

GOVERNMENT OF EAST PAKISTAN
FOREST DEPARTMENT

WORKING PLAN OF
SUNDARBAN FOREST DIVISION
FOR THE PERIOD FROM
1960-61 to 1979-80

Vol. I

Compiled by:-

A. M. CHOUDHURY,

Deputy Conservator of Forests and Divisional Forest Officer,

Working Plans Division-I, Dacca

Dated, Dacca, the 1st June, 1962

GOVERNMENT OF EAST PAKISTAN
AGRICULTURE DEPARTMENT

Section VII

No. VII/For. 14/68/342, dated Dacca, the 22nd March, 1968.

To—THE CHIEF CONSERVATOR OF FORESTS, EAST PAKISTAN.

SUBJECT: *Sanction of the Working Plan of Sundarbans (Volumes I and II).*

Reference: His Memo. No. TO/W-2/109, dated 23rd January, 1968.

The undersigned is directed to say that the Government of East Pakistan are pleased to accord their sanction to the Working Plan of Sundarbans Forest Division (Volumes I and II) for the period from 1960-61 to 1979-80.

2. The Working Plans (Volumes I and II) are returned herewith.

S.K.H. NAQVI, T.K.
Section Officer.

A - 1687
স্বাক্ষরিত
০৩ মে ১৯৬৮
স্ব. স. স. - ৩৩৭



FOREWORD

The present Working Plan of Sundarbans Reserved Forest needs special mention of certain methods which were not followed in the preparation of its previous working plans. This is the first plan the prescriptions of which are based on aerial photographic and photogrammetric techniques supported by statistically controlled ground samplings.

The exploitation of the forest has also been prescribed, unlike the past, with a view to catering for raw materials for a number of industries, viz., Khulna Newsprint Mills, Hard-board Factory, Tanning Factory and a couple of Match Factories and other industries like manufacture of bobbin, wooden sandals, etc.

Sundarbans forest is not only the abode of the famous 'Royal Bengal Tigers' but also provides ideal habitat for many other animals, birds and reptiles. Special mention has been made about its rich fauna in this working plan. Unfortunately the animal population has decreased due to poaching and tidal-bores which occurred in several consecutive years. The Sundarbans forest which was in the past a forbidden forest due to its ecology and presence of tigers on the land and crocodile in the waters, has now become exposed to lots of passenger and cargo vessels. Various activities of the Chalna Anchorage inside Sundarbans Reserved Forests are also responsible for exposing these forests to visitors and vessels. The people visiting Sundarbans take it as a hunting ground without considering the importance and necessity of following game rules prescribed for preservation of wild life. A game sanctuary has, therefore, been established over an area of 171 sq. miles comprising the compartment Nos. 3, 4, 5, 6 and 7 with a view to giving complete protection to all wild life in the area.

The fisheries inside the reserved forest and estuaries provide great scope for improvement under scientific management. The natural resources of Sundarbans forest are full of potentiality and will be earning more revenue if they can be properly tapped and profitably utilised.

The wild life and natural sceneries of Sundarbans forest provide a good opportunity for development of tourism in the region.

The Sundarbans forests were worked under a modified working plan upto March, 1947. They were worked under working schemes prepared from time to time during the period from 1947 to 1959. The present working plan has taken much longer period for its final compilation than

normal time due to frequent transfer of the working plan officers. As a result the forests had to be worked under advance prescriptions of the present working plan from 1960-61.

The undersigned wishes to thank all officers connected with the compilation of this working plan and to keep on record his appreciation for the works done.

DACCA;
The 7th April, 1967.

N. AHMAD,
Chief Conservator of Forests,
East Pakistan.

T
20 y
sion
after

T
peric
there
man:
statist

T
indu:
explc
ment
timb
erosi
are

S
in ac
The
5 m
the
kept

T
whic
local

T
half

Ir
of K
ed fr
Presc

T
comp

The

INTRODUCTION

The Working Plan for Sundarban Forest Division covers a period of 20 years from 1st June, 1960 to 31st May, 1980. No intermediate revision is prescribed. However, provisions have been kept for modification after 10 years.

The first regular Working Plan for this forest by S. J. Curtis for the period from 1931 to 1951 was found to be too elaborate to follow and therefore short-term schemes were prepared from time to time for proper management. Curtis's plan, however, provides useful informations and statistical data.

The demand for Sundarbans Forest produce both for agricultural and industrial need is increasing day by day. The plan provides for maximum exploitation to meet the increasing demand and simultaneously improvement of the growing stock by silvicultural operations. Apart from its timber value, this forest acts as a protective belt against cyclone, flood, erosion and tidal-bore. The indirect benefits derived from these forests are manifolds.

Sundarbans forests can feed large number of wood-based industries in addition to the existing ones; News Print Mill and Match Factory. The annual yield of Gewa is calculated to be 6.7 million cft. of which 5 million cft. has been prescribed for the News Print Mill. Should the management decide to expand it. About .85 million cft. has been kept for Match Factory and .89 million for other local industries.

The annual yield of Sundri is calculated to be 7.21 million cft. of which 0.7 has been kept for hard-board manufactures and the rest for local consumption and other industries.

The yield is calculated by area by taking away mature trees and half the annual growth under selection *cum* improvement fellings.

In addition to the two major species, gewa and sundri, about 3,00,000cft of Keora, Passur, Baen, Dhundal, Kankra and Goran will also be extracted from annual coupes. Golpatta is used extensively as roofing material. Prescriptions have been made to improve its stock.

The plan also provides for establishing a game sanctuary consisting of compartment Nos. 3, 4, 5, 6 and 7 for preservation of wild life.

A. HAMID,

Conservator of Forests,
Development Circle, East Pakistan.

DACCA;
The 27th July, 1964.

TABLE OF CONTENTS

PREFACE

Glossary of names of plants, local terms and abbreviations.

PART I

Summary of the facts on which proposals are based.

CHAPTER I

		Paragraph number.
The tract dealt with		
Name and situation	.. .. .	1
Configuration of the ground	.. .. .	2
Tides, tidal waves and tidal currents	.. .. .	3—6
Accretion and erosion	.. .. .	7
Development of the delta	.. .. .	8—10
Geology, rock and soil	.. .. .	11
Climate	.. .. .	12—13
Water supply	.. .. .	14
The fauna of the Sundarbans	.. .. .	15
Distribution of area	.. .. .	16
State of boundaries	.. .. .	17—18
Legal position	.. .. .	19
Rights and concessions	.. .. .	20

CHAPTER II

The Forest.

Composition and condition of the crop—

General description	.. .. .	21—25
Fresh-water forests	.. .. .	26
Moderately salt-water forests	.. .. .	27
Salt-water forests	.. .. .	28
Keora forests	.. .. .	29
Golpatta	.. .. .	30
Sundri	.. .. .	31
Gewa	.. .. .	32
Injuries to which the crop is liable	.. .. .	33—38

CHAPTER III
Utilisation of the Produce.

	Paragra number	
Needs of the neighbouring population.. .. .	3	
Marketable products :		
Timber and Fuel	40—41	
Minor produce	41	
Past outturn, revenue and expenditure	41	Ge
Markets	41	Bl
Lines of exports	41	M
Method of exploitation and their cost	50—51	C
Past and current prices	56—57	Er W
CHAPTER IV		
Staff and Labour supply.		
Staff	58—59	G
Labour supply	60	St K
CHAPTER V		
Past system of management.		
General history of the forests	61—64	M A
Survey	65	P
Past system of management and their results—		
Early management	66—67	
Trafford's working plan	68—70	
Curtis's plan	71—72	G
Chowdhury's modification	73	C
Short-term schemes	74	A
Result of past working	75	C
Water crafts, buildings and canals	80—81	M E
CHAPTER VI		
Statistics of growth and yield.		
Sample and experimental plots	83—84	
Site quality class	85	C
Density	86	T
Species composition	87	C
Volume tables	88—90	
Defect and crook factors	91—92	I
Stand tables	93	
Summary of volumes	95—96	
Growth and yield studies	97—100	

PART II

Future management discussed and prescribed.

CHAPTER I

Basis of proposals.

	Paragraph number.
General object of management	107
Block and compartments	108—109
Methods of treatment to be adopted	110—111
Cutting Cycle	112
Exploitable diameters	113—114
Working Circle	115—124
Gewa Working Circle	125
Sundri Working Circle	126
Keora Working Circle	127
Miscellaneous Prescriptions	128
Analysis and value of the Crop	129
Period of the Working Plan and the necessity for intermediate revision	130—133

CHAPTER II

Working Plan for the Gewa working circle.

General constitution	134
Character of vegetation	135
Analysis and valuation of the crop	136—137
Object of management	138
Method of treatment	139—140
Exploitable diameter limit	141
Gewa felling series I or Match wood felling series.	
General Constitution and cutting cycle	142
The yield	143
Calculation of annual cut by volume	144—145
Felling and marking rules	146
Application of volume check	147
Cutting sections	148
Sequence of fellings	149

Gewa felling series II or Khulna Newsprint Mill felling series.

	Paragraph number.
General constitution and cutting cycle.. .. .	150—151
Calculation of annual cut	152—153
Marking and felling rules ✓	154
Sequence of fellings	155
Regulation of the yield	156

Gewa felling series III or Miscellaneous felling series.

General constitution and cutting cycle.. .. .	157
The yield	158
Calculation of annual cut by volume	159—160
Sequence of fellings	161
Marking and felling rules ✓	162
Application of the volume check	163

CHAPTER III

Working plan for the Sundri working circle.

General constitution	164
Character of the vegetation	165
Analysis and valuation of the crop	166—167
Object of management	168
Method of treatment	169
Felling cycle	170
Distribution of area within each felling series	171
The yield	172—173
Marking and felling rules— ✓	
Main felling	174
Improvement felling	175
Coupe rules ✓	176
Sequence of fellings—	
Sarankhola north cutting sections	177
Sarankhola south cutting sections	178
Chandpai north cutting section	179
Chandpai south cutting section	180

	Paragraph number.
Nalianala east cutting section	181
Nalianala west cutting section	182
Burigoalini felling series	183
Kadamtala felling series north cutting section	184
Kadamtala felling series south cutting section	185
Regulation of the yield	186

CHAPTER IV

Working plan for the Keora working circle.

General constitution	187—188
Character of Vegetation	189
Analysis and valuation of the crop	190
Object of management	191
Method of treatment	192—194
Rotation	195
The yield	196—197
Sequence of felling	198
Regulation of the yield	199

CHAPTER V

Miscellaneous prescriptions.

Passur, Baen, Dhundal and Kankra	200
GORAN	
General description	201—203
Coupe and felling rules	204
GOLPATTA	
Growing stock	205
Felling rules	206
Coupe rules	207
Coupes and sequence of fellings	208—209
Honey and Wax	210
Other minor produce	211
Fishing	212
Game sanctuary	213
Drift wood	214
Felling for departmental purpose	215

A - 1687
 १९५३
 १९५३
 १९५३

X

CHAPTER VI

Research and Experiment.

	Paragraph number.
Research and experiment	216—221

CHAPTER VII

Establishment and Labour Supply.

Establishment and Labour Supply	222—224
Staff at Divisional Headquarters, prescribed and existing	225
Abstract of total strength, prescribed and existing strength in Ranges, Khuina Station and Dock-yard.	226

CHAPTER VIII

Financial Forecast.

Forecast	227
Estimated Revenue	228
Expenditure	229—230

CHAPTER IX

Control and maintenance of records.

Maps and Records	231
Maps	232
Forms and Registers	233
Control Forms	234

CHAPTER X

Summary of Prescriptions.

Summary of Prescriptions	235
----------------------------------	-----

PREFACE

The first regular Working Plan of Sundarban forest was prepared by S.J. Curtis, for the period from 1st April, 1931 to 31st March, 1951. This was modified by S. Choudhuri, for difficulties visualised for execution of certain prescriptions of Curtis's plan. The revised scheme became effective from 1st April, 1937 to 31st March, 1947.

The country became free from British Rule on 14th August, 1947 and as a result there occurred changes in the prevailing economy of the country. Established markets were cut off causing problems of disposal of certain produce like Gewa timber, construction timber and coal suffered shortage of supply causing strain on Sundri timber of the Sundarban forest. Under these unsettled conditions it was not possible to compile a regular working plan and the forests were worked on interim schemes prepared from time to time.

In 1954 it was established that the vast resources of Gewa wood could be utilised to run a Newsprint Mill at Khulna. All studies in this connection upto early 1956 have favourable indications. In order to assure the sustained yield of a minimum of 3.6 million cubic feet of a Gewa wood a comprehensive inventory of the forest was necessary. Messrs. Forestal Forestry and Engineering International Limited of Vancouver, Canada, were employed by the Pakistan Industrial Development Corporation to undertake the Survey. The Survey done was based on aerial photography, photogrammetric techniques and statistically controlled ground smpling. The main objectives of the inventory survey was to (1) prepare new set of maps of the forests, (2) obtain detailed information about occurrence, volume and yield of the species Gewa which is to be utilised as pulpwood by the Newsprint Mill and (3) prepare an overall inventory of the main species found in the Sundarban forests. Aerial photography, field survey and compilation of data were completed during September, 1957 to March, 1960. The Working Plans Division received the inventory report by September, 1960.

The writer undertook compilation of the working plan in September, 1961.

The inventory report comprising three volumes gives the following informations:—

Volume 1—Contains the report and appendices. The survey methods are described in detail and the results are presented in a comprehensive form.

Volume 2—Contains tabular timber volume summaries by blocks and stand tables for each forest stratum sampled, by blocks.

Volume 3—Contains a complete set of forest cover maps at a scale 2 inch to 1 mile, with suitable legend and reference keys.

Due to easy accessibility and facilities of cheap water transport demand on all produce from Sundarban is heavy. Therefore, it is necessary that availability of timber, fuel wood and other produce from the forest on sustained yield basis be known with accuracy and that control of operations be sufficient to ensure that no more is extracted from the forest than what is replaced for future yield. The inventory Report contains sufficient reliable data on which this Management plan has been based. Maximum yield has been prescribed and detailed Silvicultural measures have been laid down for improvement of the growing stock.

In part I (summary of facts) the changes in composition of the crop, utilisation of the produce, method of exploitation, lines of export, etc., since the time of writing of Curtis' plan, have been incorporated in this plan. There are informations mainly in chapter I which are no different than in the Curtis' plan. Attempt has not been made to change the language of Curtis in presenting these informations in this plan.

DACCA;
The 1st June, 1962.

A. M. CHOUDHURY,
*Deputy Conservator of Forests
Divisional Forest Office,
Working Plans Division-1,
Dacca.*

GLOSSARY OF NAMES OF PLANTS

Vernacular name.	Botanical name.	Family.	Description.
Amur	... <i>Amoora cucullata</i> ...	Meliaceae	... A small tree.
Baen	... <i>Avicennia officinalis</i> ...	Verbenaceae	... A large tree.
Ban-jam	... <i>Eugenia fruticosa</i> ...	Rutaceae	... A small tree.
✓ Bhadal or Bhaila	<i>Azelia bijuga</i> ...	Leguminosae	... A medium size tree.
✓ Bhola	... <i>Hibiscus tilliaceous</i> ...	Malvaceae	... A small tree and semi-climbing liana.
✓ Dacor or Dabur	<i>Cerbera odollam</i> ...		A medium size tree.
Dhundal	... <i>Carapa obovata</i> ...	Meliaceae	... A small tree.
Gab	... <i>Diospyros embryopteris</i> ...	Ebeneceae	... A medium size tree.
Garjan	... (<i>Rhizophora conjugata</i>), <i>R. mucronata</i> .	Rhizophoraceae	Medium size trees. Name applied to both species.
Gewa or Gengwa	<i>Excoecaria agallocha</i> ...	Euphorviaceae	A fair-size tree.
Gila	... <i>Entada scandens</i> ...		A large woody climber.
Golpatta	... <i>Nipa fruticans</i> ...	Palmae	... A palm with a soboliferous stem.
Goran	... <i>Ceriops Roxburghiana</i> <i>C. candelleana</i> .	Rhizophoraceae	A small tree or shrub of coppice like growth.
Goria	... <i>Candelia Rheedii</i> ...		A small tree.
Hantal	... <i>Phoenix paludosa</i> ...	Palmae	... A small gregarious palm.
Hargoza	... <i>Acanthus ilicifolius</i> ...	Acanthaceae	... A small prickly-leaved shrub.
✓ Hodo (or Tiger Fern)	<i>Acrostichum aureum</i> ...	..	A rigid tufted fern under growth.
✓ Hogla	... <i>Typha elephantina</i> ...	Graminae	... A large bulrush.
Jir	... <i>Ficus retusa</i> ...	Moraceae	... A medium sized tree, or climber.
Kankra	... <i>Bruguiera gymnorhiza</i> ...	Rhizophoraceae	A medium sized tree.
Keora	... <i>Sonneratia apetala</i> ...	Sonneratiaceae	A large tree, generally of spreading habit.
✓ Kewa-Kanta	<i>Pandanus pordoratissimus</i> , Syn. <i>P. fascicularis</i> .	Pandanaceae	... A gregarious screwpin under growth.
Khalshi	... <i>Aegiceras majus</i> ...	Myrsinaceae	... A small tree or shrub of coppice like growth.

Vernacular name.	Botanical name.	Family.	Description.
Kripa or Kirpa ...	Lumnitzera, racemosa ...	Combretaceae	A small tree.
Kumia ...	Barringtonia racemosa	Lecythidaceae	A medium sized tree.
Math-goran ...	Ceriops candellana ...	Rhizophoraceae	A small tree.
Nal ...	Orundo karka Syn. Phragmites karka.	Gramineae ...	A tall reed like tree.
Nona-jhao ...	Tamarix gallica Var.indica	..	An evergreen shrub or bush.
Ora ...	Sonneratia acida ...	Lythraceae ...	A medium sized tree.
Passur ...	Carapa meluccensis Leguminosae var. gangetica.	... ..	A fair sized tree.
Sada-baen ...	Avicennia alba ...	Verveneaceae ...	A name used by forest subordinate. A small or medium sized tree.
✓ Singra ...	Cynometra ramiflora Syn. C. Mimosoides.	Leguminosae	A small tree of spreading habit.
Sundri ...	Heritiera minor Syn. H. Fomes.	Sterculiaceae ...	A fair-sized tree.
✓ Sundri-lota ...	Brownlowia lanceolata ...	..	Agregarious withy shrub.
✓ Ullu ...	Saccharum cylindricum Syn. Imperata arundinacea.	Gramineae ...	A touch grass.
LOCAL TERMS.			
Baoali ...	.....	...	A term used to denote wood Cutters.
Bharani ...	.....	...	A term used in the Sundarbans for a khal which connects one large river with another.
Bil ...	.....	...	A damp or water covered depression.
Bund ...	.....	...	A dyke or embankment.
Char ...	.....	...	A shoal or bank of mud or sand. In the area statement char means land without tree growth, which is below the usual high tide level.
Dabba ...	.....	...	A pole laid across a boat for slinging logs or jhools floating on either side.
Dharma ...	.....	...	Matting made of split bamboo, or of reeds.

Vernacular name.	Scientific name.	Description.
Gang	...	A medium sized water channel or about 300 to 1000 yards in width; but owing to continual scouring or silting, often the word is found used with the proper names of channels of greater or less width.
Jhinook	... <i>Cyrena bengalensis</i> ...	An estuarine bivalve.
Jhool	...	Floats used on either side of a boat, in order to steady it.
Jongra	... <i>Cerithium telescopium</i> ...	A mollusc with a conical shaped shell.
Khal	...	A small sized water channel. Generally applied to all channels of less than about 300 yards in width, but owing to scouring out, the word khal may be found used with the proper name of a larger channels.
Kosture	... <i>Ostrea gryphoides</i> ...	A type of oysta.
Mallam	...	Planks laid along on top of the gunwall of a boat, and roughly caulked with mud in order to increase the free board.
Nadi	...	A river of large width. Very often the word is found used with the proper name of a comparatively small channel probably because, at one time, it was a much larger stream.
Shulas	...	Pneumatophores or woody growths which sprout up above the ground from the lateral roots of many Sundarbans trees, notably sundri, passur, dhundal, keora and baen, are more cylindrical in shape. Shulas are longer in damp areas than they are in drier places. The height of the shulas is generally indicative of the maximum high tidal level.

Term of Abbreviations.	Explanation.
A.M.H.	Average Maximum Height.
C.	Cleared land; areas which have been cleared of tree; and shrubs for usage other than productive forest. This symbol has been used in maps.
dbh.	Diameter breast height, 4.5 feet above average ground level.
d.b.h. class	1"dbh class means the range from .6 inch to 1.5", 2"dbh class means the range from 1.6" inches to 2.5 inches and so on.
D.I.B.	Diameter Inside Bark.
Forest stratum	Group of forest types of similar characteristics.
Forest type	Smallest homogenous forest cover unit, bounded by a type line in the map.
M.A.I.	Mean Annual Increment
N.C.C.	Ground cover of no commercial value, damp or water covered depressions (bills); areas of grass and weed, and areas where the trees or bushes are extremely short.
N.P.	Char land: shoals, mud banks and sandbars usually below high tide level and supporting no trees or shrubs.
P.A.I.	Periodic Annual Increment.

PART I

SUMMARY OF FACTS ON WHICH THE PROPOSALS ARE BASED

l
3
y
r

PART I

SUMMARY OF FACTS ON WHICH THE PROPOSALS ARE BASED

CHAPTER I

THE TRACT DEALT WITH

1. **Name and situation**—The Sundarban Forests of Khulna district are located at the southern extremity of the Gangetic Delta bordering the Bay of Bengal. The forests extend about 50 miles north of the Bay of Bengal and are bounded on the east by the Baleswar River and on the west by the International boundary with India. The Forests lie south of the Tropic of Cancer between latitudes $21^{\circ} 30'N$ and $22^{\circ} 30'N$ and between longitudes $89^{\circ}E$ and $90^{\circ}E$. The derivation of the name "Sundarban" is obscure. The most popular theory is that it is named after the principal tree found in it, namely, Sundri (*Heritiera minor*). At present, this tree is abundant only in the eastern portion of the forest tract of Khulna district, but some centuries ago, it was the principal tree throughout the delta. Another more probable theory seems to be that it is derived from the word "Samundar" or "Samundra ban", meaning "Sea forests".

