost exactly the same volume of timber was exported, but it's quality was quite different. Usually bad logs were exported to India, while good logs were imported for the production of sawn wood.

2.4 Wood Demand Forecast

To predict the future timber and firewood demand is almost impossible. There are too many factors influencing the actual consumption, some increasing, some reducing the consumption rate. They are briefly described in the following.

Population development:

The average annual population growth rate within the period of 1986 to 2006 was estimated at 2.3% (CSO 1988, 1989: Statistical Yearbook of Bhutan). At present the average household size is 6.7 which will most probably decline in a linear way to 5.7 in the year 2006 (UNDP/ITU, 1989: Bhutan Telecommunications Development Plan, Volume 2).

Population growth and the reduction of the household size would naturally lead to an increase in the per capita consumption for both fuelwood and for construction timber.

Livelihood:

Higher per capita income and living standard would most probably lead to a reduction in fuelwood as other more convenient fuels would be used. Also, maybe newly constructed houses would be better isolated, thus reducing the demand on fuelwood for space heating. Or space heating would be done with electricity or other energies. On the other hand more sawnwood and timber would be required for furnitures, etc.

Urbanization:

The urban demand on fuelwood is about 50% (RGOB(MOA/DOF 1991 d) of the rural demand. Urbanization would therefore decrease the per capita consumption considerably, as 52% of all the wood consumed in the three districts is used as fuelwood.

Wood market:

Continous overexploitation of forests which are not managed sustainably as a FMU will lead in the long run to a scarcity of wood. This will naturally reduce the supply with fuelwood and local construction timber. Also if the prices would increase (as this would be the case in an open market), or if subsidies would be abandoned, the wood consumption per capita would most probably be reduced considerably. Right now, there are no incentives for the people to save

wood, as it is available at low prices. Higher prices on fuelwood may lead to the use of other energies or improved stoves, higher prices on construction timber may change the local type of house construction which requires an enormous amount of wood. Or instead of wooden shingles, corrugated iron sheets or tiles made out of clay or slate might be used for roofing.

Scarcity of wood may also lead to reduction of export. Especially logging residuals which are at present carbonized and sold to BCCI might be used as fuel within the districts.

Wood demand for public buildings:

In 1993 a considerable amount of wood was required for the renovation of the Dzong at Punakha and the construction of the NRTI building in Wangdue.

It cannot be predicted whether in future this high amount of timber will be required for public buildings or not. But it is most likely, that this extraordinary high wood demand for public buildings will only be required at irregular intervals.

Wood demand forecast:

As mentioned before it is impossible to give a reliable prediction of the future wood demand. But it could be assumed, that all these factors might compensate each other and that the total wood demand (including industry, export, etc.) per capita remains at the same level or will even be reduced.

2.5 Conclusions

As mentioned before about 95 000 cbm (73% of the total demand) of wood was exploited from forest areas which are not managed in a sustainable way. This will lead in the long run to an almost irreversible depletion and devastation of accessible forests. It is therefore recommended to develop sustainable management systems incorporating socioeconomic and other landuse aspects (agroforestry, community forestry, social forestry, silvopastoral systems, just to mention some keywords).

For a continuous supply of the wood processing industry and the export market it is necessary to open additional FMU's which can provide sustainably an annual cut of about 10 000 cbm.

The forest area around Gogona which was identified as a potential FMU-area during the forest resources potential assessment (see chapter 3) in combination with temporary FMU's (smaller size units, which are only managed periodically but on a sustainable basis) could most probably meet the future demand.

The comparatively high wood demand per capita should be reduced in future. A proper pricing policy (abolition of subsidies, open market) may have an higher effect on the consumption than, for example, public campaigns on introduction of improved stoves, use of alternative energy sources etc. might have.

2.6 Further Actions Required (by BG-IFMP)

This wood demand analysis is a rough estimate. It could be improved considerably if the following questions could be answered:

- What was the amount of hewnwood, roundwood and sawnwood required for the Dzong renovation and NRTI construction in 1993 and where did it come from?
- Are the applied conversion factors realistic?
- What is the percentage of fuelwood which is collected for self supply which does not affect the standing volume (below 10 cm diameter, deadwood, fallen branches etc.)
- Are the consumption figures of 1993 typical or extraordinary?
- Is the assumption "demand = supply" correct?

Within the limited time of the short-term consultancy these essential questions could not been answered. It is therefore recommended, that BG-IFMP carries out additional studies to answer these questions and incorporates the results into this analysis.

3 Forest Resource Potential Assessment (FRPA)

3.1 Objective

To set priorities for future forest management it is of greatest importance to know whether the forest resources within Gasa, Punakha and Wangdue Dzongkhags can supply in the long run the wood demand within this area, both in an ecological and economical sustainable way.

For forest resource assessment the following four different planning levels can be distinguished:

1. Forest Resource Potential Assessment

It is the objective of the FRPA to identify on a macroplanning level all forest areas which have a potential for future forest management.

2. Reconnaissance Survey

The reconnaissance survey is a more detailed assessment including ground survey which should lead to the decision whether a particular forest area should be managed as a FMU. Resource information, environmental and socio-economic aspects are assessed on feasibility level.

3. Forest Management Plan

A forest management plan is based on detailed resource information on FMU-level and specifies the areas of intervention within a 10 years planning period. It considers environmental, economical and socioeconomic aspects in an adequate way.

4. Operational Plan

This is a type of work plan for a two years period which specifies all planned management activities. It is based on detailed resource information on coupe-level.

For the purpose of analysing the present status of forest resources and its future potential to supply the domestic wood demand, the FRPA on a macroplanning level is most relevant. The resource assessment strategies for the other three planning levels are described in chapter 4.

As mentioned in chapter 2 the wood demand of the three districts is presently supplied from the following three sources:

- Forest Management Units (FMU's);
- forests outside FMU's;
- import.

The largest share of the rural demand (firewood and local construction timber) is supplied by forests outside of FMU's which are in the vicinity of settlements. This is done by the local population itself based on permits provided by the DFO. To assess the future potential, general information on the forest condition and the size of accessible forests is required.

For the local supply of sawnwood logs are usually (at least this was the case in 1993) imported from Haa Thimpu and Paro. The import of logs is at present almost equal to the export of logs

(produced in FMU). According to information from the FSD, Haa has still enough timber to continue its supply for the next future.

The timber supply for the wood industry and for export to other districts or to India is produced presently in forest management units.

It is the policy of FSD to produce in future as much as possible of the required wood in a sustainable way within permanently managed FMU's. The main objective of the present FRPA was therefore to identify forest areas within the three districts which most probably have the potential to be managed as a FMU.

3.2 Approach and Methodology Applied

For the selection of a FMU many different criterias have to be considered. Some of them can be derived from information available on maps, remote sensing data and already existing plans, others have to be assessed in the field. For the FRPA on macroplanning level only information already available can be used.

A FMU is defined as a forest area where permanently forest management activities are carried out in a sustainable and economic way. For the purpose of FRPA a forest area can thus be considered as a potential FMU if it fulfills the following criteria:

1. Forest condition and type

The forest should be well stocked and should consist of a high percentage of valuable (commercial) species.

2. Accessibility

The forests must be accessible and/or road construction must be economically feasible and environmentally sound.

3. Technical (and economic) aspects of management

The relief should not be to difficult. The percentage of inoperable areas should be within limits, otherwise road construction and the set-up of harvesting systems would be not economic.

4. Size

To be permanently managed and to justify the set-up of forest infrastructure from the economic viewpoint a forest area should have a large enough size (> 4 000 ha).

5. Availability

The forest area should not fall into a restricted area or be already otherwise planned.

Socio-economic aspects cannot be answered on a macroplanning level. This should be a subject on reconnaissance and on management planning level.

To identify areas which fulfill the above mentioned criteria it was decided to carry out a GIS-based analysis linked with a sort of visual map interpretation. The parameters set for the GIS based analysis were:

- exclude all non-forested areas;
- exclude all areas with slopes > 100%;
- mark all areas of difficult terrain (75-100% slope);

- exclude (unproductive) forests of low canopy density or with a high percentage of not commercially attractive species which were in particular: all forests with a crown density below 40% (LUPP land use classes: FCf1, FCm1, FCb1, FBc1,), forest shrubs (FS1-3), broadleaved forests with density below 80% (FB1-2) and chirpine forests (FCc1-3).

The GIS-Unit of the FRDS was not in the position to carry out the analysis as information on slope for the concerned districts were not yet incorporated into their system. Due to software problems, the GIS-Unit on the other hand could not use the concerned DEM-files disposed by LUPP. It should be mentioned at this place, that in future the GIS systems used by LUPP and by the GIS-Unit/FRDS should be compatible. Also the same work should not be carried out twice but rather complementary (GIS/FRDS should concentrate on forestry aspects, forest types, etc. Topographic features such as altitude, slope, aspects, rivers, roads, settlements, etc. should be digitized by LUPP and disposed on DEM-files to GIS/FRDS. Vice versa this should refer to forestry related information. This would considerably reduce the work-load of GIS/FRDS.).

Due to time constraints and hardware problems LUPP could not finalize the analysis yet. To obtain already some preliminary information about the availability of potential forest areas a "manual GIS-analysis" was implemented based on two layers of mylars. The same parameters as mentioned above were applied. The information was derived from LUPP Landuse Working Maps at a scale of 1:100.000 and 1:50.000 and verified by aerial photo and satellite image (SPOT panchromatic) interpretation.

