



FIELD DOCUMENT No. 11

VOLUME 1

ASSISTANCE TO THE FORESTRY SECTOR OF BANGLADESH

THE HIGH FOREST IN THE CHITTAGONG DISTRICT

by

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ABSTRACT

During the period August 1984 - July 1985 an inventory was carried out of the high forest in the Chittagong District. This district comprises two Forest Divisions : Chittagong and Cox's Bazar. After preliminary aerial photointerpretation, four forest types were considered of which three were real high forest types (types 1, 2 and 3) and one (type 4) an open formation of brush and scattered trees.

Of the three high forest types, type 2 is the largest in area but the poorest in volume : it covers approximately 37,100 hectares in the District with an average gross volume (for trees of 30 cm diameter and above) of $51 \text{ m}^3/\text{hectare}$ and $23 \text{ m}^3/\text{ha}$ of quality 1 volume.

Types 1 and 3 (type 3 is derived from 1 through selective felling) cover 19,300 and 850 hectares respectively. The average volumes per hectare are : 107 m^3 of gross volume and 63 m^3 of quality 1 volume for type 1 ; 109 m^3 of gross volume and 82 m^3 of quality 1 volume for type 3.

Type 4 covers approximately 25,300 hectares but the variation in the volume is so big that any volume figure in the present report should be considered as a rough indicator only.

The averages (all volumes, all types) are significantly better in the Cox's Bazar than in Chittagong Division : for example the gross volume of type 1 is $116 \text{ m}^3/\text{hectare}$ in Cox's Bazar, 90 m^3 in Chittagong Division.

All types are characterised by the dominance of a few species only, and of Garjan, Dipterocarpus Spp., in particular, although it should be noted that Garjan is probably a common name for four Dipterocarpus species ; 14 species account for nearly 60 % of the total utilisable volume in the District.

1. INTRODUCTION

In the original Project Document and the corresponding Plan of Work of the Inventory Unit of the Project, no provision was made for an inventory of the natural, high forests of the Chittagong District. This administrative district comprises two Forest Divisions, the Chittagong and Cox's Bazar Divisions.

Two main reasons eventually led to the inclusion of the high inventory into the Plan of Work:

- various interested sides had recently been expressing their concern about an apparently rapid depletion of the high forest in the district related to conversion to plantations and it was felt that an up-to-date evaluation of the situation was needed.
- it was agreed by Project and Forest Department officers that it would not be possible to write cohesive working plans unless the natural forest was inventoried, which was confirmed by an appropriate Evaluation Mission recommendation and a Tripartite Review Meeting decision.

The preliminary and preparatory office work for the inventory was started in August 1984, followed by the field work in early October. All field work, including a regeneration survey of the two main forest types in the Cox's Bazar Forest Division (*) was completed by April and the office work, including data processing and area calculations, by the end of July 1985. The final maps, to be produced at a scale of 4 inches to the mile, eventually to be transformed to a decimal scale, will be available in early 1986.

While the inventory field work as such was being carried out, separate crews took measurements on felled trees in logging areas to collect the data for the construction of taper series. These data were needed as it was observed by the consultant on data processing that none of the volume tables available were suitable for the computations to be done by the Project. A short study on the relationship of stacked versus solid volume of round wood was also made at that time. A summary of the results of these activities is given in Appendix 2. More details about tree measurement for volume tables and on methodology for the construction of taper series can be found in Working Papers 6A and 6B and in Field Document No. 7.

The present Volume deals with the inventory as such, while all tables resulting from data processing and area calculations are given in Volume 2.

(*) Working Plans Division of the Forest Department requested this information for the up-dating of the working plans.

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	4
1. INTRODUCTION	7
2. METHODOLOGY	2
2.1 Sampling design	2
2.2 Stratification of the high forest	4
2.3 Photointerpretation and Mapping	3
2.3.1 Preliminary interpretation and selection of the primary units	5
2.3.2 Location of the secondary units on the photographs	5
2.3.3 Checking of the interpretation and final allocation of the units to the proper forest type	6
2.3.4 Final photointerpretation and mapping	6
2.4 Field work	7
2.4.1 Description of the field form	7
2.4.2 Types of recording according to species and diameter	15
2.5 Data compilation and processing	17
2.5.1 Principles of the tree volume calculation	17
2.5.2 Data processing	20
3. RESULTS AND CONCLUSIONS	22
3.1 Areas of the high forest types	22
3.2 Species composition and diameter distribution	24
3.2.1 Trees with a diameter of 30 cm and above	24
3.2.2 Trees with a diameter of 10 to 29 cm	24
3.2.3 Trees with a diameter below 10 cm	27
3.2.4 Bamboo	27
3.3 Volumes and sampling errors	29
3.3.1 Trees with a diameter of 30 cm and above	29
3.3.2 Bamboo	33
<u>Appendix 1</u> 1. LOCAL AND SCIENTIFIC NAMES OF THE SPECIES	36
2. SPECIES CODES AND SPECIES GROUPS	38
<u>Appendix 2</u> 1. TAPER SERIES FOR THE HIGH FOREST SPECIES	40
2. SOLID VERSUS STACKED ROUND WOOD VOLUMES	41
<u>Appendix 3</u> PHOTOGRAPHS ILLUSTRATING THE FOREST TYPES	42
<u>Appendix 4</u> KEY MAP	47

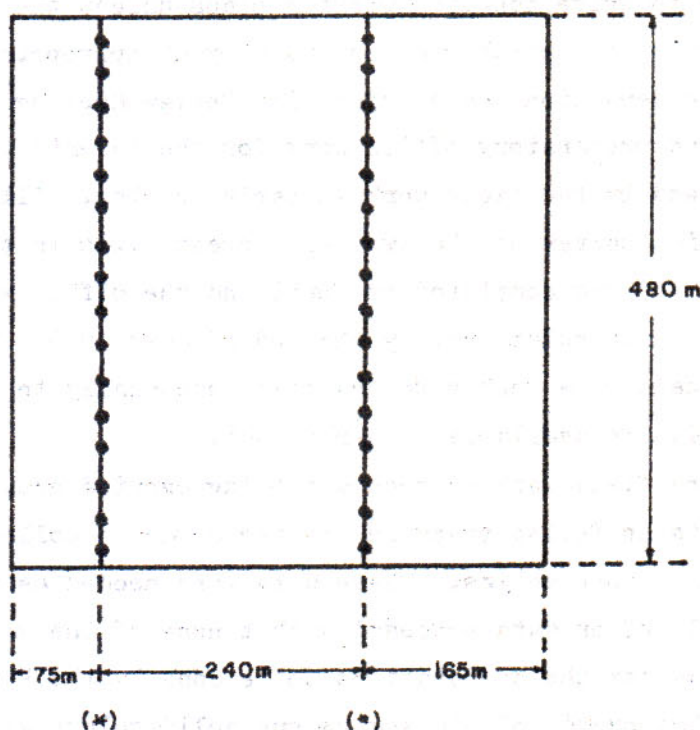
2. METHODOLOGY

2.1 SAMPLING DESIGN

From various observations on the aspect and composition of the different types of high forest, made during the inventory of the plantations carried out the previous year, and from special preliminary field trips done by the Project counterpart staff to verify specific conditions, it was decided to use a two-stage sampling with blocks or primary units of maximum 500 x 500m.

As the field crews were already very familiar with circular sample plots from the plantation inventory, it was also decided to use this system for the high forest inventory.

The sampling unit, finally adopted, is shown in the following figure :



Primary unit : block of 480m x 480m with 2 secondary units,

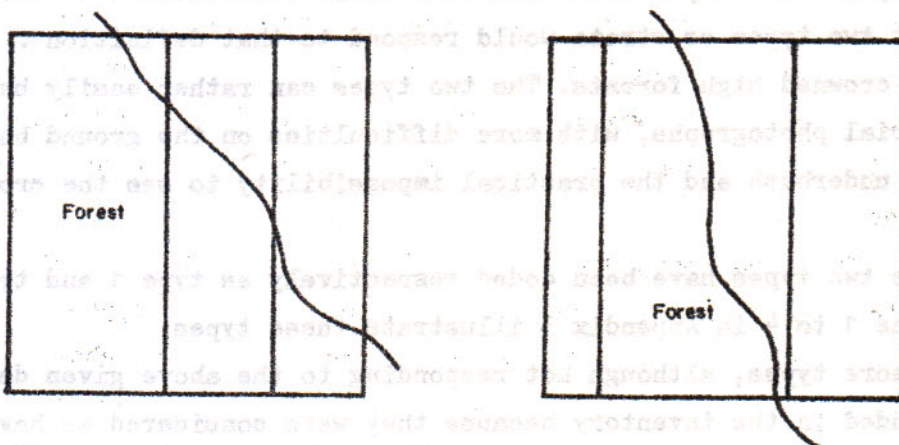
Secondary unit : line of 480m comprised of 16 plots of 0.03 hectare each
(radius of 9.77m)*.

Sampled area per primary unit : 0.96 hectare.

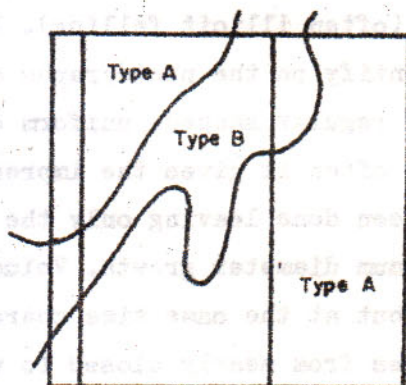
Sampling design : primary units and secondary units chosen at random.

(*) Random selection of 2 lines out of 16 possible, with a minimum distance between the two lines of 30m.

Primary and/or secondary units can be incomplete, but as long as the plots cover 50% or more of a stratum they are not discarded. The following two situations are accepted :



Primary and secondary units can also be incomplete with regard to a specific stratum, i.e. in the case that they cover more than one stratum. See following figure :



The secondary units are always South-North oriented, numbered 1 and 2 from left to right.

The sample plots are always numbered from South to North, 1 to 16 in line 1, 17 to 32 in line 2, irrespective of the direction of access to the unit.

On all plots, trees with a diameter of 30 cm and above are recorded. On plots 8, 16, 17 and 25 also the trees with a diameter 10 - 29 cm are recorded and an estimate is made of the number of bamboo culms.

Only in forest types 1 and 2 in Cox's Bazar Forest Division (see description of types on next page) were trees with a diameter below 10 cm recorded, in the same plots 8, 16, 17 and 25.

2.2 STRATIFICATION OF THE HIGH FOREST

The main purpose of the inventory was to determine the extent, potential and composition (in that order of importance) of the "high" forest, the term high defining the forest as natural, undisturbed and closed. From the preliminary photointerpretation and some field observations it soon became clear that two types or strata would respond to that definition : the large and small crowned high forests. The two types can rather easily be distinguished on the aerial photographs, with more difficulties on the ground because of the dense underbush and the practical impossibility to see the crowns in the canopy.

These two types have been coded respectively as type 1 and type 2. Photographs 1 to 4 in Appendix 3 illustrate these types.

Two more types, although not responding to the above given definition, were included in the inventory because they were considered as having some potential for the future and should therefore find a place in the future management plans of the Forest Department.

The first one, called type 3, is a disturbed forest, derived from type 1, where practically all trees of all species except Garjan* (Dipterocarpus Spp.) have been felled and cleared (often illicit felling). It is a very typical and distinctive type, easy to identify on the photographs as on the ground ; it has an open canopy, formed of regular shaped, uniform crowns all belonging to the same few species. Very often it gives the impression of a plantation forest where thinnings have been done leaving only the middle and big size diameter trees, to allow maximum diameter growth. Volume usually is high, compared to the other types, but at the same time characterized by a very big variation as density ranges from nearly closed to very open. See photographs 5 & 6 in Appendix 3.