2. **Configuration of the ground**—The forests may be classified as low lying deltaic tidal forests, most of which are flooded during the high tide of the monsoons. The area is intersected by a complex network of khals, varying in width from a few feet to several miles. These channels are the sole means of access and transportation. The larger of these waterways are the remains of former beds of the Ganges, the main stream of which has gradually shifted eastwards, leaving a number of dead, or semi-dead rivers running north and south, which, but for tidal action, would have long ago silted up. At a comparatively recent period, all these rivers were connected with the Ganges; now, however, the only one which is a direct effluence, is the Baleswar, which leaves the Ganges at Kushtia. Where it passes the northern boundary of the forests, this river is 2 miles in width; during the rains, the sea-water is fresh for some miles around its mouth, and it is responsible for most of the fresh-water that finds its way into the eastern part of the Sundarbans, a number of rivers in indirect connection, and receive the overflow of the Ganges during the rains, namely, the Passar, Sipsah, Arpangasia and Malancha, and, to a slight extent, the Jamuna and Raimangal. They also receive a considerable amount of local drainage throughout their long and meandering courses.

Into these rivers and Ganges, flow innumerable small creeks (locally called khals), caused by the scour when the water drains off the swamps at each successive ebb tide. Except where new chars are forming, the banks of the rivers and khals are generally the highest grounds; the level becomes gradually lower as one proceeds towards the interior of the island. Some khals join up one stream with another; these are called bharani, as opposed to mara khals, which gradually split up into smaller khals until they are lost in the forest. Bharani khals are very important for communication, especially when they run east and west, and join up two rivers or estuaries. Due to the bunding or dyking of lands under cultivation preventing the tidal scour, the small side channels and khals in the cultivated areas very quickly silt up; this is very evident outside the north-eastern boundary of the forest, where the former routes of export from the Bhola river to Morrelganj and Bagerhat, have closed up during the last half century.

3. **The tides**—From the above brief description, it is evident that the ebb and flow of the tide controls the formation of the islands, and by the scouring action of the drainage during the ebb, keeps the rivers and khals open. The tidal wave sweeps over the area twice a day, the tidal current changing its direction after every 6 hours. The tides penetrate further inland, and the maximum rise and fall occurs during the spring

tides of the first equinox in March and April, when there is very little streams in the rivers for the tide to contend against. During the rains, there is no flow-tide in the Passar river above Chalna, and there is a difference of only one or two feet in the tide level at Khulna. In the streamless rivers of the Western Sundarbans, the effect of the tide is felt far into the interior, the rise and fall tends to be more constant throughout the year, and varies only with the phases of the moon.

4. The tidal waves travel from sea face to the interior, at a speed varying from 30 miles an hour at the sea-face to about 15 miles an hour in the upper reaches. The tidal current in the large rivers usually varies from 2 miles an hour near the sea-face to 4 miles an hour in the northern part of the forests, but during the spring tides, currents of about 6 miles an hour, or more, are often met with; the swiftest currents are formed by the combined ebb of the streams and the rivers during the rains. The tidal wave makes its way across the Sundarbans from west to east; consequently, the tide changes earlier in Raimangal, than it does in the rivers further east. Owing to the combination of tidal wave and current, it is possible, when travelling in a launch from the sea inland, to move with the flow-tide for several hours at a time; when going in the direction of the ebb, a launch has to traverse the tidal wave, and the current will assist it only for 2 or 3 hours at a time. For this reason, launches normally go with the tide when returning to Khulna, but cannot be expected to do so, when travelling in the opposite direction.

5. The increase in the speed of the tidal current further inland is due to the gradual constriction in the width of the rivers, combined with the large spill area in the surrounding swamp forest. The tidal current in the large rivers continues to run, on its own momentum, an hour or so after the tidal wave as passed; consequently, at the end of the ebb, the suction of the current deepens the trough of the tidal wave, and, by retarding the progress of the oncoming wave, causes it to bank up, and heighten its crest. For this reason, the largest rise and fall of the tide is found where the tidal currents are the swiftest; this is generally in the northern part of the forests, because although the rivers are usually narrower still further north, the bunds around the cultivated lands lessen the spill area, and the effect of the tides gradually becomes less and less. The average rise and fall near the sea-face is about 7 feet; further up the rivers it increases to an average of about 10 feet in the Khulna district.

6. The fact that the tidal current in the large rivers continues to run for a short period after the tidal wave has passed, also accounts for the peculiarity, so frequently noticed, of the current in a small khal being in the reverse direction to that in the river of which it is tributary. The wind has a great influence on the tidal flow. When the south winds set in, the flow continues for a longer period, and the contrary happens with a north wind.

7. **Accretion and erosion by the rivers**—Erosion and compensatory accretion are occurring continually here and there along the banks of all larger rivers, but the rivers of the Sundarbans are as much more stable than the main streams of the Ganges and the Brahmaputra further east. Generally, erosion occurs on the outer bank of a curve, and accretion forms in slack water behind the inner bank of a curve. Also, new accretion and islands are continually forming in the slack water of rivers and khals, which do not receive sufficient tidal occur or stream to justify their width.

8. **The Development of the Delta**—The more eastern rivers are silt-carrying, and deposit silt over the surrounding forest swamp at every high tide during the rains; most of this silt is deposited directly when the water loses its speed and starts to spread slowly over the swamp; consequently, the banks of rivers and khals generally become higher than the rest

of the swamp in the interior; this forms a natural water-shed, and another smaller khal or creek forms to drain it. The banks of this smaller khal are in turn raised, and the process is repeated on a continually diminishing scale, until the very small creeks draining the bil areas in the middle of the islands are formed. In this way, the general level of the whole swamp is generally raised, and the closed network of khals and creeks are formed to drain it. This gradual rise in level is counteracted to some extent by hypogene agencies. The coarser grained sand is dragged down the river-beds to the sea. The silt deposited on the top of existing islands during each flood, consists only of the finer particles; on setting down this produces a heavy tenacious clay, which is the typical soil of the delta.

9. The silt which is not deposited within the delta, or which is scoured off again by the small creeks during the ebb, together with the heavier sand, is deposited at the mouths of the rivers; thus each river forms a bar, which eventually develops into an island. The river then forms a fresh channel around this obstruction, or breaks up into two or more channels, and starts forming fresh-bars and islands; in this way, the delta extends and develops. When a bank or char starts to form on the sea-face, only the heavier particles of sand are deposited; the finer silt is washed off by the waves. Most of this silt gradually sinks deep down to the shelf of the sea-bed further out in the bay, and forms the foundations for the further spread of the delta; also, large deposits of silt tend to form in the more sheltered localities near the sea-face, such as around the mouth of the Bheda Khal near Dubla, or behind the new sandy formation at Katka.

10. The sand banks formed at the mouths of the rivers, are blown up into dunes above high tide level by the strong wind of the south-west monsoon. These dunes commence by the sand being piled up by the wind against any odd pieces of waif wood and other rubbish from the forest washed up by the waves; when once they start, their development is assisted by the rapid growth of marram grass, and a sandy island is quickly formed. In the lees of a new island where there is protection from the waves, the finer silt is deposited, causing the formation of a mud flat behind the dunes. Meantime, the sand is being continually piled up against the dunes, blown off the top during every high wind, and distributed over the mud flat; in this way a flat stretch of sandy loam is formed above the high tide level, which, being unsuitable for ordinary delta forest growth, develops into a grassy maidan; this sandy maidan continues to spread until it is arrested either by a khal, or by early forest growth: the trees, both by their action as a wind-screen and the more direct obstacle of their rhizophors, tend to stop the further progress of the sand. This process will go on, and the sandy maidan will continue to spread and gradually rise in level, as long as the windward side of the island remains unprotected from the waves. As soon as a fresh island forms further out to the windward, the shore on the island behind begins to receive a supply of silt instead of sand, and the dunes behind gradually blow away; but traces of dunes, which have been protected quickly by forest growth, may occasionally be found some distance in the interior of the forest. The remains of the sandy maidans are found more often, covered as a rule by a growth of gewa (*Excoecaria agallocha*): a typical example may be seen on the western bank of the Marabhola. From the nature of their formation; one would expect to find sand dunes only on coasts unprotected from the south-west monsoon and such is the actual case. On the other hand, sea erosion takes place on exposed eastern coasts, where the waves wash away the silt, and the wind blows away the sand.

11. **Geology, rock and soil**—The Sundarban forests grow on soil formations which are of recent geological origin, consisting of a very deep alluvium which has been washed down from the gneissic mountains of the Himalays. This soil is a silty clay loam and sub-soil consists of alternate layers of clay and sand which at greater depths are compacted with shale and sand-stone. No rock formations occur in this area and the original bed rock, on which the alluvial deposits rest, has never been reached. In the

upper clay levels, peaty debris and the remains of the more durable timber of the swamp trees are found. At one time these trees and other vegetation must have been growing at or above sea level; the cause of these remains, together with soil on which they were growing, sinking to such a great depths needs explanation, the enormous weight of the materials which the Ganges and the Brahmaputra transfer from the Himalayas to the delta each year, disturbs the equilibrium of the earth's crust. For this reason, by slow seismic action the foundations of the delta have been gradually lowered, and the foundations of the Himalayas are gradually raised. Occasional mild earth tremors and earth-quakes, which are felt in the delta districts are undoubtedly due to this general subsidial tendency. In the area which is known as the Sundarban, probably no remains of the surface growth have been found below 30 ft. Underlying strata have been found to be devoid of these remains. This seems to indicate that, since this part of the delta started forming, the subsidence has not been more than about 30' ft.

In the sub-soil down to about 40 to 50 feet, clay generally predominates in the higher levels, and the sand is found mostly in the substratum beneath; but it is by no means always the case, frequently, layers of sand are found above a deep stratum of clay. Such layers are either the remains of old river beds which have shifted on top of formerly deposited mud, or the remains of old sea-faces where accretion has started again after a period of erosion, both the sinking of the mud and the erosion being due to the gradual sinking of the Sundarbans as already explained.

The surface soil of the forest area consists of close tenacious clay except near the sea-face, sandy patches are very rare; presumably, most of the remains of the sandy maidans of old-sea-face either have been washed away by erosion of the rivers, or have sunk and been covered with mud. In the eastern part of the Sundarban, where the rivers supply fresh silt each year, the top dressing is soft and fertile; in the western Sundarbans where there is no fresh supply of silt each year, even the surface soil has settled down to a hard mass, and the ground is much less suitable for tree growth.

12. **Climate**—The forests lie south of the tropic of cancer, between latitude 22°30' on the north and 21°30' on the south.

The climate is humid and the rainfall averages about 65" to 70" per year. Due to the proximity of the sea the temperature is fairly equable, the maximum average being about 75°F in January and 95°F in May and June. The hot weather commences about the middle of March and terminates about the end of September. The cooler weather begins in early November and lasts until the middle of February. The true monsoon season starts about the middle of June and ends about middle of September. However a good percentage of the annual rainfall occurs during the spring and autumn with thunder storms.

The following table prepared from figures supplied by the Pakistan Meteorological Department, gives the temperature, humidity and annual rainfall of the three recording stations nearest to the Forests.

Statement of average annual temperature, relative humidity and rainfall in respect of Khulna, Satkhira and Barisal for the years 1948 to 1960.

Year.	Air temperature.												Annual mean relative humidity in P.C. at 9 a.m.			Annual total rainfall in inches.		
	Annual mean of—																	
	Maximum.			Minimum.			Khulna.	Barisal.	Satkhira.	Khulna.	Barisal.	Satkhira.	Khulna.	Barisal.	Satkhira.			
1	2	3	4	5	6	7										8	9	10	11	12	13
1948	X	87.2	87.2	87.2	X	67.2	70.2	80	81	89	X	67.66	68.18					
1949	86.9	87.9	87.9	87.9	70.3	70.1	68.6	77	78	84	61.54	86.41	69.37					
1950	87.3	88.4	88.4	88.4	70.9	71.6	69.9	74	79	72	68.15	90.44	77.19					
1951	88.7	87.3	89.2	89.2	71.8	71.8	70.9	75	78	78	55.17	79.21	48.14					
1952	88.2	86.7	86.9	86.9	X	71.7	70.2	77	80	79	66.83	102.77	64.02					
1953	88.5	87.5	X	X	X	71.9	X	79	79	X	80.41	72.29	79.42					
1954	89.5	87.1	88.6	88.6	71.6	71.5	70.5	77	77	77	64.95	77.37	61.0					
1955	88.4	87.3	88.6	88.6	X	71.3	69.6	77	75	75	61.81	74.40	51.47					
1956	86.7	86.5	87.5	87.5	71.4	71.5	X	73	79	75	76.76	119.25	76.49					
1957	87.2	87.3	89.0	89.0	70.7	70.5	X	73	79	X	71.78	50.33	53.33					
1958	88.9	X	89.9	89.9	72.8	X	71.8	78	..	76	54.20	..	52.93					
1959	86.8	85.6	87.9	87.9	71.6	71.6	70.9	78	80	75	105.88	146.52	99.32					
1960	88.1	86.8	88.9	88.9	71.6	71.5	70.5	75	76	75	63.56	129.62	74.64					

X=Data not available.

Source of information—Pakistan Meteorological Department.

an
Ap
th
an
up
Se
no
the
cro
lac

fo
Th
of

th
be
wa
pi
su
th
fr
at
ar
is
w
ti

st
of
a
C
N

9
4

a
fr
B
fr
a
n

c
o

13. From October to the middle of March, the prevailing winds are from the north and north-east. The direction change round to a south westerly direction in March to April and change back again during September to October, causing occasional violent thunder storms. These storms develop into cyclones which may severely damage buildings and forests. Occasionally a much more serious type of cyclone develop which travels up from the south. Such cyclone generally occur in the month of May, June and September to November. These storms are of much longer duration than the ordinary nor' wester, and much more severe. Usually they are accompanied by tidal waves. Both the storms themselves and the tidal waves cause much loss of life and damage to houses, crops and cattle, as well as to the forests. Many of the boats coming out of the forests laden with forest produce are caught by such storms.

14. **Supply of Water**—The water in the rivers in the eastern part of the Sundarbans forest is less saline than that in the western part, where the channels tend to silt up. There is a corresponding relationship between the salinity of the water and the site quality of the forest which deteriorates from north-east to south-west.

Drinking water for the forest staff working within the forests is obtained from the nearest suitable tanks in the inhabited areas; the water is transported by special boats fitted with galvanised iron containers. The wood cutters and fisherman take their water-supply down to the forest with them in their boats; they store it in earthen-ware pitchers or Jallas. Occasionally, if staying in the forest is extended, they obtain a fresh supply of drinking water by digging holes in the sands on the sea beach. During the rains, the wood cutters and sometimes the forest staff, replenish the supply of water from Passur and Baleswar river at low tide as the water in these rivers is less saline at that time. This practice largely accounts for the prevalence of chronic diarrhoea among the wood cutters and the staff during the rains. Also water from village ponds is mostly contaminated and speaks greatly on the health of the forest staff. Some times water carrying Boats cannot reach the working place in the forest within the schedule time due to rough weather, such as storms, cyclone and heavy rains, etc.

The number of water carrying boats are also insufficient to supply fresh water to the staff. The water boats are plied by manual labour and normally it requires 15 days or even more for one single trip. Supply of sweet water to the staff is, therefore, a serious problem which needs special attention. It is suggested that water carrying barges and tug-boats be purchased and water supply to the forest staff from Khulna town be arranged as is done by the port authorities of Chalna anchorage and the Khulna Newsprint Mill.

15. **The fauna of the Sundarban**—The fauna of the Sundarban has never been thoroughly surveyed. As a result it is difficult to get an accurate and detail general one and it would give a broad outline of the major groups of animals of the Sundarban area.

Mammals—The Royal Bengal Tiger and the Spotted Deer are the most well-known animals of the Sundarban. Although theoretically these animals are to be commonly found all over East Pakistan, actually they have almost completely vanished from the rest of the country except the Sundarban where they are still the most dominant mammals. Boars are still well represented. Other mammals such as wild cats, Mongoose, Otter, foxes and jackals, several species of bats, rats, mice and squirrels, porcupines, monkeys are also found. The lesser one horned Rhinoceros and Buffaloes were once well represented in the Sundarbans, but they are extinct long before.

Birds—As a swamp forest, the Sundarban support more bird of aquatic habitat than the others. There are two large sanctuaries near Kandamtala and Jewdhara with thousands of these birds, especially Greater and Lesser Adjutants and open-bill Storks, as well

as a large number of herons, painted Storks, cormorants and others. Other aquatic and semi-aquatic birds include curlew, whimbrel avocets, sandpipers, plovers, lapwings, stints, snipes, terns, gulls, etc. Several species of raptorial birds, including vultures, kites, eagles, falcons, etc., are to be found in and around the Sundarban. Other terrestrial birds include the Red Jungle Fowl, spotted Dove, Ring Dove, Turtle Dove and Emerald Dove, Green Fruit Pigeon, Imperial pigeon, Rock pigeon; parakeet; some species of king fishes including the Collard, Pied, Blackeapped, and Storkbilled Kingfishers, one Bee-eater, different species of woodpeckers, owls, flycatchers and babblers, as well as sunbirds, flowerpeckers, orioles and others. The Indian peafowl was present here until recently, but it is almost absent now.

Reptiles—The Sundarban is the most stronghold of crocodiles. The poisonous snakes are numerous and include the King Cobra Chandrabora; 'Shankachur' etc., as well as the Sea-snakes. Python is also present here though not numerous. Other reptiles include different species of skins, gekko, other lizards, varanus, Typhlop, tortoises and turtles. According to the local fishermen there is a small island about 10 miles south-west of the Sundarban. It remains submerged in the rainy season but come above of water during the winter. A large number of marine turtle lay eggs in that island and the fishermen collect them in Hundreds and sell in the market.

Fishes and Crustaceans—Estuarine fishes constitute a very important animal wealth of the Sundarban. The important fishes include the Bhetki, Rekha, Boucha, Parisa, Pangas, Ritha, Salon, etc. A large number of carfish including Singhi, Magur, Aor, Boal, etc. are also common. In recent years *Hilsa* has become a very important commercial fish. Sharks are also caught in large numbers. Besides, the lobster, Shrimps, etc., are very large in size and are being exported in increasing numbers in foreign markets.

Another important product is the honey. Local people still use their old and crude method, as there is no apiculture or other scientific methods in force; yet more than 300 mounds of honey are said to be collected annually.

One more thing is the shell. These shells are available in the coast in large numbers, but no proper exploitation of this wealth has yet been made.

The Future of the Sundarban Fauna—Thus it is evident that the fauna of the Sundarban is rich and varied. As mentioned earlier, as an accurate assessment of the present status of the faunal elements is not possible in the absence of any survey. However, those who know the fauna of the Sundarban are unanimous that the present fauna is just the skeleton of what it was fifty to one hundred years ago. The spotted deer may appear to be numerous to new comers, but the population is not even one-fourth of what it was ten years before. The Rhinoceros and buffaloes existed in the Sundarbans even in the twenties or thirties. The peafowl was also present until recently. But now they are completely gone. And the same may be true for many other less known groups. Even the tiger population is also decreasing fast.

The Forest Department with its limited resources and personnel has been trying its best to implement the game rules and regulations strictly. But still illegal and indiscriminate killing of animals have been going on. Visitors to the Sundarban know no mercy, they think that any living thing in the forest other than men is meant for killing or destruction, whether it is a tiger or a deer or anything else, and whether it is a helpless baby or a mother feeding the baby or a pregnant animal, and whether it is a closed or open season. Venison is freely available for purchase in the market in and around the Sundarban. The Mangla port has turned out to be the biggest poacher to the Sundarban animals in recent times, as hunters can easily reach the forest from there.

Even indiscriminate killing of tigers is undesirable. There are numerous examples where the removal of the predators had serious effects on the prey as well as on the vegetation. Too much killing of tigers would assist in the increase of the deer population to a size not consistent with the capacity of the area concerned, they would face food shortage and would completely wipe out the bushes, jungles, seedlings and any other vegetation within their reach; then they will become weak and start dying. Such deaths bring the size of the population far below the minimum optimum at that point animals which live in a 'colony' or groups do not get the required social stimulation and therefore the population deteriorates further and further till it is completely eliminated. On the other hand the forest once lost cannot easily revive. But the presence of the tigers acts as a natural check, and a wonderful equilibrium is maintained between the primary producers such as plants and primary consumers such as deer on the one hand, and between the primary consumers and primary carnivorous animals such as tigers. But now indiscriminate killing, extensive exploitation of forest, etc., have certainly brought about a state of instability in the ecosystem of the Sundarban. If no check on the present trend is placed and no scientific method is applied then the future of this wonderful fauna of the Sundarban is really very black.

It is, therefore, necessary that we make an assessment of the animal wealth of the Sundarban and then suggest ways and means for its conservation as well as economic exploitation. Rules for hunting and shooting are given in Appendix I.

Game sanctuary should be highlighted for future protection of animals.

16. **Distribution of area**—The total land area of the Sundarban Forests, situated in the district of Khulna is 1,006,060 acres of which 939,820 acres are productive forest land. Except for 3,030 acres of immature stands, the total productive acreage is exploitable. The gross area including Khals and rivers is 1,425,895 acres.

The forests have been divided into five Ranges. The following statement shows the land area of each Range:

TABLE I

Sl. No.	Range.	Compartments.	Total land area of Range (Acres).	Total land area of the forest of Sundarbans in Khulna Civil district (Acres)
1	Sarankhola Range	.. 1, 2, 3, 4, 5, 6, 7, 8, 11, 12B, 24, 45.	2,21,400	..
2	Chandpai Range	.. 9, 10, 12A, 13, 14, 15, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31.	2,00,400	..
3	Nalianala Range	.. 16, 17, 18, 19, 20, 32, 33, 34, 35, 36, 37, 38, 39, 40.	2,30,635	..
4	Burigoalini Range	.. 41, 42, 43, 44, 46, 50A, 51A, 52.	1,58,445	..
5	Kadamtala Range	.. 47, 48, 49, 50B, 51B, 53, 54, 55.	1,95,180	10,06,060

A list of compartments with gross area including rivers and khals, and land area is given in Appendix II.

17. **State of boundaries**—The boundaries of the forests are mostly natural ones formed by creeks rivers, estuaries and the sea. Artificial boundaries are of small extent. The length of boundaries covered by each of creeks and rivers, estuaries and the sea, and artificial lines are as follows—

Creeks and rivers .. .. .	..	..	..	210 miles.
Estuaries and the sea .. .. .	..	..	..	47 miles.
Artificial .. .. .	..	..	..	2·8 miles.