Additionally already existing FMU's (Kothoka, Nahi, Rimchhu. Kame Chhu and Chendebji), National Parks (Jigme Dorjie, Black Mountain) and other restricted areas (conservation area for

Black-necked Crane wintering at Phobjikha, watershed of hydroelectric power station at Basechhu) were excluded. Based on visual assessment the remaining areas were checked on their potential accessibility (considering technical, economical and environmental aspects) and size.

3.3 Preliminary Results

After application of all the above mentioned criterias only the following two potential forest areas could be identified.

Forest near Gogona, Athang-Bjena Gewog, Wangdue Dzongkhag

This forest has an area of about 6 000-7 000 ha and consists mainly of conifer and mixed conifer forests of good condition.

The area has been visited and the potential for future management seems to be quite good.

Most parts of the forests are intensively used for browsing (yak-wintering and cattle).

The construction of about 20 km forest road starting from Phobjikha would make the whole area accessible. Road construction would be, from the technical viewpoint, quite easy as the terrain is not very difficult. Total costs for road construction would be around 17 Mio Nu (850 Nu/m based on BG-IFMP estimate). Most of the area could be harvested by cable crane. The percentage of inoperable areas seems to be within limits.

A disadvantage, however, is the long transport distance from Phobjikha to the timber market at Lobesa (wood industry), which takes about almost 3 hours by car. Also the road has not everywhere been constructed for the use of heavy transports. The production of semi-finished products (local sawmills, etc.) within the FMU could help to minimize transport cost.

Another alternative would be to do without road construction from Phobjikha, but instead to connect Gogona with Kothoka FMU by establishing a cable crane system for the transport of semi-finished products. This alternative, however, has to be considered very carefully, as already today the Tashila ropeway is the bottleneck for the management of Kothoka (remark: all the timber produced by Kothoka FMU has to be transported via the privatized Tashila ropeway. Kothoka FMU has no direct road connection to Lobesa).

As described more detailed in chapter 4.3.1 before deciding on the opening of Gogona a reconnaissance survey comprising of more detailed resource information, a socio-economic study, a cost-benefit analysis with special consideration of the required infrastructure and a preliminary environmental impact assessment should be carried out.

Forest near Sephu, Sephu Gewog, Wangdue Dzongkhag

This forest area is partly included in Chendebji FMU which belongs to Tongsa Gewog. The remaining area is about 2 000 ha and is too small to be managed permanently as a FMU. Due to time constraints, the area could not be visited.

The largest part of the forest consists of mixed conifers of density class 2 (40-80% canopy) according to LUPP land use category. The forest area could be made accessible by construction of a forest road of approximately 7 km length. Due to the difficult terrain the total cost are estimated at around 12 Mio Nu (850 Nu/m * factor 2).

Other Areas

There are more forest areas which fulfill all the above mentioned criterias but which have a size below 2 000 ha.

3.4 Preliminary Conclusions

If the above mentioned potential FMU at Gogona and the smaller Unit at Sephu (in combination with Chendebji FMU?) would be opened, the present wood demand required from permanently managed FMU could most probably be met in future (see also chapter 2.5).

To avoid the further degradation of accessible non-FMU forest areas it should be a future forest policy to supply, as much as possible of the public wood demand, from sustainable managed forest areas (FMU). For this purpose and to meet irregular, extraordinary high timber demand for public buildings, smaller forest areas should be taken under management, too. They could be managed temporarily based on a type of rotation system in order to safeguard long-term sustainability. How this could be done in detail is not subject of this study.

3.5 Further Actions Required

A more specific and detailed FRPA will result from the LUPP analysis. This will include area information based on different forest types on Gewog-level.

Once the LUPP GIS-based analysis is available, FRDS - with technical support of BG-IFMP - should undertake the following steps:

1. Exclude existing and already planned FMU's, national parks and restricted areas as was done for the "manual GIS-analysis" (see chapter 3.2).

2. Calculate the remaining area of the different forest types on Gewog-level.

3. Identify potential permanent (> 4 000 ha) and temporary (500-4 000 ha) FMU's.

4. Calculate based on inventory results of other FMU's with similar forest condition average stand data (standing stock, increment, tree species and diameter distribution). This should be done by incorporating inventory plot location references into the GIS-system to enable a linkage of the inventory plots with the LUPP land use categories. Then for all inventory plots of the same land use category the average stand data should be calculated using the <PLOT> data processing program.

5. Calculate for the whole project region result tables for:

   - each potential temporary FMU;
   - each potential permanent FMU;
   - all potential non FMU forests;
   - potential non FMU forests in the vicinity of settlements.

6. Calculate the total production potential for the Project region.

7. Analyse and valuate the result (in particular in its relation to the wood demand).

3.6 Recommendation to BG-IFMP

As a result of the FRPA and the Wood Production and Demand Analysis the need for forest framework planning on district level becomes obvious. It is therefore proposed that the BG-IFMP should assist FSD/FRDS/DFO in the development of forest framework planning for the three Dzonkhags and in the development of forest management concepts within and outside of FMU's.

Also, as a large proportion of the wood is presently produced by the local people itself in a not very much sustainable way, another field of engagement for BG-IFMP could be to support the territorial forest service which is responsible for non-FMU forest management. This should include the development of sustainable management systems incorporating socioeconomic and other land use aspects (agroforestry, silvopastoral systems, community forestry, social forestry, etc.) and assistance in the establishment of decentralized timber utilization units (mobile saws, etc.).

4 Forest Resource Inventory and Management Planning

According to the Draft Forest Policy, 1990, commercial logging in Bhutan is only allowed in areas for which an approved management plan exists. The strategy of the Government is to establish one forest management unit in each dzonkhag during the 7th five year plan i.e. before July 1997 (M. Määttä, 1993 b).

Forest management planning in Bhutan is carried out by the Forest Resources Development Section (FRDS) of the Forestry Services Division (FSD).

For management planning various information on the forest resource is required. Area information on different land uses and forest types are provided by the Aerial Photo Interpretation Unit (API) and by the Geographic Information System Unit (GIS).

The most essential information for management planning is information on the forest condition such as tree species and diameter distribution, standing stock, increment, etc. This information is gathered by specialist teams of the Forest Inventory Unit.

Based on this information and on own field checks and additional studies the management planner prepares a management plan for a particular FMU for a period of 10 years.

The management planner therefore depends to a large extent on the information obtained from forest inventories and the final management plan can only be as good as the information provided.

It was the task of the short-term consultant to critically analyse the applied forest inventory methods and to assess the validity of the inventory data.

4.1 Brief Description of Forest Inventory Methods

There are at present four different types of inventories or field surveys carried out within the area of a forest management unit in Bhutan which are:

- Reconnaissance Survey
- Forest Management Inventory
- Operational Inventory
- Tree Marking

4.1.1 Reconnaissance Survey

It is the objective of the reconnaissance survey to provide information for the planner to decide whether a forest area is suitable for commercial logging and whether a FMU should be opened or not.

Beside field cruising, information is gathered by analysis of (1) topographical maps (mostly dating from the 1960's), (2) satellite imagery (panchromatic SPOT images from 1990), (3) PIS land use maps (1976 - 1981) and (4) LUPP working maps (from 1994 onwards). There is no systematic sampling or forest assessment being carried out at this stage.

The results of the reconnaissance inventory is presented in the form of a report describing the general conditions of the area, together with maps outlining a more precise boundary definition and preliminary zoning for utilization (Laumans, 1994 f).

4.1.2 Forest Management Inventory

If the results of the reconnaissance survey are positive and the decision is made to declare a particular forest area (usually a complete watershed) as a FMU, the exact boundary is defined and a forest management inventory is carried out.

This inventory has to provide all information required for the preparation of the management plan and the calculation of the AAC. Therefore this inventory is most essential as its result defines the management for the next 10 years.

The implementation of the forest inventory is carried out following the "Guidelines for Forest Management Inventory Fieldwork" which was prepared July, 1994 by P. Laumans within the UNDP/FAO Forest Resources Management and Institutional Development Project. A flowchart

describing the individual inventory steps from reconnaissance survey to field work is attached in Annex 7.

Data processing and compilation of results is done based on the tailer-made <PLOT> System (S. Kowalcyzk, 1993).

P. Laumans, 1994 (f) formulated the general objectives of the forest management inventory as follows:

O1: "to obtain, in an efficient and practical way, sufficiently accurate key information concerning the composition of forest resources in the FMU in the form of thematic maps, tabular overviews, general descriptions and interpretations. In this respect, generally not more data should be collected than is really needed and will be actually used during subsequent data processing."

O2: "to include in the forest resources more specifically: resources of timber and fuelwood (dbh 10+ cm), its regeneration potential (dbh > 10 cm), growing conditions and the quality of the site, non-wood forest produce, and the presence of keey wildlife species."

O3: "to collect comprehensive information on the forest resources only on areas within the FMU defined as natural forest lands having a crown closure of 10 percent or more which are considered accessible, either physically or otherwise."

O4: "to ensure, as a guide for the precision of the obtained results, a final sampling error for the estimate of the overall gross wood volume of the forest area of +/- 10%, at a confidence level of 95%."

O5: "to obtain, during the course of the fieldwork, other advance information which may assist in the subsequent management plan preparation for the FMU such as: socio-economic data (household requirements etc.), the effect of past and ongoing forestry operations (removals, regeneration status etc.) and more specific aspects of nature conservation".

Basemaps and determination of sample grid:

As basemap for the inventory field work mylar enlargements of the relevant toposheets are prepared at a scale of 1:20 000 or 1:25 000 which contains 40 m contour lines and reference points.