The last type, number 4, has been defined as brush with scattered trees. In the Cox's Bazar Forest Division this type is quite distinctive (as regards aspect, scattering of trees) but in the Chittagong Forest Division it is a much more difficult type to delineate (especially on the 1 : 50,000 photographs) as it varies considerably over short distances from brush with scattered high trees to practically clear brush. For this reason the volumes and other figures given in the tables of Volume 2 and discussed in Chapter 3 of this Volume should

* The name Garjan is given to all the Dipterocarp found in the District. There seem to be four species of which Dipterocarpus turbinatus and D. pilosus are the dominant ones. They vary from each other mainly by size (diameter and height), and cannot be distinguished by the crewleaders, foresters from the Forest Department.

be considered as rough indicators only. It is a non-economical forest type, to be considered eventually for reforestation on the better sites. Therefore it has been omitted from Table 6 showing the total volumes.

2.3 PHOTOINTERPRETATION AND MAPPING

2.3.1 Preliminary interpretation and selection of the primary units

A lay-out was made of the 1 : 50,000 aerial photographs, taken in 1982, and on a transparent overlay the areas of all types appearing like high forest were delineated.

A grid was drawn on the overlay with squares equal to the size of the primary units, at that scale, covering entirely the delineated areas.

Each square was then numbered, starting from 1, and the required number of units was drawn at random. It was estimated that approximately 120 sampling units would be needed but a larger number was drawn in order to have replacement units for the ones to be discarded for one reason or another.

Units which were situated for more than 50% outside a delineated area were immediately discarded and replaced.

Each of the selected units was then located exactly on the 1 : 15,000 aerial photographs, also taken in 1982, to verify if it really covered one (or more) of the 4 types. This could be done with more precision on the 1 : 15,000 than on the 1 : 50,000 photographs.

When a unit was finally accepted it was given its sampling unit number. If not, it was replaced by another one, fulfilling the conditions.

Finally, 126 primary units were selected to allow for some loss during field work (f.ex. : 2 units were discarded as they fell in a high forest belonging to tea estates).

2.3.2 Location of the secondary units on the photographs

In each selected primary unit two secondary units (or lines) were drawn at random, out of a possible total of 16 (i.e. two adjacent lines had to be separated from each other by a distance of 30 metre).

The primary and secondary units were then drawn as accurately as possible on the 1 : 15,000 aerial photographs and the easiest and surest access to one of the secondary units was looked for and described in detail. The field crews used the aerial photographs and the access description for the location of the units.

2.3.3 Checking of the interpretation and final allocation of the units to the proper forest type

When the field sheets returned from the field each individual secondary unit was checked on the photographs against the field data to detect and correct any possible error. Access to the forest in the Chittagong District is, in general, easy and there are sufficient recognition points (identifiable on the ground as well as on the aerial photographs) to ensure a proper location. Still, errors were made, one of the most common one being that the crew leader started his numbering of the sample plots from the wrong end of the line. Another mistake, easily to be corrected, was that the numbering of the plots started with the first plot within the forest boundary line and not at the starting point of the line (which in many cases was situated outside that boundary).

Most of the errors could easily be corrected and only in a few cases was relocation and remeasurement necessary.

It should be mentioned that one Forest Ranger's main and permanent job in the field was to supervise the crew leaders during the location of the sampling units.

However, what happened much more often was that the forest was not there anymore, clearfelled since the time the photographs were taken. In that case also replacement units were selected.

2.3.4 Final photointerpretation and mapping

The final photointerpretation was done in the first half of 1985 on the recent (1984) 1 : 50,000 photographs : the four types were delineated and the areas calculated using a dot grid. The final maps will be produced on a scale of 4 inches to the mile, eventually to be transformed to a decimal scale, and will be available in early 1986.

Obtention of the 1984 photographs also allowed the Project to carry out a comparative study of the area of the high forest with an exact 2 year interval (January 1982 - January 1984). The results of this study are published separately, in Working Paper No. 10.

2.4 FIELD WORK

2.4.1 Description of the field form.

On page 8 an example is shown of the field form used during the inventory.

Hereafter follows a description, column by column, of that sheet with an explanation of the methodology used, the measurements taken, the observations made etc...

Deck : column 1 = job code (digit 5, already printed on the form).

I.U. : column 2 = inventory unit (digit 1, for Chittagong District, already printed on the form).

G.A. : column 3 = geographical area.

Digit 1 for Chittagong Forest Division

Digit 2 for Cox's Bazar Forest Division.

Prim.Unit : columns 4-6 = primary sampling unit number.

From 001 to 122.

S.U. : column 7 = secondary sampling unit number.

Digit 1 for left-hand unit or line

Digit 2 for right-hand unit or line.

Plot No. : columns 8-9 = plot number.

From 01 to 16 if column 7 is 1 ; from 17 to 32 if column 7 is 2.

Str.P : column 10 = stratum (or forest type) code as determined from the aerial photograph after checking with the field data : 1, 2, 3 or 4.

This is the type code used for the data processing.

Str.G : column 11 = stratum (or forest type) code as observed on the ground by the crew leader.

Slope : column 12 = average slope in the plot = $\frac{1}{2}$ of steepest slope.

Recorded in 10% classes as follows :

0 - 9 % = 0

10 - 19 % = 1

20 - 29 % = 2

30 - 39 % = 3

40 - 49 % = 4

50 - 59 % = 5

60 - 69 % = 6

70 - 79 % = 7

80 - 89 % = 8.

90 % + = 9

Adjustment to the plot radius for slopes is done by the crew leader.

Slope adjustment tables for plot radius as well as for the 30m

distance between the plot centers were provided to the crew leaders.

Soil : column 13.

Registered as follows :

Sand	:	1
Sandy loam	:	2
Sandy clay	:	3
Loam	:	4
Clay	:	5
Peat	:	6
Gravel	:	7
Boulders	:	8
Rock outcrop	:	9

Note : the crew leaders, foresters by profession but not having received special training in soil type recognition, were not expected to make an exact distinction between 2 and 3 and between 4 and 5.

Inf. : column 14 = influence, i.e. factor influencing the normal aspect or composition of the forest type inside the plot : from 1 to 8.

Windfall	:	damage to trees	:	1
Fire	:	damage to trees	:	2
Lianas and creepers	:	damage to trees	:	3
Trail or logging road	:	partial plot	:	4
Creek	:	partial plot	:	5
Clearing (agriculture or shifting cultivation)	:	0 - plot	:	6
Clearing (logging)	:	0 - plot	:	7
Non forest	:	error (photointerpretation or plot location)	:	8

If more than 50% of a partial plot was trail, logging road or creek the plot was considered as a 0 - plot.

Tree No : columns 15-16 = tree number in the plot.

On each field form there is space for the recording of three sample plots with a maximum of 10 trees each. If more than 10 trees have to be recorded (this can be the case in plots 8, 16, 17 and 25 where, apart from the trees of 30 cm and above, also the 10-29 cm trees and the bamboo are recorded) the numbering already printed on the field form is changed on the spot : 11 instead of 01, 12 instead of 02 etc...

Species code : columns 17-19.

See Appendix 1.

Diam. (cm) : columns 20-22 = diameter of the tree measured in centimeters.

Up to the digit 5 after the comma rounding off is downward ; from 6 and above upward.

Ref.H. (cm) : columns 23-25 = height from the ground in centimeters where the diameter is measured.

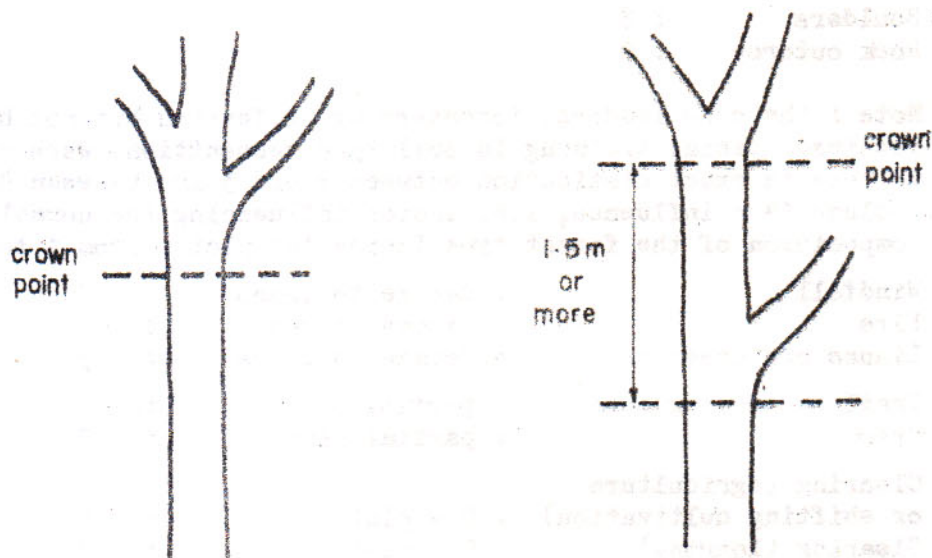
For non-buttressed trees : at 130 cm from the ground.

For buttressed trees : at 150 cm, 175 cm, 200 cm etc... from the ground, always at a multiple of 25 cm.

An instrument is used for measuring diameters above 175 cm from the ground (See Inventory Technical Note No. 1).

St.H.(m) : columns 26-27 = stem height in meters from ground to crown-point.

One single branch, regardless of its diameter, situated at 1.5 meter or more from the next branch(es) is not considered as crown point.



Q1A : column 28 = quality of stem section 1A from ground to 1.5m

Q1B : column 29 = quality of stem section 1B from 1.5 to 3.0 m

Q1C : column 30 = quality of stem section 1C from 3.0 to 4.5 m

Q1D : column 31 = quality of stem section 1D from 4.5 to 6.0 m

Q2 : column 32 = quality of stem section 2 from 6.0 to 12.0 m

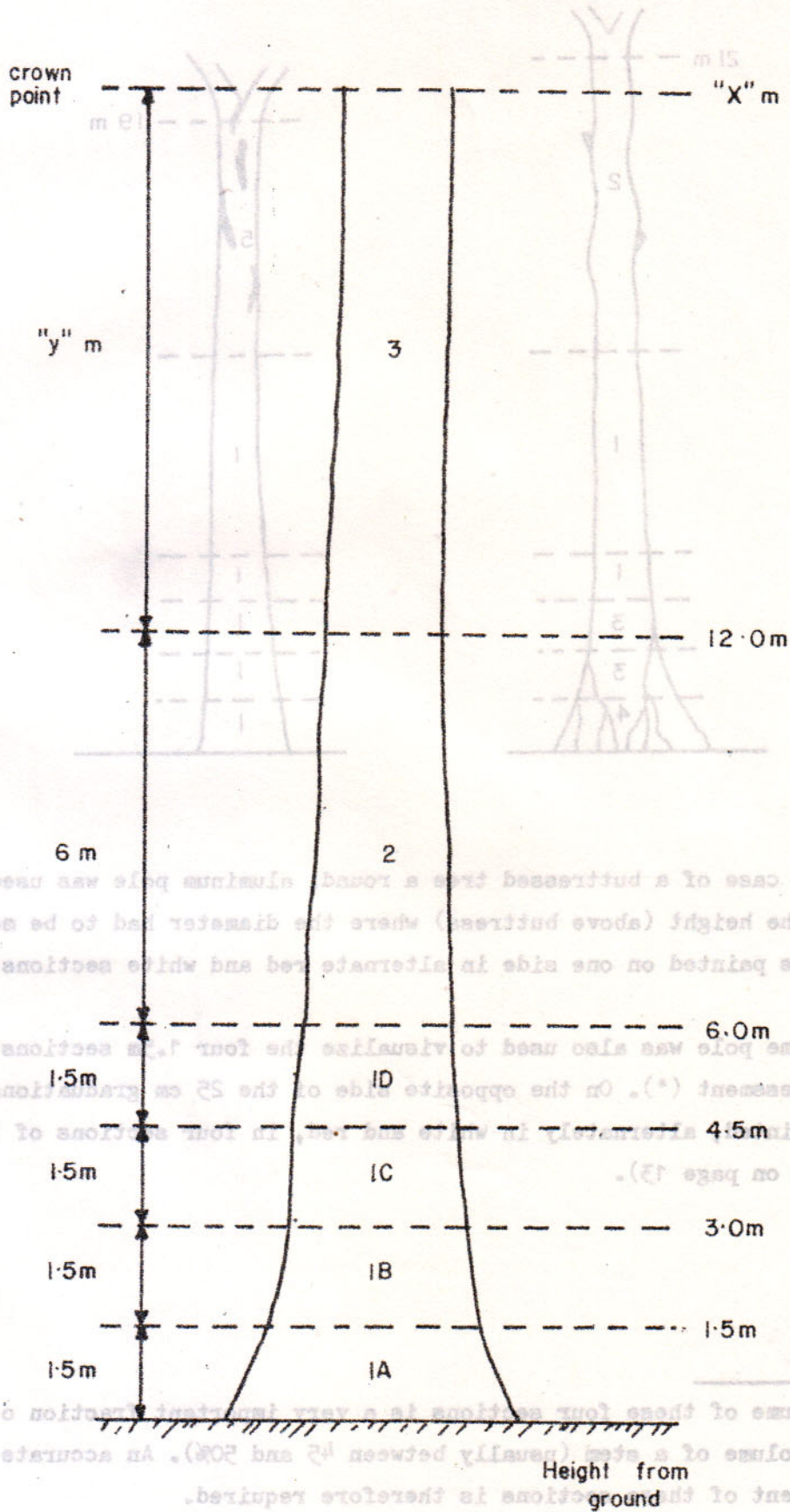
Q3 : column 33 = quality of stem section 3 above 12 m.