The distances have been calculated from the new set of maps (1" to $\frac{1}{2}$ mile maps prepared for this working plans).

18. Position of the artificial boundary has not changed since the compilation of the last working plan. The artificial boundaries are as follows—

- (i) Between the Bhola river and the Bogi khal 2,530 yards demarcated by wooden pillars, and an artificial channel navigable by small boats at high tide.
- (ii) Around a small plot on the forest side of Chachan Gang, near Chandpai Revenue Station 1,375 yards demarcated by wooden boundary pillars.
- (iii) Between Dhaji Khal and Mirgang 829 yards demarcated by an artificial channel and wooden boundary pillars. (The channel has altered its course, slightly towards the forest side, and the pillars should be taken as the authentic boundary).
- (iv) Between the Kalindri river and Madargang, demarcating the small piece of reserve which forms the compound of Koikhali Revenue Station—281 yards, demarcated by two wooden boundary pillars.

19. **Legal position**—The whole of the forest covered by this Working Plan is reserved forest and provisions of the Forest Act of 1927 are applicable in this area. The list of Notifications relating to reservations and disforestations are given in Appendix III. Transit rules, formula for measurement of boats and drift rules are given in Appendix IV, V and VI.

20. **Rights and concessions**—No right or concession in the Forest exists in favour of any person or community.

CHAPTER II

THE FOREST

Composition and condition of the Crop.

21. **General description**—The forests occupy a flat deltaic swamp extending over more than 2300 square miles of area on the flat and muddy shores of the Bay of Bengal to the south of the civil district of Khulna. Most of this forest is washed by high spring tides during the rainy season. Therefore, the crop consists of species peculiar to tidal swamp, whose physiology is adapted to a close clayey soil, and alternate flooding at the high tide and drainage during the ebb with salt or slightly brackish water.

22. Littoral or swamp forests, as the forests of the Sundarban are ordinarily known, occur in all tropical and parts of subtropical seas, specially on flat muddy shores where the water is relatively calm, as in lagoons, inlets, estuaries, but not where rocky soil and breakers prevail. The other condition to foster growth of mangrove forest is large rivers to deposit masses of mud silt on gently sloping sea shore. All these conditions are present in the case of the forests of Sundarban to make it the biggest mangrove forest of the world.

23. The ground within the Sundarbans forests is extremely flat, and it is very rare to find any area higher than five feet above the mean high tide level. As is natural, a high percentage of the tree species growing in the Sundarban produce pneumatophores, or breathing roots, which protrude from the ground like innumerable inverted tent pegs. Pneumatophores help to take in oxygen from the air for the tree roots during periods of flooding. The breathing roots may grow upto a height of four or five feet, the average being about a foot.

24. The floristic composition of world mangroves is poor in number of species and these species are tolerably uniform over the mangrove forests all over the world. The predominant tree species in the forests of Sundarban are Sundri and Gewa, followed by smaller percentages of Passur, Keora, Baen, Dhundul, Golpatta palm and a few other minor species. Goran, Kewa-kanta, Hantal, Bhola, Hargoza and Hodo (tiger fern) are the main species forming the undergrowth below the taller mature trees.

25. Broadly speaking, the forest may be divided into three zones according to the degree of salinity of the water in the surrounding rivers. Comparatively fresh water area consists of all forests to the north and the east of an imaginary transverse line drawn from the Cobadak Forest Station on the northern boundary to the mouth of the Katka Khal on the sea face. Moderately salt-water area lies to the west of this line, but east of Malancha river. Forests, west of the Malancha river is in the salt water zone.

26. **Fresh water Forests**—During the rainy season, the rivers and creeks in this area are either quite fresh or only slightly saline, and the soil gets a good coating of fresh silt each year. The predominant species is Sundri gregarious shade bearer. This is mixed with varying quantities of Gewa. Proportion of Gewa increases and Sundri decreases as one proceeds the West and South. The species next in importance is Passur which is frequently associated with Kankra. These two trees are not generally gregarious, but are commonly found in damper places throughout the forest. Common species found as an under-storey beneath Sundri, are Singra on comparatively dry soils, and Amur on moister soils. Towards the more saline areas, these species, though still common become less plentiful and Goran becomes the principal under-storey.

27. **Moderately Salt-Water Forests**—This zone consists of Forests near the sea-face, and around the semi-moribund rivers in which water is somewhat less saline in the rains than it is in dry season. The predominant crop consists of Gewa mixed with varying proportion of Sundri, growing over a fairly dense jungle of Goran. Near the boundary of the fresh-water forests, Sundari is an important tree in the mixture, but further west and south, its proportion gradually decreases, until near the Raimangal river, it become comparatively scarce. The Sundri is of small size, but being of slower growth the percentages of heartwood is greater here than in the fresh-water zone.

This type of Sundri is locally called Pukka Sundri, Passur is more frequently met with here. Associated with Kankra and Baen it is plentiful in northern area between the Kalindri and Arpangasia rivers where the ground level is generally low.

28. **Salt-water Forests**—West of Malancha river, the rivers remain practically sea-salt throughout the year. The soil is hard. The forests consists mainly of sparsely spaced Gewa of below twenty feet height over dense Goran, interspersed with dense patches of Hantal on the drier soils. Dhundul, Passur and Kankra occur sporadically throughout the area. On the drier soils in the interior, the vegetation often consists of Goran of dwarf and scurby type which is locally called Math Goran.

29. **Keora Forests**—Keora occurs as a pioneer species on newly formed muddy lands and islands. The peculiarity of this species is that it does not regenerate in the area where it colonizes as a pioneer species. Other species like Sundri, Gewa and Goran start establishing themselves under Keora and Keora starts dying out; ultimately Keora disappears in that site and colonizeis new accretions which are frequently occurring in the Sundarbans area. Keora, wherever, it occurs, is of fairly uniform quality except in the far-west where Keora trees are low and spreading in nature.

30. **Golpatta**—Golpatta palm is of high economic importance and is found in the banks of small channels and creeks. Golpatta is scarce in the west in salt-water area.

The following is a brief description of Sundri and Gewa, the two main species in the Sundarban forests.

31. **Sundri (*Heritiera minor*)**—Sundri is a moderately large tree growing upto 90 feet in height in exceptional cases; usually 50 to 70 feet tall in the north-eastern part of the Sundarbans where it grows best. It decerases in height to 15 to 20 feet in the south-eastern part of the forest. The average height throughout the forest is 35 to 45 feet. In exceptional cases a Sundri tree with dbh of 18 inches may be found but these trees are very rare. The average dbh throughout the forest is 6 to 7 inches. The fairly large leaves are dark green on the upper side and light grey below.

The light-brown bark is usually fairly rough except on younger trees. The older trees are often found with several thin plate like buttresses supporting the main stem. These buttresses may reach as high as 9 feet up the bole. The Sundri tree produces dense pneumatophores which make the pure Sundri stands difficult to walk through, especially if the pneumatophores are over a foot tall.

Sundri stands are normally found on the higher ground in the forest although the species will not survive on dry soil. This species is gregarious and tolerent and regenerates well from seed under a closed forest canopy. It produces abundant, regular crops of large seeds which float and are thus widely distributed throughout the forest by the tides.

Sundri wood is hard and reddish in colour and is used extensively for timber, poles, house posts, rafters, masts, oar handles and planking. It is a good durable wood with a weight of 65 pounds per cubic foot (at 12 per cent. moisture content) and will not float.

32. **Gewa (*Excoecaria agallocha*)**—Gewa is a medium-sized tree with smooth grey bark covered with prominent lenticels. This tree occasionally grows to 60 to 70 feet in the north-eastern parts of the forest, but is normally found from 30 to 35 feet in height depending upon the site and location within the forest. It is small and stunted on the Western boundary. Very few Gewa trees are found over 12 inches in dbh, the normal tree in the better parts of the forest having dbh of 6 or 7 inches. The main volume of merchantable Gewa falls between the 5 inch and 6 inch dbh classes.

The milk-like juice in the bark is injurious to the eyes and skin, causing it to be named the "blinding tree". This species does not have buttresses for the peg-like pneumatophores growing from the ground; instead, the root comes to the surface at scattered points in the form of a knee or knuckle, which is supposed to perform the same function as the taller pneumatophores. The leaves of the Gewa tree are smaller and light to medium green depending upon the age of the tree. The older trees generally have darker leaves. Gewa is a gregarious species but is more tolerant to dry conditions and of salinity than Sundri, although it is less tolerant to shade. It regenerates reasonably well under a closed forest canopy, but becomes established and grows much faster on open, and cleared areas. It is frequently one of the pioneer tree species on newly formed land. It produces abundant, regular crops of small seed which float and are dispersed throughout the forest by the tides.

The wood of Gewa is soft and whitish in colour. It has a weight of 25 pounds per cubic foot at 12 per cent. moisture content, and floats in water. This is used for cheap box planking, matches and matchboxes, jhools or steadying floats besides boats or for planks fixed above the gunwale to increase the freeboard. It has now been found to be a good wood for the production of pulp.

Injuries to which the crop is liable.

33. **Wind**—Sporadic windfalls are caused by Norwesters of April and May and storms and cyclones during June to October. Occasionally severe cyclones occur which cause large scale damage to trees, building and water-crafts in the sundarbans. Severe cyclones occurred on 16th and 17th October, 1909, 24th September, 1919 and 10th May, 1961. The speed of wind reached about 90 miles in the last cyclone and was accompanied by high tidal waves. Sarankhola and Chandpai Ranges were mostly affected by these cyclones. Barisal district and eastern part of Khulna district were the worst sufferers.

34. **Erosion**—Erosion is continually occurring in places along the banks of the large streams and rivers, and on the sea-face. In the rivers, the trees mostly sink down in to the river-beds and disappear; on the sea-face, their roots are laid bare by the scour of the waves or smothered by encroaching sand. Every year, large quantities of timber and golpatta are lost by erosion.

35. **Animals**—Animals cause serious damage to regeneration of Gewa and Golpatta in the moderately salt-water, where Gewa is the predominant crop. Cheethal deer are the principal offenders. Their favourite foods are keora fruit and leaves, and grass, but if these are not available, they will consume regeneration of Sundri, Gewa, Amur, Golpatta, and most other species excepting goran. Browsed down Gewa regeneration is seen almost everywhere. They also chew the younger leaves of mature golpatta plants, and by continual attention in this way, eventually kill them. Monkeys frequently kill

off young Golpatta regeneration by pulling up the plants, nibbling the young shoots and throwing them away. Pigs are fond of rooting up seed and seedlings; but they are not so numerous as the cheethal; the damage they do is, therefore, not so extensive. Small mud crabs are suspected of being the cause of the lack of keora regeneration in the fenced-in sample plots, and are very probably responsible for holes found in the bases of Gewa trees in the more saline areas.

36. **Insects**—Damage by insects is not very serious. The larvae of the moth, *Hymenoptychis sordida*, destroy most of the sundri fruits each year, but there is always sufficient left for regeneration purposes. *Hypsipyla robusta* is a similar pest found in the Passur seeds. Each year, an unknown insect makes holes in practically every leaf of Ben (*Avicennia officinalis*), and a boring beetle does a certain amount of damage to the heartwood of both species of Goran and Dhundal.

37. **Other natural causes**—*Polypodium quercifolia* and *P. inciodes* are common epiphytes in the forest, but do not appear to interfere seriously with the growth of the trees. In compartments 47 and 48, *Loranthus longiflorus* is a common epiphyte on the unhealthy and stag-headed Sundri and Passur, and appears to do a certain amount of damage. Climbers are comparatively scarce, and the damage they do is negligible. On the higher ground near the banks of khals in the fresh-water forests, *Derris uliginosa* and *Sarcolobus globosus* are common. On high sandy patches near the sea-face, and on the remain of salt golas and other runs, *Entada scandens* and *Derris sinuata* are generally present. On the true delta soils, the prickly creeper, *Mezoneurum cucullatum* is met with occasionally in the fresh-water areas; but as a rule, the forests in the interior of the islands are remarkably free from creeper growth. Occasionally, within the sundri forests, one meets small circles of dead trees, suggestive of a root fungus. Lightning is also sometimes responsible for patches of dead trees.

38. **Theft**—Petty thefts are committed by labourers of lot purchasers and permit holders. The permit holders also cause minor damage by violating felling rules. Theft of trees occur in the boundary of the forest adjoining villages.

whi
and
stic
fuel
also
larg

mos
oar
mat

Nev
mat
Gev

boa
and
truc

Barl
mos
shap
hoo

The
mat

Rhi
and

hou
Ullu
the
loca
The
and
of H
worl
khal
estua

CHAPTER III

UTILISATION OF THE PRODUCE

39. **Needs of the neighbouring population**—The more important kinds of forest produce which the local population need for their use are timber for boats, poles for house posts and rafters, Golpatta leaf for roofing, Nal grass for making into matting for walls, Goran sticks for forming the core of mud walls and for fencing and any kinds of wood for fuel for which Sundri, Goran and Singra are preferred. Hard and durable timber is also consumed in the neighbouring district of Jessore for cart wheels and cart axes, large quantity of timber is also used for various local agricultural implements.

MARKETABLE PRODUCTS

40. **Timber and Fuel**—Sundri in the form of timber, poles and fuel wood is the most important marketable product. Its principal uses are house-posts, rafters, masts, oar handles and planking for boats. Sundri has been found suitable for use as raw material for a Hard-board Factory. Sundri buttresses are used as oar blades.

41. **Gewa** is another important marketable produce of the Sundarban forests. The Newsprint Mill and two match Factories in Khulna are run entirely with Gewa as raw material. Demand for Gewa in other Match Factories of the province is also pressing. Gewa is suitable for box planking and dunnage in ships.

42. **Keora** is a large tall tree and its timber is now used extensively for baling boards in packing newsprint in the Mill. This is also suitable as box planking, bobbins and centering in building construction. Passur and Dhundal are used in general for construction work.

43. **Goran** is widely used for small house posts, cores of mud walls and fencing. Bark of this species yield tanin which is used for tanning fishing nets. Singra is the most popular fuel in the Sundarbans, it is utilized for this purpose in all sizes and shapes down to brush wood. Amur is much sought after for small house-post and hookah stems.

44. **Bark of Goran, Gurjan, Dhundal, Passur and Kankra** is rich in tanning content. There is good prospect of establishing a tanning extraction factory using the barks as raw material.

45. Practically every species is used as fuel if other kinds are not available, and Rhizophoraceae such as Kankra, Gorjan and Gorla are used for cheap rafters, scantlings and occasionally house-posts.

46. **Minor produce**—Important minor products are Golpatta for thatching cheap houses and goran bark for tanning fishermen's nets. Honey and wax are in great demand. Ullu grass makes the most durable type of local thatching, but its supply is limited to the sandy maidans on the sea face. Nal grass is used extensively for making a matting, locally called dharma, which is used for walls of houses, covering of boats, and mats. There is a small demand for Hogla, the split reeds of which are used in cheap fencing and walls; it is not very durable and seldom lasts more than one season. The stems of Hantal are used extensively in the construction of small huts as roof rafters and frame work of the walls. Jhongra shells are collected of the mud banks of the rivers and khals, for burning into lime for using with pan (betel leaf). Jhinook, the shells of an estuarine, bivalve are also quite common and often collected for this purpose.

47. A statement showing outturn of timber, firewood and other minor produce and revenue expenditure for past few years is given below:

Outturn of timber, Firewood and minor produce of Sundarbans Forest.

Species.	1957-58 April '57 to March '58, cft.	1958-59 April '58 to June '59, Cft.	1959-60 July '59 to June '60, cft.	1960-61 Cft.
1	2	3	4	5
<i>Timber</i>				
Sundri	61,82,944	62,34,788	49,70,482	55,12,750
Passur	6,55,147	9,29,211	2,99,937	5,21,441
Kankra	4,85,351	5,43,394	1,03,697	71,023
Keora	4,29,959	3,17,446	10,09,878	3,86,312
Gewa	14,52,361	13,11,425	18,69,655	40,72,336
Goran	12,61,530	18,98,446	16,14,391	18,25,148
Amur	1,15,272	1,54,732	56,192	1,33,432
Baen	1,46,217	1,64,209	1,44,339	1,71,319
Kripa	85,099	13,031	3,194	2,872
Others	2,85,329	1,09,508	1,00,652	1,00,588
Dhundal	9,882	1,018	13,506	16,740
<i>Fire Wood</i>				
Sundri	1,65,24,316	2,41,57,075	2,30,22,454	2,52,10,891
Passur	1,40,600	2,71,850	87,800	68,418
Kankra	69,500	41,300	22,300	10,763
Keora	30,450	1,94,752	2,24,486	1,82,835
Gewa	44,550	2,300	4,000	2,950
Goran	1,73,250	2,81,100	2,56,700	1,64,202
Baen	1,43,300	1,89,514	60,885	48,427
Others	1,36,250	2,45,296	5,83,628	69,341
Singra	37,000	55,250	2,57,889	24,720

Species.	...	1957-58 April '57 to March '58 Cft.	1958-59 April '58 to June '59 Cft.	1959-60 July '59 to June '60 Cft.	1960-61 Cft.
1		2	3	4	5
Bhola	...	2,90,304	1,70,210	2,28,650	1,72,590
Jir	...	48,550	1,11,350	80,350	56,190
Goria	...	4,250	299	...	...
<i>Minor produce.</i>					
Golpatta	...	31,63,143 mds.	30,57,386 mds.	32,06,553 mds.	32,56,258 mds.
Hontal	...	90,388 Nos.	1,57,989 Nos.	1,33,650 Nos.	41,350 Nos.
Shells	...	1,64,520 mds.	3,56,050 mds.	2,27,550 mds.	1,08,655 mds.
Honey	...	6,868 ,,	11,378 ,,	6,787 ,,	3,481 ,,
Wax	...	1,728 ,,	2,799 ,,	1,663 ,,	872 ,,
Cane	...	2,725 ,,	...	675 ,,	1,050 ,,
Fish	...	65,133 ,,	69,205 ,,	77,189 ,,	55,616 ,,

Past revenue and expenditure.

Year.	Revenue.	Expenditure.					
		A-Con-servancy.	B-Estab-lishment.	63-B Deve-lopment.	65-Capital outlay.	65-B-Dev. merged to 10-Forests.	Total expen-diture yearly.
1	2	3	4	5	6	7	8
1956-57 April' 56 to March '57.	24,75,486	2,72,509	4,54,617	30,525	..	..	7,57,651
1957-58 ..	32,69,169	3,07,125	5,18,203	19,875	..	..	8,45,203
1958-59 April' 58 to June '59.	44,35,225	3,42,116	7,04,806	56,095	..	..	11,03,017
1959-60 July' 59 to June, 1960.	32,59,878	5,40,498	5,52,139	..	92,000	82,000	12,66,637
1960-61 ..	36,97,621	4,26,499	5,16,236	20,737	2,51,477	65	12,58,949

Note—Expenditure shown under 63-B—Development and 65-Capital are expenditure incurred for execution for specific projects under Five -Year Development Plan. These are not revenue expenditure.

48. **Markets**—Forest produce from the Sundarban find their way to most parts of the surrounding districts which are within reasonable transportation distance by water. Besides Khulna, Jessore, Comilla, Barisal, Faridpur, Pabna, Kushtia, Rajshahi and Dacca are the markets for produce from Sundarban. Golpatta and Goran bark are carried to Noakhali and Chittagong districts by large boats across the sea during the winter season. News print produced in Khulna News-print Mill and safety matches produced in the Match factories from Gewa wood find their market in foreign countries also.

LINES OF EXPORT

49. Practically, the export to the various markets is exclusively by natural water channels in boats, barges or rafts. Railway and road transport are used where water transport is not available. The courses of the rivers, khals and bharanis are marked on the modern maps. The main north and south routes from the forest are the following river systems.—

- (1) The Madhumati, Baleswar river and its tributary with Kacha river.
- (2) The Bhairab, Rupsa, Kajibugha and Passur river.
- (3) The Bhadra, Ghengrail, Badurgacha and Sipsah river.
- (4) The Kobadak and Arpangasia river.

Within the forests, the bharani khals or connecting links between these systems are adequate and numerous.

Chittagong, Noakhali and southern part of Bakarganj can be reached across the estuary of the Baleswar and the Bay of Bengal; this route is passable only during the calms of the winter season.

METHODS OF EXPLOITATION AND COST

50. Exploitation under Government agency has rarely been undertaken in the past except for occasional supply of firewood to the Railway and the Departmental sale Depot at Dacca. All trees in coupes are sold standing and purchasers remove to produce. Felling marking and sale markings are done according to Divisional Standing Orders.

51. Logs in suitable sizes and fuelwood is carried on shoulder or dragged along muddy forest floor to the river bank from where they are removed to the markets by boats. Boats used, vary in sizes from under 100 mds. capacity to more than 5,000 mds. capacity.

52. The Newsprint Mill employs a fleet of tugs to tow big rafts from the forest site to the mill site.

53. Trees are of such size that they can be easily handled manually in the forest site and carried on shoulder to the river bank. There are creeks near to every bit of the forest and hence such manual hauling is easy and comparatively inexpensive. Water transport also provide easy and cheap means of transportation of produce from the forests.

54. **Cost**—As there is very little departmental extraction, the knowledge of actual cost of extraction of various produce is limited. Cost incurred and reported by lot purchasers and wood cutters are confusing as they do not maintain any formal written account and the method of payment to their labourers are not necessarily in cash.

55. A rough estimates of cost of extraction to timber and firewood on cash payment basis is given below. These rates will vary according to position of the khals and rivers in relation to the site, the distance of hauling of logs or firewood and distance of transportation.

Timber—

(i) Extraction and loading from an average site	..	Rs. 2.25 per cft.
(ii) Transport to Khulna	.. ..	Rs. 2.00 per cft.

Firewood—

(i) Extraction and loading	.. ..	Rs.50.00 per 100 mds.
(ii) Transport to Khulna	.. ..	Rs.20.00 per 100 mds.