Aerial photo interpretation is then carried out for the defined FMU area which includes topographical details and classification of different land use types (forest types). Intensive ground truthing is then carried out to verify the information in the field. Finally the aerial photo interpretation map has to be transfered to the "API-basemap". This requires perspective and affine corrections as the aerial photographs contain displacements due to tilt and the mountaineous relief. This is either done by the Survey of Bhutan or by using the Bausch & Lomb zoom transfer scope at the API-Unit of FRDS). As this is a time consuming process the aerial photo interpretation basemap is usually not available when the field inventory starts.

This basemap is then digitized using the vector-based GIS software PC-ARC/INFO and together with the attribute databases they form the "GIS-map". This GIS-map is in most cases only available after the inventory field work had already been carried out.

The inventory design presently applied is a linear distribution of fixed sample circles throughout the FMU area. As usually neither the API- or the GIS-basemap is available at the beginning of the inventory field work, the proposed stratified systematic sampling and, the limitation of the field survey to accessible natural forest areas with a crown closure of more than 10%, is in most cases not applied (see Objective O3).

The calculation of the number of sample plots required and the determination of the sampling grid to be used has therefore to be based on an estimated average coefficient of variation (CV%). As the whole FMU area is regarded as the target population the grid distance is quite broad (e.g.: Nahi: 250X1 000 m, Rimchhu: 325X450 m).

The sample grid is then transfered to the topographic basemap and a starting point for the grid is defined. For the individual inventory plot locations the geographic coordinates are then calculated to enable a transfer of the plot locations into the GIS basemap or the use of GPS.

Inventory field work is carried out by specialist teams. At present, for the whole of Bhutan two teams consisting out if two crews each, are available.

Sample plot design and field work:

The following different types of data are assessed in the field

1. Observations along the survey (grid) line:

While approaching a given sample plot observations made on a 50 m wide strip on both sides of the grid line are recorded in a "compass sheet" (for an example see Annex 8). This refers in particular to:

- slope correction
- land use type
- tree canopy (tree height and closure)
- particularities (remarks)

The main purpose of the compass sheet is to provide a wider overview of the conditions in the FMU compared to observations made on only the plots themselves, to be a logbook, to verify the location of the line as against the basemap, for future reference, to serve as a ground control of the image interpretation, and to assess the wildlife status of the area (P. Laumans, 1994 f). Tree data entry for the compass sheet is optional.

2. Data collected at the sample plot:

There are two different type of sample plots: normal plots and special plots. For both types general plot information (altitude, land use type, estimated canopy height and closure, accessibility), tree related data, site informations (aspect, stand condition, non-tree vegetation, signs of human impact, soils, etc.) and observation on wildlife are collected (see Tally Sheet attached in Annex 8). For special plots additional tree related information is collected (usually every fourth plot is regarded as a special plot).

All trees with a dbh > 30 cm within a radius < 12.62 m and all trees with a dbh 10-29 cm within a radius < 5.64 m are regarded as sample trees. For these sample trees the following data are asssessed:

- tree species and species code
- dbh

and for special plots additionally:

- special features (e.g.: fork, broken top, decay, etc.)
- total tree height (measured)
- visual log grading
- last 10 years' radial wood increment (for conifers only)
- single bark thickness (for conifers only)

On both, the normal and the special plots, the number of regeneration with a dbh < 10 cm per species is counted.

The species list contains more than 330 different species (trees and other vegetation), which have to be identified if they occur (other vegetation only for special plots)!

The location of the sample plots are surveyed with the help of the basemap, compass, altimeter and measurement tape starting from a reference point. GPS (Ground Positioning Systems) are not available, but their use was already proposed by P. Laumans. For survey in hilly terrain slope correction is neccessary which is done with the help of a slope correction table presented in the guidelines (P. Laumans, 1994 f). The horizontal projection of distance measurements has to be done for the identification of the plot location as well as for the radius of the sample circles. The slope correction factor however, is different for line measurements and for the correction of a sample circle radius. This has not been considered in the slope correction table presented in the guidelines which leads to an error in the sample size (see chapter 4.2).

Calculation of results:

As mentioned before, for the calculation of the inventory results a tailor made EDP software named <PLOT> is used. The program is quite flexible and allows different types of analysis. Data processing is done by the Inventory Section of FRDS.

For every FMU the results are presented in an Inventory Report. This report contains various sets of result tables (e.g. number, basal area, volume and increment for different species according to different diameter classes, regeneration, site and stand characteristics, statistics) and local volume tables. The results are calculated on a probability level of 95%, but only for the total FMU area the standard error should be within the 10% limit. The results are also calculated for different strata, but with a much higher standard error (e.g. Nahi: 20.1 % for Hardwood with Oak, 39.9% for Hemlock!). The inventory results are therefore only reliable estimates for the total area and cannot be used for estimates on block or compartment level.

For volume calculation the PIS volume functions are used. The volume is calculated as stem volume under bark from stump to 5 cm top diameter.

Local volume tables are calculated for each FMU based on diameter/height measurements.

4.1.3 Operational Inventory

As mentioned above, the results of the forest management inventory can only be used for the total FMU area. For practical forest management, in particular for deciding on the annual coupe size and whether the required set-up of infrastructure (roads, cable crane) is economic, more detailed and accurate information is required.

Therefore operational plans are prepared for a specific part of a FMU in order to schedule the activities for the next two years, within the framework of the overall 10 year management plan. An inventory of the area that is to be scheduled is required to provide the basic information for the operational plan (P. Laumans, 1994 a).

The set-up and the design of an operational inventory is described in detail in the "Guidelines for Operational Inventory" by P. Laumans May 1994 which were elaborated in frame of the UNDP/FAO Forest Resources Management and Institutional Development Project.

An operational inventory covers at last an area of 3 times the size of the annual allowable cutting area which is around 50-150 ha for an average FMU.

Operational inventories are carried out by the divisional forestry staff under the responsibility of the DFO and not by FRDS.

According to Laumans, fieldwork, assuming 1-2 field crews, should usually take less than one week to complete, depending on terrain conditions, minimum dbh required, and size of area. This time frame seems to be very optimistic.

The system applied is similar to the forest management inventory however the sampling density is much higher. Laumans recommended a systematic distribution of a minimum of 30 and a maximum of 50 sample plots for the total area. The sampling precision for a operational inventory is +/- 30% on 95% probability level. But the results obtained for this particular area is much more precise than if the strata results of the management inventory would be used as an estimate.

The same type of concentric fixed-size circular sample units are used as in the mangement inventory. However, the use of the "Bitterlich" relascope for basal area counts (factor 9) is already proposed in the manual.

In contrast to the management inventory the operational inventory concentrates on information on the timber resources, but only species, dbh, special features and for every 5th plot the tree heights are recorded. Log grading is not done! Regeneration and site or other parameters are

not assessed. But in addition, a sketch map of the area around the approach line has to be prepared as a complement to the compass sheet (tally sheets see Annex 9).

Data compilation procedures hav been designed in such a way that they can be accomplished using a simple pocket calculator. Compilation proceed in a step-wise fashion by filling in prerecorded forms.

4.1.4 Tree Marking

Before opening of a coup the FMU Incharge and the BLC Incharge of the Production Unit jointly mark every tree to be exploited. Serial number, diameter and estimated height are recorded in the Tree Marking Book and the exploitable timber volume is then calculated. Based on this information the DFO approves or disapproves on the opening of the coup.

After felling and transport of the logs to the log disposal, all logs are measured and recorded in the Log Measurement Book by the BLC Incharge of the Timber Disposal Section.

4.2 Valuation of Inventory Methods and Assessment of Validity of Results

The individual inventories have been designed for a particular purpose and are of a quite high technical standard. However, they have not been developed based on an overall forest resources assessment strategy. Thus the individual objectives of the inventories are not quite clear and they are not reconciled with each other. For example, the reconnaissance inventory should lead to the decision whether a FMU should be opened or not. But this information is only based on the analysis of topographic and landuse maps and random field checks. The economic potential of the forest, the cost for the establishment of infrastructure, socio-economic feasibility, environmental aspects, etc. are not accurately enough assessed to allow such an important economic long-term decision. As it was pointed out in RGOB/MOA/DOF 1991 (b) "The precision needed in the estimates of the planning parameters must be in a sound relation to the cost of a wrongly made decision".

The information provided by the management inventory are not in line with the objectives set. For example in objective 1 it is mentioned "... generally not more data should be collected than is really needed and will be actually used during subsequent data processing." For example, the assessment of the compass sheet and the collection of site parameters are quite time consuming activities. For what is this information required on management planning level? Does it give any impact on the plan to know that in relation to the total FMU-area there is that much

percentage of bamboo, stoniness, topsoils colour etc., if we don't know where? Is it really important to distinguish more than 330 different tree and other plant species, if we are finally only interested in a few particular species or species groups?

Of course, all these informations are important, but only if they are available at a particular level of forest resources management planning. General information on wildlife, biodiversity, intensity of human impacts etc. is already required at the reconnaissance inventory level before the decision for opening of a FMU is made. Information on site, soil, relief, etc. is very important for silvicultural planning on site- or coupe-level. But this type of information is right now collected by the management inventory on FMU-level and is thus of not much value. On the other side, this information is not collected on operational inventory level, which is designed to produce information for stand- or coupewise planning. Also the most important information required for harvesting planning - the expected log recovery - is not assessed. Why to carry out every two years an operational inventory which only provides information on standing volume for different species and diameter classes if this is anyhow much more precisely assessed by the tree marking (which is done one year before the coupe is opened)?