The figure on page 11 shows the stem sections to which qualities were given. This applied to all trees in the sample plot except for the trees with a diameter below 30 cm.

The qualities given were the following ones :

- Quality 1 : sound, straight log (of a quality suitable for veneer)
- Quality 2 : sound log but bent, crooked, with branches, knots or swellings.
- Quality 3 : buttress with usable volume
- Quality 4 : buttress with unusable volume or tree completely fluted
- Quality 5 : visible rot or hollow
- Quality 6 : dead tree (all sections).

STEM SECTIONS TO WHICH QUALITIES ARE GIVEN

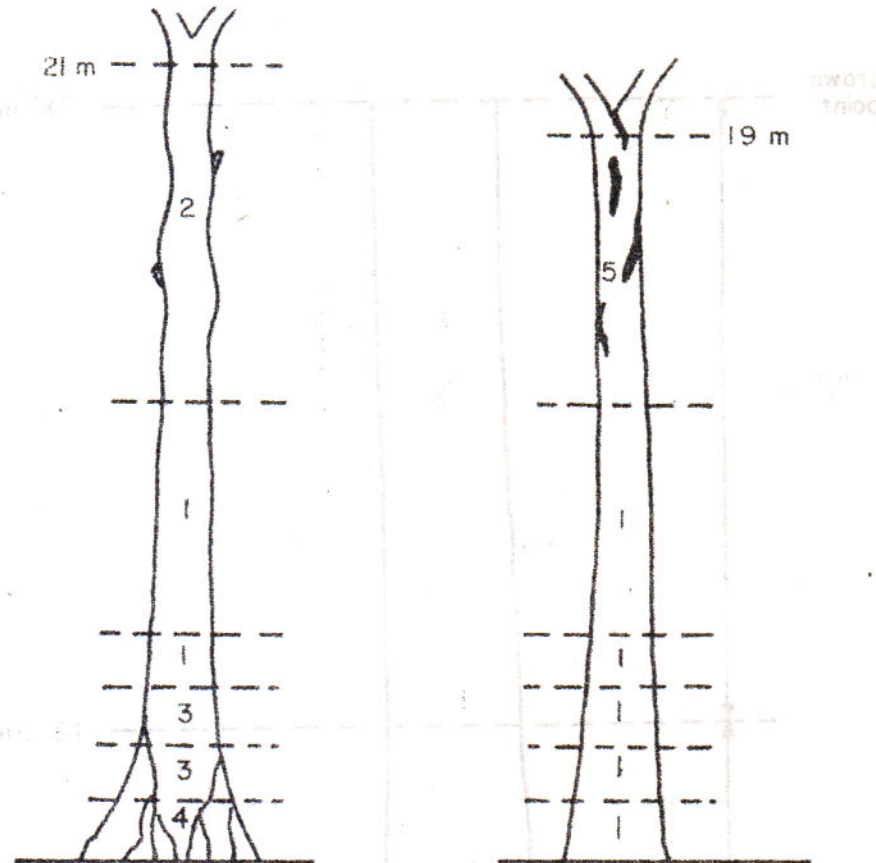


(*) The volume of these four sections is a very important function of the total volume of a stem (usually between 15 and 20%). An accurate quality assessment of the sections is therefore required.

In the case of a buttressed tree a round aluminum pole was used to determine the height (above buttress) where the diameter had to be measured. The pole was painted on one side in alternate red and white sections of 25 cm each.

The same pole was also used to visualize the four 1.5 m sections for the quality assessment (*). On the opposite side of the 25 cm graduations, the pole was painted in white and red in sections of 1.5 m. (See figure on page 13).

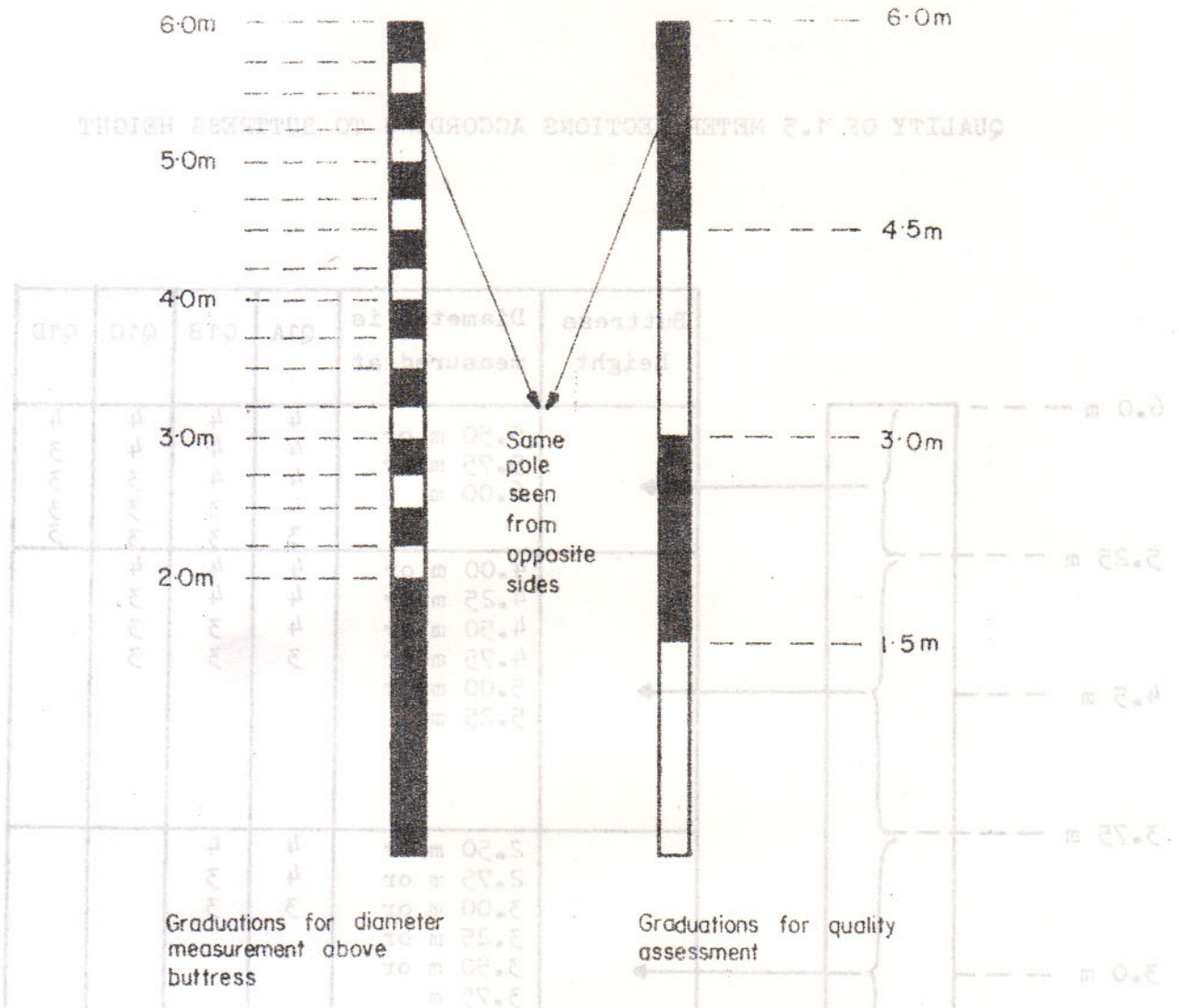
Two examples of quality assessment are given :



In the case of a buttressed tree a round, aluminum pole was used to determine the height (above buttress) where the diameter had to be measured. The pole was painted on one side in alternate red and white sections of 25 cm each.

The same pole was also used to visualize the four 1.5m sections for the quality assessment (*). On the opposite side of the 25 cm graduations, the pole was painted, alternately in white and red, in four sections of 1.5m. (See figure on page 13).

(*) The volume of these four sections is a very important fraction of the total volume of a stem (usually between 45 and 50%). An accurate quality assessment of these sections is therefore required.



From the foregoing it is obvious that there is a definite relation between some qualities and the individual 1.5m, 6m or variable length sections. If the tree has no buttress only qualities 1, 2, 5 and 6 can be given to its sections, except if the tree is completely fluted. If the tree has a buttress the height of diameter measurement determines the number of sections which will receive quality 3 or 4. It was assumed that if a buttress does not reach up to the midpoint of a 1.5m section the section in question is considered non-buttressed and cannot receive quality 3 or 4. If the buttress comes to the middle of a section or goes above that point, the whole section is considered as buttressed.

The following table and figure show all the qualities which can be given to the 1.5m sections according to the height of the buttress.

QUALITY OF 1.5 METER SECTIONS ACCORDING TO BUTTRESS HEIGHT

Buttress height	Diameter is measured at	Q1A	Q1B	Q1C	Q1D
6.0 m	5.50 m or 5.75 m or 6.00 m	4	4	4	4
		4	4	4	3
		4	4	3	3
		4	3	3	3
5.25 m	4.00 m or 4.25 m or 4.50 m or 4.75 m or 5.00 m or 5.25 m	4	4	4	
		4	4	3	
		4	3	3	
		3	3	3	
4.5 m	2.50 m or 2.75 m or 3.00 m or 3.25 m or 3.50 m or 3.75 m	4	4		
		4	3		
		3	3		
3.0 m	1.50 m or 1.75 m or 2.00 m or 2.25 m	4			
		3			
1.5 m	No buttress				
1.3 m	1.30 m				
0.0 m					

Bamboo Mature : columns 34-37 = number of shoots in classes of 50.

Bamboo Immature : columns 38-41 = number of shoots in classes of 100.

2.4.2 Types of recording according to species and diameter*

The design of the field form permits all types of recording needed during the survey in relation to species and diameter. The following "recording types" described hereafter are shown on a model of the field form on page 16.

0 - plots

To facilitate the checking and the processing of the data, 0-plots are recorded as follows (type 1, page 16) :

- columns 1 to 16 included
- 8888 in columns 28 to 31 in case the plots is a so-called "normal" 0-plot (i.e. integral part of one of the four types but no measurable trees found on it). This type of plot enters in the statistical calculations.
- 9999 when "influence" is 4 or 5 (more than 50%), 6 or 7. This type of plot does not enter the statistical calculations.