56. **Past and current prices—**Since after independence in 1947 a lot of changes have occurred in the use and markets of produce from Sundarban. The Calcutta market, which consumed all the Gewa wood for match industries, went out of hand and Gewa from Sundarban suffered from complete lack of a market for few years till construction of match factories and the Newsprint Mill at Khulna. Calcutta and adjacent districts of West Bengal accounted for large quantity of timber, fuelwood and golpatta before independence. But market for these produce soon developed in the country as the produce were in demand. The price structure continued to be unsteady and the trend is still in the increase due to increasing demand and general higher cost of living.

57. Prices of major items of produce in Khulna from 1947 to 1961 and 1962 were as follows:

Market rate of different Forest Produces at

Serial No. 1	Name of species. 2	1947. 3	1948. 4	1949. 5	1950. 6	1951. 7	1952. 8
1	Sundri logs of all measurement	2.25	2.25	2.25	2.50	3.00 to 3.25	3.00 to 3.25
2	Sundri sawn timber of all measurement.	4.50	4.50	5.62	6.00 to 8.00	6.00 to 8.00	6.25 to 8.25
3	Passur log	4.00 to 4.50	4.00 to 4.50	4.50	4.50	4.00	5.00
4	Passur sawn timber	6.75 to 10.00	6.75 to 10.00	6.75 to 10.00	6.75 to 10.00	9.00	9.00
5	Keora logs	1.12 to 1.25	1.12 to 1.25	1.12 to 1.25	1.00	1.12	1.12
6	Keora sawn timber	4.00 to 4.50	4.00 to 4.50	4.00 to 4.50	3.37	4.00 to 4.50	4.00 to 4.50
7	Baen logs	1.12 to 1.25	1.12 to 1.25	1.12 to 1.25	1.12 to 1.25	1.12 to 1.25	1.12 to 1.25
8	Baen sawn timber	4.00 to 4.50	4.00 to 4.50	4.00 to 4.50	4.00 to 4.50	4.00 to 4.50	4.00 to 4.50
9	Kankra logs	1.12	1.12	1.12	1.12	1.12	1.12
10	Kankra sawn timber	3.50	3.50	3.50	3.50	3.50	3.50
11	Goran Khuti per 100 mds. ..	125.00	125.00	125.00	125.00	125.00	125.00
12	Goran fuel per 100 mds. ..	60.00 to 65.00	60.00 to 70.00	70.00 to 75.00	70.00 to 75.00	75.00 to 80.00	75.00 to 80.00
13	Sundri fuel per 100 mds. ..	42.00 to 50.00	42.00 to 50.00	50.00 to 60.00	50.00 to 60.00	50.00 to 60.00	55.00 to 65.00
14	Golpatta per kahan	20.00 to 25.00	25.00 to 30.00	30.00 to 35.00	30.00 to 35.00	30.00 to 35.00	35.00 to 40.00

Khulna from 1947—1961 per Cft.

1953.	1954.	1955.	1956.	1957.	1958.	1959.	1960.	1961.
9	10	11	12	13	14	15	16	17
3-00 to 3-25	3-00 to 4-00	3-50 to 4-00	3-50 to 4-00	3-00 to 4-00	3-00 to 4-00	3-50 to 5-00	3-50 to 5-00	3-00 to 5-50
6-25 to 8-25	6-50 to 8-50	6-50 to 8-50	6-50 to 8-50	7-00 to 9-50	7-00 to 10-00	7-00 to 11-00	7-00 to 11-00	7-00 to 8-00
5-00	5-00	5-50	6-00	6-00	6-00	6-00	6-00	6-00
9-00	9-00	11-25 to 12-00	11-00 to 12-00	11-00 to 12-00	11-00 to 12-00	11-00 to 12-00	11-0 to 12-00	11-00 to 12-00
1-12	1-12	1-12	2-00	2-00	2-00	2-00	2-00	2-00
4-00 to 4-50	4-00 to 4-50	4-00 to 4-50	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00
1-12 to 1-25	1-12 to 1-25	1-12 to 1-25	2-00	2-00	2-00	2-00	2-00	2-00
4-00 to 4-50	4-00 to 4-50	4-00 to 4-50	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00	5-00 to 6-00
1-12	1-12	1-12	1-50	1-50	1-50	1-50	1-50	1-50
3-50	3-50	3-50	4-00	4-00	4-00	4-00	4-00	4-00
125-00	125-00	125-00	125-00 to 150-00	125-00 to 150-00	125-00 to 150-00	125-00 to 150-00	125-00 to 150-00	125-00 to 150-00
80-00 to 85-00	85-00 to 90-00	80-00 to 95-00	85-00	85-00	85-00 to 100-00	85-00 to 100-00	85-00 to 100-00	85-00 to 120-00
55-00 to 65-00	55-00 to 65-00	60-00 to 70-00	60-00 to 70-00	65-00 to 70-00	70-00 to 80-00	80-00 to 90-00	90-00 to 100-00	90-00 to 100-00
35-00 to 40-00	40-00 to 50-00	40-00 to 50-00	45-00 to 55-00	55-00 to 60-00	60-00 to 70-00	60-00 to 70-00	60-00 to 70-00	60-00 to 70-00

Price of Timber and Other Forest Produce at Khulna during February, 1962.

Sl.No.	Name of Species.	Measurement.	Rate.	Unit.	Remarks.
1	2	3	4	5	6
1	Sundri Log ..	All girth	Rs. 4.50 to 6.50	cft.	
	Sundri sawn timber	2" x 1" to 5" x 5" upto length 15'ft.	7.00 to 8.50	cft.	
	Sundri sawn timber	Do. 16'ft. to 24'ft.	8.50 to 10.50	cft.	
	Sundri sawn timber	2" x 2" to 5" x 5" over 24'ft. ..	10.50 to 12.75	cft.	
2	Passur logs ..	All girth	7.00 to 8.00	cft.	
	Passur sawn timber	2" x 1" to 5" x 5" upto 9' length ..	11.50 to 13.00	cft.	
	Passur sawn timber	Over 9' length	13.00 to 15.00	cft.	
3	Keora logs ..	All girth	2.50 to 3.75.	cft.	
	Keora sawn timber	All measurement	6.75 to 7.00	cft.	
4	Kankra logs ..	All girth	3.25 to 4.50	cft.	
	Kankra sawn timber	All measurement	6.50 to 8.50	cft.	
5	Baen logs ..	All girth	3.00 to 3.50	cft.	
	Baen sawn timber ..	All measurement	5.50 to 7.00	cft.	
6	Goran timber ..	.. ..	150.00 to 300.00	Per 100 mds.	
	Goran fuel ..	All measurement	125.00 to 150.00	..	
7	Sundri fuel ..	All measurement	90.00 to 110.00	Per 100 mds.	
8	Golpatta ..	All measurement	125.00 to 150.00	Per 100 mds.	
9	Honey ..	....	80.00 to 90.00	Per maund.	

CHAPTER IV

STAFF AND LABOUR SUPPLY

58. **Staff**—The staff prescribed in Curtis' Plan was adequate but was not available for execution of the plan. When staff required for prescribed work in the forest was not available, cultural operation for improvement of the forest was sacrificed. Therefore, economy by curtailing technical personnel is not good economy.

59. Sanctioned strength of staff of all grades with reference to sanction orders is given in Appendix VII.

60. **Labour supply**—Labourers required for working in the forest have to be brought from localities away from the forest. They have to be provided with transport, lodging, food supply and drinking water as it is not possible for them to arrange these necessities themselves. The demand for labour has increased in the past years due to the establishment of Chalna anchorage. The Newsprint Mill also employs about 3,000 labourers in the forest camps almost throughout the year. It is not hard to procure labourers for forest work. But the wages are on the increase every year. The present rate has been Rs. 2.50 to Rs. 3.00 per labour per day. It is, however, extremely difficult to procure labourers during the cultivation and harvesting seasons. Therefore, forest works where employment of large number of labourers is involved, need to be planned and timed accordingly.

CHAPTER V

PAST HISTORY OF MANAGEMENT

61. **General History of the Forest**—The formation on which the Sundarban forests are situated is geologically of recent origin. Some thousand years ago, most of the swamp, now under forest, must have been well under sea level. Until sixteenth century, when the main flow of the Ganges changed from Bhagirathi and the Bhairab to the Padma, the growth of the part of the delta with which we are concerned must have been very rapid. Since then, accretion on the coast line has declined. The maps prepared by Major Ellison in 1874 show very much the same coast line as that in 1958. Since 1874 some new chars have been formed between the Baleswar and the Passar.

62. Remains of buildings in compartment 39 near the Sipsah river including the famous Shekertek temple indicate that some areas of forest were cleared and inhabited at a not very remote period. After the Ganges changed its course and the Bhairab began to lose its former great volume of stream there was a gradual influx of salt water. It was probably for this reason that, these old habitations were abandoned and allowed to revert back to forest.

63. In the eighteenth century, the forests were about double their present size. Zaminders on the northern boundaries were allowed to reclaim, as much of the jungle bordering on their land as they could. The British Government assumed the proprietary rights to the forests in the Sundarban under Regulation III of 1828. Large leases were granted to capitalists including Europeans for clearing and cultivation under this regulation. This large scale destruction of forests continued for more than four decades when Government realised the adverse effects of removal of forests and bunding up of land. Leasing of large areas of fresh land in Khulna district was stopped in 1875 when the remaining unleased forest areas in Bagerhat and Sadar subdivisions were declared reserved forest under Act VII of 1855. In 1876, most of the remaining unleased forest in the Satkhira subdivision was declared reserved under this Act and was placed under the control of the Forest Department. In 1879 the forests, so reserved, were declared again as reserved forests under the Forest Act of 1878. During the same year a further small area of 24 square miles in the Satkhira subdivision was declared protected forest. This area was disforested again, and leased out in 1896. In the north of present Koikhali Revenue Station, a small area of 2200 acres of the reserve was disforested in 1904.

64. A list of Notifications concerning reservation and disforestation is given in Appendix III

65. **Surveys**—Since 1769, several surveys were made to prepare charts of rivers for navigation. Revenue surveys were made during 1855 to 1859. The data from these various surveys were collected together by Major James Ellison, who published a complete map of the Sundarbans in 1873 on a scale of 1 inch to 4 miles. During the period 1905 to 1908, the forests were surveyed in detail by the Provincial Survey Department. The maps in scale 1 inch to 1 mile were published in 1909. The latest revised sheets of these maps incorporating the small erosion and accretions were published in 1924. During the working of the forest since then, details were checked and small Khals have been mapped. Fresh set of maps in 2 inch to 1 mile scale in 15 sheets have been prepared by aerial survey for the purpose of this Working Plan. Expenditure incurred for this survey is Rs. 1,72,948.00.

PAST SYSTEM OF MANAGEMENT AND THEIR RESULTS

66. **Early management**—The early management of the Sudarban forests was confined to the realisation of revenue on the export of forest produce. During 1872 to 1874 Mr. A. L. Home, Deputy Conservator of Forests, made an examination of the forests and Dr. Schlich, a reputed forestry expert, and Sir Richard Temple visited the Sundarbans in 1874. Their recommendations formed basis for reservation and forest conservation. The first step to conserve forests was to fix a minimum girth limit 3 feet 9 inches for Sundri and revenue stations were established on the main routes of export.

67. The first Working Plan for the forests of Sundabran came into force in the year 1893-94. The first working plan was revised in 1903-1904 and in 1906-1907. In all these plans the forests of Khulna and Bagerhat subdivisions were divided into 2 felling series and 10 annual coupes. The felling cycles and exploitable girth limits were revised at every revision. All these plans dealt with conservation and exploitation of Sundri and to a certain extent with Keora, Passur, Kankra and Amur. Felling of other species remained practically unregulated.

68. **Trafford's Working Plan**—A regular working plan was prepared by Mr. Trafford for the period from 1912-1913 to 1931-32. This plan divided the whole forest into two Working Circles, namely, the Sundri or Eastern Working Circle and the Western Working Circle.

69. The Eastern Working Circle consisted of compartments 1 to 40. The System of management was selection felling with exploitable girth limit for Sundri at 3'-6" at 4'-0" and Amur, Kankra, Passur at 2'-0". Only one felling series was prescribed and the felling cycle was 40 years. In fresh water areas improvement fellings were prescribed on 20 years' cycle. As there was no restriction on felling of other species those were overcut during the working of the plan. Some restrictions were imposed on other species in 1925.

70. Western Working Circle consisted of rest of the area. No coupes were detailed for that area and fellings were restricted to trees of same girth limit as in Eastern Working Circle. In this working circle trees seldom reached the girth limit prescribed and as a result the main timber species were not properly worked. The area was divided into 5 blocks for cutting of firewood.

71. **Curtis' plan**—The plan of S. J. Curtis covered the period from April, 1931. Curtis took great pains in collecting very accurate data for his Working Plan. Line enumerations were done throughout the forest and detailed stock-maps were prepared. Analysis of all data was done in great detail.

The principal object of this plan was to economise in utilisation by concentrating the fellings of all species rather than Sundri, Keora, Kankra, Passur and Amur, in coupes and to give proper silvicultural treatment to all important species. It was also the aim of this plan to obtain a balanced age gradation of all species throughout the forests. In this plan, theoretical work, based on intensive data collected, was done in much detail which hampered the execution of the plan in the field: (1) Attempt was made to compare the existing crop with theoretical normal crop. Assumptions on which this was based were questioned by some authorities. (2) Exploitable dimeters for all species was fixed with too great refinement. Variation of the exploitable diameter according to variation of the quality of the site indicated by 5 feet difference in height was beyond practical application. (3) Rotation was fixed at the nearest year of theoretical calculation for the several quality classes into which the crop was classified. (4) Yield was calculated to decimals of a cubic foot per acre for timber and fuel. (5) Volume check

prescribed was very difficult to adopt in practical working. The Sundarban is a very valuable forest property needing intensive management, but this plan was made too intensive in one step. However, it contained exceptionally rich records about the forests of Sundarbans and shall remain to be a reference book for the Sundarban in the future. Curtis' plan was one of the most talked of plan prepared in India at that time. It faced criticism and received appreciation from highest forestry authorities and the reader will certainly find it interesting to go through these illuminating discussions which will be available from old records.

72. **Working Circle**—The forests were divided into two zones, namely, the fresh-water zone to the north and east which consists mainly of dense well stocked forests of first and second quality and moderately salt water zone to the south and west which consist mostly of less densely stocked third quality forest. In the former Sundri is the predominant tree while in the latter Gewa predominates numerically. This division into zones formed the basis of two main working circles, namely, the Fresh-water Working Circle and moderately Salt-water Working Circle. The working circles were divided into suitable felling series and cutting sections and annual coupes were detailed. The following exploitable diameter limits were prescribed for a selection system of management:—

Quality Class of the locality.	Average maximum height of surrounding forest in feet.	Exploitable diameter.				
		Sundri (Inches).	Gewa (Inches).	Passur (Inches).	Dhundal (Inches).	Kankra (Inches).
First ...	65 and over	14	14	12	6	9
	60—64	13	13	12	6	9
	55—59	12	12	12	6	9
	50—54	11	11	12	6	9
Second ...	45—49	10	11	12	6	9
	40—44	9	10	12	6	9
	35—39	8	9	11	6	9
Third ...	30—34	7	8	10	6	9
	25—29	6	7	9	6	9
	20—24	5	6	8	6	8

73. Exploitable diameter limit for Keora and Baen were fixed by compartments as the quality of this species does not always vary with that of the surrounding forest. The exploitable diameter for Keora was fixed between 20 inches to 28 inches in different compartments and that of Baen was fixed between 18 inches to 25 inches.

74. Felling cycle for Fresh-water Working Circle was 20 years while that for Moderately Salt-water Working Circle was 30 years.

75. An overlapping Working Circle for Goran was also prescribed with felling cycle of 20 years.

76. Detail felling and coupe rules were prescribed in all the Working Circles and improvement operations were prescribed in details. The Working Plan contained elaborate prescriptions for minor produce like Golpatta, Honey and Wax.

77. **Chaudhury's Modification**—Attempts were made up to 1935-36 to work the forest under Curtis' Working Plan. But it was found that the prevailing markets did not justify the intensive working prescribed nor the organisation available was capable of following the elaborate and precise prescriptions. The plan was rewritten by Mr. S. Chaudhury the then Divisional Forest Officer and the rewritten plan was in force from 1st April, 1937 to 31st March, 1947. This rewriting was based on data of Curtis' Plan and only simplification of prescriptions more or less in the same line was done. Instead of 4 quality classes as prescribed by Curtis for selection marking according to diameter limit varying by 5' difference in height of surrounding trees, Chaudhury prepared a list of compartments allotting each compartment to one of the three quality classes.

78. **Short Term Schemes**—Subsequent to 1947, *i.e.*, expiry of Chaudhury's Plan, forest of Sundarban have been worked under scheme, prepared by the Divisional Forest Officers. These schemes were more or less extension of the past plan modified to the extent dictated by changed markets due to independence and partition of the undivided province of Bengal.

Result of past working.

79. Since after publication of Curtis' Plan in 1931, forests of Sundarban drew attention of the authorities as regards its potential value. Management of forest on silvicultural principles was started and continued till the present day. Markets for produce which already had demand has developed as a natural course and produce for which market was non-existent has been developed and as a result working has become intensive. Silvicultural practice and administrative methods have become standardised. Working of Golpatta which is a substantial revenue earner has become highly systematised. Unfortunately, Silvicultural research is lagging behind and number of problems are still to be solved.

During the past working, over mature and big sized trees of all species have been removed and as a result trees much above the exploitable size are hardly noticed. The stock map prepared for this Working Plan has been compared with the stock map of Curtis. There is striking similarity in site class distribution and composition of the crop. Number of seedlings, saplings and trees of Sundri of different diameter classes per acre was plotted against diameter class in inches. The curve has been found to be similar to that of a normal forest.

Miscellaneous works and Improvements.

80. **Floating crafts**—There are no touring bungalows and no roads in this Division. When on tour, or working within the swamp forests, the more senior officers live in launches or in house boat. The subordinate staff lives in small country made accommodation boats or in thatch sheds constructed on machans inside the forest. A list of water crafts in the Division is given in Appendix VIII.

81. **Buildings**—At present the coupe offices and other offices and quarters for field staff is constructed with golpatta roofing and wooden planking which is quite unhealthy for the staff and it requires regular maintenance cost. Considering all this it is suggested that all the temporary coupe and other offices should be constructed with prefabricated material so that it may be shifted from one place to another. It is also suggested that Range and station office and quarter at Range Head Quarter and station Head Quarter should be of pucca type as cyclone and tidal bore is a regular feature of Sundarban area. The list of buildings of the Division is given in Appendix IX.

82. **Canals**—In Sundarban area water ways are the main source of communication. So, it is suggested that some of the rivers and canals such as Bhadra river from Sutar-khali to the point where Bhadra river meets Passur river to be excavated. Also re-excavation is essential for canal from Sarankhola station to Bogi station.

CHAPTER VI

STATISTICS OF GROWTH AND YIELD

83. **Sample and Experimental plots**—A number of sample plots, Diameter Increment Plots, Girth Increment plots and Experimental Plots were laid out in the forests of Sundarban since 1893. Some plots have since been abandoned and others are available on record. Mr. Curtis had analysed data available from the existing plots upto 1930. Record of this analysis is available in Appendix X. For the study of rate of growth Messrs. Forestal Forestry and Engineering International, Ltd., employed Dr. R. W. Wellwood, Professor of Forestry at the University of British Columbia, and a World recognised authority in wood technology, with considerable experience of tropical species. Dr. Wellwood undertook ring counting of several specimen of Gewa and Sundri selected from representative areas. 6 Gewa plots, 4 Sundri plots and 1 Keora plot were also studied for the purpose. All these plots were established between 1931 and 1945. Age of the trees at the time of plot establishment was not, however, known.

84. The inventory of the forests of Sundarban was carried out with modern survey methods based on Aerial photography and the application of photogrammetric techniques combined with statistically controlled ground samplings. For details Volume I of Forest Inventory Report (1958-59) of Sundarban forest by Forestal Forestry and Engineering International, Limited, may be referred to.

85. **Site Quality Class**—The forests were divided into four different height classes (average mean height) which correspond to Curtis' quality classes as follows:—

Site quality.	Height class (AMH).
Site 1	50 feet and over.
Site 2	35-49 feet.
Site 3	25-35 feet.
Site 3 (—)	20-24 feet.
Site	Less than 20 feet.

The "3(—)" height class was incorporated because the large areas of the Western and South-western Sundarbans forests in this category are distinguishable on the photos. The volumes per acre of these stands are sufficiently distinct from those of height class 3 to warrant this subdivision.

86. **Density**—Density of the forest types were estimated from crown closure in the following four classes:—

Density class a	90 to 100 per cent. crown closure.
Density class b	75 to 90 per cent. crown closure.
Density class c	50 to 75 per cent. crown closure.
Density class d	Less than 50 per cent. crown closure.

87. The species composition of types are represented as below:

Species composition.	Type of nomenclature.
75 to 100 per cent. Gewa and 0 to 25 per cent. Sundri ...	G
50 to 75 per cent. Gewa and 25 to 50 per cent. Sundri ...	GS
25 to 50 per cent. Gewa and 50 to 75 per cent. Sundri ...	SG
0 to 25 per cent. Gewa and 75 to 100 per cent. Sundri ...	...

88. **Volume Tables**—During the course of the inventory, a total of 1,123 sample trees were felled throughout the Sundarbans forests. The species distribution of these trees is shown in the table below:

Sample Trees Felled.

Species.	Number of trees felled.
Gewa ...	572
Sundari ...	404
Keora ...	34
Passur ...	67
Kankra ...	32
Baen ...	7
Other species ...	7
Total	1,123

89. These trees formed the basis for the construction of new volume tables. Detail specifications are available in Appendix X of Inventory Report Volume I as referred in para 84 of this chapter. The compilation of the individual tree, volumes and the derivation of volume curves was done with the help of an electronic digital computer in Vancouver, Canada. The resultant gross cubic-foot volume tables were prepared for Gewa and for Sundri in different site classes and to each of the three utilisation standards, namely, 4', 3', 2', utilisation standards and gross volume. In the case of Keora, a species of limited distribution occurring on areas of uniform site quality, a standard volume table was computed for each of the four utilisation standards, but not for separate site classes. Because species other than Gewa, Sundri and Keora are of secondary importance, a check of existing volume tables was thought more suitable than construction of new tables. Cubic-foot volume to a 4" inch top DIB was calculated by the computer for each felled sample tree, and compared graphically with equivalent tree volume read from the modified Curtis' table for the species. Differences between measured and table were insignificant. As a result of these tests the modified Curtis' table for Passur, Kankra, Baen and Goran were adopted without further modification. The modified Curtis' table for 'miscellaneous species' was adopted for volume compilation of Amur, Dhundal, Singra and all other such minor species. All volume tables used in the compilation of inventory volumes, together with the tables to other utilization standards, are

shown in Appendix 12 of the Inventory Report. The following extracts from this is appended in Appendix XI to this Working Plan.