There would be more examples to show that the collection of information on the different inventory levels are not always in line with the objectives set or are not really required for planning purposes.

More comments to management planning inventory

On special plots visual log grading is carried out for all sample trees > 30 cm dbh. The system applied follows the BLC log grading rules. It is very detailed and distinguishes 6 different grades. To do the assessment on a standing tree seems to be quite complicated and time consuming. On the other hand, the only result used for management planning is the total log volume in cbm per working group. This information could be assessed in a more simple way (by measuring the bole length or by using log recovery functions).

Objective 3: "to collect comprehensive information on the forest resources only on areas within the FMU defined as natural forest lands having a crown closure of 10 percent or more which are considered accessible, either physically or otherwise."

This is a very important recommendation which would reduce the cost of the inventory considerably. But at present, due to the insufficient capacity of the aerial photo interpretation section, mapping has to be done simultaneously with the inventory field work. On the other hand, stratified sampling, which has been already proposed by Laumans, 1994 (f) and which

would lead to a reduction of the required number of samples or to an increase in precision, cannot be applied either.

Objective 5: "to obtain, during the course of the fieldwork, other advance information which may assist in the subsequent management plan preparation for the FMU such as: socio-economic data (household requirements etc.), the effect of past and ongoing forestry operations (removals, regeneration status etc.) and more specific aspects of nature conservation".

It is not described in the guideliness which data and how they should be assessed.

Due to labour and time constraints in many cases control checks have not been carried out. This may lead to a high percentage of bias.

The application of fixed concentric sample circles for the selection of sample trees is not very much appropriate out of the following reasons:

1. To keep the sample area constant, slope correction has to be carried out in hilly and mountaneous terrain. This slope correction should be ideally done in three dimensions which is practically not feasible. At present slope correction is done by increasing the sample radius according to a slope correction factor provided by Table 4-1 of the Guidelines.

2. It is a quite time consuming activity to measure an exact circle on a steep slope, especially if it is densely stocked.

3. The most important information which has to be provided from the management inventory is an estimate of the standing volume and the increment. This is used as basic information for the calculation of the AAC during management planning. Both, the standing volume and the increment are more dependent from the diameter of the tree than from the number of trees per ha. The selection of sample trees according to probability proportional to size (that would mean dependent from the dbh) would increase the preciseness of the estimate on standing volume and increment and would allow a reduction of the number of sample plots, if the same preciseness level (+/- 10% on 95% level) would be applied.

The above mentioned constraints led to the fact that the presently applied forest inventory systems require at present a high input in terms of budget and human resources without getting the optimum on information and preciseness.

Validity of Results:

If the slope correction factors of Table 4-1, Page 47 of the "Guidelines for Forest Management Inventory Fieldwork" and of Annex 2 of the "Guidelines for Operational Inventories" are applied, than the calculation of the standing volume and the increment is wrong!!!

Explanation: Slope correction is carried out in the field in order to measure always a fixed sample area (for example: for trees > 30 cm dbh the sample size should always be 500 m^2, which corresponds to a radius of 12.62 m on horizontal projection). On slopes the horizontal projection of a circle is an ellipse, as correction has to be made only along the slope line (see Figure 1).

Figure 1: Slope correction of sample circles

sample circle horizontal/slope	corrected circle	horizontal projection of circles on slope
rs = r*cf	rc =_(rs*r)	

r = radius of sample circle
rs = horizontal slope correction for radius r (rs=r*cf)
rc = corrected radius
cf = correction factor for horizontal distances

The area of the corrected circle (Acc) must be equal to the area of the ellipse (Ael):

Acc = rc^2*_
Ael = r*rs*_

The correct radius for the sample circle on a slope is then:

rc^2*_ = r*rs*_
rc =_(r*rs) or rc = r*_cf

The correction radius however was calculated in Table 4-1 as follows:

rc = rs

This leads to a considerable overestimation of the sample area with increasing slope as shown in the following example:

slope: 30° or 58%

horizontal slope correction factor: 1.156
r= 12.62 (sample area: 500 m^2)

correct rc = _(12.62 * 12.62 * 1.156) = 13.56 m

If this circle is horizontally projected the emerging ellipse has the following area (Ac):

Ac = r1*r2*_ = (13.56/1.156 * 13.56)*_ _ 500 m^2

wrong rc = 14.58 m

If this circle is horizontally projected the emerging ellipse has the following area (Aw):

Aw = (14.58/1.156 * 14.58)*_ _ 577 m^2

For a slope of 30° the area overestimate is already more than ((577-500)/500)*100) = 15%. For Nahi FMU the standing volume was overestimated for 18.1% (see calculation based on Table 28 of Nahi Inventory Report in Annex 10). Additionally another factor has to be kept in mind. With increasing slope the number of trees per ha and the average growing stock per ha increases, too. The real overestimate is therefore most probably much higher. This error occurs also in the results of the operational inventories.

In Annex 10 the procedure how to correct already implemented inventory results is explained using the example of Nahi FMU. In Annex 11 a new slope correction table for sample circles is attached.

4.3 Proposals for Improvement of Inventory Methods Based on an Overall Forest Resources Assessment Strategy

Forest resources planning should be based on an overall strategy and the applied assessment systems should be designed according to the objectives of each planning level. As described in chapter 3.1 more detailed the following four planning levels can be distinguished:

1. Forest Resource Potential Assessment
2. Reconnaissance Survey
3. Forest Management Plan
4. Operational Plan

For each of the planning step information on the forest resources is required which have to be provided for planning level 2, 3 and 4 by different types of forest inventories. In the following proposals are made, how the already existing inventories could be improved in order to provide better and more accurate information for each of the planning steps.

A forest inventory and management planning system on FMU level is already well established in Bhutan. The system has been permanently improved and till today quite a number of inventories were carried out and management plans were elaborated. Staff is already well trained and is familiar with the work. The institutional set-up of FRDS is adjusted to the system and all the equipment required is available.

Therefore, the proposals made are based on the following premises:

- The change of a well established system creates usually many new problems. Therefore changes should be only made if the expected benefits overrule the problems. It should be rather tried to incorporate improvements into the existing system than to change it.

- There are limitations in human resources and in finance. The improved system should not be more expensive or more demanding as far as human resources are concerned. It also should be in line with the organisational and administrative set-up.

- Changes made in inventory designs should be compatible with the tailor made <PLOT> program.

- Innovations to be introduced should consider the qualification of the available staff.

It is proposed to reduce the number of inventories or field surveys on FMU level to the following three:

4.3.1 Reconnaissance Inventory

The forest resource potential assessment (see chapter 3) identifies forest areas which could be either managed as temporary or permanent forest management units. This macroplanning step is based entirely on topographic, landuse and vegetational information incorporated into a GIS based analysis. For the final decision, whether such a potential area should be taken under management or not, additional information is required which has to be provided by a reconnaissance survey. This survey should consist out of four components:

a) information on forest resources

b) socio-economic study of the concerned area
c) cost/benefit analysis with special consideration of required infrastructure
d) preliminary environmental impact assessment

ad a) Information on forest resources

The information on the forest resources should be assessed by implementing a reconnaissance inventory which should provide at least the following information:

- identification of protection areas with and without yield
- identification of priority areas for production (mature and overmature stands
- estimate of the percentage of inoperable areas
- estimate of the total standing stock, tree species and diameter distribution, expected harvestable volume and increment per stratum
- rough estimate on a potential AAC.

Brief description of a suitable inventory design:

1. Preparation of a GIS-map showing all protection areas with a slope above 100% (protection without yield) and between 75% and 100% (protection with yield). This map should be based on 40m contour lines.

2. Prestratification of the remaining production area based on the available Land Use Working Map (1:50.000 LUPP) and SPOT panchromatic satellite imagery, verified with aerial photo interpretation.

3. Definition of type of information required and preciseness level for each stratum.

4. Random distribution of clustered sample units.

Sample trees should be selected according to probability proportional to size by using the Bitterlich Mirror Relascope. This would also solve the problem of slope correction. Cluster location should be identified with the help of GPS and field survey. Relascope sampling and the use of GPS for plot identification was already proposed by Laumans. The use of the relascope and the GPS will reduce the time required for the assessment of a sample plot considerably. Also the arrangement of samples in clusters will reduce the time needed to access the plot location. It is estimated, that the implementation of the field work may take for two crews about one month.

For the reconnaissance inventory there is no need to assess natural regeneration (trees < 10 cm dbh) nor to assess site parameters (tally sheet 2/2). Also there is no need for the preparation of a compass sheet. The tally sheet 2/1 which is currently used for the assessment of the normal plots by the management inventory could be employed, also the corresponding part of the "Guidelines". Data processing could be carried out - after slight modification - by using the <PLOT> program.

However, observations on wildlife, minor forest products, human impacts and on biodiversity should be recorded. This should be also subject of the socio-economic study (PRA, RRA).

Control checks of 10% of the samples should be carried out in order to avoid biased errors.

Different concepts for a reconnaissance inventory design should be elaborated (type of cluster, etc.) and a comparative analysis concerning costs and benefit should lead to the final selection of the design.

ad b,c,d: not subject of this report.