Bamboo (type 2, page 16)

- columns 1 to 19 included
- columns 34 to 41 included ; if no bamboo is found in one of the two classes 0's must be filled in.

Stumps (type 3, page 16)

- columns 1 to 25 included

Stumps in 0-plots (type 4, page 16)

- columns 1 to 25 included
- columns 28 to 31 included

Trees of diameter class 10 - 29 (type 5, page 16)

- columns 1 to 27 included

Trees with a diameter of 30 cm and above (type 6, page 16)

- columns 1 to 33 included

(*) For the regeneration survey, which was a straight forward counting only, a simplified form was used.

Deck	V	U	C	Prim. Unit			S	Plot No	Str.			Slope	Soil	Int	Tree No	Species Code	Diam. (cm)	Ref. H. (cm)	St. H. (m)	Q1			Q2	Q3	Bamboo																											
				A	B	C			D	Mature	Immature																																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41												
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RECORDING TYPES

(1) (2) (3) (4) (5) (6)

2.5 DATA COMPILATION AND PROCESSING

2.5.1 Principles of the tree volume calculation

1. General

The individual tree volumes are the basis for the calculation of the volume per unit area and of the corresponding standard errors within certain confidence limits.

The computation of these individual volumes takes into account qualitative as well as quantitative factors or criteria. In order to calculate these volumes, and apart from the traditional measurements such as diameter and bole height,

- taper series have to be calculated
- the bark thickness has to be determined, all volumes being calculated inside bark
- the quality of the various stem sections has to be assessed

A substantial amount of basic data has therefore to be collected before any volume calculations can be carried out. The data for the taper series and bark thickness calculations were collected from felled trees. The quality of the stem sections was obtained during the main field work itself.

ii. Calculation of the taper series

A taper series is a set of figures giving the relation between the diameter at certain heights above the ground and the reference diameter. How taper series are arrived at is described in Working Paper No. 6B and the results of the calculations for the high forest species in the Chittagong District are shown in Appendix 2.

iii. The quality appraisal on the standing tree

The qualities applied to each individual tree in the sample plot during the field work, are described in Paragraph 4.1.

iv. Tree volume calculations

The following volumes were to be calculated for each individual tree :

- Gross volume = volume of sections of quality 1, 2, 3, 4, 5 and 6
- Sound volume = " " " " " 1, 2, 3 and 4
- Utilisable volume = " " " " " 1, 2 and 3
- Quality 1 volume = " " " " " 1

Further specifications to be applied during the calculations were :

- all volumes are volumes inside bark
- a quality 1 log must have a minimum length of 2.5 meter and a minimum top diameter of 20 cm.
- stump height to be taken at 0.5 meter from the ground in case of a non-buttressed tree and of buttressed trees of quality 3.

Note : after the data processing it was found that the differences between the gross volume and the sound volume on the one hand, and between the sound volume and the utilisable volume on the other were so small that they were not significant. The sound volume is therefore not mentioned in the text anymore and is also excluded from the tables of Volume 2.

Using the taper series which allow the calculation of the diameter at any desired height from the ground, it is possible to represent the tree by a certain model. The model on page 19 for example, is a model based on a reference diameter D_0 and an imaginary taper series which allows to calculate the diameter at 2.25m, 3.75m, 7.50m, 10.50m, etc..., i.e. at the midpoint of 4 sections of 1.5 m and of "n" sections of 3 m. It should be noted that :

1. The taper series factor at 0.75m ($F_{0.75}$) is considered the same as at 1.30 m ($F_{1.30}$) and is always equal to 1.0.

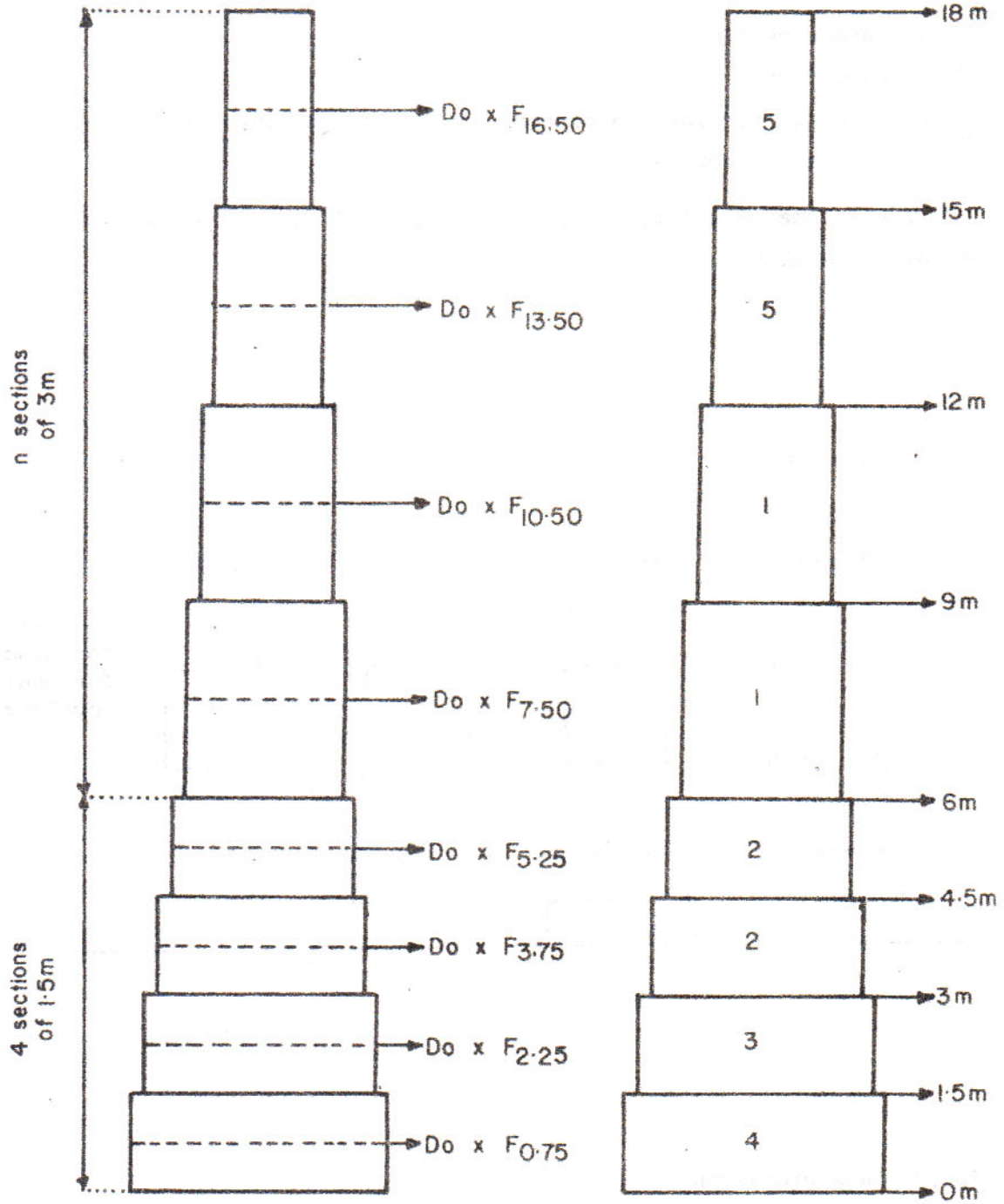
2. One can select a series giving the diameters at any height from the ground (in the case of high forest inventory series were used that gave the diameters at intervals of 1 meter above 6 meters from the ground) but the above example was chosen for simplicity.

Let us now assume that the tree in the field, referred to by the model, was a Garjan with a diameter of 56 cm, a stem height of 18 meter and had received the following quality assessment : "4, 3, 2, 2, 1, 5". (See quality assessment on page 19).

The taper series for a Garjan tree of 56 cm diameter and 18 m height is as follows (see Appendix 2) :

1.30m	2.25m	3.75m	5.25m	7.50m	10.50m	13.50m	16.50m
1.000	0.951	0.900	0.849	0.788	0.709	0.644	0.577

and the bark factor 0.940.



Tree model based on a taper series

Quality assessment

The volume of any section is calculated as follows :

$$V_n = \frac{\pi (D_o \times BF \times F_n)^2}{4} \times L_n$$

in which

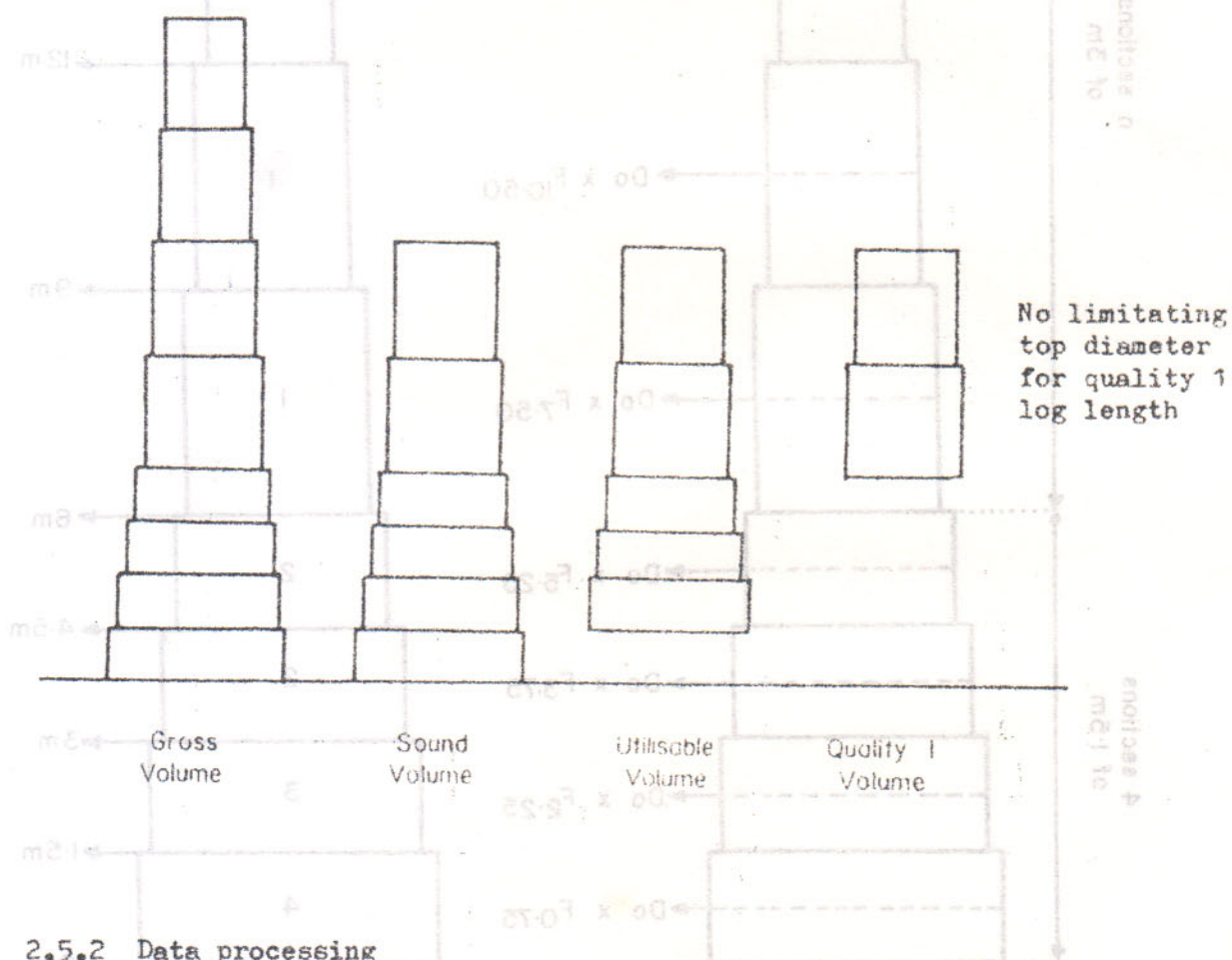
D_o = reference diameter

BF = bark factor

F_n = taper factor for the corresponding section midpoint

L_n = length of section

The volume calculations for our example of page 19 would result in the following results :



2.5.2 Data processing

The entire data processing procedure is explained in detail in Project Document No. 8 "Data Processing System for Forest Inventory". Therefore, a short summary only is given hereafter on the purposes and functions of the processing.