- (i) Volume table for Gewa for trees from 5 inches dbh class to 20 inches dbh class with utilization standard of 3 inches and 4 inches top DIB.
- (ii) Volume table for Sundri for trees from 7 inch dbh class upwards to 4 inches top DIB utilization standard.
- (iii) Volume table for Keora, Passur, Kankra and Baen.

90. Further details will be available in Appendix 12 of the Inventory Report, Volume I, which contains the following :—

Gewa—(i) Gross volume tables in height classes varying by 5 feet, and to utilization standards of 4 inches, 3 inches and 2 inches top DIB.

(ii) Total gross volume table.

Sundri—(i) Gross volumes of trees between 5 inches diameter class and 4 inches diameter class to utilization standard of 4 inches, 3 inches and 2 inches top DIB. Difference into quality classes have not yet been made.

(ii) Total volume.

Passur, Kankra, Baen, Goran and other miscellaneous species.—Volume tables of gross volume to 4 inches top D.I.B. Utilization standard.

91. **Defect and Crook Factors**—It was necessary to determine deduction factors to apply to gross volume in order to arrive at net merchantable volumes. Net volume means volume after deduction for rot and bark seam; and net merchantable volume means volume after further deduction for crook.

92. The necessary deduction factors were derived from data collected from 1,123 felled sample trees. The actual cubic foot deduction for defect and for crook were calculated as percentages to the total gross volume for each diameter class within each block. No significant differences for either defect or crook were noticeable between blocks or between the diameter groupings. Accordingly, it was decided to apply a blanket percentage deduction for defect and for crook. A table showing these percentage deduction for each species and for each utilization standard is shown in Appendix 13 of Inventory Report.

93. For current utilization standards for Gewa, *i.e.*, to a top diameter of 3 to 4 inches, the following volume reductions apply :—

Defect ...	... 2 to 3 per cent. of gross volume.
Crook ...	... 2 to 4 per cent. of gross volume.

The equivalent figures for Sundri are—

Defect ...	... 0.5 to 2.5 per cent. gross volume;
Crook ...	... 2.0 to 3.5 per cent. of gross volume.

94. **Stand Tables**—concurrent with the preparation of volume tables and determination of defect and crook factors, stand tables were also compiled for each stratum which had been sampled in each block. The stand table has been prepared to utilization standard: V4—that is, volume in cubic-feet to a 4" top DIB. If conversion of stand table data to other utilization standard were desired at any time, it would merely be a

question of multiplying by the values from the appropriate volume table. 92 stand tables, showing gross, net and merchantable volumes for each stratum sampled have been presented in bound form with the Inventory Report as Volume II.

95. **Summary of volumes**—From the stand tables, summaries by strata of the net merchantable volumes were prepared. A separate summary was made for trees of the dbh classes 5 inches and over and 9 inches and over, for each block. Where a stratum in any block had not been sampled due to small acreage, the volumes were determined by weighting the per-acre values from an adjacent block or from an allied stratum, as noted on the summary sheets. The total net merchantable volumes by strata and for each species were thus calculated and are shown on the 24th summary sheets which are presented in bound form together with the stand table data (Volume II of the Inventory Report). Additional summaries were prepared for per-acre volumes and for total volumes. In this, further summarisation of all strata were combined and volume figures are recorded by species and by blocks. These summaries, which are presented in Appendix XII (of Appendix 14 of volume I of Inventory Report), have been prepared for the same dbh groups as in the 24 tables mentioned earlier, i.e., for dbh classes 5 inches and over, 6 inches and over, and 9 inches and over.

96. A total summary for the entire forest is shown in the table below:

SUMMARY OF NET MERCHANTABLE VOLUMES

SUNDARBAN FORESTS

Utilisation standard : To 4 inch top DIB.

Reference—Appendix 14 of the Inventory Report, Volume I.

DBH class Species	Total volume (cubic feet).			Volume per acre (cubic feet).		
	5 inches and over.	6 inches and over.	9 inches and over.	5 inches.	6 inches.	9 inches.
Gewa ...	111,726,530	67,184,730	9,211,850	119	72	10
Sundri ...	520,735,640	449,229,180	204,999,970	556	480	219
Passur ...	28,074,710	25,950,260	14,512,060	30	28	15
Kankra ...	17,677,170	15,515,960	7,224,940	19	16	8
Baen ...	15,284,290	15,152,870	14,498,850	16	16	15
Keora ...	19,471,200	19,389,150	18,764,460	21	21	20
Other species ...	4,246,820	2,827,420	1,479,200	5	3	2
Total ...	717,216,360	595,249,570	270,691,330	766	636	289

97. **Growth and Yield studies**—The source for studies of growth and yield is the sample plots and experimental plots maintained by the Silvicultural Research Division. As mentioned earlier, data available from them are not sufficient to arrive at reliable conclusion. At present Gewa has developed to be the raw material for a large scale Newsprint Factory and for a number of Match Factories. Due to these demands, Gewa is required to be worked to be intensively. It is necessary to know growth pattern of the species before intensive working can be prescribed. Dr. R. W. Wellwood, Professor at the University of British Columbia and a Wood-Technologist of International Standing, was reference to for undertaking the studies on growth and yield of Gewa.

98. Dr. Wellwood, after considerable research into the problems of growth determination in tropical trees, after consultation with other authorities throughout the world, and after examination of some 250 wood samples from the Sundarbans has stated the following:—

- (i) It is possible to count growth rings on Gewa wood samples.
- (ii) It is possible to distinguish the growth rings that are true annual rings from those which are false, discontinuous rings occurring at other than annual intervals.
- (iii) At 50 to 60 years of age, dependent upon site, Gewa is over mature and decadent and growth is negligible. It is felt that it dies shortly after reaching maturity and thereafter passes rapidly out of the stand.

99. Dr. Wellwood's Report is included in Appendix 15 of Inventory Report, Volume I, and detailed results of the mean annual increment to dbh diameter classes, as determined from his counts of annual rings, are presented in Appendix 16 of the Inventory Report.

100. The results are summarised in the Table below:

Table—Gewa Diameter Growth Rate as determined from the counting of Annual Rings.

Source of wood sample.	Number of sections counted.	MAI. (Inches at dbh)
Sections cut from trees growing throughout the Sundarbans ...	51	0.141
Sections cut from trees growing in the Gewa permanent sample plots.	27	0.165
Sections cut from immature trees growing on recently cleared areas.	45	0.299
Overall average	123	0.188

101. These results are in accordance with the findings of Curtis who reported a MAI to dbh of 0.137 inches, based on the ring counting of sections from 77 trees (of Curtis Report, Volume I, Page 69).

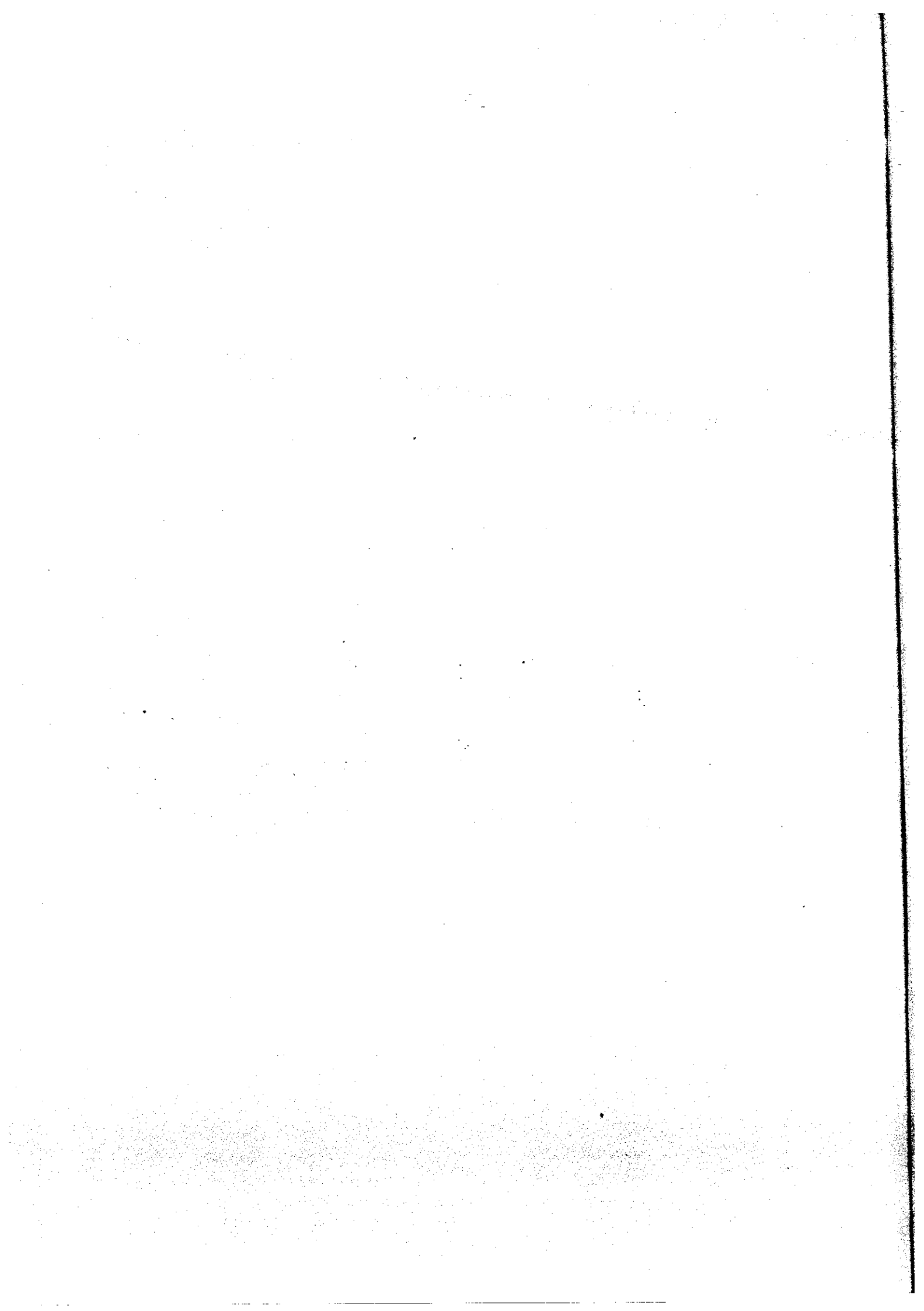
102. The above results, however, show a marked difference from those determined by a remeasurement of Gewa in permanent sample plots and the determinations for Gewa, Sundri and Keora are presented in Appendix 16 of Inventory Report, Volume I. The overall rate for Gewa shows a mean PAI to dbh of only 0.059 inches, a rate which is only 31.4 per cent. of the average rate as determined by the counting of growth rings. The Appendix 16 of the Inventory Report, Volume I, is included in this Working Plans as Appendix XIII.

103. The two determinations are reconciled by a realisation that the low value for Periodic Annual Increment determined from the permanent sample plot data, covers a period when the stands had reached maturity and the growth rate had declined very appreciably; whereas, the higher value for Mean Annual Increment, determined by the counting of growth rings, covers the entire life of the trees; both the initial period of comparatively fast growth and the final period of virtual decadence. A synthesis of the two sets of results, together with those determined by Curtis was made to determine the growth used to predict future yield. These rates for Gewa and Sundri were adjusted for site class and are shown in the stand table projections in Appendix 17 of Inventory Report, Volume I.

104. The rates of growth for other species were not determined because of the insufficient data, and yield predictions in these cases were based on a formula not requiring direct growth rate informations.

105. During the compilations of the data from the permanent sample plots, the mortality of Gewa trees originally tallied was determined. The rates of natural mortality during the 18 years since plot establishment were very high and very closely co-related to diameter, as shown in Appendix XIII (Appendix 16 of the Inventory Report). The substance of the conclusion of Dr. Wellwood is that after reaching maturity, Gewa trees die and rapidly pass from the stand. The estimated mortality rates from Gewa and Sundri were adjusted for site variation and are shown in the stand table projections in Appendix 17 of the Inventory Report. The yield of Gewa at the present time is 119 cubic feet per acre (net merchantable volumes to 4 inch top DIB) in trees in the 5 inch dbh class and over.

106. This figure is the average value for the entire Sundarban. Current yield values for the species in specific strata or by blocks can be determined from an examination of the Stand Tables and Volume Summaries contained in Volume 2 of the Inventory Report and from the Volume Summaries shown as Appendix 14 of the Inventory Report.



FUTURE MANAGEMENT DISCUSSED AND PRESCRIBED

PART II

PART II

FUTURE MANAGEMENT DISCUSSED AND PRESCRIBED

CHAPTER I.

BASIS OF PROPOSALS

107. **General Object of Management**—The main object of management for the forests of Sundarban is —

Maintenance of the forest stand and its gradual conversion into a regular Selection Forest with a balanced distribution of all age classes and thereby—

- (a) ensuring possible protection of the cultivated lands in the interior from the devastations caused by periodic cyclones, storms and tidal waves ;
- (b) guaranteeing an annual sustained yield of timber, firewood pulpwood, thatching materials and other minor forest produce as far as practicable for meeting demand of the people and the existing and developing industries ;
- (c) applying silvicultural practices as are considered correct from the existing data, that will promote increase yields in future.

108. **Blocks and Compartments**—To facilitate sampling during the inventory survey the forests were divided into eight blocks, defining broad differences in site quality and species distribution. Each of these blocks was a grouping of compartments. The previous compartments as laid down by Curtis in his plan have been retained unaltered as these have been found suitable and also in order that the records of their histories may be contained. Areas of each compartment have been recalculated from the new set of maps.

109. A summary of land areas of each compartment is given below—

Block.	Compartment.	Areas in acres.	Total area in Block.
I	1	25,035	..
	2	13,645	..
	13	13,760	—
	14	10,345	—
	21	11,360	—
	22	11,455	—
	23	9,240	—
	24	13,100	—
	25	10,925	—
	26	9,350	—
II	27	9,505	—
	28	9,810	147,530
	3	14,050	—
	9	32,030	—
	10	15,020	—
	11	13,305	—
	12	14,680	—
	15	13,685	102,770

Block.	Compartment.	Areas in acres.	Total area in Block.
III	4	15,505	..
	5	12,605	..
	6	18,670	..
	7	27,460	..
	8	32,720	..
	45	26,000	132,960
IV	29	10,680	..
	30	12,420	..
	31	15,440	..
	32	13,385	..
	33	12,115	..
	34	12,825	..
	35	15,810	..
	36	17,450	..
	39	14,955	..
	40	10,090	135,170
V	16	15,675	..
	17	18,770	..
	20	19,040	..
	37	14,275	..
	38	16,460	..
	41	18,210	..
	46	27,710	..
	47	24,830	154,970
VI	18	30,540	..
	19	19,245	..
	42	18,890	..
	43	27,350	..
	44	23,680	..
	52	29,485	149,190
VII	48	19,470	..
	49	27,105	..
	50	18,890	..
	51	23,845	89,310
	53	19,925	-
	54	34,770	..
	55	39,465	94,160
		Total	1,006,060

Shot of
13,627.33 AC.
from AM. Club's Plan

as per ODA 401632 ha
= 9,92,432.67 Acres

METHODS OF TREATMENT TO BE ADOPTED.

110. Forests of the Sundarban have in the past been worked under a silvicultural system of selection-*cum*-improvement. These workings have maintained the balance of the various species. The quality of material available as well as the distribution of diameter classes has improved through the removal of over mature and decadent trees. This has been observed by comparing old stock map of Curtis with the new stock map prepared for this plan. However, as the demands and markets have changed and more up-to-date information has become available from the Inventory Report, it is realized that some changes in management prescriptions are necessary. The results of this inventory have been summarised in Part I, Chapter VI of this Working Plan. Full details will be available in volumes I and II of the Inventory Report.

111. Working under this plan, will, in the case of all timber species continue to be under the silvicultural system of selection-*cum*-improvement with prescribed exploitable limits. Golpatta and Goran will continue to be harvested under the system currently in use.

112. **Cutting Cycle**—The cutting cycle prescribed for the important species, will be 20 years for the convenience of management.

113. **Exploitable Diameter**—For the purposes of the plan, the exploitable diameter limits for the important species have been established as follows :

Species.	Quality Class I.		Quality Class 2.		Quality Class 3.	
	Dia limit.	Exploi-table age.	Dia limit.	Exploi-table age.	Dia limit.	Exploi-table age.
Sundri ...	10·6"	80	8·6"	80	6·6"	80
Gewa in Newsprint Felling Series.	<u>4·6"</u>	<u>50</u>	<u>4·6"</u>	<u>60</u>	<u>4·6"</u>	<u>60</u>
Gewa in Match-wood Felling Series.	<u>6"</u>	<u>60</u>	<u>6"</u>	<u>70</u>	<u>6"</u>	<u>70</u>
Passur ...	10"	100	10"	100	8"	100
Dhundal ...	6"	100	6"	100	6"	100
Kankra ...	8"	100	8"	100	8"	100
Keora ...	11·6"	...	11·6"	...	11·6"	...
Baen ...	22"	160	18"	160	14"	160

114. The information contained in Part I, Chapter VI, and the plot files and information recorded by Curtis was used to establish these diameter limit which achieves the best balance between increment and mortality. It has also been necessary to consider the diameter requirements of wood to meet local demand and the requirements of industry. Number of trees for each diameter class in each block according to site qualities has been checked and it has been observed that the required number of trees of size higher than the exploitable diameter limit will be available in subsequent felling cycles.

115. **Working Circles**—The annual requirements of large industrial users of Sundarbans wood within the next 10 years is expected to be—

		cft.
Gewa	Khulna Newsprint Mill	4,500,000
	Match Factories	750,000
Sundri	Hardboard Manufacture	<u>700,000</u>

116. Sundri and Gewa are the two main species in the forests of the Sundarban both from commercial and stock point of view. The total volume of trees 4-6" dbh. and over to a 4' top DIB is 717.2 million cubic feet, Sundri accounts for 520.7 million cubic feet and Gewa 111.7 million cubic feet or 73 per cent. Sundri and 16 per cent. Gewa (of : page ii, para. 6 of the Inventory Report).

117. Sundri is used extensively for lumber, house posts and fuel wood throughout the province. The demand for Sundri poles for transmission lines is increasing. This species is likely to be used for the manufacture of hardboard.

118. Gewa is used for the manufacture of pulp and paper by Khulna Newsprint Mill and is also the main wood used by the match industry at Khulna.

119. Keora has attained new use as bobbins, baling boards and boxwood. Peculiar silvicultural characteristics of Keora as a pioneer species demands special treatment.

120. Golpatta is used extensively as thatching material and contributes substantially to the revenue of the Division.

121. Goran finds use in building and as fuel wood. The bark of the species will probably be the basis of a tannin extraction industry to be located in Khulna.

122. Other timber species do not exist in sufficient quantity to be of prime importance. Their management and exploitation will continue under the coupes for Sundri.

123. Working for all other minor species and produce has been prescribed under Chapter V Miscellaneous prescriptions.

124. For the purposes of management the forests of the Sundarban in Khulna district have been divided into the following Working Circles.

I—GEWA WORKING CIRCLE.

125. This Working Circle covers the whole forest. It has, however, been divided into three separate felling series based on quality and uses. Different felling rules have been prescribed for each of these subdivisions. The felling series are as follows :—

- (I) Block 1, comprising an area of 147,530 acres has been reserved for supply of Gewa wood in large dimensions for use by the match industry.
- (II) Block 2-6 inclusive, comprising an area of 675,060 acres have been reserved for supply of Gewa wood to satisfy the demand of Khulna Newsprint Mill.
- (III) Block 7 and 8, comprising an area of 183,470 acres of generally low quality Gewa wood and which is situated away from the existing markets will meet the minor local needs and needs of markets which may develop.

II—SUNDRI WORKING CIRCLE.

126. This Working Circle covers the whole forest of 1,006,060 acres. It is divided into five different felling series for administrative convenience and to meet the needs of different local markets.

III—KEORA WORKING CIRCLE.

127. The Keora Working Circle comprises the patches of Khulna forest scattered throughout the Sundarban. Patches which are very small in extent and located far away from other bigger patches have not been included in the Working Circle.

MISCELLANEOUS PRESCRIPTIONS.

128. It is not considered necessary to prescribe the constitution of separate working circles for Goran, Golpatta, Passur, Kankra, Baen, Dhundul, etc. Detailed felling rules have been prescribed for these species.

ANALYSIS AND VALUE OF THE CROP (BASIS OF THE PLAN).

129. The Working Plan has as its basis the information contained in the "Forest Inventory, 1958-59, Sundarbans Forests" a survey undertaken by Forestal Forestry and Engineering Limited of Vancouver, Canada in collaboration with the Working Plans Division of the Forest Department. This survey was undertaken for Sandwell and Company Limited of Vancouver who were acting for Pakistan Industrial Development Corporation on the development of a pulp and paper industry in the Khulna area. The survey was based on modern aerial photography, photogrammetric techniques and statistically controlled ground sampling. The main objectives were to obtain detailed informations about occurrence, volume and yield of the species Gewa which is utilized as pulpwood by Khulna Newsprint Mill and to provide overall inventory of the main species found in the Sundarban Forests.

Refer Part I, Chapter VI, for further details and also Volumes I and II of the Inventory Report.

PERIOD OF THE WORKING PLAN AND THE NECESSITY FOR INTERMEDIATE REVISION.

130. This Working Plan has been prepared to cover a period of 20 years, which is also the cutting cycle for the major species, such as Sundri and Gewa. The effective dates for the plan are June 1, 1960 to May 31, 1980.

131. It is not felt necessary at this time to prescribe intermediate revision of this plan. However, the results of actual working may be checked after 10 years and suitable modifications made.

132. It is expected that during the life of this plan various experimental works will be undertaken to establish with some degree of accuracy the growth rates, increment, defect and mortality of the major species. Various methods of operation should be studied and the results evaluated.