4.3.2 Forest Management Inventory

Once the decision has been made to open a potential forest area as a FMU, detailed information are required for management planning. As from the reconnaissance inventory an estimate of the AAC (both in terms of cut and area) is available, the approximate working area (mature and overmature stands, etc.) for the management planning period can be roughly calculated and allocated. To economically use human resources and to save costs it is proposed to carry out management inventory only on the predecided working area. It makes no sense to carry out an expensive inventory in an area which might be used more than 10 years later. The working area will be for a FMU of about 5 000 ha and an estimated cutting cycle of 100 years about (5 000/100)X10 = 500 ha. As, of course, not the whole area can be exploited, it is proposed to define as working area for the first planning period at least double of the size making it about 1 000 ha.

The forest management inventory shall provide accurate information on stand level. This would allow to prepare a management plan which could provide for a defined working area:

- a management map at a scale 1:10 000;
- a detailed stand description;
- detailed information on site condition, human impacts (Tsamdo, Sokshing, etc) and other parameters (wildlife, minor forest products, etc.) on stand level;

- standwise silvicultural planning;
- standwise monitoring and evaluation;
- calculation of an AAC, based on standwise silvicultural planning and a realistic log recovery estimate;
- accessibility and harvesting plan for the working area.

(The preparation of management plans based on standwise planning was already proposed by Seltzer, 1991.)

Operational inventories would no longer be required. The information for operation plans or working plans could be directly derived from the management plan.

Brief description of suitable inventory design (to be applied only for the predecided working area):

1. Preparation of an API-basemap indicating different forest strata.

2. Preparation of a preliminary stand map, taking into consideration the results of the API-basemap and spatial aspects (stand size 10-30 ha).

3. Linear distribution of samples (density for each stand about 6 to 8 samples).

The total amount of samples to be assessed can be roughly estimated as follows: 1 000 ha working area devided by average stand size of 20 ha = 50 stands. 50 stands times an average of 7 samples = 350 samples. 1000 ha devided by 350 samples would mean one sample represents about 2.8 ha. A grid system of 150 X 200 m would be appropriate.

The use of the relascope (see also chapter 4.3.1) for the assessment of trees above 10 cm dbh would speed up the plot assessment. It is estimated that one crew could assess in average about 4 plots per day. The total time required would then be about 88 days per crew, or one team (consisting of 2 crews) could implement the inventory field work in about two to three month.

The assessment of the sample trees should be done according to the "Guidelines". Compass sheet, normal plots and special plots should be assessed accordingly. The same tally sheets can be used and the data processing can be done by using the <PLOT> program. However it is proposed to slightly modify the system as follows:

- Instead of the visual log grading, log recovery should be estimated based on log recovery functions (see chapter 4.3.2 and 4.6), or by measuring the bole length.

- Tree and plant species list should be reduced to leading species, other species groups (commercial, non-commercial, etc.) and for other plants to those important for other uses and for plants which are site indicators. The total number of species to be distinguished by the inventory team should not exceed 50 species.

- Additionally to the compass sheet a sketch map should be prepared as it is done in the operational inventory. This would allow to prepare a very detailed management map, showing particularities such as footpathes, gaps, etc.

To apply this proposed management inventory would also effect management planning in a way, that forest functions (within the working area) could be clearly defined and successively mapped (e.g.: forests used by local people for Tsamdo and Sokshing, erosion protection, watershed protection, biodiversity, wildlife habitat, etc.). Results of a socio-economic study could be incorporated into the plan on stand level. Different objectives could be formulated and in the long-run silvicultural systems for different forest types and forest functions could be developed based on the analysis of stand condition and input/output (standwise monitoring and evaluation).

Operational planning, in particular the selection of coupes and the harvesting methods to be applied can be based on the standwise information of the plan. Also the approximate exploitable standing stock can be estimated.

4.3.3 Tree Marking

Tree marking before opening of the coupe is a necessary silvicultural measure and should continue as it is done right now.

As mentioned earlier, the calculation of the log recovery based on inventory results has not yet been solved satisfactorily.

It is proposed to use the information collected during tree marking and from the recording of the logs at the log disposal to develop local log recovery functions for different species. For this purpose only the results of the Tree Marking Book and the Log Measurement Book have to be linked. This would require, that each tree in the field is marked with its serial number and that every log produced from this tree is marked with the same number. Additionally, during tree

marking the height of at least every 5th to 10th tree has to be measured. The other tree heights can be calculated by using the available height/diameter functions.

Based on these data log recovery functions could be calculated depending on diameter and height which should be incorporated into the <PLOT> program.

The data collection should be done in different FMU's and on different sites.

4.4 Comments on Nahi Forest Management Plan

Management planners depend on the data they obtain from remote sensing, forest inventory and own field checks. As described above, the present management inventory system does not allow a standwise planning or a more accurate calculation of the AAC. This deficit has been clearly seen by the FRDS which resulted in the introduction of operational inventory and planning.

According to the Management Plan from 1993 the AAC of Nahi is determined at 10 000 cbm/year. It was calculated based on the total stock of the operational area devided by the cutting cycle for different working groups. This estimate of the AAC seems to be too high out of the following reasons:

Due to the application of a wrong slope correction factor the area overestimate is about 18.1 % (see chapter 4.2 and Annex 10). The error percentage is the higher the steeper the slope is. On the other hand on steeper slopes there are naturally more trees per ha and there is a higher standing volume. Taking this into consideration the AAC based on the real standing volume might be about 80% of the determined AAC or about 8 000 cbm.

To calculate an AAC (in terms of area and cut) based on the total standing volume of the operational areas of a FMU implies the assumption that the standing stock is everywhere the same. Silvicultural aspects are not considered. A forest can be degraded, immature or in the growing phase, consolidated or even overmatured. At Nahi for example, the eastern part consists out of degraded chirpine, mixed chirpine and broadleaved forests of comparatively low density and fairly bad quality. These forests are also intensively used by the local people for browsing, sokshing and leave fodder production. They are not very much suitable for commercial exploitation, they rather need to be rehabilitated (if the objective is optimization of timber production) or being managed as multifunctional forests in an integrated approach (silvo-pastoral system, community or social forestry etc.). But that would mean that they should be excluded from the calculation of the AAC (or better only the amount of timber removed for local

use or for rehabilitation purpose should be included). A mapping of the Nahi FMU according to the functions and the development of silvicultural systems for each forest type and function would give a more realistic picture of the AAC.

The AAC of Nahi is less than the annual increment estimate of 13 772 cbm. The increment was calculated for conifers based on measurement of increment cores. For broadleaved species this was not done. For these, the growth was estimated based on the assumption, that the relative increment is the same as for conifers. This might be a very optimistic estimate, as usually conifers (spruce, hemlock, fir) grow faster than broadleaved species (e.g. oak). It goes without saying that also the increment calculation is biased due to the area overestimate. But even if the AAC is below the increment it does not necessarily mean that mangement would be sustainable. The average standing stock per ha could be below the potential standing stock. This is definitely the case in the chirpine stands and the broadleaved forests in the east. Utilization of the increment would then mean that the standing stock would be kept at the same level and that these forests could never be improved in order to reach their full production potential in future.

It cannot be quantified to what extent these considerations would lead to a reduction of the AAC, but - if only the economic viewpoint of commercial logging is regarded - the understocked, degraded eastern part should be excluded from the calculation. The total "exploitable" area might then be reduced from 4 200 ha to maybe around 3 000 ha.

Forests of good potential for commercial exploitation are found on higher elevations in the western part behind Nahi (blue pine and hemlock). The terrain there is quite rough and steep slopes dominate. The silvicultural system proposed in the management plan for these forests (they belong to the Timber Harvesting Working Group) is clear cutting followed by artificial regeneration with a proposed maximum clear cut size of 5 ha. Harvesting of timbers and firewood would be done using cable crane. Because of the good potential for natural regeneration and out of environmental aspects (erosion control, protection of watershed) a selective cutting system should be applied rather than clearfelling. The applied silvicultural system and the harvesting method (transport of firewood by cable crane?) also have an effect on the AAC.

Finally accessibility also effects the AAC. Is it worth while to construct a road to an area where the exploitation potential is low? The management plan does not provide area related information on standing stock, this is done at present by the operational inventory. However, accessibility is an important component of the management plan and road construction has to be done before exploitation can start. In case it would not be economic (cost/benefit analysis) to

construct a road to a particular forest area, this should, of course, be excluded from the calculation of the AAC.

It can be concluded, that the AAC of at present 10 000 cbm/year was fixed at a much too high level, because of lack of reliable area-related information. To give an estimate on a more realistic AAC is not possible without further investigation.

4.5 Recommendation to FRDS

The error due to the application of the wrong slope correction factor in management inventories should be corrected and the AAC adjusted accordingly for all FMU's.

The best and most correct way would be, to recalculate the inventory results with the <PLOT> system. As the slope is known for each sample plot (tally sheet 2/2, see Annex 8) a slight modification of the <PLOT> program would be necessary to do this. Simply for each sample plot the area-overestimate has to be calculated and the plotwise results have to be corrected accordingly. However, it is sometimes difficult and also critical to change or modify a tailor made program.

Another way to do the correction is described in Annex 10 on the example of Nahi. For other FMU's only the shaded columns have to be adjustd accordingly. If this type of correction is done, there would be still a biased overestimate due to the already mentioned fact that with increasing slope the average standing volume (and increment) increases, too.

4.6 Recommendation to BG-IFMP

<u>Proposals for the present Orientation Phase:</u>

It is recommended, that during this phase, BG-IFMP should assist FRDS in designing a program for the development of log recovery functions as proposed in chapter 4.3.3. This would require some technical assistance in logistics, data collection and processing and in statistical analysis.