The main functions of the data processing were :

1. Identification and classification of data.
 - Description of the field forms, limits of parameters etc...
2. Transcription of data.
 - Data on the field forms were transferred to diskettes.
3. Checking of data.
 - Source data (input information) was checked for validity and accuracy before it was used in further processing
4. Organisation of data.
 - Sorting data before the processing
 - Creating data files = storing the controlled information
5. Computation and analysis.
 - A local IBM System 34 computer was used.
 - Program language : Fortran IV.

The processing required the following set of programs :

1. Calculation of the taper series (See Working Paper No. 6B and Project Document 7) and the bark factors.
2. Calculation of the individual tree volumes.
For each tree in a sample plots, the four volumes described above were calculated.
3. Summation of the volumes per Forest Division, forest type, line (secondary unit), and per species or species group or utilization group.
Variations of these programs also produced the stand and stock tables.
4. Calculation of the arithmetic means and standard errors (sampling errors).
All errors shown in the tables include the t-factor, i.e. they are all at the 95% level of probability.

3. RESULTS AND CONCLUSIONS

3.1 AREAS OF THE HIGH FOREST TYPES

The areas were calculated from the interpreted 1:50,000 aerial photographs taken in January 1984. The figures in the following table, the same one as table 4 in volume 2, show the actual forested land, i.e. recent clearings and areas where logging was taking place have been excluded from the figures.

Forest Type	Chittagong Forest Division (ha)	Cox's Bazar Forest Division (ha)	Chittagong District (ha)
1	7,456	12,891	20,347
2	22,037	17,882	39,919
3	510	521	1,031
Sub-Total*	30,003	31,294	61,297
4 Total	22,468*	3,205*	25,673*
Total	52,471	34,499	86,970

Forest type 2, the poorest of the three high forest types, is the most dominant with 65% of the total forest area in the District (57% in Cox's Bazar Forest Division, 74% in Chittagong Division).

As regards the two better types, 1 and 3, combined they represent approximately 20,000 hectares in the whole of the District. At present, this figure will already be below 20,000 hectares because of the exploitation which has taken place since the time the photographs were taken.

According to the Working Plans of the Forest Department there are approximately 70,900 hectares reserved and protected forests in the Cox's Bazar Forest Division, approximately 112,700 hectares in the Chittagong Division. That a large part of these areas are barren or denuded hills, bush or bamboo with or without scattered trees, is obvious from the above table even when the plantations are included:

(*) Only 1, 2 and 3 to be considered as "high forest" types. See paragraph 2.2.

Chittagong Forest Division : Trees with a diameter of 30 cm and above

- high forest types (1, 2 and 3) = 27,200
- type 4 = 14,600
- plantations = 13,400
- others (*) = 57,500

Class (cm)	Chittagong Forest Division			
	1	2	3	4
30 - 49	17,200	12,000	12,000	17,200
50 - 69	14,600	11,100	11,100	14,600
70 - 89	13,400	10,800	10,800	13,400
90 +	0.0	0.0	0.0	0.0
Total	45,200	34,900	34,900	45,200

All four types, in the Chittagong Division as well as in Cox's Bazar, are characterized by the dominance of a few species only and of one species in particular: *Garjan* (*Dipterocarpus* sp.). The summary table on page 25, showing the number of trees per hectare of the dominant species in the two most important forest types, illustrates this.

Note: when it comes to volumes, as we shall see later on, the dominance of *Garjan* is even more outspoken because that species is better represented in the middle and lower-upper diameter classes (in total number per hectare and percent-wise in its own diameter distribution) than the other species.

3.2.2 Trees with a diameter of 10 to 29 cm.

With a few exceptions the same dominant species are in this diameter class as in the bigger ones given above. There is one significant difference: *Jam* (*Syzygium* sp.), also called *Other Jam*, has taken the place of *Garjan* as the most dominant species. See summary table on page 26.

(*) Some industrial plantations, such as oil palm for example, are included in these areas.

(*) See footnote on page 4.

3.2 SPECIES COMPOSITION AND DIAMETER DISTRIBUTION

3.2.1 Trees with a diameter of 30 cm and above

The following short summary table shows the number of stems, per 20 cm diameter class, per forest type, in both Forest Divisions :

Ø Class (cm)	Chittagong Forest Division				Cox's Bazar Forest Division			
	Forest Types				Forest Types			
	1	2	3	4	1	2	3	4
30 - 49	67.3 (79.1%)	49.6 (86.1%)	11.1 (20.8%)	22.0 (78.0%)	70.5 (78.5%)	52.8 (84.5%)	30.3 (47.6%)	32.5 (81.7%)
50 - 69	14.7 (17.3%)	6.9 (12.0%)	32.2 (69.1%)	4.6 (16.3%)	15.3 (17.0%)	8.2 (13.1%)	20.8 (32.7%)	5.2 (13.1%)
70 - 89	2.5 (2.9%)	0.8 (1.4%)	2.2 (4.7%)	1.1 (3.9%)	3.7 (4.1%)	1.2 (1.9%)	8.9 (14.0%)	1.8 (4.5%)
90 +	0.6 (0.7%)	0.3 (0.5%)	1.1 (2.4%)	0.5 (1.8%)	0.3 (0.4%)	0.3 (0.5%)	3.6 (5.7%)	0.3 (0.7%)
Total	85.1	57.6	46.6	28.2	89.8	62.5	63.6	39.8

All four types, in the Chittagong Division as well as in Cox's Bazar, are characterised by the dominance of a few species only and of one species* in particular : Garjan (*Dipterocarpus* Spp.). The summary table on page 25, showing the number of trees per hectare of the dominant species in the two most important forest types, illustrates this.

Note : when it comes to volumes, as we shall see later-on, the dominance of Garjan is even more outspoken because that species is better represented in the middle and lower-upper diameter classes (in total numbers per hectare and percent-wise in its own diameter distribution) than the other species.

3.2.2 Trees with a diameter of 10 to 29 cm.

With a few exceptions the same dominant species are in this diameter class as in the bigger ones given above. There is one significant difference : Jam (*Syzygium* Spp.), also called Other Jam, has taken the place of Garjan as the most dominant species. See Summary table on page 26.

(*) See footnote on page 4.

NUMBER OF TREES PER HECTARE, DIAMETER 30 CM AND ABOVE ;
SUMMARY TABLE FOR TYPES 1 AND 2 IN CHITTAGONG AND COX'S BAZAR FOREST DIVISION

SPECIES	CHITTAGONG FOR. DIV.			COX'S BAZAR FOR. DIV.			% of Total
	Type 1	Type 2	% of Total	Type 1	Type 2	% of Total	
817 - GARJAN	11.9	4.0	6.9	29.6	6.5	33.0	10.5
518 - JAM	5.4	3.9	6.8	12.2	10.7	13.6	17.1
512 - CHAPALISH	1.9	1.5	2.6	-	-	-	-
322 - SIMUL	1.0	-	-	-	-	-	-
315 - CIVIT	-	-	-	3.4	1.0	3.8	1.6
OTHER COMMERCIAL	1.3	1.5	2.6	2.0	1.9	2.2	3.0
332 - CHUNDUL	5.6	1.0	1.7	6.7	3.2	7.5	5.1
233 - DAKIJAM	1.1	-	-	1.6	1.2	1.8	1.9
431 - BATNA	-	1.1	1.9	2.1	1.9	2.3	3.0
OTHER IMPORTANT	1.2	0.6	1.1	1.5	0.2	1.7	0.3
055 - GUTGUTIA	8.0	5.2	9.0	-	-	-	-
352 - BANDERHOLA	2.2	-	-	-	-	-	-
365 - URIAM	1.5	-	-	1.2	-	1.3	-
059 - SILBHADI	-	-	-	-	-	-	-
OTHER POTENTIAL	2.8	4.7	8.2	2.0	2.6	2.2	4.2
077 - MISCELLANEOUS	21.9	17.4	30.2	15.0	17.8	16.7	28.5
088 - UNKNOWN	18.2	16.7	29.0	11.0	11.8	12.2	18.9
TOTAL	85.1	57.6	100.0	89.8	62.5	100.0	100.0

BRUNNEN LARTE 108 LILDE J YND S IN CHITTAGONG YND COX'S BAZAR FOREST DIVISION
MANGES OL LARTE 585 HECTARE, DIVISIONS 40 10 50 CM

NUMBER OF TREES PER HECTARE, DIAMETER 10 TO 29 CM ;
SUMMARY TABLE FOR TYPES 1 AND 2 IN CHITTAGONG AND COX'S BAZAR FOREST DIVISION

SPECIES	CHITTAGONG FOR. DIV.			COX'S BAZAR FOR. DIV.		
	Type 1	Type 2	% of Total	Type 1	Type 2	% of Total
				Type 1	Type 2	% of Total
315 - CIVIT	-	-	-	2.1	-	1.7
817 - GARJAN	7.6	1.2	0.9	7.7	6.4	3.4
518 - JAM	11.4	2.6	2.0	22.1	25.1	13.3
322 - SIMUL	-	1.9	1.5	-	1.5	0.8
OTHER COMMERCIAL	1.9	2.5	1.9	1.0	1.4	0.7
431 - BATNA	3.8	2.8	2.2	6.3	5.9	3.1
332 - CHUNDUL	-	-	-	2.5	1.5	0.8
233 - DAKIJAM	-	-	-	1.7	2.0	1.1
237 - TALI	-	-	-	2.4	-	-
OTHER IMPORTANT	1.9	0.1	0.1	1.2	0.1	-
053 - CHALMUGRA	-	-	-	1.0	-	-
254 - GODA	-	-	-	-	1.0	0.5
055 - GUTGUTIA	5.7	3.3	2.6	2.1	1.3	0.7
059 - KHOIRJAM	1.9	2.4	1.9	-	-	-
064 - SILBHADI	-	-	-	-	3.6	1.9
365 - URIAM	1.9	1.2	0.9	1.4	-	-
OTHER POTENTIAL	2.9	2.3	1.8	0.5	1.5	0.8
077 - MISCELLANEOUS	35.2	38.8	30.2	31.5	60.0	31.8
088 - UNKNOWN	94.3	69.3	54.0	43.9	77.7	41.1
TOTAL	168.5	128.4	100.0	127.4	189.0	100.0

3.2.3 Trees with a diameter below 10 cm (regeneration)

The dominant species are the same as in the other diameter classes, only in a different order, as shown in the following summary table.

SPECIES	Cox's Bazar For. Div.			
	Forest type 1		Forest type 2	
	< 5 cm	≥ 5 cm	< 5 cm	≥ 5 cm
518 - JAM	56.2	17.7	63.0	11.3
817 - GARJAN	57.4	13.6	15.3	4.6
365 - URIAM	34.5	9.6	31.8	8.6
431 - BATNA	21.3	4.8	10.7	3.7
233 - DAKIJAM	28.9	7.6	13.8	2.1
332 - CHUNDUL	19.7	9.6	-	-
OTHERS	39.6	16.8	35.0	13.3
077 - MISCELLANEOUS	250.6	38.1	211.9	41.0
088 - UNKNOWN	654.6	98.0	769.4	96.6
TOTAL	1,162.8	215.8	1,150.9	181.2

3.2.4 Bamboo

The table on page 28, shows the number of bamboo culms per hectare, divided into mature and immature, in all four types in the two Districts.

Also here, some species are dominant to very dominant : Daloo (*Nechouzeana dulloca*), Kali (*Oxytenanthera nigrociliata*) and Muli (*Melocanna baccifera*).