133. Generally speaking, however, elaborate field work will not be necessary during the term of this plan.

CHAPTER II.

WORKING PLAN FOR THE GEWA WORKING CIRCLE.

134. **General Constitution**—The Working Circle comprises the whole of the Sundarban Forests in Khulna district.

135. **Character of Vegetation**—The forests have been described in Part I, Chapter II.

136. **Analysis and Value of the Crop**—The total land area covered by this Working Circle is 1,006,060 acres of which 939,820 acres are productive forest land. The balance is composed of new accretions and char lands. Except for 3,030 acres of immature stands, the total net-merchantable volume of Gewa contained in trees of 4.6 inches diameter at breast height and over to a 4 inch top diameter inside bark is estimated as 111,726,530 cubic feet or approximately 16 per cent. of the total timber volume available in all species to these standards.

137. The following summary gives the volumes of growing stock available by Blocks to the above standards (Appendix 14 of Inventory Report):

Block.	Net merchantable volume of Gewa in trees 4.6" inches dbh. and cover to a 4" inches top DIB.
1	cft. 21,880,610
2	15,784,210
3	22,107,870
4	10,054,430
5	16,578,130
6	12,587,340
7	5,881,780
8	6,852,160
	<u>111,726,530</u>

138. **Object of Management**—The Gewa Working Circle is constituted to provide—

- (i) Specific rules for the systematic exploitation of the maximum volume of Gewa on sustained yield basis.
- (ii) Suitable raw materials for existing industries and to meet local demand.
- (iii) Specific silvicultural measures for maintaining and if possible increasing the available volume of this species.

139. **Method of Treatment**—The silvicultural system prescribed for this Working Circle is diameter limit selection. The diameter limits vary with the felling series and are designed to give the maximum volume of the required sizes of timber to supply existing industries and to meet local demand in perpetuity. The felling cycle for this Working Circle has been fixed at 20 years.

140. The distribution of areas within the three felling series is shown in the following statement:

Felling Series.	Block.	Total area in acres.	Area containing mature timber in acres.	Remarks.
1	2	3	4	5
I. Matchwood Felling Series	1	147,530	143,870	The following acres containing Golpatta patches have been deducted from areas shown in para. 136:
II. Khulna Newsprint Felling Series.	2	102,770	101,620	
<i>4.6" dbh</i>	3	132,960	121,960	Block.
	4	135,170	129,990	Area.
	5	154,970	150,420	1 180 acres.
	6	149,190	138,140	2 30 acres.
				3 110 acres.
			4 50 acres.	
			370 acres	
Total Felling Series-II	...	674,060	642,130	
				(Appendix II of Inventory Report, Page 3).
III. Miscellaneous Felling Series.	7	89,310	75,090	
<i>4.6"</i>	8	94,160	75,330	
	Total Felling Series-III	...	183,470	150,420

141. **Exploitable Diameter Limit**—Exploitable diameter limits have been fixed separately for the felling series.

The needs of the industries concerned and the quality of timber growing in the different areas have been considered in addition to study of growth rate and mortality for fixing exploitable diameter limits.

Felling Series.	Exploitable diameter limit breast height.
I	6"
II	4.6"
III	4.6"

GEWA FELLING SERIES I OR MATCHWOOD FELLING SERIES.

142. **General Constitution and Cutting Cycle**—Block 1 is allotted to the Matchwood Felling Series for the supply of large size Gewa billets to the Match Industry. All Gewa 6 inches dbh. and over is to be cut on a 20 years cutting cycle. Utilization is to be to a 4" inches top DIB.

143. **The Yield**—The Yield has been prescribed by area. While prescribing annual coupes, the site quality and density of stocking have been considered and the areas of the different year's coupes have been determined to equalise the volume yield as far as possible. Adjustment of areas of annual coupes for the purposes of volume control and regularity of coupe boundaries by *plus* or *minus* 300 acres in each cutting section by the Divisional Forest Officer is permissible.

144. **Calculation of Annual Cut by Volume**—The allowable annual cut calculation is based on stand table projections (Appendix 17 of Inventory Report). Standing mature timber volume 6" dbh. class and over 6" dbh. and over and estimated growth to a 4" inches top DIB is as follows (of: Appendix 14 of Inventory Report):—

Area containing mature timber (Acres).	Total merchantable volume.		MM cu. ft.	Average annual growth during 2nd cutting cycle. cu. ft. per acre.
	6" dbh. class and over.	6" dbh		
1	2	3	4	
Block I 143,870	15.6	11.0	7.6	

The total volume in trees 6" dbh. and over with a utilization standard to a 4" top DIB has been calculated by taking the inventory volume for the 6" dbh. class and over and subtracting $\frac{2}{3}$ of the volume contained in the 6" dbh. class. This approach provides for the actual volume distribution within the 6" diameter class.

15.6 MM cu. ft. $-\frac{2}{3}$ (6.9) MM cu. ft. = 11.0 MM cu. ft. volume contained in trees of 6" inches dbh. class has been determined by calculation from Volume II of Inventory Report.

145. During the first cutting cycle, that is before any release effect from cutting is achieved, it is estimated that growth rates will be one-half of those shown above. These reduced rates are used for allowable cut calculation for the first cutting cycle.

Allowable cut during the 20 years cutting cycle.

Allowable cut = Present standing mature volume *plus* $\frac{1}{2}$ growth during period.

Allowable cut = 11.0 MM *plus* 3.8 cft. \times 20 years \times 143.870 ac.

$2 \times 1 \text{ MM.}$

= 11.0 *plus* 5.5 = 16.5 MM cu. ft.

Allowable annual cut = $\frac{16.5}{20} = .825 \text{ MM cu. ft.}$

8.25 line off

146. **Felling and Marking Rules**—(i) The annual coupes prescribed have been listed in paragraph 149. Each coupe will be divided into sections of approximately 40 acres each by making north-south and east-west lines 20 chains apart. The lines should be surveyed and chained accurately and at the end of each chain a stick should be placed with the

number of the chain painted on it. With the aid of these lines, the coupe will be mapped on a scale 4" inches to 1 mile. The course of the small Khals will be shown on this map.

(ii) All unsound, and badly shaped or otherwise defective trees will be marked provided their removal does not create a permanent gap. Deceased trees will be removed under any circumstances.

(iii) All trees 6" inches diameter and above at breast height should be marked for felling.

(iv) Marking of a group of trees in one place and the enlargement of an existing blank area to be avoided, except where regeneration has been established. This rule does not place an embargo on the marking of single, large and spreading trees which inevitably, will cause a blank when felled.

(v) Felling of one arm of a forked tree should be avoided as the remaining arm generally becomes unsound.

(vi) All trees should be hammer-marked at a height of 4'-6" and at the base. The base mark should be as low down as possible to avoid waste.

(vii) List of trees marked should be prepared according to 1" inch diameter classes.

(viii) Utilization will be to 4" inches top diameter and all attempts should be made to avoid any waste.

147. Application of Volume Check—See Paragraph 143.

148. Cutting Sections—In order to distribute the work in two administrative units, i.e., two Ranges in which the working circle falls, the area has been divided into two cutting sections, namely, Sarankhola Cutting Section and Chandpai Cutting Section. The areas covered by each cutting section are as follows:

Sarankhola Cutting Section.		Chandpai Cutting Section.	
Compartment.	Area (ac.).	Compartment.	Area (ac).
1	25,035	25 B West of Arwaber Khal	7,255
2	13,645	14	10,345
13	13,760	21	11,360
24	13,100	22	11,455
25A East of Arwaber Khal.	3,670	23	9,240
	69,210	26	9,350
		27	9,505
		28	9,810
			<u>78,320</u>

149. Sequence of Fellings—Annual coupes and the sequence of fellings in the two cutting sections are given in the tabular statements below—

GEWA WORKING CIRCLE.

MATCHWOOD FELLING SERIES.

Cutting Section I or Sarankhola Cutting Section.

Year.	Compartment.	Area.	Description.	
1960-61	...	1	2403	} Area worked over according to old scheme and incorporated in the Working Plan.
		2	1379	
1961-62	...	2	3782	
1962-63	...	2	3782	
1963-64	...	2	3470	South of 1962-63 Coupe.
1964-65	...	2	1230	Balance.
		13	2250	Southern portion.
1965-66	...	13	3470	
1966-67	...	13	3470	
1967-68	...	13	3470	
1968-69	...	13	1100	Balance.
		25A	2400	
1969-70	...	25A	1270	Balance.
		24	2200	Northern portion.
1970-71	...	24	3470	
1971-72	...	24	3470	
1972-73	...	24	3470	
1973-74	...	24	490	
		1	3100	
1974-75	...	1	3500	
1975-76	...	1	3550	
1976-77	...	1	3550	
1977-78	...	1	3600	
1978-79	...	1	3700	
1979-80	...	1	4035	Balance.

GEWA WORKING CIRCLE.

MATCHWOOD FELLING SERIES.

Cutting Section 2 or Chandpai Cutting Section.

Year.	Compartment.	Area.	Description.
1960-61	--	27	2756
		28	5574
1961-62	--	25	3845
		28	3485
1962-63	--	25	6989
		26	1341
1963-64	--	23	3100
1964-65	--	23	3100
1965-66	--	23	3040
1966-67	--	14	3450
1967-68	--	14	3450
1968-69	...	14	3445
1969-70	...	21	3100
1970-71	--	21	3100
1971-72	--	21	3100
1972-73	✓	21	2060
		22	1300
1973-74	--	22	3350
1974-75	--	22	3400
1975-76	--	22	3405
1976-77	--	26	3100
1977-78	...	26	3100
1978-79	...	26	3150
1979-80	...	28	3300

Area worked over according to old scheme and incorporated in the Working Plan.

Northern portion.

South of 1963-64 coupe.

Balance.

Northern portion.

South of 1966-67 coupe.

Balance.

North-West of 1968-69 coupe.

Balance.

Southern portion.

North of 1975-76 coupe.

Balance.

Southern portion.

GEWA FELLING SERIES II OR KHULNA NEWSPRINT MILL

FELLING SERIES.

150. **General Constitution and Cutting Cycle**—Supply of Gewa wood for the Newsprint Mill will be made from Blocks 2, 3, 4, 5, and 6. All Gewa within this area will be cut to a 5" inches dbh class limit on a 20 years cutting cycle.

151. The agreement of the Pakistan Industrial Development Corporation with the Government lays down a clause (clause No. 2) assuring the Newsprint Mill a supply of 3.6 million cft. of solid Gewa wood from the licensed area which will be allotted from time to time. In the felling series for Newsprint Mill in Gewa Working Circle the yield calculated is 5.0 MM cft. This yield can provide for an expansion of the industry. It cannot be assessed at this stage as to what extent the Newsprint Mill can utilize the excess quantity available. The position may be reviewed by 1965 in the first instance and at the end of ten years from the date of agreement (1st January, 1959) and any excess or deficit of the allowable cut of the Gewa wood will be subject to adjustment. This provision is made for the reason that if any additional use of Gewa is found, the surplus stock, if any, may be diverted for national productivity. A copy of the agreement is given in Appendix XIV.

152. **Calculation of Annual Cut**—The allowable annual cut calculations are based on stand table projections (Appendix 17 of Inventory Report).

Standing mature timber volume (5" inches dbh class and over to 3" inches top DIB utilization standard) and growth rates.

Block.	Area in acres.	Total volume MM. cubic feet. Appen- dix 18 of Inventory Report.	Average annual growth during 2nd cutting cycle cubic feet/acre.
1	2	3	4
2	101,620	18.8	11.9
3	121,960	25.9	11.7
4	129,990	11.5	3.6
5	150,420	19.5	9.9
6	138,140	15.0	7.9
Total	642,130	90.7 weighted average.	8.8

153. The average annual growth rates shown were derived by weighting with acreage the rates determined by the method of stand table projection for each site class in each block. The growth rates are those which, it is estimated, will prevail during the second 20 year cutting cycle after the stand has been cut to a 5" inch dbh class limit. During the first cutting cycle, that is before any release effect from cutting is achieved, it is estimated that the growth rates will be one-half of those shown above. These reduced rates are used for allowable cut determinations in the first cutting cycle.

Allowable cut during first 20 year cutting cycle.

Allowable cut = Present standing mature volume + $\frac{1}{2}$ growth during period.

Allowable cut = $90.7 \text{ MM} + 4.4 \text{ cft.} \times 20 \text{ years} \times 642130 \text{ acres}$

$$= 90.7 + \frac{2 \times 1 \text{ MM.}}{20} = 90.7 + 28.2 = 118.9 \text{ MM.cft.}$$

$$\text{Allowable annual cut} = \frac{118.9}{20} = 5.9 \text{ MM. cft.}$$

Allowing 900,000 cft. for retention of seed bearers the Allowable Annual Cut is fixed at 5 MM.cft.

154. **Marking and Felling Rules**—(i) Felling plans covering the geographical and chronological distribution of the Newsprint cutting operation will be prepared by the Forestry Section of Khulna Newsprint Mill. These felling plans will cover periods of 5 years, commencing from July, 1960. Plan I covering operations from July, 1960 to June 30, 1965 is included in this Working Plans as Appendix XV.

(ii) Where it is considered necessary, in the estimation of the Divisional Forest Officer, sufficient sound healthy and well shaped Gewa trees above 4.6" dbh will be marked with paint for retention as seed bearers.

(iii) Felling of group of trees in any one place and thereby enlarging an existing blank is to be avoided, except where regeneration is established. This rule does not place an embargo on felling of individual large and spreading trees or any diseased tree which will eventually cause a blank when felled.

(iv) All Gewa trees 4.6" inches dbh and not covered by the restrictions in rule (ii) or (iii) will be felled.

155. **Sequence of Fellings**—The Sequence of Fellings for the period July 1, 1960 to June 30, 1965 has been shown in the 5 years felling plan, submitted by the Newsprint Mill which is contained in Appendix XV. The subsequent felling plans will be prepared for presentation to the Government during the 6 months proceeding the end of each 5-years period.

156. **Regulation of the Yield**—The Forestry Section of the Khulna Newsprint Mill in their five-year plan indicate the estimated outturn from the operational area. A check should be made with the actual outturn to satisfy whether the estimate and the actual remain within the permissible accuracy standard. All differences should be adjusted at the time of preparation of the next five year plan.

GEWA FELLING SERIES III OR MISCELLANEOUS FELLING SERIES.

157. **General Constitution and Cutting Cycle**—Blocks 7 and 8 are allotted to the Miscellaneous Felling Series for Gewa. This area, which is away from the established markets for Gewa, contains a high percentage of site quality 3 and 4 areas. At present there is little demand for this produce. It should, however, be used to meet local demand, if any, and the requirement of industries that may develop in future. All trees in the 5" inch dbh class and above may be cut. The cutting cycle will be 20 years.

158. **The Yield**—The Yield has been prescribed by area. While prescribing annual coupes, the site quality and density of stocking have been considered and the areas of the different years coupes have been determined to equalise the volume yield as far as possible.

159. **Calculations of Annual Cut by Volume**—The allowable annual cut calculations are based on stand table projections (Appendix 17 of Inventory Report).

Standing mature timber volume (5" inches dbh. class and over to a 4" inches top DIB) and growth rates.

Block.	Area.	Total volume MM. cubic feet.	Average annual growth during 2nd cutting cycle cft./acre.
7	75,090	5.88	5.2
8	75,330	6.85	7.7
	150,420	12.73 weighted average.	6.4

Allowable cut = Present standing mature volume + $\frac{1}{2}$ growth during period.

Allowable cut = $12.73 + \frac{3.2 \times 20 \times 150420}{2 \times 1MM.}$ acres

$2 \times 1MM.$

$= 12.73 + 4.80 = 17.53$ MM cu.ft.

Allowable annual cut = $\frac{17.53}{20} = .89$ MM. cu. ft.

160. During the first cutting cycle, that is before any release effect from cutting is achieved, it is estimated that growth rates will be one-half of those shown above. These reduced rates are used for allowable cut calculations for the first cutting cycle.

161. **Sequence of Fellings**—Annual coupes for the period of the plan are listed in the table below—

GEWA WORKING CIRCLE.

FELLING SERIES III—MISCELLANEOUS FELLING SERIES.

Year.	Compartment.	Area.	Description.
1961-62 and 1962-63 ...	...	...	Working according to previous scheme.
1963-64 ...	48	8100	Northern portion.
1964-65 ...	48	8100	South of 1963-64 coupe.

Year.	Compartment.	Area.	Description.
1965-66	...	48	3270 Balance.
		50	5400 Northern portion.
1966-67	...	50	8600 South of 1965-66 coupe.
1967-68	...	50	4890 Balance.
		49	4800 Northern portion.
1968-69	...	49	8600 South of 1967-68 coupe.
1969-70	...	49	8600
1970-71	...	49	5105 Balance.
		51	4000 Northern portion.
1971-72	...	51	9000
1972-73	...	51	9000
1973-74	...	51	1835 Balance.
		53	7200 Northern portion.
1974-75	...	53	9000
1975-76	...	53	3725 Balance.
		54	5300 Northern portion.
1976-77	...	54	9200
1977-78	...	54	9200
1978-79	...	54	11070 Balance.
1979-80	...	55	14000 Southern portion.

162. **Marking and Felling Rules**—Coupes should be divided into sections of convenient sizes and disposal may be by auction or permit system or any other method as found suitable.

163. **Application of the Volume Check**—At present there is little demand of Gewa from the area covered by this felling series and full yield is not expected to be realised in next few years till new markets are established. Adjustment of areas of annual coupes by 500 acres is permissible by the Divisional Forest Officer.

CHAPTER III.

WORKING PLAN FOR THE SUNDRI WORKING CIRCLE.

164. **General Constitution**—The Working Circle comprises the whole of the Sundarban Forest in Khulna district.

165. **Character of Vegetation**—The forests have been described in Part I, Chapter II.

166. **Analysis and Value of the Crop**—The total land area covered by this Working Circle is 1,006,060 acres of which 939,829 acres are productive forest land. Except for 3,030 acres of immature stands, the total productive acreage is exploitable. 66,240 acres are unproductive being mainly char land and new accretions.

167. The total net merchantable volume of Sundri contained in trees over 10.5", 8.5" and 6.5" inches diameter at breast height for site qualities 1, 2 and 3 respectively to a 4" inches top diameter (inside bark) utilization standard is 107,231,000 cubic feet. A statement showing the mature growing stock by blocks and site quality classes is given in Appendix XVI.

168. **Object of Management**—Sundri Working Circle is constituted to provide for systematic exploitation of the maximum volume of Sundri on an annual sustained yield basis commensurate with Silvicultural treatment for maintaining and if possible increasing the available volume of Sundri.

169. **Method of Treatment**—The Silvicultural system prescribed for this Working Circle is selection-*cum*-improvement. Exploitable diameter limit varies with variation in the site quality and is as follows (See para. 112):

Site Quality.	Exploitable diameter limit.
1	11" dbh. class and above, <i>i.e.</i> , 10.6" and above.
2	9" dbh. class and above, <i>i.e.</i> , 8.6" and above.
3	7" dbh. class and above, <i>i.e.</i> , 6.6" and above.

170. **Felling Cycle**—Felling Cycle for Sundri Working Circle has been fixed at 20 years. While fixing the felling cycle available increment data, mortality, distribution of number of trees of various size classes in each block and site qualities have been studied and considered. The felling cycle of 20 years has been found to be more suitable than any other shorter or longer felling cycle.

171. Distribution of areas within each felling series is shown in the following statement:

Felling Series.	Cutting Section.	Compartment.	Area.	Total of Cutting Section.
1	2	3	4	5
Sarankhola Felling Series.	North Cuttin Section	1	25,035	
		2	13,645	
		3	14,050	
		11	13,305	
		12B	9,305	
		24	13,100	88,440

Felling Series.	Cutting Section.	Compartment.	Area.	Total of Cutting Section.
1	2	3	4	5
Sarankhola Felling Series.	South Cutting Section	4	15,505	
		5	12,605	
		6	18,670	
		7	27,460	
		8	32,720	
		45	26,000	132,960
Chandpai Felling Series.	North Cutting Section	22	11,455	
		23	9,240	
		25	10,925	
		26	9,350	
		27	9,505	
		28	9,810	
		29	10,680	
		30	12,420	
		31	15,440	98,825
		South Cutting Section	9	32,030
	10		15,020	
	12A		5,375	
	13		13,760	
		14	10,345	
	15	13,685		
	21	11,360	101,575	

Felling Series.	Cutting Section.	Compartment.	Area.	Total of Cutting Section.		
1	2	3	4	5		
Nalianala Series.	Felling East Cutting Section	16	15,675			
		17	18,770			
		18	30,540			
		32	13,385			
		33	12,115			
		34	12,825			
		39	14,955	118,265		
			West Cutting Section	19	19,245	
				20	19,040	
				35	15,810	
		36	17,450			
		37	14,275			
		38	16,460			
		40	10,090	211,370		
Burigoalini Series.	Felling --	41	18,210			
		42	18,890			
		43	27,350			
		44	23,680			
		46	27,710			
		50A	4,665			
		51A	8,455			
		52	29,485	158,445		

Felling Series.	Cutting Section.	Compartment.	Area.	Total of Cutting Section.	
1	2	3	4	5	
Kadamtala Series.	North Cutting Section.	47	24,830		
		48	19,470		
		49	27,105		
		50B	14,225		
			51B	15,390	101,020
	South Cutting Section.	53	19,925		
		54	34,770		
		55	39,465	94,160	

172. **The Yield**—It is not practicable to control the yield by volume only as the yield will consist of—

- (i) Outturn from Sundri and of above exploitable diameter.
- (ii) Outturn from thinnings.
- (iii) Outturn from species other than Sundri.

It is not possible to forecast accurately the outturn from items (ii) and (iii). Therefore, the yield has been prescribed by area. The areas for each year's coupes have been listed in Paragraphs 177 to 185. While prescribing annual coupes the areas have been fixed so as to equalise the volume yield as far as possible.

173. The estimated annual outturn of Sundri is calculated below on the basis of total net merchantable volume of and above the exploitable diameter and increment during the felling cycle. Total standing mature volume of and above exploitable diameter up to 4" inches top DIB has been calculated from Volume II of the Inventory Report and the details have been shown in Appendix XII. It appears from Volume II of the Inventory Report that there is very little exploitable Sundri in Blocks 7 and 8. Therefore, the calculations below have been based on data from Blocks 1 to 6.