A training course in the application and use of the Bitterlich Relascope for FRDS-staff including inventory team leaders and for DFO- staff should be implemented. Especially the use of the relascope for quick volume estimates (basal area count * height estimate * estimated form factor), and for height and slope measurements should be trained. Relascopes are already available at FRDS, but not yet used. This could be combined with a training in the use of GPS.

However, this would require the purchase of GPS equipment as only one instrument is available at FRDS.

The Project should also technically assist the FRDS in the correction of the inventory data by adjusting and modifying the <PLOT> program.

It was also decided at the wrap-up meeting at the end of the mission, that BG-IFMP should support FRDS in a comparative cost/benefit analysis of the two different potential road alignments for Nahi, taking into consideration technical, economic, socio-economic and environmental aspects (see Annex 5).

Proposals for a future engagement of BG-IFMP (Phase II):

BG-IFMP could assist FRDS in the further development of the forestry planning system, in particular in modifying and designing the inventory methods as proposed in this report. It could actively assist and support the elaboration of management planning guidelines (function and objective oriented, based on standwise planning) and the development of silvicultural models and concepts for different forest types.

It could assist in the incorporation of modifications into Nahi Management Plan in particular in adjustment of the AAC and in a forest function based, objective oriented silvicultural planning.

5 Establishment of Permanent Sampling Plot System

The objective for the installation of such a system has to be determined first.

The assessment of changes and dynamics of different forest resources under different conditions is usually done by continuous forest inventories on national level. After periodic repitition the results can also be used for the calculation of local volume tables and increment functions. To establish such a system on project region level (three districts) is not reasonable.

Continuous forest inventories are very expensive, they have to be repeated at least every 10 years and only after several periods reliable results will be available. The inventory field work requires highly qualified staff because measurement mistakes have to be avoided by all means. This requires a high percentage of control measurements by independent teams. Also the individual sample plot must be hidden in order to avoid biased treatments. Usually a linear sampling design is applied for this type of inventory. Taking into consideration the difficult topography of Bhutan and the accessibility of its forests, it is obvious that even with the use of

GPS the periodic identification of the sample plot location will be extremely difficult, time demanding and expensive. The applied inventory design must be objective oriented, consider the different forest conditions and uses (users) and must be verified economically. This requires a lot of preparatory field work. A not carefully planned and tested design might at the end not bring any valuable result and would be a waste of money.

Considering the human resources, the time and financial constraints and the expected results on the other, the set-up of a continous forest inventory system seems to be of low priority compared to other pertaining problems.

For growth and yield modelling permanent research plots should be established as proposed by P. Laumans (1994 d) which could be silviculturally treated in a different way and permanently monitored by a research unit. The calculation of local volume tables could be better done by tree sectioning. Guidelines for this has already been prepared by Lauman 1994 c.

If management plan would contain standwise forest condition assessment and planning, sustainability of management could be controlled based on the results of the management inventory of the following period and on standwise monitoring and evaluation of input and output. There would be no need to establish permanent sample plots for this purpose. It has to be mentioned in this context, that permanent sample plots were previously established within FMU areas. But because of difficulties in relocation of the plots, changing quality of measurements and changing of inventory system the establishment of permanent sample plots was abandoned (Määttä, 1993).

All the above mentioned constraints have been discussed intensively. It was decided not to follow up the idea of establishing a permanent sampling plot system in the project area.

6 Assessment of Forest Management and Forest Organization on Forest-Enterprise Level

For this purpose Kothoka FMU was visited and discussions were held with the Assistant of the FMU-Incharge and the BLC-Incharge of the Log Disposal Section.

Due to time constraints it was not possible to carry out a detailed assessment of the forest management and forest organisation on forest-enterprise level. More intensive and detailed discussions with BLC on different levels as well as with the territorial forestry staff of other FMU's is required to allow a reliable assessment and valuation. It was therefore decided by the BG-IFMP to postpone this activity.

However, one important aspect can already be pointed out. The implementation of forest management in the field by BLC has a big advantage. BLC is a corporation which is owned by the Ministry of Finance (100% shareholder). This makes BLC independent from an annual budget allocation. Revenues from forest exploitation can thus be reserved to be used later on for other forest activities such as planting, tending, etc. as specified by the management plan. If forest management would be carried out by FSD directly the creation of a sort of revolving fund would be necessary in order to gain the same benefit. Also FSD would have to be reorganized accordingly. This would also be necessary, if BLC would be privatized.

Annex 1 Terms of References

Annex 2 Time Schedule

14.6.1995	Departure Altusried, collection of visa at Indian Consulate, Frankfurt
15.6.1995	Arrival at Delhi and departure to Paro/Bhutan; first Contact with IFMP, Mr. R. Krezdorn
16.6.1995	Courtesy calls: Dasho Sangay Thinley, Joint Secretary FSD K.J. Subba, Joint Director FRDS D.B. Dhital, FMU/FRDS K. Deki, GIS/FRDS: introduction in GIS C. Giri, API/FRDS: forest stratification based on aerial photo interpretation Pasang, FI/FRDS: forest inventory design, etc. M. Stykzen, LUPP: discussion on GIS facilities, stratification, resource assessment
17.6.1995	BG-IFMP: E. Mayer: general discussions, program, study of literature
18.6.1995	study of literature on forest management and inventory
19.6.1995	AIP/FRDS: C. Giri: stratification on aerial photos and transfer to Spot panchromatic satellite imagery GIS/FRDS: T. Deki: inventory plot allocation and analysis of potential forest areas LUPP: M. Stykzen: analysis of potential forest areas SNV: O. Pekelder: operational planning for FMU's Survey of Bhutan: K. Wangdi: availability of aerial photos and satellite imagery BG-IFMP: E. Mayer: strategy on forest resource assessment and wood demand analysis
20.6.1995	transfer to BG-IFMP office at Lobesa E. Mayer, B.B. Subba: joint preparation on overlay maps for the identification of potential forest areas A. Baskota (DFO), U. Kievelitz: first contacts
21.6.1995:	E. Mayer, Singay Jamtsho: calculation of wood demand for Gasa, Punakha, Wangdi
22.6.1995:	E. Mayer, Singay Jamtsho: calculation of wood demand Gasa, Punakha, Wangdi
23.6.1995:	B.B. Subba, E. Mayer: finalization of wood demand assessment; field trip to Phobjikha; contact with beat officer Dawa Tashi
24.6.1995:	B.B. Subba, E. Mayer: field investigation in various forest strata of potential FMU No. 5; test of suitability of relascope for forest assessment; intensive discussions about local use of forest; CF

25.6.1995:	Tshering Dorji (Chuzumsa Beat), B.B. Subba, E. Mayer: reconnaissance field trip to potential FMU No. 3; transect from Phubjica to Kothoka; intensive discussions on infrastructure, forest management and inventory design
26.6.1995:	B.B. Subba, E. Mayer, FMU Kothoka: B.K. Chetri, Head of Disposal Section (BLC), Karma Dorjie, Assistant of the FMU Officer in charge, B.B. Subba, E. Mayer: analysis of FMU management, organisational set-up; responsibilities of BLC and Divisional Forest Office
27.6.1995:	B.B. Subba, M.B. Chuhan, E. Mayer: meeting with DFO Baskota at Lobesa, introduction of first findings to DFO; discussion on timber sale, coordination with BLC. Afternoon: field trip to Rimchu; testing of relascope in recently logged-over broadleaved forests; discussion on applied inventory design
28.6.1995:	E. Mayer: trip to Nahi FMU; discussion on standing volume, reliability of inventory data (standing volume), accessibility, road construction, human interference; return to Thimpu
29.6.1995:	Pasang, Dhital, E. Mayer: meeting at FRDS: discussion of preliminary results; inventory design, management planning system
30.6.1995:	R. Krezdorn, U. Kievelitz, E. Mayer: meeting at BG-IFMP: discussion of preliminary results and future Project approach
1.7.1995:	Preparation of preliminary report
2.7.1995:	Preparation of preliminary report
3.7.1995:	R. Krezdorn: discussion about the content of preliminary report; Dasho Sangay Thinley, Director of FSD: presentation of preliminary results and Nahi FMU; discussion with C. Giri, AIP-Unit on boundaries of FMU and Jigme Dorjie National Park
4.7.1995:	C. Giri (AIP-Unit), K. Deki: boundaries of FMU's and National Parks; aerial photo interpretation, inventory design
5.7.1995:	Presentation of results to FSD; transfer to Paro
6.7.1995:	Flight to Delhi
7.7.1995:	Return to Altusried

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Annex 4 Preliminary Report

Main results and some conclusions concerning forest resources management in relation to the Bhutan-German Forest Management Project.

(Werner Schindele, short-term consultant to BG-IFMP)
July 2, 1995

- Preliminary Draft -

The Bhutan-German Integrated Foresty Project is at present in its Orientation Phase. To get a frame and some reference points for further concerted action a short-term consultancy was invited to work on various aspects of forest resources management. The TOR were set quite broad as at this stage only approximate assessments were necessary for the BG-IFMP in order to orient itself and to define its future strategy. During the mission it was decided to give priority to the analysis of the timber production, forest resource potential assessment, inventory and management planning.

This report briefly describes the main findings of the short-term consultant and comes up with some propsals for an improved forest resource management.

1. Timber production analysis of Gasa, Punakha and Wangdue Dzongkhag

The timber production analyses was elaborated in close cooperation with the Divisional Forest Office at Lobesa. It is based on the official royalty statistics, which have been available for 1993 and partly for 1994. The fuelwood consumption was verified with the results of the Master Plan, Annex Report No. 6 "Wood based energy demand and supply in Bhutan". Due to time constraints own assessment couldn't be made.