The number of culms per hectare reaches quite high figures, much more so in the Chittagong Division than in the Cox's Bazar Division : up to 22,000 culms in type 4 of Chittagong Division. As explained before, in this Division this type is a very poor and open type of brush with scattered trees and from the above it is quite obvious that most of the brush must be bamboo.

NUMBER OF BAMBOO CULMS/HA - CHITT. FOR. DIV.

Species Code	Type 1		Type 2		Type 3		Type 4	
	MAT	IMM	MAT	IMM	MAT	IMM	MAT	IMM
091	2,520	6,860	4,030	9,900	-	-	5,680	8,730
092	20	100	300	1,210	-	-	-	-
Sub-t.	2,540	6,960	4,330	11,110	-	-	5,680	8,730
093	-	-	-	-	-	-	-	-
094	-	-	280	210	-	-	3,560	3,000
095	710	1,290	330	1,240	-	-	-	-
096	1,050	3,000	390	1,260	420	830	370	660
097	-	-	-	-	-	-	-	-
098	-	-	-	-	-	-	-	-
Sub-t.	1,760	4,290	1,000	2,710	420	830	3,930	3,660
Total	4,300	11,250	5,330	13,820	420	830	9,610	12,390

NUMBER OF BAMBOO CULMS/HA - C. B. FOR. DIV.

Species Code	Type 1		Type 2		Type 3		Type 4	
	MAT	IMM	MAT	IMM	MAT	IMM	MAT	IMM
091	400	1,250	850	3,310	290	210	-	-
092	130	1,040	120	490	-	-	-	-
Sub-t.	530	2,290	970	3,800	290	210	-	-
093	-	-	20	200	-	-	530	710
094	-	10	-	-	-	-	-	-
095	310	890	110	510	-	420	210	940
096	590	1,270	360	840	210	620	1,930	6,060
097	10	10	40	40	-	-	-	-
098	30	50	20	20	-	-	-	-
Sub-t.	940	2,230	550	1,610	210	1,040	2,670	7,710
Total	1,470	4,520	1,520	5,410	500	1,250	2,670	7,710

3.3 VOLUMES AND SAMPLING ERRORS

3.3.1 Trees with a diameter of 30 cm and above*

The tables on pages 30, 31 and 32 are summary tables, derived from the more detailed ones given in Volume 2, showing the gross, utilisable and quality 1 volumes (in m³/ha) together with their sampling errors (in %), per forest type and per 30 cm diameter class. The table on page 30 is for the whole of the Chittagong District, the two following ones are for the Chittagong and the Cox's Bazar Forest Divisions respectively. As mentioned before, the figures for type 4 are given for general information purposes only because of the wide variation encountered in that type.

Only in type 1 (and 3 which is derived from 1) can the gross volumes be considered as average for this type of dominantly semi-evergreen tropical forest, varying as they do between 90 and 120 m³/ha.

In forest type 2 the volumes are significantly lower : approximately 46 m³ in Chittagong Forest Division, 57 in Cox's Bazar.

Type 3 is characterised by its high volume in the middle and upper diameter classes (species Garjan and Jam) giving it the highest volume of all types in Cox's Bazar Division : 120 m³/ha. However, the area of this type is very small, the sampling was limited and the sampling errors obtained were way above the 30% limit considered in the tables for the individual diameter classes.

The difference in all the types between gross and utilisable volume is small but considerable between utilisable and quality 1. Also here the figures are better in types 1 and 3 than in 2 and 4, and better in Cox's Bazar than in Chittagong Forest Division : the 71 m³/ha of quality 1 volume in forest type 1 of Cox's Bazar Division is quite an impressive figure.

The dominance of a few species is clearly reflected in the volume figures :

- type 1, Chittagong Division : 11 species** represent 58% of the gross volume
- type 2, Chittagong Division : 5 species - 31 %
- type 1, Cox's Bazar Division : 8 species - 76 %
- type 2, Cox's Bazar Division : 7 species - 52 %

* No volumes were calculated for trees with a diameter below 30 cm

** Always keeping in mind that species Garjan represents probably 4 Dipterocarp species of which two are dominant.

VOLUME (m³/ha) AND SAMPLING ERRORS (%) BY FOREST TYPE AND DIAMETER CLASS
CHITTAGONG DISTRICT

Type of volume	Forest type 1							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	74.2	7.7	30.0	20.4	3.0	-	107.3	8.4
Utilis.	73.0	7.8	29.1	20.5	2.8	-	104.9	8.5
Qual.1	42.3	11.5	18.8	23.7	1.5	-	62.6	12.4

Type of volume	Forest type 2							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	40.7	8.0	8.6	21.9	1.9	-	51.2	8.8
Utilis.	39.7	8.1	8.4	22.5	1.8	-	49.9	8.9
Qual.1	18.1	11.7	4.7	27.9	0.6	-	23.4	13.6

Type of volume	Forest type 3							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	42.9	-	50.7	-	15.8	-	109.4	-
Utilis.	42.0	-	49.8	-	15.5	-	107.3	-
Qual.1	30.6	-	40.1	-	11.4	-	82.1	-

Type of volume	Forest type 4							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	18.8	24.6	6.6	-	2.7	-	28.1	29.7
Utilis.	18.4	24.6	6.6	-	2.7	-	28.1	29.7
Qual.1	9.5	28.9	3.9	-	2.1	-	15.5	-

VOLUME (m³/ha) AND SAMPLING ERRORS (%) BY FOREST TYPE AND DIAMETER CLASS
CHITTAGONG FOREST DIVISION

Type of volume	Forest type 1							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	64.3	9.8	22.4	18.9	3.5	-	90.2	7.3
Utilis.	63.4	9.5	22.2	19.2	3.0	-	88.6	7.9
Qual.1	32.3	13.3	12.5	25.1	0.8	-	45.6	13.1

Type of volume	Forest type 2							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	37.3	13.3	6.9	-	1.4	-	45.6	13.6
Utilis.	36.4	13.7	6.8	-	1.3	-	44.5	14.0
Qual.1	16.3	18.9	3.2	-	0.4	-	19.9	21.3

Type of volume	Forest type 3							
	30-59	SE%	60-89	SE%	90 +	SE%	Total	SE%
Gross	48.1	-	34.3	-	6.7	-	89.1	-
Utilis.	48.1	-	34.3	-	6.7	-	89.1	-
Qual.1	34.0	-	29.0	-	5.7	-	69.0	-

Type of volume	Forest type 4							
	30-59	SE%	69-89	SE%	90 +	SE%	Total	SE%
Gross	16.4	-	5.2	-	2.8	-	24.4	-
Utilis.	16.1	-	5.0	-	2.8	-	23.9	-
Qual.1	7.7	-	3.0	-	2.3	-	13.0	-

VOLUME (m³/ha) AND SAMPLING ERRORS (%) BY FOREST TYPE AND DIAMETER CLASS

COX'S BAZAR FOREST DIVISION

Type of volume	Forest type 1						Total	SE%
	30-59	SE%	60-89	SE%	90 +	SE%		
Gross	79.1	9.8	33.7	26.0	2.8	-	115.6	10.8
Utilis.	77.8	9.9	32.7	26.3	2.8	-	113.3	11.0
Qual.1	47.4	13.8	22.0	28.7	1.8	-	71.2	14.6

Type of volume	Forest type 2						Total	SE%
	30-59	SE%	60-89	SE%	90 +	SE%		
Gross	44.4	8.5	10.5	28.3	2.3	-	57.2	10.2
Utilis.	43.0	8.4	10.0	29.1	2.1	-	55.1	10.3
Qual.1	20.0	13.7	6.2	-	0.8	-	27.0	16.4

Type of volume	Forest type 3						Total	SE%
	30-59	SE%	60-89	SE%	90 +	SE%		
Gross	40.0	-	59.7	-	20.7	-	120.4	-
Utilis.	38.9	-	58.1	-	20.2	-	117.2	-
Qual.1	28.7	-	45.9	-	14.5	-	89.1	-

Type of volume	Forest type 4						Total	SE%
	30-59	SE%	60-89	SE%	90 +	SE%		
Gross	25.1	-	10.4	-	2.2	-	37.7	-
Utilis.	24.6	-	10.3	-	2.2	-	37.1	-
Qual.1	14.8	-	6.0	-	2.2	-	23.0	-

The table on page 34 shows the utilisable volume of Garjan, as a % of the total, for the four types in the District. These figures are given only to demonstrate the dominance of the Dipterocarps.

The sampling errors, at the level of probability of 95 %, are quite small and therefore define the means very well : ± 10.5 % for both gross and utilisable volume in types 1 and 2 in Cox's Bazar Division, ± 15 % for quality 1 volume. In Chittagong Division : ± 7.5 % for gross and utilisable volume in type 1, ± 14 % for type 2 ; respectively 13 and 21 % for the quality 1 volume in types 1 and 2.

The table on page 35 shows the total utilisable volumes for types 1, 2 and 3 combined in Chittagong and Cox's Bazar Divisions, and in the District. (More detailed figures are found in tables 6A, 6B and 6C in Volume 2).

This table shows that quite appreciable volumes are still available at present, especially of the commercial species (56 % of the total volume in Cox's Bazar Forest Division, 31 % in Chittagong Division and 46 % in the District), which makes this high forest in the Chittagong District an economically interesting forest.

Up-dated management plans, prescribing reasonable, allowable cutting rates and rational exploitation methods, could significantly contribute to the conservation of some of the most promising and valuable areas of this high forest.

3.3.2 Bamboo

The Project did not carry out any volume calculations for bamboo but, by comparing the stand tables (Tables 1F1, 1F2, 1F3 of Volume 2) with some figures from Field Document 9 - UNDP/FAO Project BGD/78/010 - "A study on supply and demand of bamboos and canes in Bangladesh", a rough estimate was made of the bamboo resources, in terms of volume, in the high forest.

In Cox's Bazar Forest Division the bamboo as "understorey in the high forest" arrives at approximately 1.6 A.D. tons per hectare, a figure which is within the limits of those shown in the Field Document mentioned above. In the Chittagong Division it is considerably higher, up to 4 A.D. tons per hectare. This could either be a normal feature of characteristic of the forest in that region or an indication that the high forest types are more open than in Cox's Bazar region, therefore containing more bamboo.

UTILISABLE VOLUME (in m³/ha) OF GARJAN - CHITTAGONG DISTRICT

Utilisable volume	Forest type 1							
	30-59	%	60-89	%	90 +	%	Total	%
Garjan	24.5	33.6	15.7	53.9	1.3	46.3	41.5	39.6
Total	73.0		29.1		2.8		104.9	

Utilisable volume	Forest type 2							
	30-59	%	60-89	%	90 +	%	Total	%
Garjan	4.8	12.1	2.8	33.3	0.4	22.2	8.0	16.0
Total	39.7		8.4		1.8		49.9	

Utilisable volume	Forest type 3							
	30-59	%	60-89	%	90 +	%	Total	%
Garjan	34.0	81.0	46.6	93.6	10.6	68.4	91.2	85.0
Total	42.0		49.8		15.5		107.3	

Utilisable volume	Forest type 4							
	30-59	%	60-89	%	90 +	%	Total	%
Garjan	2.6	14.1	2.9	43.9	1.0	37.0	6.5	23.5
Total	18.4		6.6		2.7		27.7	

TOTAL UTILISABLE VOLUMES (in 1,000 m³), FOREST TYPE 4
NOT INCLUDED*

SPECIES	CHITTAGONG FOREST DIVISION	COX'S BAZAR FOREST DIVISION	CHITTAGONG DISTRICT
817 - GARJAN	251.7	907.8	1,159.5
518 - JAM	87.4	251.7	339.1
315 - CIVIT	-	106.5	106.5
322 - SIMUL	19.1	-	19.1
512 - CHAPALISH	58.5	-	58.5
521 - KOROI	7.5	-	7.5
OTHER COMMERCIAL	42.2	81.1	123.3
332 - CHUNDUL	69.8	187.7	257.5
233 - DAKIJAM	9.5	42.6	52.1
431 - BATNA	-	56.2	56.2
OTHER IMPORTANT	34.2	13.8	48.0
055 - GUTGUTIA	111.7	-	111.7
059 - KHOIRJAM	13.6	28.8	42.4
365 - URIAM	15.0	20.1	35.1
352 - BANDERHOLA	21.1	-	21.1
064 - SILBHADI	-	44.4	44.4
OTHER POTENTIAL	99.2	61.4	160.6
077 - MISCELLANEOUS	381.2	362.7	743.9
088 - UNKNOWN	306.4	250.0	556.4
TOTAL	1,528.1	2,414.8	3,942.9

* For reasons explained in paragraph 2.2.