Area containing mature timber in acres Blocks 1 to 6.	Timber volume in trees of and above exploitable diameter limit to 4" inches top DIB.	Average annual growth during 2nd cutting cycle. cft. per acre (Appendix 18 of Inventory Report).
726,080	10,72,31,044	10.2

During the first cutting cycle, that is before any release effect from cutting is achieved, it is estimated that growth rates will be one-half of the growth rate shown above for the second cycle.

$$\begin{aligned}
 \text{Allowable cut} &= \text{Present standing mature volume} + \frac{1}{2} \text{ growth during the period.} \\
 &= 107.23 \text{ M} + \frac{5.1 \times 20 \times 726.080}{2 \times 1 \text{ M}} \\
 &= 107.23 + 37.03 \\
 &= 144.26 \\
 \text{Allowable annual cut} &= \frac{144.26}{20} = 7.21 \text{ MM.cu. ft. of mature Sundri.}
 \end{aligned}$$

Marking and Felling Rules.

174. **Main Felling**—(i) The annual coupes prescribed for each cutting section have been listed in paragraphs 177 to 185. Each coupe will be divided into sections of approximately 40 acres each by making north-south and east-west lines 20 chains apart. The lines should be surveyed and chained accurately and at the end of each chain a stick should be placed with the number of the chain painted on it. With the aid of these lines, the coupe will be mapped on a scale 4"=1 mile. The course of the small Khals will be shown on this map.

(ii) All trees of and above the exploitable diameter limit should be marked for felling in accordance with provisions in (iii).

Allotment of areas under different quality classes has been given in Appendix XVII as a guide to the marking officer. Detailed break down of areas in each compartment according to quality class of the locality and species composition has been shown in the stock map of each compartment.

(iii) Marking of group of trees in one place and the enlargement of an existing blank are to be avoided, except where regeneration has been established. This rule does not place an embargo on the marking of single, large and spreading trees which, inevitably will cause a blank when felled. Diseased trees should be marked for felling.

(iv) Felling of one arm of a forked tree should be avoided as the remaining arm generally becomes unsound.

(v) List of trees marked should be prepared according to 1 inch diameter classes.

175. **Improvement Felling**—(i) Improvement Fellings will consist of removal of dead, dying and unsound stems and thinning in congested crop. The forests of Sundarban are being managed under the selection system which necessitates maintenance of all age gradations in right proportions in every bit of the area. Thinning in such cases is, therefore, a complicated operation and different from the conception of thinning in forests managed under uniform system. It is difficult to lay down hard and fast rules for marking officer for thinning and much will count on his skill and judgment. Thinning will automatically be done by the removal of the mature trees in main felling and the dead trees. Improvement felling will only consist of removal of those trees which are

directly interfering with the growth of another or a group of better stems. Before deciding removal of a stem in thinning it has to be considered whether sufficient number of stems including possible mortality will remain for future fellings. Passur, Dhundal, Kankra and Baen occur mixed with Sundri and Gewa in different proportions according to locality. All these species have demand and it is necessary to maintain them in proper proportion. Therefore, a tree of any of these species should not be sacrificed in thinning for a Sundri.

(ii) For facility of work and convenience of sale, thinning marking upto certain diameter limit should be done with marking for mature trees. As demand for posts and poles vary in different localities, the minimum diameter limit upto which marking will be done in each coupe will be decided by the Divisional Forest Officer from time to time. In most coupes, marking may be done upto 6" dbh for auction lots. It should, however, be clearly understood that marking below the exploitable diameter limit is a purely thinning operation for improvement of the remaining crop and for maintenance of correct balance among the various diameter classes.

176. Coupe rules—(i) Coupes and sections should be laid out as described in paragraph 174(i).

(ii) The main felling operations consisting of removal of trees marked above exploitable diameter and thinning operations in trees having timber sizes, will be carried out during the year in which the coupe is prescribed to be worked as shown in paragraphs 177 to 185.

(iii) After the sections are worked for main felling, subsidiary felling for fuel by thinning should be started. Procedure, here will be the felling of marked stems by issue of permits and felling will closely follow marking. For better control of the operation only part of the coupes should be opened for subsidiary felling at a time and after work in this portion is completed, work should be started in the next portion. What area will be opened at a time will be decided by the Divisional Forest Officer according to demand and availability of staff. Marking should be completed first before permit holders are allowed to start work.

(iv) In order to prevent theft each section should be marked with a hammer dissimilar to that used in the adjoining sections. Similarly, different hammers should be used in thinning marking for subsidiary felling in different areas.

(v) After completion of main felling and subsidiary felling in a coupe, it should be opened for removal of brushwood and dry fuelwood. For better control, this also should be done in patches instead of allowing work in the whole coupe at a time.

(vi) Fellings should be confined to coupes only except when it is absolutely necessary for allowing for Jhools to boats for Golpatta or other minor produce. Jhools should be selected by thinning only.

(vii) Attempts should be made to complete works in a coupe in two years but work in a coupe should not linger more than three years.

**SEQUENCE OF FELLING
SUNDRI WORKING CIRCLE.**

Sarankhola Felling Series.

177. Sarankhola North Cutting Section--

Year.	Compartment.	Area.	Description.
1960-61..	1	2,403	
	2	1,379	
1961-62..	2	3,782	
1962-63	2	4,140	South of 1961-62 coupe.
1963-64	2	4,350	Balance.
1964-65	12B	4,100	North-Eastern Portion.
1965-66	12B	4,100	South of 1964-65 coupe.
1966-67	12B	1,105	Balance.
	11	3,000	Northern Part.
1967-68	11	4,100	South of 1966-67 coupe.
1968-69	11	4,100	
1969-70	11	2,105	Balance.
	3	3,050	North-Western Part.
1970-71	3	4,200	South-Western part.
1971-72	3	4,200	
1972-73	3	3,600	Balance.
	1	3,800	Southern part includes about 300 acres of non-Sundri area.
1973-74	1	4,250	North of 1972-73 coupe.
1974-75	1	4,250	
1975-76	1	4,250	
1976-77	1	4,250	
1977-78	1	4,235	
1978-79	24	4,400	Northern part.
1979-80	24	4,350	South of 1978-79 coupe.
1980-81	24	4,350	South of 1979-80 coupe.

SUNDRI WORKING CIRCLE—*Contd.*Sarankhola Felling Series.—*Concl'd.*

178. Sarankhola South Cutting Series—

Section

Year.	Compartment.	Area.	Description.
1961-62 and 1962-63	.. ..	..	Work according to previous scheme.
1963-64	.. .. 5	6,300	Northern part.
1964-65	.. .. 5	6,395	Balance.
1965-66	.. .. 6	11,400	Southern portion includes areas covered by Keora and other non-Productive forest.
1966-67	.. .. 6	6,200	
1967-68	.. .. 6	1,070	Balance.
		4	5,150 Southern portion.
1968-69	.. .. 4	6,200	
1969-70	.. .. 4	4,155	Balance northern portion.
		7	2,300 Northern portion.
1970-71	.. .. 7	6,300	South of 1968-69 coupe.
1971-72	.. .. 7	6,300	
1972-73	.. .. 7	6,300	
1973-74	.. .. 7	6,260	Includes 800 acres of Keora and other non-Productive area in the southern side.
		8	1,500 Southern portion.
1974-75	.. .. 45	7,000	Southern portion.
1975-76	.. .. 45	6,300	
1976-77	.. .. 45	6,300	
1977-78	.. .. 45	6,400	
1978-79	.. .. 8	6,700	North of the area in coupe of 1972-73.
1979-80	.. .. 8	6,300	

SUNDRI WORKING CIRCLE—*Contd.*

Chandpai Felling Series.

179. North Cutting Section—

Year.	Compartment.	Area (acres).	Description.
1960-61	...	27	2,756
	...	28	5,574
1961-62	...	25	3,845
	...	28	4,485
1962-63	...	25	6,989
	...	26	1,341
1963-64	...	31	4,900 Northern portion.
1964-65	...	31	4,900 South of 1963-64 coupe.
1965-66	...	31	4,900
1966-67	...	31	740 Balance.
	...	30	4,200 Northern portion.
1967-68	...	30	4,900 South of 1966-67 coupe.
1968-69	...	30	3,320 Balance.
	...	29	1,600 Northern portion.
1969-70	...	29	4,900 South of 1968-69 coupe.
1970-71	...	29	4,180 Balance.
	...	22	800 South portion.
1971-72	...	22	4,900 North of 1970-71 area.
1972-73	...	22	4,900
1973-74	...	22	855 Balance.
	...	23	4,200
1974-75	...	23	5,040
1975-76	...	26	4,900 Southern portion.
1976-77	...	26	4,450 Balance.
	...	25	450 Southern portion.
1977-78	...	25	4,900 North of 1976-77 area.
1978-79	...	25	4,900
1979-80	...	25	675 Balance.
	...	27	4,300 Western portion.

SUNDRI WORKING CIRCLE—*Contd.*Chandpai Felling Series—*Concl'd.*

180. South Cutting Section—

Year.	Compartment.	Area (acres).	Description.
1960-61
1961-62	...	9	9,563
1962-63	...	9	9,563
1963-64	...	9	5,000 North of 1962-63 coupe.
1964-65	...	9	5,000
1965-66	...	9	2,900 Balance.
		10	1,850 Southern portion.
1966-67	...	10	4,600
1967-68	...	10	4,600
1968-69	...	10	3,970 Balance.
		15	600 Southern portion.
1969-70	...	15	4,450
1970-71	...	15	4,450
1971-72	...	15	4,185 Balance.
		21	300 Western portion.
1972-73	...	21	4,450
1973-74	...	21	4,450
1974-75	...	21	2,160 Balance.
		14	2,300 Western portion.
1975-76	...	14	4,450
1976-77	...	14	3,597 Balance.
		13	900 Northern portion.
1977-78	...	13	4,450
1978-79	...	13	4,450
1979-80	...	13	3,960
		12	600 Northern portion.

SUNDRI WORKING CIRCLE—*Contd.*

Nalianala Felling Series.

181. East Cutting Section—

Year.	Compartment.	Area (acres).	Description.
1960-61	...	33	3,227
1961-62	...	33	1,827
	...	34	2,400
1962-63	...	34	3,227
1963-64	...	34	6,000 South of 1962-63 coupe.
1964-65	...	34	1,200 Balance.
	...	39	4,800
1965-66	...	39	6,000
1966-67	...	39	4,155
	...	16	1,700 Balance.
1967-68	...	16	5,800
1968-69	...	16	6,000
1969-70	...	16	2,175 Balance.
	...	17	3,800
1970-71	...	17	6,000
1971-72	...	17	6,000
1972-73	...	17	2,970 Balance.
	...	18	3,000
1973-74	...	18	6,000
1974-75	...	18	6,000
1975-76	...	18	6,000
1976-77	...	18	6,000
1977-78	...	18	3,540 Balance.
	...	32	2,100
1978-79	...	32	5,640
1979-80	...	32	5,645 Balance.

SUNDRI WORKING CIRCLE—*Contd.*Nalianala Felling Series—*Concl'd.*

182. West Cutting Section—

Year.	Compartment.	Area (acres).	Description.
1960-61	...	35	2,840
		40	414
1961-62	...	35	3,254
1962-63	...	35	3,254
1963-64	...	35	5,452
1964-65	...	35	1,000 Balance area.
		36	4,600 Northern portion.
1965-66	...	36	5,600
1966-67	...	36	5,600
1967-68	...	36	1,650 Balance area.
		37	4,00 Northern portion.
1968-69	...	37	5,600
1969-70	...	37	4,675 Balance area.
		38	1,200
1970-71	...	38	5,700
1971-72	...	38	5,800
1972-73	...	38	3,760 Balance area.
		19	2,300
1973-74	...	19	6,500
1974-75	...	19	6,500
1975-76	...	19	3,945 Balance area.
		20	2,700
1976-77	...	20	6,600
1977-78	...	20	6,700
1978-79	...	20	3,040 Balance.
		40	3,500
1979-80	...	40	6,590 Balance area.

SUNDRI WORKING CIRCLE—Contd.

Burigoalini Felling Series

183.....

Year.	Compartment.	Area (acres).	Description.
1960-61	.. .. 41	7,457	
	.. .. 44	3,333	
1961-62	.. .. 41	4,236	
	.. .. 42	3,221	
	.. .. 44	3,333	
1962-63	.. .. 42	7,457	
	.. .. 44	3,333	
1963-64	.. .. 44	8,800	Adjacent to 1962-63 coupe.
1964-65	.. .. 44	4,880	North of 1963-64 coupe.
	.. .. 43	3,800	
1965-66	.. .. 43	8,600	
1966-67	.. .. 43	8,600	
1967-68	.. .. 43	6,350	Balance.
	.. .. 42	2,450	
1968-69	.. .. 42	8,800	
1969-70	.. .. 42	7,640	Balance.
	.. .. 41	1,110	
1970-71	.. .. 41	8,800	
1971-72	.. .. 41	8,300	Balance.
	.. .. 46	400	Northern portion.
1972-73	.. .. 46	8,600	
1973-74	.. .. 46	8,600	
1974-75	.. .. 46	8,600	
1975-76	.. .. 46	1,510	Balance.
	.. .. 50A	4,665	
	.. .. 51A	2,500	
1976-77	.. .. 51A	5,955	Balance.
	.. .. 52	1,800	
1977-78	.. .. 52	8,500	
1978-79	.. .. 52	9,595	
1979-80	.. .. 52	9,590	Balance area.

SUNDRI WORKING CIRCLE—*Contd.*

Kadamtala Felling Series.

184. North Cutting Section—

Year.	Compartment.	Area (acres).	Description.
1960-61	..	47	1,436
1961-62	..	47	1,436
1962-63	..	47	1,436
1963-64	..	47	4,800 South of Jhingabaria Khal.
1964-65	..	47	4,900 Southern portion of the compartment.
1965-66	..	47	4,700 North of 1964-65 coupe.
1966-67	..	47	4,686 Balance portion of the compartment.
1967-68	..	48	5,100 Northern portion.
1968-69	..	48	5,100
1969-70	..	48	5,100
1970-71	..	48	4,170
		49	850
1971-72	..	49	5,250
1972-73	..	49	5,250
1973-74	..	49	5,250
1974-75	..	49	5,250
1975-76	..	49	5,255
1976-77	..	51B	5,100
1977-78	..	51B	5,150
1978-79	..	51B	5,140
1979-80	..	50B	5,050

SUNDRI WORKING CIRCLE—*Concl'd.*Kadamtala Felling Series—*Concl'd.*

185. South Cutting Section—

Year.	Compartment.	Area (acres).	Description.
1960-61	53	6,350	
1961-62	53	6,350	
1962-63	53	6,350	
1963-64	53	875	Balance.
	54	2,900	Northern part.
1964-65	54	3,600	South of 1963-64 coupe.
1965-66	54	3,600	
1966-67	54	3,600	
1967-68	54	3,600	
1968-69	54	4,000	
1969-70	54	4,500	
1970-71	54	4,500	
1971-72	54	4,470	
1972-73	55	5,100	Southern portion.
1973-74	55	5,100	
1974-75	55	5,100	
1975-76	55	4,965	
1976-77	55	4,800	
1977-78	55	4,800	
1978-79	55	4,800	
1979-80	55	4,800	

186. Regulation of the Yield—The permissible annual outturn from Sundri of and above exploitable diameter upto a utilization standard of 4 inches top DIB has been calculated in paragraph 173. In addition to this there will be timber and fuelwood from thinnings and other species like Passur, Kankra, Baen, Amur, Dhundal, Goran, etc. It is not possible to forecast annual outturn from thinnings and other species. Therefore, a volume check on a prescribed volume yield will not be practicable. The yield has been prescribed by area, *vide* paragraph 172 and annual area for each year's coupe has been prescribed in paragraphs 177 to 185. Adjustment of areas of annual coupes for the purpose of equalising annual outturn and regularity of coupe boundaries by *plus* or *minus* 300 acres in each coupe by the Divisional Forest Officer is permissible.

CHAPTER IV

WORKING PLAN FOR THE KEORA WORKING CIRCLE

187. **General Constitution**—The Keora Working Circle comprises the patches of Keora forest scattered throughout the Sundarban. Patches which are very small in extent and located far away from other bigger patches have not been included in this Working Circle. The list of areas included in this Working Circle is given below. Areas have been calculated by using an acre-grid on 2"=1 mile maps of each patch. The volume content has been calculated by using per acre figure from Appendix 14 of the Inventory Report.

Compartment.	Area of Keora patch (acres.)	Net merchantable volume 9" dia. class and over with 4" top DIB utilization standard.	Remarks.
		Cft.	
1	3,120	19,17,550	On the South of the compartment, along the banks of Baleswar and Bhola rivers.
3	310	1,21,210	On the island on the North of the compartment in Dudhmukhi gang.
4	210	2,04,320	On the North of the compartment along the Chorabetmore khal.
6	1,910	26,09,800	On the South of the compartment along the Bay below Kochi khal and Chapra khal and on Katka Island.
7	1,545	16,72,222	On the South of the compartment along banks of Betmar gnag and Kapra khal.
8	1,075	5,00,710	In three patches—one on the North of the compartment along bank of Jafagang, the 2nd patch on north-east corner of compartment along west bank of Selagang near the confluence of Selagang and Bara Sialagang, the 3rd patch is on the south-east corner of the compartment along Bhangra river.
17	655	1,42,895	On the island on the Mardat gang and narrow strip along banks of Mardat.
40	360	5,65,600	On the north-east side of the compartment along bank of Sipsa river.
43	1,955	9,44,155	On the north and west sides of the island between Barapangar river and Khajuri khal, also a narrow strip along banks of Sejkhali.

Compartment.	Area of Keora patch in acres.	Net merchantable volume 9" dia. class and over with 4" top DIB utilization standard.	Remarks.
44	2,575	Cft. 21,47,135	On the southern part of the compartment.
45	2,290	16,36,590	On the Dubla and Tinkonia island.
47	150	83,410	Along banks of Chunkurir khal on the south of the compartment.
50	110	1,13,290	Along bank of Chunkurir khal on the north of the compartment.
54	1,370	8,58,363	On the east of the compartment on Chars lying both north of the mouth of Chandbari khal.
55	390	57,320	On the south-west corner of the compartment along bank of Harinbhanga river.

188. As operations in this Working Circle proceed and the overmature Keora is removed the cut over areas will be withdrawn from the Keora Working Circle and will form part of the Sundri Working Circle and the Gewa Working Circle only. These two working circles cover the whole of the Sundarban forests. New lands formed on which Keora is the pioneer species will be added to the working circle as necessary. This procedure should maintain the area and volume of Keora at or near its present level.

189. **Character of Vegetation**—Keora occurs as a pioneer species on the newly formed muddy lands and islands. The species grows as a pure crop or scattered trees as a nurse crop for Sundri and Gewa. The growth rate is comperately faster than other species. Keora is one of the biggest trees in the Sundarban forests reaching a height of about 100 feet and diameter of 36 inches under optimum conditions. But the trees start developing rot and die out as soon as they reach maturity.

190. **Analysis and Valuation of the Crop**—Area of forest covered by Keora included in this Working Circle is 18,025 acres. The total net merchantable volume of Keora contained in trees of 9" inches diameter class and over is 13,577,672 cft. with a utilization standard of 4" DIB.

191. **Object of Management**—The Keora Working Circle is constituted in order to (1) exploit the over mature as early as possible before they pass out of the stand due to rot and other defects. (2) prescribe specific rules for systematic exploitation of Keora to realise the maximum sustained yield. (3) Prescribe silvicultural measures for maintaining and tending of the crop.

192. **Method of Treatment**—The method of treatment will vary depending on the type of Keora stand and condition of crop. There are two distinct types of Keora stand in the areas allocated to this Working Circle. There are areas containing a pure fully stocked more or less even aged Keora as a pioneer species on newly formed land. These stands have little or no under-storey. The other type of stand is one which has attained maturity and contains an understorey of Sundri, Gewa or Goran which in many cases is well established.

193. In the second type described above the better trees of larger sizes have been cut over during past working and the remaining trees are generally badly shaped and defective, waiting for the complete removal to allow better growth to the understorey of higher potential value.

194. Therefore, the method of treatment prescribed is—

- (1) Selection system with exploitation diameter limit of 12" and over in pure Keora stands and removal of dead and dying trees in the same area.
- (2) Clearfelling of the Korea in stands where there is well established understorey of Sundri, Gewa or Goran.

195. **Rotation**—Enough data are not available to work out an accurate rotation age for Keora. Mr. Curtis works out the growth of 27" inches diameter in about 70 years and it is mentioned in the Inventory Report that Keora can attain a diameter of about 36" inches in 80 years. For a conservative estimate of volume yield a rotation of 80 years has been assumed.

196. **Yield**—The total net merchantable volume contained in the areas allotted in this Working Circle in trees of 9" diameter class and over is 13,577,672 cu. ft. The yield is calculated according to Von Mantel's formula $\frac{2 \times G}{R}$ where G is the growing stock and R is the rotation.

$$\text{Yield} = \frac{2 \times 13,577,672}{80} = 339,500 \text{ cu. ft. annually.}$$

197. The yield has been calculated on the basis of growing stock of 9" inches dbh class and over, but the exploitable diameter limit has been prescribed at 12" inches dbh class. Observations in the field indicate that bulk of the mature stand is composed of trees over 12" inches dbh. class and any reduction of the yield from the selected areas by using 12" inches dbh class will be compensated by the additional volume obtained from trees of lower diameter classes obtained from clearfelling areas. However, for safety the annual yield is fixed at 300,000 cu. ft.

198. **Sequence of Felling**—It is not considered advisable at this time to prescribe a geographical and chronological sequence for felling for 20 years. This should be left to the Divisional Forest Officer, who should allocate each years operational area to ensure that cutting is carried out in areas based on silvicultural desirability. Cutting for the period 1961-62 to 1965-66 should be following:—

Year.	Compartment.	Volume. Cft.
1961-62	... 1 & 3	240,000
1962-63	... 4 & 7	300,000
1963-64	... 6	300,000
1964-65	... 45	300,000
1965-66	... 43 & 54	300,000

After the expiry of first five years, the Working Plans Officer will allocate areas for next five years' working.

199. **Regulation of the Yield**—Control in this Working Circle should be on a volume extracted basis rather than on area check. Scaling and stamping of logs on the khal banks together with a damage appraisal for merchantable material left in the forest should ensure maximum utilization of this species.