(Remarks: The statistics of the DFO are based of No. of trees marked by the Beat Officer. These trees have not been measured. The calculation into standing volume was done by using conversion figures calculated by the BG-IFMP. Also it has to be kept in mind, that firewood collected by the people must not necessarily come from the standing volume (branches, deadwood). Also the supply of timber for Dzong renovation and for NRTI construction are included under construction timber. The figures given below are therefore rough estimates and need some verification.)

In the following the most important results are briefly described. A detailed brakedown of the timber production and consumption is attached (table 1 and 2) at the end of this report.

The total amount of wood consumed in 1993 was about 120.000 cbm (inclusive export) of which was:

43% firewood
2% poles
34% local hewnwood
14% sawnwood
7% round wood (industry and export)

The average consumption per capita and year was around:

1.3 cbm firewood
1.3 cbm construction wood
0.3 cbm used by wood processing industries and export

2.9 cbm in Total

(Remark: this includes Dzong renovation and NRTI construction, it cannot be regarded as the wood consumption of an ordinary rural or urban household.)

The required rawmaterial came from:

managed FMU's 17%
other forests 76%
import 7%

Import from other Districts (Paro and Thimpu) was used mainly for the urban and rural supply. Roundwood and sawn timber was exported to India. Import and export were almost balanced.

Comments:

The per capita consumption is compared to other regions within limits, however surprises the comparatively high consumption of construction timber. This can be explained by the highly wood demanding type of construction for local houses and public buildings (Dzong, NDTI construction). Also the use of shingleps for roofing, which have to be replaced about every five year, counts for this high amount.

Only 17% or about 21.000 cbm of the consumed wood came from "managed" FMU's (Kothoka and Rimchu, Kametsu), while the largest share was produced in the remaining forest areas. For the rural and urban supply of sawnwood, roundwood was imported from Paro and Thimpu. To meet the future demand of wood which has to be produced sustainably in FMU's the need to open-up new FMU's becomes obvious, as in the near future only Kothoka (6 000 cbm/year) and Nahi (10.000 cbm/year) will be managed sustainibly according to a mangement plan.

73.000 cbm of wood was exploited outside of FMU areas. If this remains at the same level, this will lead to an increasing degradation of forests especially around and in the vicinity of settlements. Solutions for a more sustainable production of this locally required wood should be elaborated as soon as possible.

Timber demand forecast is very difficult as it is influenced by too many factors, such as

- irregular high timber demand for the construction of public buildings (for example in 1993 quite a high amount of timber was consumed for the NRTI-building)

- subsidiced timber prices

- population growth and urbanization (urban wood demand is much lower than that of the rural households)

- degradation of accessible forest areas

It is assumed that all these factors will more or less compensate each other and that the wood demand per capita will remain on almost the same level. This will be explained more detailed in the final report.

Further actions required:

- Verify conversion figures for construction (hewnwood) timber.
- Identify the wood consumption of 1993 for Dzong renovation and NRTI construction.

2. Forest Resource (Potential) Assessment for Gasa, Punakha, Wangdue Dzongkhag

To assess the present state of the forest and to appraise their potential, the GIS-Section of LUPP was requested to carry out an analysis based on the already available landuse and topographic computer stored data and to provide a map at a scale 1:100.000 to identify all the potential forest areas within the three districts. (Remarks: the GIS-Unit of FRDS also has the landuse information, but for the concerned areas the topographic features (slope) were not yet available. Due to some software problems the GIS-Unit cannot use the concerned DEM-files of LUPP).

The following parameters were applied:

- exclude all non-forested areas
- exclude all areas with slopes > 100%
- mark all areas with difficult terrain (75-100%)
- exclude unproductive forest areas (FCf1,FCm1,FCb1,FCc1-3,FBc1, FB1-2,FS1-FS3.

Due to hardware problems at the GIS-Section, LUPP was not able to provide the information within the time frame of this short-term consultancy.

To get some preliminary information about the potential forest areas and to plan the field trip already at the beginning of the mission a manual "GIS" was implemented using two layers of mylar.

The applied parameters were the same as mentioned above. To identify potential Forest Management Units the following criterias were additionally considered:

- already existing FMU's and National Parks have to be excluded;
- remaining potential areas should have at least an area of about 4 000 ha.

Altogether 7 potential FMU areas could be identified. These areas were then be further checked whether they

- belong to reserved or restricted areas;
- or are inaccessible from the economic viewpoint.

Out of the 7 potential FMU's

2 are within the restricted area for the planned Hydrel at Basechu
1 is within the black crane restricted area (WWF)
1 is inaccessible
1 has already been harvested (Rimchu!)
The only two remaining potential FMU's are located:

- near Sephu (approx. size only 3 000-4 000 ha)
- around Gogona (approx. size 6 000-7 000 ha)

A field trip was made to Gogona and the forest area seems to be quite potential for sustainable permanent forest management.

There are also a lot of smaller areas which have quite a good potential, but because of their size, they could only be managed temporarily.

Comments:

If the above mentioned potential FMU's at Sephu and Gogona would be opened, the wood demand (from FMU's) could be most probably met in future. However, if the demand would increase or, if there would be an irregular, extraordinary high demand on wood, smaller areas could be opened as temporary units. A type of rotation system based on a cutting cycle of about 120 years could be considered to be sustainable.

Further actions required:

Once the GIS-analysis of Lupp is available the total area of potential forests will be known. Restricted areas and already existing FMU's (including Rimchu and Kametsu) and National Parks have then to be incorporated. Also potential forest areas of smaller size and inaccessible forests have to be excluded. The remaining areas should then be devided into permanent and temporary FMU's. For each unit an area statistic on landuse (forest types) should be elaborated.

To get an idea of the potential (standing stock, increment) available inventory data from similar areas should be analysed (allocation of each plot to Lupp landuse categories) to provide information on the forest condition of each landuse category.

3. Forest Inventory, Forest Management Planning

Forest management planning and implementation is based on the information obtained from the following four different kind of inventories:

1. Reconnaisance Field Survey: provides broad information on forest resources and leads to the decision whether a FMU should be opend or not.

2. Forest Management Inventory: linear sampling which provides general information for the total FMU area; based on this information the management plan is prepared and the Annual Allowable Cut (AAC) is calculated.

3. Operational Inventory: a dense linear sampling is carried out by DFO field staff for the areas subject to exploitation within the next two years. This provides "standwise" information and defines the proposed coup.

4. Tree Marking: one year before exploitation starts all harvestable trees are jointly marked by the FMU Incharge and BLC. Based on this information the DFO decides whether the coup will be opened or not.

The first two inventories are carried out by the inventory field staff of the FRDS. Altogether 2 inventory teams consisting out of 2 field crews are at present available for the whole of Bhutan.

To give a detailed description and the technical aspects of it cannot be the subject of this paper. However, the following general comments have to be made:

The individual inventories have been designed for a particular purpose and are of a quite high technical standard. However they have not been developed based on an overall forest resources assessment strategy. Therefore, the individual objectives of each inventory are not quite clear. This leads to the fact that datas are sometimes collected which are not really necessary and which are finally not used. On the other hand required information for a particular planning stage (the AAC should not only be based on the standing volume or overall increment but on the availability of exploitable logs (log recovery)) could not be provided. It is also not quite understandable why to carry out an operational inventory two years before opening of a coup and one year later a detailed tree marking.

Also the different forest inventories have not been tested on their economic validity.

From the technical viewpoint, fixed sample circles are not the best solution for mountanous areas. Slope correction of circles are quite difficult. Due to labour and time constraints in many cases control checks could not been carried out. Also aerial photo interpretation for the stratification of forest areas had to be carried out simultaneously or even after the field inventory.

The above mentioned constraints led to the fact that forest inventories require at present an high input in terms of budget and human resources without getting the optimum on information and preciseness.

Proposals:

The different forest inventory systems should be designed according to an overall forest resources assessment strategy and the individual objectives should be clearly defined. Based on these objectives inventory designs should be elaborated and verified from the economical viewpoint.

During the last few years technical innovations were made which facilitate inventory work. This refers particularly to the remote sensing technics (satellite image and arial photo interpretation), GIS, the development of the Global Positioning System and the use of the Bitterlich Mirror Relascope. These innovations should be incorporated into the inventory design and applied in inventory field work (GPS, relascope).

It is proposed to reduce the number of inventories on FMU-level to the following three:

1. Reconnaissance Forest Inventory: prestratification of the potential FMU using the latest remote sensing technics (GIS and aerial Photos); application of a two phase cluster design; data collection reduced to those which are required to provide the following information:

- location of protection areas
- estimate of the percentage of inoperable areas
- estimate of the total standing stock, tree species and diameter distribution, expected harvestable volume and increment per stratum
- accessibility

The results should be documented in an reconnaissance inventory report. At the same time a socio-economic study should be carried out in the proposed area to identify the needs and perceptions of the local people. Both informations should lead to the final decision whether the FMU should be opened or not.

2. Forest Management Planning Inventory: linear sampling of production areas; density according to variation coefficient and importance of stratum; assessment of site data and other landuse parameters (browsing...). This inventory should provide information on stand-level to allow the management planners and implementors:

- to prepare a forest function map
- to calculate the AAC on the real harvestable potential
- to carry out stand wise planning
- to prepare a 10 years utilization plan on stand-level
- monitoring and evaluation on stand-level

The implementation of an operational inventory would no longer be required.