Chittagong and Cox's Bazar Forest
Division - Total Volume

Forest Type	Chittagong Forest Division	Cox's Bazar Forest Division	TOTAL Chittagong District
1 (HF)	7,456	12,891	20,347
ha	90.2	115.6	
m ³ /ha			
Total m ³	672,531	1,490,200	2,162,731
2 (LF)	22,037	17,882	39,919
ha	45.6	57.2	
m ³ /ha			
Total m ³	1,004,887	1,022,850	2,027,738
3 (GF)	510	521	1,031
ha	89.1	120.4	
m ³ /ha			
Total m ³	45,441	62,728	108,169
4 (ST)	22,468	3,205	25,673
ha	24.4	37.7	
m ³ /ha			
Total m ³	548,219	120,829	669,048
Total m ³	2,271,078	2,696,606	4,967,684

Appendix 11. Local and scientific name of the species

Banaspata	Podocarpus neriifolius
Banderhola	Duabanga grandiflora
Batna	Quercus Spp.
Boilam	Anisoptera glabra
Chalmugra	Hydnocarpus kurzii
Champaful	Michelia champaca
Chapalish	Artocarpus chapalasha
Chatian	Alstonia scholaris
Chikrassi	Chukrasia velutina
Chundul	Tetrameles nudiflora
Civit	Swintonia floribunda
Dakijam	Syzygium grande
Gamar	Gmelina arborea
Garjan	Dipterocarpus Spp.
Goda	Vitex peduncularis
Gutgutia	Protium serratum
Haritaki	Terminalia chebula
Jam	Syzygium Spp.
Jarul	Lagerstroemia speciosa
Kadam	Anthocephalus chinensis
Kainjail	Bischofia javanica
Kamdeb	Calophyllum polyanthum
Khoirjam	Syzygium syzygioides
Konak	Schima wallichii
Koroi	Albizia Spp.
Minjiri	Cassia siamea
Pitali	Trewia nudiflora
Pitraj	Amoora Spp. ; Dysoxylum Spp.
Raktan	Lophopetalum fimbriatum
Silbhadi	Garuga pinnata
Simul	Bombax ceiba and Bombax insigne
Tali	Palaquium polyanthum
Telsur	Hopea odorata
Toon	Toona ciliata
Uriam	Mangifera sylvatica

Appendix I

Local and scientific name of the species

Bamboo

Bariala
Basali
Daloo
Kali
Kalisera
Mitenga
Muli
Orah

Bambusa vulgaris	Banagata
Teinostachyum griffithii	Banderhola
Neohouzeaua dulloca	Barna
Oxytenanthera nigrociliata	Bolan
Oxytenanthera auriculata	Chalmara
Bambusa tulda	Champala
Melocanna baccifera	Chapalia
Dendrocalamus longispatus	Chitra
	Chikra
	Chundi
	Civi
	Dakjam
	Damar
	Darjan
	Doda
	Dudula
	Hariaki
	Jam
	Jaru
	Kadam
	Kajali
	Kandob
	Khoirjam
	Konak
	Koroi
	Minjiri
	Pitaji
	Pitaj
	Raktan
	Silbandi
	Simali
	Tali
	Telaur
	Toon
	Uria

2. Species codes and species groups

The first digit of the code indicates the utilisation :

- 1 = furniture and cabinet making
- 2 = construction work
- 3 = packing cases, matches, veneer
- 4 = agricultural use
- 5 = 1 + 2
- 6 = 1 + 3
- 7 = 1 + boat building
- 8 = 2 + boat building
- 9 = 3 + boat building
- 0 = unknown uses

Commercial species

	Code
Boilam	723
Champfuf	611
Chapalish	512
Chatian	313
Chikrassi	114
Civit	315
Gamar	716
Garjan	817
Jam	518
Jarul	819
Kadam	320
Koroi	521
Simul	322

Important species

Batna	431
Chundul	332
Dakijam	233
Kamdeb	934
Tali	237
Telsur	238
Toon	839

Potential species

Banaspata	051
Banderhola	352
Chalmugra	053
Goda	254
Gutgutia	055
Haritaki	056
Kainjail	057
Konak	058
Khoirjam	059
Minjiri	060
Pitraj	561

Pitali	362
Raktan	363
Silbhadi	064
Uriam	365
<u>Miscellaneous</u>	077
<u>Unknown</u>	088
<u>Bamboo</u>	
Muli	091
Mitenga	092
Bariala	093
Basali	094
Daloo	095
Kali	096
Kalisera	097
Orah	098

The first digit of the code indicates the utilization:

1 = furniture and cabinet making
 2 = construction work
 3 = packing cases, matches, veneer
 4 = agricultural use
 5 = 1 + 2
 6 = 1 + 3
 7 = 1 + boat building
 8 = 2 + boat building
 9 = 3 + boat building
 0 = unknown uses

Commercial species

353	Bolam
354	Champala
355	Chapala
356	Chatan
357	Chikra
358	Chit
359	Chit
360	Chit
361	Chit
362	Chit
363	Chit
364	Chit
365	Chit
366	Chit
367	Chit
368	Chit
369	Chit
370	Chit
371	Chit
372	Chit

Important species

373	Batun
374	Chundul
375	Dakjan
376	Kandob
377	Tali
378	Tauru
379	Toon

Potential species

051	Banapata
052	Banapata
053	Banapata
054	Banapata
055	Banapata
056	Banapata
057	Banapata
058	Banapata
059	Banapata
060	Banapata
061	Banapata

TAPER SERIES	SPECIES	SPECIES CODE	DIAMETER GROUP	BARK FACTOR	FOREST DIVISION
1	Garjan	817	30 - 59	0.940	C.B.
2	Garjan	817	60 - 89	0.955	C.B.
3	Garjan	817	90 +	0.965	C.B.
4	Jam*	518	30 - 39	0.945	C.B.
5	Jam	518	40 +	0.955	C.B.
6	Civit	315	30 - 39	0.965	C.B.
7	Civit	315	40 - 59	0.970	C.B.
8	Civit	315	60 +	0.975	C.B.
9	Chapalish	512	30 - 59	0.940	C.B.
10	Chapalish	512	60 +	0.950	C.B.
11	Dakijam	233	30 - 39	0.945	C.B.
12	Dakijam	233	40 - 59	0.950	C.B.
13	Dakijam	233	60 +	0.955	C.B.
14	Uriam	365	30 +	0.950	C.B.
15	Telsur, Boilam	238, 723	30 +	0.950	C.B. + C
16	Batna	431	30 - 49	0.945	C.B.
17	Batna	431	50 +	0.950	C.B.
18	Khoirjam	059	30 +	0.970	C.B.
19	Simul group*		30 - 49	0.940	C.B.
20	Simul group*		50 +	0.955	C.B.
21	Miscellaneous	077	30 - 39	0.950	C.B.
22	Miscellaneous	077	40 - 49	0.955	C.B.
23	Miscellaneous	077	50 - 59	0.955	C.B.
24	Miscellaneous	077	60 +	0.965	C.B.
25	Miscellaneous	077	30 - 49	0.945	C.
26	Miscellaneous	077	50 +	0.950	C.
27	Silbhadi, Goda	064, 254	30 +	0.950	C.
28	Jam*	518	30 - 49	0.950	C.
(28)	Jam	518	50 +	0.965	C.
29	Chapalish	512	30 +	0.955	C.

* Simul group = Simul (322), Banderhola (352), Pitraj (561), Tali (237), Chatian (313), Pitali (362), Kadam (320).

(*) Jam is also known as "Other Jam".