CHAPTER V

MISCELLANEOUS PRESCRIPTIONS

* PASSUR, BAEN, DHUNDAL AND KANKRA.

200. Passur, Baen, Dhundal and Kankra are timber species which come in importance after, Sundri and Gewa. These should be worked in annual coupes prescribed for Sundri Working Circle in paragraphs 177 to 185 and according to diameter limit selection prescribed in paragraph 113. Thinnings should be carried out in the same manner as prescribed for Sundri in paragraph 175.

GORAN.

201. **General Description**—Goran is a species of small coppice like growth, but it is valuable for use as small house posts, fencing, sticks, and fuel wood. The bark of Goran is rich in tanning and investigation is in progress to find out feasibility of establishing a tanning extraction factory from Goran bark. Large quantity of Goran bark is used locally for painting fishing nets by Goran-bark-tanning. Most of the Goran is available in the third quality forest of blocks 7 and 8 and in the sea face and more saline areas in other blocks.

202. Extraction of Goran will be confined to annual coupes in Sundri Working Circle. There will be three stages in extraction of Goran, namely (a) felling for Goran poles by selection, (b) this will be followed by fellings of ordinary Goran, and finally (c) fuel felling which will consist of thinning congested crop. Fuel felling also includes removal of all tops and branches left in the forest in various stages of cutting.

203. Selected Goran poles will be those sticks above 1" inch diameter at the point just above the butt swelling and which will yield a post of over 5 feet length. All other Goran sticks will be considered as ordinary Goran, locally known as khadi.

204. **Coupe and Felling Rules**—(1) Felling for poles and ordinary Goran as described in (a) and (b) above should be completed during the period between completion of marking for Sundri and other species and felling of the marked trees so that Goran fuel working may coincide with the subsidiary fellings in the coupe in general.

(2) In the extraction of Goran it must be seen that at least one shoot is left in each bunch. Except where absolutely unavoidable, wood cutters should not be allowed to cut young withes merely to facilitate felling of the selected shoot and not for actual utilization.

(3) For facility of management, fellings should be localised as far as practicable. Purchasers should not be allowed to cut anywhere they choose within the coupe but only in the particular selection or khal allotted to them.

(4) Marking before Felling is neither practicable nor necessary. The coupe staff should be able to supervise and enforce the few felling rules, prescribed.

(5) Other species utilizable in small sizes which will be exploited along with Goran in the annual coupes, are Amur, Singra, Khalsi, Kipra, Mathgoran and Tora. Singra over 5" inches diameter should be pollarded to produce more number of sticks for fuel for future.

GOLPATTA

205. **Growing Stock**—Sale of leaves of Golpatta is responsible for a substantial amount of revenue of the Division and it provides for a widely used material for thatching. The method of extraction, conservation and regeneration have been standardised to a large extent in the past several years. Demand of the material is increasing and it is of utmost importance that the few rules prescribed for regulating felling of Golpatta be observed strictly in order that the maximum outturn may be realised without deteriorating the growing stock.

206. **Felling Rules**—(1) Exploitation should not be allowed in any area more than once in a year and cutting of Golpatta should not be allowed during the month of June, July, August and September which is the growing period.

(2) The unopened "frond", *i.e.*, the so called "Central leaf" and the leaf next to it in each clump must be retained.

(3) All dead and dry leaves will be cut at the time of cleaning the clumps.

(4) Flowers and fruits should in no way be disturbed at the time of cutting leaves.

(5) Sample plots must not be disturbed.

(6) Purchasers must not be allowed to cut leaves which they do not intend to utilize but leave on the ground to rot. In this way the maximum leaf surface possible will be left on the rhizome after it has been cut over and thus maximum energy will be left in the plant.

(7) Young plants with only one utilizable leaf should not be cut.

207. **Coupe Rules**—(1) Though Golpatta will be worked annually all over the forest, for facility of management, seven coupes by names of rivers have been prescribed. The main work of the coupe staff will be to see that felling rules are observed and that no Golpatta in the interior is left unworked before the coupes move on. Each purchaser will be allotted a khal or part of it to work in and should not be allowed to move on into a fresh area until the area already allotted to him is worked over completely.

(2) Areas towards the sea face should be worked over during the calm season.

(3) As they travel over the forests, coupe staff will prepare stock maps on a 2 inches to one mile scale in each compartment. Sufficient number of copies should be prepared for maintaining records in Divisional Office and Range Office. Approximate outturn, in maundage, will be noted against each khal on the map.

(4) All Jhools, tharias, dabas, masts and mallums, etc., which are felled for using in Golpatta boats should be hammer-marked before felling and the outturn should be recorded against the outturn of the compartment from which timber is felled. Permit for felling for Jhools, tharias, dabas, etc., should be allowed from the annual coupes as far as possible and permits from areas outside the coupes may only be allowed sparingly when the coupe is not within a reasonable distance from the working area for Golpatta. When such permits are allowed felling should be by way of thinning and should be under close supervision and the choice of species should be with the coupe staff.

208. Coupes and Sequence of Fellings—

Coupes.	Sequence.
1. Supati Bhola	.. Compartments—7B, 6, 5, 4, 3, 2, 1, and 24.
2. Sela	.. Compartments—7A, 9B, 10B, 11, 12, 14, 13, 23, 25, 26, 28 and 27.
3. Chandpai	.. Compartments—45, 8, 9A, 10A, 15, 21 and 22.
4. Sipsa	.. Compartments—14, 10A, 19B, 20, 38, 40 and 35.
5. Aura-Sipsa	.. Compartments—43, 18B, 19B, 42, 37 and 36.
6. Bhadra	.. Compartments—17B, 16, 39, 34, 33, 32, 31, 30 and 29.
7. Satkhira	.. Compartments—54, 55, 53, 52, 51, 49, 48, 47, 46, 50A and 50B.

209. The above sequence of felling within each coupe is prescribed for convenience of the Divisional Forest Officer. He may modify this sequence in any year if required for facility of work or administrative reasons.

HONEY AND WAX.

210. Permits for collection of honey and wax are to be issued only from April 1 to June 15 each year. Sanctuary for bees, should not be disturbed. It is not necessary to establish permanent sanctuaries. Each year the Divisional Forest Officer will choose one compartment in each Range to form sanctuaries for bees. Permits for collection of honey and wax may be issued from any Revenue Station or coupe office.

OTHER MINOR PRODUCE.

211. Permit for collection of Hantal, Cane, Grasses, Shells and other kinds of minor produce may be issued without restriction on payment of royalty. Bhola may be treated as minor produce and the exploitation of the species for fuel or for any other purpose may be permitted without restriction on payment of royalty.

FISHING.

212. Large number of fishermen enter the forests all through the year for fishing. It is necessary to keep a watch on these people so that persons other than actual fishermen do not enter the forest for game poaching, stealing trees or other forest produce or even for robbery which occur occasionally. The fishermen certainly use firewood while inside the forest, Goran bark for tanning fishing nets and Golpatta for thatching boat-roof. It is, therefore, necessary that the existing arrangement of realising fishing toll and royalty on fish brought out be continued.

GAME SANCTUARY.

213. There is a scheme under execution for establishment of Game Sanctuary covering the area in compartments 3, 4, 5, 6 and 7. The Conservator of Forests may order modification of certain prescriptions in those localities in any year if required for proper execution of this scheme.

DRIFT WOOD.

214. Drift wood and trees which have fallen as a consequence of erosion of the river banks may be removed from any part of the forest.

FELLING FOR DEPARTMENTAL PURPOSE.

215. Felling of trees or collection of any other produce for departmental use within the Division or for the purpose of research and experiment may be done at the discretion of the Divisional Forest Officer in any part of the forest. But, all attempts should be made to collect the materials from a coupe of the year as far as possible.

CHAPTER VI

RESEARCH AND EXPERIMENT

216. The demand and supply structure so far as it relates to the forest produce of Sundarban, has considerably changed during the last decade or so. The demand for fuel, timber and industrial raw materials has tremendously increased. Therefore, research is desperately needed to find out conditions under which optimum production can be achieved.

217. The objectives for research and laying out sample plots should be examined *denovo* and the scope of study should be much more widened than what was considered suitable in olden days. The Central Silviculturist has already recommended closing down of some of the existing plots which may not serve the purpose needed under the present day conditions.

218. Under the agreement with Government, the Pakistan Industrial Development Corporation which consumes maximum quantity of Gewa wood, one of the major species, has undertaken, should it be necessary, "to develop the growth of plantations, execute silvicultural experiments and develop appropriate cutting system for Gewa Wood and other Pulpwood species, in accordance with the approved Working Plans and Felling Plans" (of: clause 5 (i) of the agreement between the Government of East Pakistan and the Pakistan Industrial Development Corporation, Appendix XIV). There are, therefore, enough scope of co-ordinating departmental research planning and that of the consuming interests.

219. While it is conceded that the research programme in Sundarban would be varied and cannot, therefore, be strictly outlined. It may be useful to enumerate broadly the fields in which the research programme can be based.

(a) *Rate of Growth*—Rate of growth study based on the establishment of permanent sample plots in representative localities of all different site classes need be undertaken for Sundari, Gewa, Keora, Passur, Dhundal, Kankra, Baen and Goran in mixed stand. The objectives for the study will be to determine the most suitable exploitable diameter for the most suitable felling cycle in selection system of management.

(b) *Improvement operations*—Sample plots need be established to determine the most suitable grade and method of thinning required in the forest to induce best growth to the selected species and also to attain the ideal age gradation in the selection forest.

(c) *Mortality*—Mortality at different stages and under different treatment need be studied for future yield projections.

(d) *Regeneration*—Regeneration studies to determine under what conditions seed production, seed dissemination, germination and establishment either as pure or as mixed stand are at an optimum. Regeneration by coppicing should be investigated together with the possibilities of artificial regeneration if and where necessary. The area clearfelled in Kalamula as a Divisional experimental plot for studying effect of clearfelling on regeneration and growth should be taken over by Silvicultural Research Division for systematic records.

(e) *Products Research*—Experiment. ^{to} determine the proportion of Goran bark to wood of the species need be under taken as Goran bark is soon expected to be used for commercial extraction of tannin. Statistics regarding availability of Goran bark should be collected.

220. The above list only contains the items needing immediate study and this list is not, by any means, an exhaustive one. Whenever facilities are available, protection studies to consider the amount of damage caused by deer and other wild animals, insects and by fungi should be under taken. Studies on utilization of the products should be made a continuous process. All the yield calculations in the plan are based on assumption of certain utilization standards. While at the present time, special efforts will be needed to achieve those utilization standards studies should be undertaken to find out more complete utilization of the products.

221. It is left to the Silviculturists to design the experiments and select the sample plots.

CHAPTER VII

ESTABLISHMENT AND LABOUR SUPPLY

221. Sundarban forests contain extremely valuable resources of timber, fuelwood and various other minor produce for local needs as well as raw material for various industries dependent entirely on such produce. There is market for maximum utilization of all products. Therefore, very strict control over feelings and silvicultural improvement operations are needed to ensure perpetuity of supply of the produce. At present, shortage of technical staff is affecting improvement operation in the forest.

223. The function of the staff are four-fold, namely (1) carry out the prescription of the plan and strictly follow silvicultural rules prescribed, (2) protection of forest against theft, (3) superior control with clerical assistance at Divisional Headquarters, and (4) staff for boat and marine fleet. The staff prescribed may appear to be high in comparison with the existing, but this is the minimum that is required to carry out the prescription of the plan and derive additional outturn for improvement in the standard of living in the country. Thus additional revenue will also be realised to enrich the Government exchequer.

224. The following abstract shows the total strength of personnel required. This list does not include the crew for the marine fleet which is according to standard prescribed by Government Marine Superintendent for each unit. The list also does not contain staff for Game Sanctuary which is also according to specific scheme. There is a sanctioned strength of 438 boatmen existing in the Division. The same strength will be required and distribution of boatmen is left with the Divisional Forest Officer according to local need. There is a staff of one senior Ranger, two Deputy Rangers, six Forest Guards, one Orderly and three Boatmen for supervising work of Newsprint Mill Forest Operation. This staff is paid for by the Newsprint Mill and has not been included in this list.

The Divisional Forest Officer may work out his requirement of the marine fleet for efficient management from time to time.

225. Abstract of total staff at Divisional Headquarters and in Ranges and Khulna Station is given separately in the two statements below. A list showing detail distribution of staff proposed is given in Appendix XVIII.

STAFF AT DIVISIONAL HEADQUARTERS.

	Existing.	Proposed.
Divisional Forest Officer	1	1
Additional Divisional Forest Officer	1	1
Subdivisional Forest Officer	...	2
Tour Assistant (Deputy Ranger)	1	1
Head Clerk	1	1
Accountant, Clerks and Typist	16	21
Orderlies	3	5
Peons	2	3
Dakwalla	...	2
Night Guard	...	1
Forest Guard for Dak-cutting	1	1
Sweeper	1	1

226. Abstract of total staff prescribed and existing staff in Ranges, Khulna Station and Dockyard.

Ranges.	Senior Ranger.		Forest Ranger.		Deputy Ranger.		Forester.	
	Exis-ting.	Pro-posed.	Exis-ting.	Pro-posed.	Exis-ting.	Pro-posed.	Exis-ting.	Pro-posed.
1	2	3	4	5	6	7	8	9
1. Sarankhola Range	1	2	4	4	6	10	18
2. Chandpai Range	1	2	4	2	6	10	19
3. Nalianala Range	1	2	4	5	6	15	22
4. Borigolani Range	1	2	2	4	3	7
5. Kadamtala Range	3	..	5	..	12
6. Keora Working Circle	1	..	3
7. Golpatta Coupes	4	7	3	7
8. Khulna Station and Dock- yard.	..	1	1	1	..	2	2	2
9. Fuel Marking	4	4	6	6
10. Tour Assistant to D.F.O.	1	1	..	..
Total	4	8	18	22	42	49	96

Ranges.	Forest Guard.		Carpenter.		Black Smith.		Remarks.
	Exis-ting.	Pro-posed.	Exis-ting.	Pro-posed.	Exis-ting.	Pro-posed.	
1	10	11	12	13	14	15	16
1. Sarankhola Range ..	14	30	..	..	..	..
2. Chandpai Range ..	16	34	..	..	..	..
3. Nalianala Range ..	24	36	..	..	..	..
4. Borigolani Range ..	12	12	..	..	..	..
5. Kadamtala Range ..	..	21	..	..	..	..
6. Keora Working Circle ..	..	4	..	..	..	..
7. Golpatta Coupes ..	7	14	..	..	..	..
8. Khulna Station and Dock- yard.	3	4	3	3	..	1	
9. Fuel Marking ..	..	8	..	..	..	..
10. Tour Assistant to D.F.O.	1	..	..	..	..	..
Total ..	77	163	3	3	..	1	

CHAPTER VIII

FINANCIAL FORECAST

227. The forests under the plan are being worked upto the full capacity and revenue derived should continue to be more or less even in years to come except that it may vary if rates of royalty are changed or if auction values vary according to competition amongst auction purchasers. There is an apprehension of decrease of revenue in future if Silvicultural Improvement Operations as prescribed are not carried out. The revenue is estimated as below—

228. Estimated Revenue—

	Rs.
1. Gewa Working Circle	3,50,000·00
2. Sundri Working Circle—	
(a) From timber of all species	30,00,000·00
(b) From firewood	6,00,000·00
3. Keora Working Circle	60,000·00
4. Golpatta	3,00,000·00
5. Other miscellaneous	1,00,000·00
Total	44,10,000·00
Say	44,00,000·00

229. Expenditure—

B—Conservancy and Works	10,00,000·00
C—Establishment	8,00,000·00
Total	18,00,000·00

Therefore a net surplus of Rs.26,00,000·00 is expected annually.

230. Some launches and boats need replacement and additions to the marine-fleet will also become necessary due to prescribed increase in establishment. The Divisional Forest Officer will work out a phased programme of strengthening the marine fleet. Similar action need also be taken for construction of buildings.

CHAPTER X

235. Summary of Prescriptions—

Paragraph
Number.

Gewa Working Circle.

Method of treatment—The silvicultural system prescribed is selection system 139

Felling Cycle—Felling cycle prescribed is 20 years 112

Division into Felling Series—Three felling series have been prescribed, namely—

I Matchwood Felling Series.

II Newsprint Felling Series.

III Miscellaneous Felling Series 140

Exploitable diameter limit—Exploitable diameter limits vary in the three Felling Series and are as follows:—

<i>Felling Series.</i>	<i>Exploitable diameter limit at breast height.</i>
I	6"
II	4.6"
III	4.6" 14

The Yield—The yield has been prescribed by area, Annual yield by volume 143—145
has been calculated and annual coupes by area have been prescribed in such
a way that calculated volume is extracted annually.

Matchwood felling series.

Method of executing the feelings—Felling and marking rules have been 146
prescribed in details.

Sequence of Fellings—Annual coupes in two cutting sections up to 1979-80 149
have been prescribed.

Newsprint mill felling series.

The Yield—The annual yield has been calculated and fixed at 50,00,000 cft. 153

Marking Rules—Marking rule have been prescribed 154

Sequence of Felling—5 year felling plan given in Appendix-XV .. 155

CHAPTER IX

CONTROL AND MAINTENANCE OF RECORDS

231. **Maps and Records**—The following books and maps should be maintained in order that all necessary and useful information may be easily available:—

232. (a) **Maps**—A set of maps for the whole of the forest in scale of 2 inches to one mile in 15 sheets have been prepared and sufficient copies have been printed. These maps form the Atlas for the Division. These maps have shown in them block boundaries compartment boundaries, forest type classification and many other useful information. These maps should be kept up-to-date by inserting location of stations, boundary-pillars, etc. One set of these maps should be maintained as a permanent record showing progress of works in coupes in each year. A set of stock map in scale 2 inches to one mile for each compartment has also been prepared. As work in any compartment is completed the stock maps for that area should also be revised and kept as a permanent record in a running flat file.

(b) **Coupe-maps**—Annual coupe maps with section lines should be maintained in 4 inches to one mile map. Quality class of the locality should be shown on this map.

233. The following Registers and forms should be maintained—

(a) Marking Register C. F. form No. 14.

(b) Compartment description.

(c) Compartment outturn.

(d) Compartment history.

234. **Control Forms**—The following prescriptions are subject to Control:—

- | | | |
|--|-------|---------------------------|
| (i) Gewa Working Circle in all felling series | .. | (a) Yield by area. |
| | | (b) Sequence of fellings. |
| (ii) Sundri Working Circle in all felling series | .. | (a) Yield by area. |
| | | (b) Sequence of fellings. |
| (iii) Keora Working Circle | .. .. | Yield by volume. |

For the purpose of controlling these prescriptions the standard Control Form A, AI, B and Deviation Statement should be submitted to the Conservator of Forests.

Miscellaneous felling series.

	Paragraph Number.
<i>The Yield</i> —The yield has been prescribed by area. Annual yield by volume has been calculated.	159
<i>Sequence of Felling</i> —Annual coupes upto 1979-80 have been prescribed ..	161
<i>Marking and Felling Rules</i> —Marking and felling rules have been prescribed	162
Sundri Working Circle.	
<i>Method of treatment</i> —Silvicultural system prescribed is selection-cum-improvement.	169
<i>Exploitable diameter limit</i> —The exploitable diameter limits vary with the quality of the locality and are as follows—	
Site Quality.	Exploitable diameter limit.
1 ..	11" dbh. class, <i>i.e.</i> , 10.6" and above.
2 ..	9" dbh. class and above, <i>i.e.</i> , 8.6" and above.
3 ..	7" dbh. class and above, <i>i.e.</i> , 6.6" and above.
<i>Felling Cycle</i> —Felling Cycle prescribed is 20 year	170
<i>Felling Series</i> —The working circle has been divided into five felling series, namely,—	
I Sarankhola Felling Series,	171
II Chandpai Felling Series,	
III Nalianala Felling Series,	
IV Burigoalini Felling Series,	
V Kandamtala Felling Series.	
<i>The Yield</i> —The yield has been prescribed by area. Estimated annual outturn from Sundri on the basis of total net merchantable volume of and above the exploitable diameter has been calculated.	172—173
<i>Marking and Felling Rules</i> —Marking rules, felling rules, rules for improvement felling and coupe rules have been prescribed.	174—176
<i>Sequence of Fellings</i> —Annual coupes upto 1979-80 in each felling series and cutting section have been prescribed.	177—185

Keora Working Circle.

<i>Method of treatment</i> —There are two distinct type of keora stand in the areas allocated in this Working Circle. Selection felling has been prescribed in pure Keora stand and clearfelling has been prescribed in stands where there is well established understorey of Sundri, Gewa or Goran.	192—194
--	---------

	Paragraph Number.
<i>The Yield</i> —The yield has been prescribed by volume. Calculated annual yield is fixed at 3,00,000 cft.	196—197
<i>Sequence of Fellings</i> —Sequence of fellings has been prescribed upto 1965-66	198
Miscellaneous Prescriptions.	
PASSUR, BAEN, DHUNDAL AND KANKRA	
Selection felling has been prescribed to these species in annual coupes prescribed for Sundri.	200
GORAN.	
Coupe and Felling rules have been prescribed for working of Goran within annual coupes prescribed in Sundri Working Circle.	202—204
GOLPATTA.	
Detailed rules for management of coupes and for felling within the coupes have been prescribed.	206—209
HONEY AND WAX.	
Collection of honey and wax will be by issue of permits. A floating sanctuary for bees has been prescribed.	210
Other Minor Produce 	211
Fishing 	212
Game Sanctuary 	213
Drift wood 	214
Felling for Departmental purpose 	215
Research and Experiment—	
Broad out line for research and Experiment needed during the period of the plan has been indicated.	216—221
Establishment and Labour Supply—	
Staff in all categories needed for carrying out the prescriptions of the plan have been prescribed.	225—226
Detailed distribution of the proposed staff has been given in Appendix XVIII.	
Control and maintenance of records—	
<i>Maps</i> —Maps prepared have been listed and maps that will be required to be maintained have been prescribed.	231—232
<i>Registered and Forms</i> —Registers and forms required to be maintained have been listed.	233
<i>Control Forms</i> —The prescriptions which are subject to control and control forms which are required to be prepared and submitted to the Conservator of Forests have been listed.	234