3. Tree Marking: as done up to now this should be implemented one year before opening of the coup based on silvicultural considerations, which however are now clearly prescribed in the management plan. It is proposed to create a link between the tree marked in the forest and the log produced. On this basis a log recovery function could be calculated for each species depending on the diameter and height. This would be of very high value as then this formula could be incorporated in the inventory programms and would allow a much more precise estimate on the real log recovery.

Management Planning

Management planners depend on the data they obtain from remote sensing, forest inventory and field checks. As described above, the present inventory system does not allow a standwise planning or a more accurate calculation of the AAC. This deficit has been clearly seen by the FRDS which resulted in the introduction of operational inventory and planning.

As in the Management Plan of Nahi the AAC is calculated based on the total standing stock of the operational area devided by the cutting cycle of different working groups. This implies the assumption that the standing stock of each forest stand of the same stratum (altogether 8 different strata were distinguished) is the same.

The annual cutting area is calculated for the clearfelling system applied in the Timber Harvesting Working Group (THWG) by deviding the total operational area with the cutting cycle of 120 years. At Nahi, however, the THWG area includes Blue pine and Hemlock forests. In these forests a type of selective cutting should be applied rather than clearfelling, as there is a high potential for natural regeneration. The AAC is also depending on the silvicultural system and the harvesting method applied.

For the Chir Pine Improvement Working Group (CPIWP), where harvesting is done on a type of selection system the yield is regulated by the total standing volume of the operational area devided by the cutting cycle of 100 years.

The particular silvicultural situation of the individual stand is not considered in both systems. A particular forest stand might be degraded, immature or in the growing phase, consolidated or overmatured. Only if this information is available the decision whether a stand should be harvested or not can be made. The distribution of these different development stages has to be considered by calculating the AAC.

Also the function of a particular stand should be considered. For example a forest which is intensively used by local people for browsing, sokshing and leave fodder collection should be silviculturally treated in a different way. The application of a clear felling system would restrict these uses for a long period. The same applies for forests which have a particular protection function for watersheds or for erosion control. Therefore, the whole forest area of a FMU should be mapped according to these functions, and silvicultural guidelines should be set up on how to treat different types on forest having different functions. This will of course have an high impact on the AAC.

Only an improved forest management planning inventory as described above together with a RRA or PRA can provide these information and allow the calculation of a realistic AAC.

4. Installation of a permanent sampling plot system in the Project area.

The objective for the installation of a such a system has to be determined first.

Permanent sample plot systems or continous forest inventories are usually designed to assess changes and dynamics of different forest resources under different conditions. They also can be used for the calculation of local volume tables. They are usually carried out on national level.

For the valuation and control of forest management within a particular FMU this is not the right instrument. A standwise management planning, monitoring and evaluation fulfills this purpose much better.

Continous forest inventories are very expensive, they have to be repeated at least every 10 years and only after several periods reliable results will be available. The inventory field work requires highly qualified staff because measurement mistakes have to be avoided by all means. This requires a high percentage of control measurements by independent teams. Also the individual sample plots must be hidden, in order to avoid biased treatments. Considering the

topography of Bhutan and the accessibility of its forests even with the help of GPS the identification of the sample plot location (after 10 years) would be a very difficult and time demanding task.

The inventory design applied must consider the objective, the various forest condition and must be verified economically. This requires a lot of preparatory field work. A not carefully planned and tested design might at the end not bring any valuable result and would be a waste of money.

Considering the availability of human resources, the time and financial constraints on one side and the expected results on the other, the set-up of a permanent sampling plot system in the project area seems to be of low priority compared to other pertaining problems.

6. Proposals for a future engagement of the BG-IFMP

According to the personal opinion of the short-term consultant this does not necessarily reflect the view of BG-IFMP or RGOB) there could be four different fields of interventions, which could of course also be combined:

1. To assist in the development of forest framework planning for the three Dzongkhags and in the development of forest management concepts within and outside FMU's. (FRDS/DFO)

2. To assist in the improvement of forestry planning systems in particular in management planning guidelines, inventory designs, silvicultural models for different forest types and to use the potential Gogona FMU as a model. (FRDS)

3. To assist in the implementation of Nahi management plan after incorporating of standwise planning, forest function based silvicultural planning, adjustment of the AAC. (FRDS/DFO)

4. To support the territorial forest service outside of FMU's. Development of sustainable management systems incorporating socioeconomic and other landuse aspects (agroforestry, silvo-pastoral systems, community forestry, social forestry). (DFO)

Annex 5 Minutes of Meetings

Presentation of main results of the short-term consultancy on forest resource management to the Joint Secretary of FSD.

July 3, 1995

Participants:

Dasho Sangay Thinley, Joint Secretary of FSD
E. Krezdorn, Teamleader of BG-IFMP
W. Schindele, short-term consultant

Mr. Schindele explained the tasks of his mission and presented his results and his conclusions as outlined in his preliminary report.

Dasho S. Thinley asked for an area statistic of the potential areas. This was promised to be produced after the GIS analysis by LUPP has been finalized.

Asked about his opinion on the Nahi FMU, Mr. Schindele pointed out that his opinion on Nahi is only based on a one days field trip through the Nahi area. According to him, Nahi is not a typical FMU, because in the eastern part it is intensively used by the local people. Also there, the potential of the forest is very low, because of intensive browsing, sokshing, fodder production for cattle and frequent forest fires. These forest needed to be rehabilitated rather than exploited. The potential forest areas are in the west, where on the other side the terrain becomes quite rough. He also pointed out, that he feels that the AAC calculated for Nahi is too high (see preliminary report). The total potential area in the Management Plan is about 4 200 ha. If the degraded forest areas are excluded maybe 2200 ha remain of which only about 2 000 might be operable or accessible. If the AAC of at present 10.000 cbm would be devided by 2 000 ha this would be almost about 5 cbm/ha which would be, compared to the annual increment of 3.28 cbm/ha/year) quite high. He also pointed out, that according to his opinion the blue pine and helmlock stands in the west should be silviculturally treated in a selective cutting or seed tree system and not, like planned, applying a clearfelling system. But that would mean, that only about 40% of the standing volume could be removed during the first cut, which would also have consequences on the AAC. He pointed out again, that this is only based on his impression he gained from the field trip and has not been verified yet. He further pointed out, that the problem of AAC calculation is a direct effect of the forest management planning inventory design, which does only give figures on the different strata (8 for Nahi) and the total FMU area.

On the question of Dasho Sangy Thinley about the road alignement, it was agreed, that a comparative analysis should be made based on forestry, socio-economic, environmental and economic considerations.

Finally it was agreed to presentate the results in the same way on Wednesday the 5th, to various staff of the FSD and to BLC.

Presentation of the main results and conclusion of the short-term consultancy of the forest resources management expert for BG-IFMP

July 5, 1995

The presentation was held at the conference room of FSD.

Participants:

Dasho Sangay Thinley, Joint Secretary, FSD
K.J. Subba, Joint Director, FRDS
D.B. Dhital, Management Planning Unit, FRDS
A. Baskota , Project Manager, BG-IFMP, DFO Wangdue
Namgye, FRDS
B.B. Chettri, Social Forestry Extension Service, FRDS
T. Wangchuk, Nature Conservation Section, FRDS
Sangay, Policy and Planning Division, MoA
Tara Giri, Managing Director, BLC
R. Krezdorn, Team Leader, BG-IFMP
W. Schindele, Short-term consultant, GfB

The short-term consultant presented its results and conclusions according to his preliminary report. Additionally he pointed out that there might be a mistake in the inventory lay-out of fixed sample circles as the slope correction factor for sample circles might be wrong. In case of Nahi this would result into an overestimation of 18% of the standing volume. He assured that in his final report this matter will be definitely dealt with.

Mr. Baskota asked, how the self supply was estimated. Mr Schindele explained, that the average consumption per rural household was estimated on 1 cbm/capita/year as calculated by many different studies (reference to the Master Plan). For space heating he pointed out, that this was calculated different from the Master Plan as follows: space heating starts at 2 000 m, and for every 1 000 m intervall 2.5 cbm of fuelwould was added per household. The self supply is simply the difference between the official supply and the result of this calculation. He also pointed out again that this should be also subject to further investigation.

Mr. K.J. Subba explained, that the transporting distance from Gogona to Lobesa is quite far and that this has to be considered before opening a FMU. Mr. Schindele agreed and added, that before opening of a new unit, the cost for transport and required road construction works have to be carefully calculated. This should be done at level of the reconnaissance survey together with the socio-economic survey.

Dacho Sangay Thinley mentioned that he feels, that the demand on construction timber is quite high. Mr. Schindele responded, that this is due to the fact, that all the construction timber produced in the three districts, was included even those used by the industry, for export and for the Dzong renovation and for the NRTI construction. He further explained that the average consumption figure of 2.9 cbm/capita/year is not the real consumption of a rural or urban household.

Concerning forest invntory design and management planning, K.J. Subba pointed out, that it is very difficult to incorporate innovations into an already well developed system. This would include a lot of changes, starting from training programs up to the change of computer programs.

Dacho Sangay Thinley asked the short term consultant upon his opinion on the road alignment for Nahi FMU. The short-term consultant proposed that a comparative analysis of both alternative road alignements should be elaborated. This should include economic, socio-economic, environmental and forestry aspects. In the following discussion it was agreed, that BG-IFMP should take up the matter in cooperation with all involved sections and organisations.

Thimpu, 6th of July, 1995

Werner Schindele