Appendix 2

1. Taper series for high forest species in the Chittagong District

Height (in m)	
1.30	2.25 3.75 5.25 6.50 7.50 8.50 9.50 10.50 11.50 12.50 13.50 14.50 15.50 16.50 17.50 18.50 19.50 20.50 21.50 22.50 23.50 24.50 25.50 26.50 27.50 28.50 29.50
1.000	0.51 0.900 0.249 0.811 0.788 0.759 0.735 0.709 0.688 0.668 0.644 0.621 0.599 0.577 0.556 0.532 0.517 0.499 0.481 0.467 0.449 0.427 0.409 0.390 0.375 0.355 0.335
1.000	0.556 0.911 0.255 0.820 0.795 0.774 0.752 0.732 0.718 0.698 0.670 0.663 0.647 0.630 0.615 0.599 0.580 0.569 0.550 0.538 0.530 0.515 0.505 0.480 0.478 0.469 0.459
1.000	0.663 0.913 0.275 0.845 0.826 0.807 0.791 0.778 0.761 0.748 0.735 0.722 0.704 0.694 0.681 0.669 0.659 0.644 0.634 0.623 0.611 0.600 0.588 0.575 0.564 0.554 0.545
1.000	0.890 0.899 0.858 0.815 0.790 0.770 0.750 0.738 0.715 0.699 0.682 0.670 0.658 0.645 0.630 0.617 0.608 0.597 0.575 0.573 0.568 0.560 0.551 0.542 0.536 0.531 0.527
1.000	0.951 0.898 0.740 0.803 0.770 0.755 0.730 0.712 0.690 0.661 0.652 0.637 0.625 0.603 0.589 0.575 0.560 0.530 0.530 0.525 0.514 0.504 0.499 0.485 0.475 0.469 0.460
1.000	0.912 0.921 0.885 0.859 0.839 0.819 0.800 0.781 0.761 0.745 0.729 0.710 0.700 0.681 0.665 0.649 0.640 0.621 0.610 0.600 0.580 0.563 0.549 0.535 0.520 0.506 0.492
1.000	0.974 0.939 0.915 0.887 0.869 0.850 0.837 0.820 0.800 0.786 0.770 0.751 0.740 0.725 0.710 0.699 0.682 0.668 0.650 0.645 0.630 0.620 0.610 0.595 0.583 0.573 0.563
1.000	0.952 0.891 0.839 0.800 0.785 0.770 0.740 0.690 0.656 0.640 0.610 0.598 0.565 0.540 0.515 0.490 0.468 0.445 0.423 0.400 0.382 0.365 0.341 0.325 0.305 0.287 0.269
1.000	0.915 0.915 0.865 0.830 0.809 0.780 0.751 0.731 0.719 0.690 0.670 0.646 0.627 0.611 0.598 0.575 0.561 0.548 0.529 0.515 0.499 0.489 0.473 0.460 0.450 0.439 0.429
1.000	0.955 0.895 0.845 0.805 0.780 0.751 0.727 0.705 0.681 0.667 0.650 0.630 0.611 0.599 0.585 0.572 0.562 0.555 0.548 0.540 0.535 0.533 0.520 0.520 0.525 0.525
1.000	0.960 0.925 0.865 0.831 0.811 0.785 0.764 0.741 0.725 0.705 0.690 0.669 0.657 0.647 0.631 0.616 0.605 0.591 0.583 0.576 0.567 0.560 0.550 0.540 0.530 0.510 0.480
1.000	0.965 0.925 0.888 0.865 0.845 0.825 0.805 0.787 0.772 0.755 0.742 0.730 0.715 0.700 0.690 0.680 0.669 0.660 0.652 0.642 0.637 0.628 0.620 0.618 0.610 0.602 0.598
1.000	0.960 0.910 0.860 0.829 0.799 0.778 0.750 0.728 0.710 0.692 0.678 0.660 0.645 0.628 0.611 0.601 0.591 0.578 0.565 0.555 0.544 0.539 0.528 0.520 0.515 0.510 0.506
1.000	0.883 0.825 0.785 0.752 0.725 0.695 0.668 0.645 0.620 0.600 0.577 0.560 0.542 0.526 0.510 0.498 0.480 0.466 0.455 0.440 0.430 0.418 0.406 0.395 0.384 0.373
1.000	0.946 0.881 0.828 0.789 0.762 0.738 0.715 0.690 0.668 0.650 0.627 0.608 0.590 0.572 0.558 0.541 0.527 0.510 0.496 0.483 0.469 0.458 0.445 0.432 0.422 0.412 0.401
1.000	0.947 0.886 0.838 0.808 0.787 0.767 0.749 0.735 0.723 0.710 0.698 0.687 0.678 0.668 0.660 0.651 0.645 0.639 0.630 0.624 0.618 0.610 0.608 0.605 0.600 0.595 0.591
1.000	0.955 0.894 0.850 0.819 0.794 0.775 0.757 0.742 0.725 0.715 0.699 0.684 0.674 0.664 0.654 0.644 0.635 0.627 0.619 0.612 0.607 0.602 0.598 0.590 0.584 0.578 0.572
1.000	0.956 0.896 0.843 0.800 0.775 0.745 0.720 0.690 0.670 0.649 0.622 0.599 0.576 0.559 0.540 0.519 0.499 0.479 0.456 0.441 0.423 0.405 0.388 0.369 0.355 0.341 0.328
1.000	0.955 0.895 0.845 0.810 0.787 0.760 0.740 0.719 0.696 0.675 0.656 0.637 0.615 0.598 0.578 0.562 0.543 0.525 0.508 0.490 0.472 0.458 0.442 0.429 0.415 0.401 0.389
1.000	0.958 0.901 0.848 0.810 0.780 0.749 0.725 0.695 0.668 0.642 0.617 0.591 0.568 0.544 0.519 0.500 0.475 0.452 0.434 0.413 0.388 0.369 0.349 0.332 0.315 0.300 0.285
1.000	0.957 0.889 0.838 0.793 0.762 0.729 0.708 0.681 0.660 0.638 0.610 0.589 0.574 0.555 0.535 0.518 0.499 0.474 0.453 0.438 0.421 0.409 0.391 0.375 0.364 0.353 0.343
1.000	0.959 0.902 0.856 0.820 0.797 0.775 0.750 0.731 0.711 0.690 0.670 0.655 0.635 0.618 0.600 0.584 0.568 0.553 0.537 0.520 0.508 0.493 0.481 0.467 0.455 0.443 0.431
1.000	0.922 0.888 0.860 0.838 0.815 0.796 0.779 0.758 0.740 0.725 0.710 0.690 0.675 0.659 0.642 0.629 0.612 0.598 0.584 0.569 0.559 0.548 0.533 0.520 0.507 0.495
1.000	0.929 0.834 0.772 0.724 0.690 0.661 0.638 0.610 0.583 0.564 0.545 0.521 0.509 0.490 0.473 0.458 0.445 0.429 0.410 0.408 0.395 0.384 0.372 0.361 0.351 0.341 0.332
1.000	0.958 0.900 0.845 0.804 0.775 0.742 0.717 0.687 0.660 0.634 0.607 0.580 0.558 0.533 0.509 0.486 0.465 0.444 0.424 0.403 0.384 0.365 0.347 0.328 0.309 0.290 0.273
1.000	0.928 0.833 0.750 0.694 0.654 0.615 0.577 0.548 0.517 0.490 0.465 0.442 0.420 0.402 0.384 0.368 0.352 0.339 0.329 0.320 0.310 0.305 0.298 0.290 0.281 0.272 0.270
1.000	0.935 0.850 0.783 0.732 0.695 0.662 0.633 0.604 0.577 0.555 0.530 0.509 0.490 0.472 0.459 0.445 0.435 0.424 0.417 0.410 0.403 0.398 0.390 0.388 0.379 0.370 0.361
1.000	0.925 0.839 0.764 0.710 0.670 0.640 0.610 0.582 0.560 0.540 0.518 0.500 0.490 0.474 0.460 0.445 0.432 0.420 0.410 0.400 0.390 0.380 0.375 0.370 0.366 0.362 0.359

2. Solid versus stacked roundwood volumes

During data collection for preparation of volume functions for high forest species at Cox's Bazar Forest Division, some photographs of wood stacks were taken in order to find a relationship of stacked versus solid (true) volume. The stacks were composed of round woods of varying size.

The photographs were taken in black and white and 4 of them were enlarged to a suitable size for measurement.

The blank and wooded areas of the four photographs were traced on transparent overlays and the blank areas were coloured. A dot grid was then used to count the dots of the blank areas and of the total area after which the percentages of wooded and blank areas were calculated.

Results :

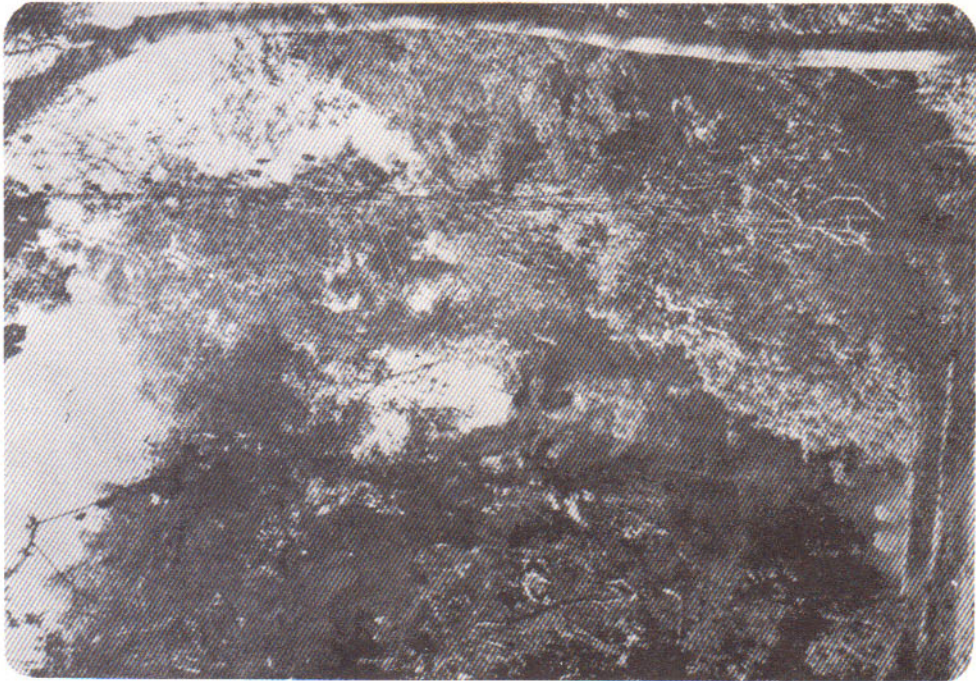
Photo no.	Area of the stack (cm ²)	No. of dots of the stack	No. of dots of blank area	% Blank area	% Wooded area
1	39.60	990	288	29.09	70.91
2	89.09	2227	809	36.33	63.67
3	78.40	1960	663	33.80	66.20
4	97.50	2437	728	29.87	70.13

The average percentage of wooded and blank areas are 67.73 and 32.27 respectively.

Appendix 3



P 2



P 1

Forest type 1 : Large crowned, high forest



P 3



P 4

Forest type 2 : Small crowned, high forest



P 5



P 6

Forest type 3 : Open, high forest.



P 7

Forest type 4 : Brush with scattered trees
Example of best stand.



P 8

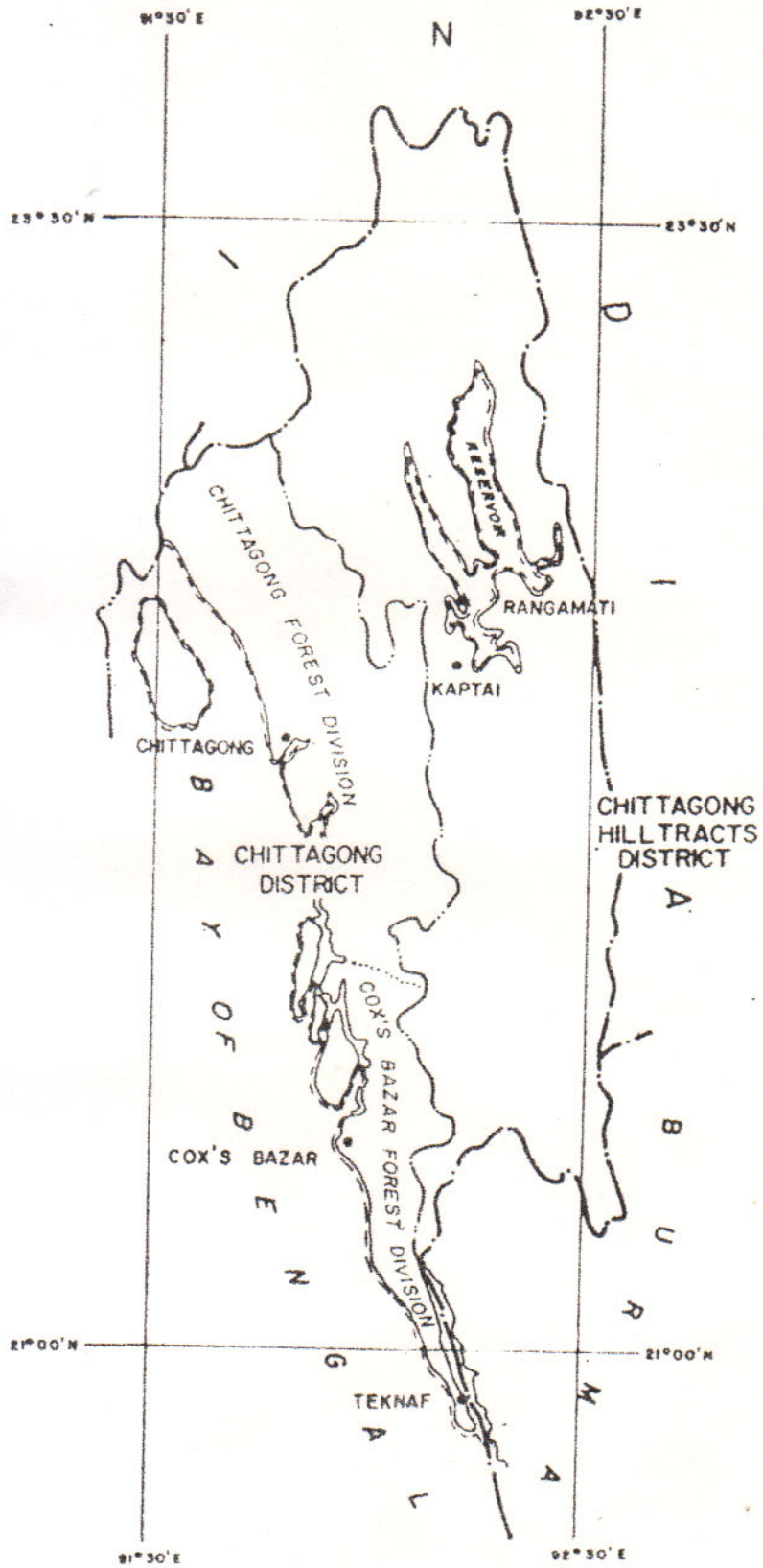
Forest type 4 : Brush with scattered trees
Example of average stand





P 9

Forest type 4 : Brush with scattered trees
Example of worst stand, very
common, especially in
Chittagong Forest Division.

Appendix 4



LEGEND

-  International boundary
-  District boundary

Scale 1 : 1,820,000 (approx.)